CUSH CREEK
COLDWATER CONSERVATION PLAN

Prepared by:

Western Pennsylvania Conservancy

water, land, life.

Watershed Conservation Program

Supported by:

Clearfield County Conservation District

Indiana County Conservation District

Ken Sink Chapter of Trout Unlimited

Coldwater Heritage Partnership

Contents

Introduction and Background

The Western Pennsylvania Conservancy (WPC) protects and restores exceptional places to provide our region with clean waters and healthy forests, wildlife and natural areas for the benefit of present and future generations. The Conservancy creates green spaces and gardens, contributing to the vitality of our cities and towns, and preserves Fallingwater, a symbol of people living in harmony with nature. WPC is working to improve our region's water quality. Through a number of strategic projects and initiatives - such as streambank restorations, in-stream habitat improvements and riparian plantings - our watershed conservation program works to protect and restore local rivers and streams. We're improving wildlife habitats, drinking-water sources and opportunities for recreation, while working to ensure that our waterways remain healthy and viable for generations to come.

This project was financed in part by a grant from the Coldwater Heritage Partnership on behalf of the PA Department of Conservation and Natural Resources (Environmental Stewardship Fund), the PA Fish and Boat Commission, the Foundation for Pennsylvania Watersheds, and the PA Council of Trout Unlimited.

This Coldwater Conservation Plan (CCP) for the Cush Creek Watershed reports on watershed assessment activities completed by WPC in 2021 & 2022. The objective of this plan is to summarize the methods and results of the assessment as well as identify and prioritize potential actions which may be taken to further conservation of the native & wild trout resources within the drainage.

Due to the onset of this project occurring during the COVID-19 pandemic, the initial public meeting for the project was foregone in favor of other methods of acquiring public input. Various other methods were employed to differing success; however, the support and participation of the Indiana County Conservation District and Ken Sink Chapter of Trout Unlimited contributed greatly to the effort.

Description of the Watershed

The Cush Creek watershed lies in northeastern Indiana County and southwestern Clearfield County (Figure 1). The watershed's headwaters form near the village of Hillsdale, Indiana County, and Cush Creek confluences with the West Branch of the Susquehanna River near the town of Burnside, Clearfield County. The watershed size is approximately 21 square miles, with almost 45 miles of streams draining the area. The mainstem of Cush Creek is 10 miles long. Major tributaries include Brady Run, Horton Run, South Branch Cush Creek and an unnamed tributary (UNT) known as the West Branch Cush Creek.

The Cush Creek watershed is largely rural. One small borough, Glen Campbell, has the densest population with development in Banks, Burnside, Grant and Montgomery townships being more dispersed. The 2020 census shows an overall decline in population from 2010, with the exception of Glen Campbell which increased slightly, Table 1.
Small villages cluster around homes and businesses, especially along PA Route 286 which bisects the watershed from south to north. These include Arcadia, Hillsdale and Gipsy. The route follows the direction of Cush Creek, which has the effect of concentrating development within the riparian areas of the stream in many locations.

TABLE 1 – POPULATION IN THE WATERSHED

Municipality	2020	2010	Percent Change
Banks Township	899	1,018	-11.7
Glen Campbell Borough	256	245	4.5
Grant Township	626	741	-15.5
Montgomery Township	1,430	1,568	-8.8
Burnside Township	1,055	1,076	-2.0

Census Tract 9601, which covers the northern portion of the watershed is identified as an Environmental Justice Area due to the high rate of population living below the poverty line. There is a small population of Amish in the watershed, who primarily operate farms for growing crops or raising animals. Additional farms are scattered throughout the watershed. The majority of the working population travels to nearby towns for employment or work for the few commercial/industrial facilities in the immediate area.

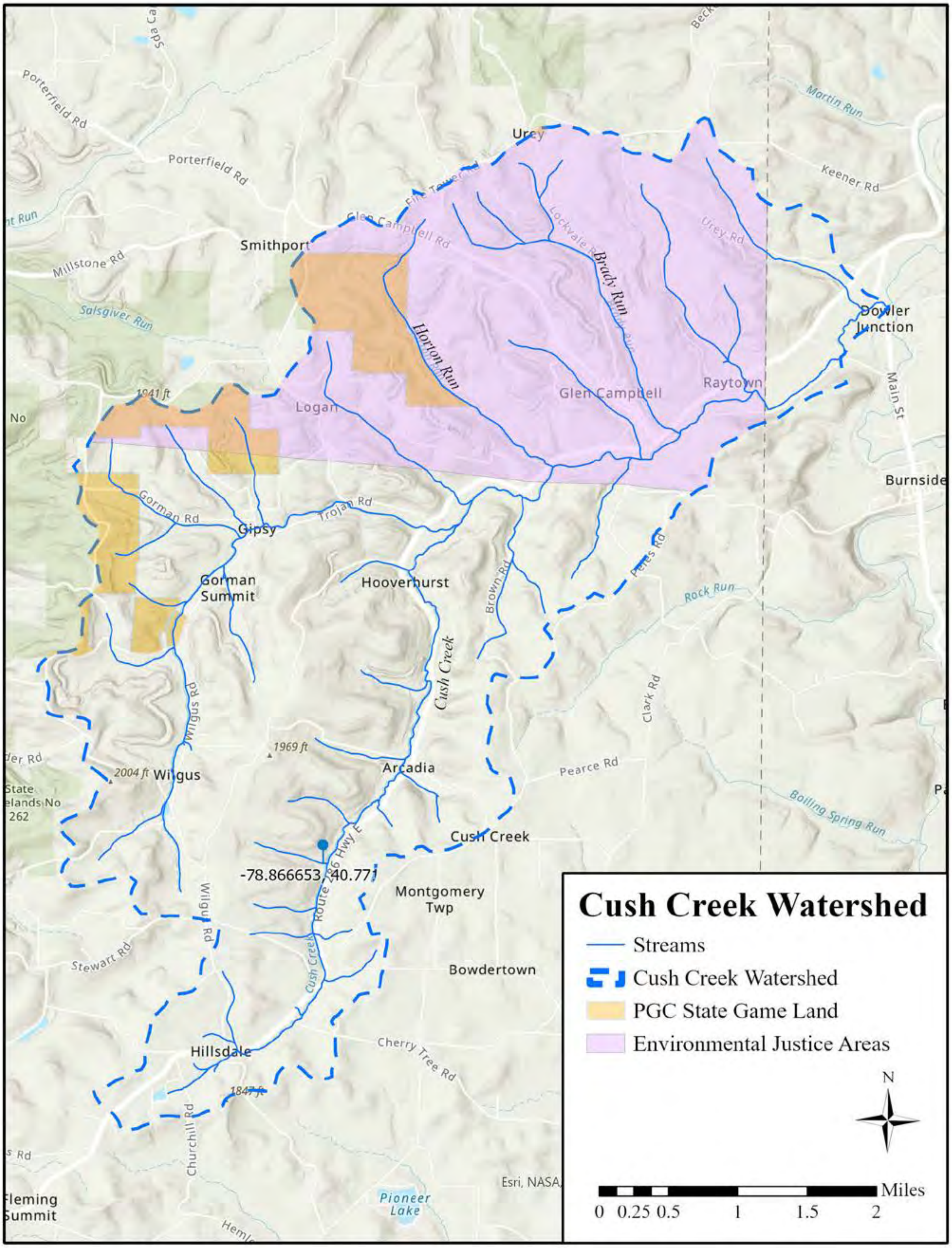

FIGURE 1 – CUSH CREEK WATERSHED LOCATION MAP

The primary impetus for the development of this project is the 6.7-mile segment of Cush Creek that has been designated by the PA Fish and Boat Commission (PFBC) as supporting a Class A population of wild brown trout (Figure 2). In addition, over 23 miles of streams in the watershed have been identified by the PFBC as supporting native and wild trout. This is significant in Indiana County, where there are not many streams that are healthy enough for Class A designation. From the bottom of the Class A section of Cush Creek, the mainstem is stocked with hatchery trout to the mouth.

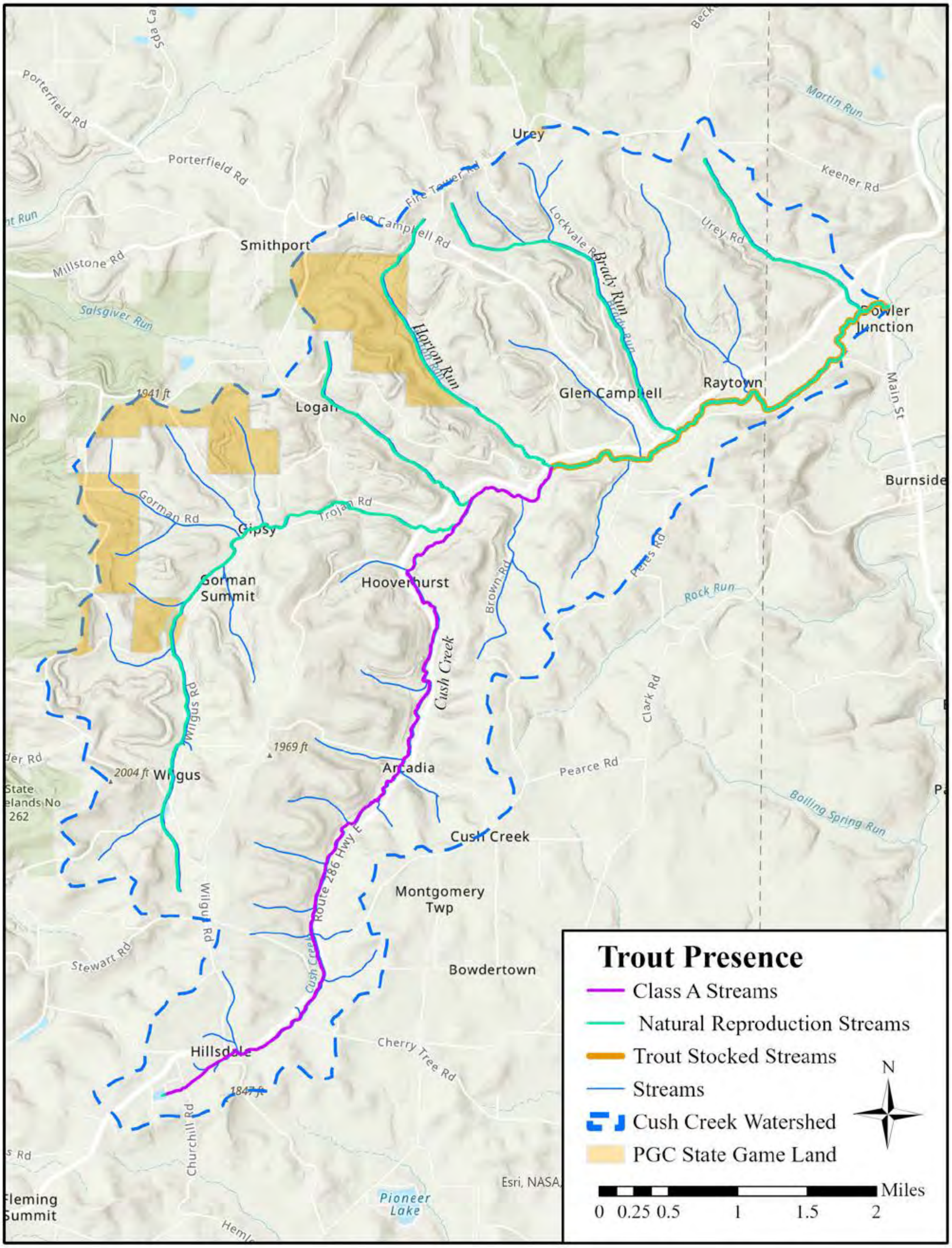

FIGURE 2 – TROUT PRESENCE AND BIOMASS

Land Cover & Land Use

As noted above, the majority of the Cush Creek watershed is rural. Forest and agricultural vegetation dominate the land cover types. Development in the form of buildings and roads are relatively low in coverage, but are often densely spaced within the stream corridors.

The land cover data represents land cover conditions as evident in NAIP (National Agriculture Imagery Program) imagery for the years 2013/2014 (Figure 3). This data was developed by analysts at Chesapeake Conservancy. Table 2 shows the acreage and overall percentage for land cover types in the watershed. Land use within the watershed can be interpolated from this data. Much of the land use is forest or agriculture.

TABLE 2 – LAND COVER IN THE WATERSHED

Land Cover Type	Percentage	Acres
Water	0.3%	38.91
Wetlands	0.1%	9.35
Tree Canopy	67.1%	9,179.03
Shrubland	1.3%	176.29
Low Vegetation	28.6%	3,908.77
Barren	0.7%	100.85
Structures	0.2%	32.73
Impervious Surfaces	1.7%	231.67
	100.0%	13,677.63

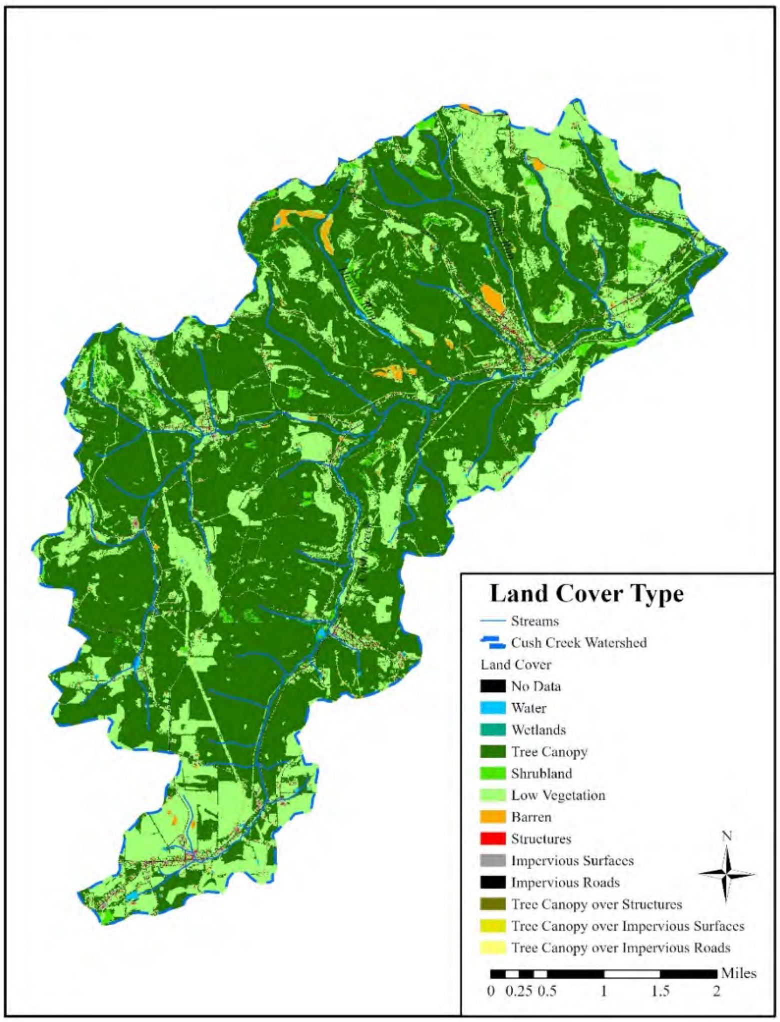

FIGURE 3 – LAND COVER

The vast majority of the watershed is privately owned, with only small tracts of State Game Lands in the headwaters of several small tributaries. This means the majority of the watershed is inaccessible for public fishing, including several reaches of the Trout Stocked mainstem.

DIRT & GRAVEL ROADS (DGR)

Roads and trails surfaced with dirt and/or gravel can provide an economical alternative to impervious surfacing materials like concrete or asphalt. They provide several environmental benefits as well: allowing stormwater to more readily infiltrate into the ground, slowing the flow of runoff, and, where limestone is used, they can help buffer the effects of acid precipitation. However, if improperly constructed or maintained, they can negatively impact the watersheds they traverse. Sediment that washes off DGRs quickly finds its way into streams, filling the interstitial spaces between cobble and gravel that provide habitat for fish and aquatic macroinvertebrates. These interstitial spaces are essential locations for spawning activities for fish, particularly trout, and are often used as colonization areas by a number of important macroinvertebrate taxa.

Cush Creek has 14,811.4 feet or 2.8 miles of dirt and gravel roads in the watershed. Many of these roads intersect with streams. During in-field assessments, dirt and gravel roads were noted when observed within each segment, as well as any obvious issues that may have been associated with them. These issues may have included stream fords, drainage ditches discharging high amounts of sediment to the stream, and changes in streambed substrate composition near the road-stream intersection.

Cush Creek Mainstem and its Tributaries

The mainstem of Cush Creek has been encroached upon throughout its reach. The headwaters of the stream fall within one of the most developed areas in the watershed, the village of Hillsdale. The source of Cush Creek flows out of a manmade pond. Residential development and its associated impacts encroach upon Cush Creek for more than a mile. Here Cush Creek has been channelized, deforested, and "cleaned out." The stream channel is significantly narrower than forested sections upstream and downstream of this reach. Bank erosion is prevalent and there is minimal, oftentimes no, riparian vegetation. Instream habitat is expected to be significantly degraded. Tributaries that enter Cush Creek here are subject to the same challenges, including one stream which has been confined to a long culvert pipe for several hundred feet. This area is also a concentration of agriculture, with row crops, hayland, horse pasture and dairy cattle all in close proximity to the waterway.

FIGURE 4 - HORSE PASTURE IN HEADWATERS

FIGURE 5 - GOOD HABITAT ON MAINSTEM CUSH CREEK

After this section, Cush Creek passes under PA 286. From that outlet, Cush Creek flows, relatively unimpeded for several miles, through a forested landscape. Utility lines parallel closely to the mainstem, degrading the riparian area and reducing canopy cover. The local sewage treatment plant also outlets along this reach. There are signs of active streambank erosion; however, these reaches of Cush Creek feature some of the best habitat in the entire watershed. A large beaver complex appears, with the mainstem spreading out across the open floodplain just before the stream crosses under Number 11 Road.

Cush Creek passes under a bridge in the village of Arcadia and signs of the watershed's coal mining legacy begin to appear. Spoil lined streambanks, the remnants of an old bridge, and a modified stream channel are evidence of the impact coal extraction has had upon these reaches. While the majority of abandoned mine lands are along the tributaries, six DEP Abandoned Mine Land Inventory (AMLI) polygons lie in close proximity to the mainstem. Cush Creek crosses back under PA 286 through this reach and will remain on the eastern side of the major route for the remainder of its course. It is here, downstream of Hooverhurst, where the larger tributaries to Cush Creek begin to enter the mainstem.

FIGURE 6 - COAL MINE BRIDGE ON CUSH CREEK DOWNSTREAM OF ARCADIA

First in order is Unnamed Tributary (UNT) 27115, usually referred to as the West Branch Cush Creek. The West Branch has a similar sized drainage area as the mainstem of Cush Creek at this point. The West branch and its tributaries are more forested than the upstream reaches of Cush Creek, however residential development and agriculture are still encroaching upon the streams, especially near the villages of Wilgus and Gipsy.

Horton Run enters Cush Creek soon afterwards. This stream is the only significant tributary to Cush Creek with public land as a bounding feature with state game lands along the western edge of Horton Run. Horton Run also has numerous AMLI polygons within its watershed, with features immediately adjacent to Horton Run on its eastern side. Much of the development through this reach is scattered, but often proximate to the mainstem. There is evidence of degradation from that development, discussed more in the visual assessment section.

FIGURE 7 - DAM ON MAINSTEM CUSH CREEK NEAR GLEN CAMPBELL

Glen Campbell is the next village through which Cush Creek flows, however the majority of development here is along UNT 27109 as Cush Creek sits removed from the village proper on the far side of PA 286. There are two low-head dams on main stem Cush Creek through this reach, resulting in definite barriers to aquatic organism passage. Brady Run enters soon after. This stream also carries evidence of historic mining in the upper parts of its watershed. The next stream, UNT 27102, has an active surface mine within its watershed, however there is not significant impairment evident. This stream and UNT 27101 are both identified as impaired by abandoned mine drainage.

At this point, Cush Creek is rather far removed from the road, however it sits in a broad valley, bound between the highway and an abandoned railroad grade. Cush Creek is noticeably straight next to the railroad grade, evidence suggesting channelization when the railroad was first constructed. It becomes more sinuous again when the railroad bed turns south and crosses under US 219 shortly before the confluence with the West Branch Susquehanna River.

FIGURE 8 - GOOD HABITAT NEAR CUSH CREEK MOUTH

Primary concerns from development, whether residential, commercial or agricultural are increased nutrient and sediment impacts to waterways. Of significance in the Cush Creek watershed is the impacts of sedimentation. Sediment threatens the food supply and habitat for the wild brown trout as well as the other fish communities. Silt and sediment fill in niche spaces, leaving limited macroinvertebrate habitat. Trout populations are dependent on a diverse macroinvertebrate population and this diversity is dependent on proper habitat, which includes a mix of gravel, cobble, boulders, fine woody debris and leaves. Without this habitat, both the fish and their food source will be limited in their abilities to survive. Because of the forested nature of portions of the watershed, there are stretches of quality habitat, but some reaches are not as well forested. This allows sediment from agricultural land, residential areas and dirt & gravel roads to move downstream through the watershed, covering otherwise suitable habitat.

All of the streams in the Cush Creek watershed are designated as a Coldwater Fishery (CWF). Portions of the stream are listed as natural reproduction with some even listed as class A natural reproduction. The Cush Creek Watershed: Trout Streams map (Figure 2) shows where the trout stocked, natural reproduction, and Class A sections are located within the watershed. There is overlap between the trout stocked sections of Cush Creek and its lower biomass natural reproduction sections. Cush Creek is not approved for stocked trout in its Class A section.

Previous and Current Studies/Analysis of the Watershed

Existing Information

Previous studies that have taken place within the Cush Creek watershed include Pennsylvania Natural Heritage Program (PNHP) inventories for Indiana and Clearfield Counties and PFBC electrofishing surveys, both of which focused on the biological resources of the area. There was also an analysis completed on riparian landowners within the watershed through a partnership project lead by the Pennsylvania Department of Conservation and Natural Resources (DCNR) known as Prime Prospects. Additionally, the Susquehanna River Basin Commission (SRBC) and the Pennsylvania Department of Protection (DEP) have collected data on mining activity and abandoned mine drainage for the watershed. Each of these data discussed in further detail below.

The PFBC has completed five stream surveys on mainstem Cush Creek between 1931 and 2017. The 1931 survey found Cush Creek "badly polluted" with "sulphur water," (PFBC 1931). Interestingly, the 1931 report notes that there are no posted properties for the entire length of the mainstem. It also noted that the stream becomes polluted only one mile from its source. An assessment completed in 1968 to determine if the stream was suitable for stocking found some improvement, as the surveyors noted macroinvertebrates and some fish at the three locations they visited. The physical descriptions of the sites are similar to what WPC observed in the field during the completion of this plan. The result of this survey determined the stream was still not suitable for a trout fishery (PFBC, 1968). Significant improvements in water quality must have occurred between 1968 and 1985, when a stream survey was completed in anticipation of a coal mine opening in the watershed. This survey completed chemical, macroinvertebrate and fish sampling at six sites, two on Cush Creek with the additional surveys on unnamed tributaries, all of which entered Cush Creek from the left facing downstream. Chemical sampling found pH ranging from 6.4 to 7.3. The chemical data also showed a significant increase in aluminum between the upper and lower mainstem sites with UNT03 discharging 1,470 ug/l of aluminum. While high levels of aluminum and iron were found, the report notes that those measured were within the limits set forth by the Chapter 93 Water Quality Standards. Improvements were also noted in the macroinvertebrate community, as previously unobserved mayflies and stoneflies, which "represent relatively unpolluted aquatic systems" (PFBC, 1985). The study completed in 1986 and published in 1987 documented a Class A mixed brook and brown trout population on Cush Creek Section 01, from the headwaters to the confluence with Horton Run. The PFBC survey completed in 2016 confirmed those findings: Cush Creek continues to be a naturally reproducing trout stream with 4.7 miles of the stream supporting a Class A population of wild brown trout.

SRBC has evaluated the water quality of Cush Creek in multiple ways. For the *West Branch Susquehanna Subbasin Survey* (SRBC, 2003) SRBC collected chemical and biological samples and examined physical characteristics. The sampling site was located at the mouth of Chest Creek, in the same area as WPC's Cush-1 monitoring site. The SRBC sampling found mid-level quality, as it slightly exceeded the standard for aluminum concentrations. The macroinvertebrate population was also slightly impaired and instream habitat in the immediate area was marginal. SRBC's *AMD Restoration Strategy* (SRBC, 2008) notes that historically, Cush Creek was polluted by AMD. The report notes that there are four AMD discharges in the watershed, however their impact is relatively minor in comparison to neighboring streams. Forty-nine acres of abandoned mine lands were reported in the watershed.

Information from these studies helped direct data collection for the Cush Creek CCP. This includes utilizing those studies in planning for the locations of the water quality surveys, instream habitat assessment and additional field work. Descriptions of the field data collection parameters are listed in an Overview subsection and the results of the work will be summarized following the overview. Components of the results will also be discussed throughout this document.

Assessment and Monitoring

Visual Assessment Overview

In order to record current habitat conditions, a modified visual habitat assessment was conducted throughout the watershed. This was done by walking along the stream as much as possible. In an effort to create comparable data, the stream was broken into reaches based on confluence points. For example, the point where Cush Creek joins with the West Branch Susquehanna River to the point where the first un-named tributary joins with Cush Creek mainstem is a segment. The data collected for each segment was based off of a modified version of the US Environmental Protection Agency's (USEPA's) Rapid Bioassessment Protocol for Streams and Wadeable Rivers. The EPA protocol assigns a numeric value to ten different stream characteristics, or "assessment elements," equating to overall stream quality. The assigned assessment scores range from zero to twenty, with twenty being the highest in quality, and are based on specific conditions associated with each assessment element. An example of the assessment sheets used in the field can be found in the appendices (appendix 1 and 2). The ten individual assessment scores for each segment were totaled and averaged to yield an overall habitat assessment score. This average score was then broken into four categories: optimal, with an average score ranging between 16-20, suboptimal, with an average score ranging between 11-15, marginal, with an average score ranging between 6-10, and poor, with an average score ranging between 0-5. To help identify on which side of the stream pollution sources are located, a designation of "river right" or "river left" is used, which is the standard practice used by the American Canoe Association when describing locations on a stream. These directions are given in relationship to the observer always facing downstream. In this way, the repetition of north, south, east, and west directions are minimized as streams are constantly shifting the direction in which they flow.

Visual Assessment Efforts and Results

With these four scoring categories as a reference (Table 3), the Cush Creek Watershed Visual Assessment map (Figure 9) was developed based on the overall score for each assessed segment.

There are 45 miles of stream in the Cush Creek watershed, which break down into 86 individual reaches based on the habitat assessment protocol. Unfortunately, public access to Cush Creek is extremely limited, even on the mainstem. During the course of this project, WPC staff walked the mainstem of Cush Creek and the majority of the South Branch Cush Creek. The scores for the assessments are shown in Figure 9.

TABLE 3 – VISUAL ASSESSMENT SCORING RANGES

Habitat Assessment Ranking	
Optimal	*average score ranges between 16-20*
Suboptimal	*average score ranges between 11-15*
Marginal	*average score ranges between 6-10*
Poor	*average score ranges between 0-5*

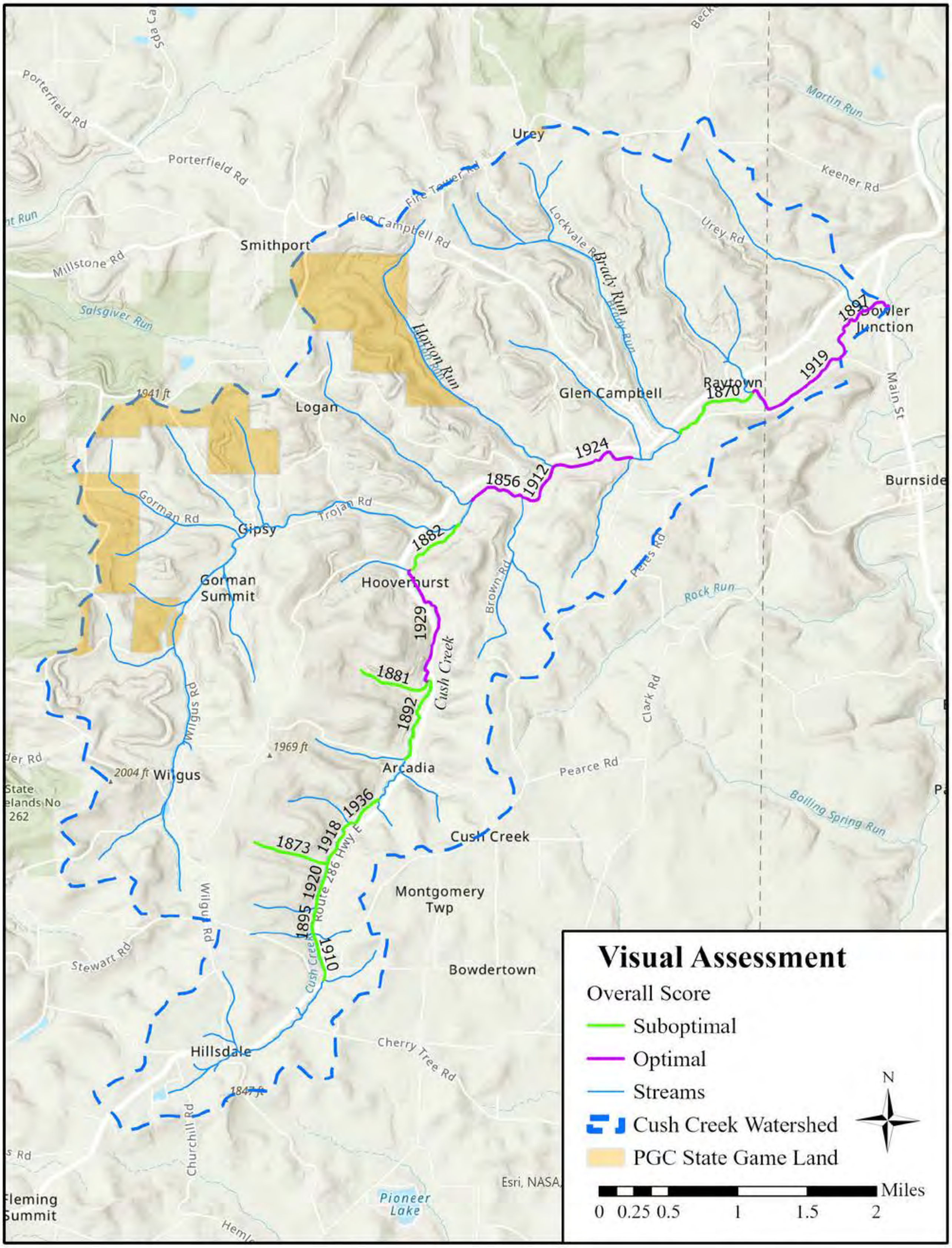

Figure 9 – Visual Assessment results

Additional reaches that were inaccessible due to being private/posted property, were assessed in part, based upon "windshield surveys" from adjacent roadways. The primary use for these assessments is to identify potential best management practice locations and incompatible land use.

Visual assessment scores for the 14 reaches of Cush Creek mainstem and South Branch were split between Optimal and Suboptimal, with Total Scores ranging from 12.7 to 17.8. Within specific characteristics being assessed, Suboptimal scores were more prevalent in the Sediment Deposition, Channel Alteration, Bank Stability and Riparian Vegetation Width categories. Even so, there were very few characteristics which scored as Marginal. One segment of mainstem Cush Creek suffered from issues related to Channel Alteration significant enough to be considered marginal. Overall the Visual Assessment results depict a watershed in fairly good condition, but in need of targeted improvements to ensure the aquatic resources can continue to thrive.

The largest benefit of the Visual Assessment was the opportunity to walk the mainstem of Cush Creek and identify specific locations were restoration projects could occur. During this process WPC documented multiple low head dams on mainstem Cush Creek, previous attempts at improving fish habitat in need of repair, and large beaver pond complexes. More than 60 georeferenced photographs were taken during the completion of the Visual Assessment. These photos include reference points of good habitat as well as photos of potential project sites. Types of projects identified include Abandoned Mine Land Reclamation, Culvert Replacement, Riparian Buffer Planting and Stream Bank Stabilization. More discussion of sites and restoration approaches can be found in the Recommendations section of this plan.

Water Quality Overview

Knowing about the existing water quality conditions throughout various sites in the watershed will help with the overall evaluation of the Cush Creek watershed. Having data points at different locations, high and low in the watershed, will also help determine where problems may be coming from or reconfirm that a section is staying in good condition. There are expected differences in data between spring and fall collection seasons, but having information from both time periods is valuable for future evaluation and conservation efforts. The following information provides descriptions about the water quality parameters that were analyzed for the project.

Temperature and Dissolved Oxygen

- **Temperature** influences dissolved oxygen levels, rate of photosynthesis by aquatic plants, metabolic rates of aquatic organisms, and sensitivity of organisms to toxins, parasites, and diseases. Temperature can be controlled by the amount of vegetative cover along stream banks, sediment levels, and waste distribution into a stream.
- **Dissolved oxygen** concentration in a stream is the mass of oxygen gas present, in milligrams per liter of water. A healthy stream is considered to be 90-100 % saturated with oxygen.

pH and Alkalinity

- **pH** is a measurement of how acidic or basic water is. Acidic water (less than 7.0) or basic water (greater than 7.0) has the ability to impair aquatic life. Most aquatic organisms are able to tolerate small fluctuations in this parameter but as a general rule of thumb, a pH of less than 6.0 or greater than 8.0 will affect aquatic communities.
- ***Alkalinity*** measures the buffering capacity of a stream, referring to how well it can neutralize acidic pollution or resists abrupt changes in pH.

Conductivity and Total Dissolved Solids

- **Conductivity** is a measure of the ability of water to pass an electrical current. Conductivity in streams and rivers is affected primarily by the geology of the area through which the water flows.
- **Total dissolved solids** in stream water consist of calcium, chlorides, nitrate, phosphorus, iron, sulfur, and other particles. If a stream has too much dissolved solids it will negatively impact stream communities (high values for this parameter depend on variety of factors but will typically be over 500 ppm).

Water Quality Sampling Effort and Results

WPC staff completed in-field water quality sampling several times over the course of this project. Sites were chosen based on location within the watershed in an effort to provide the best overall view of the conditions throughout the watershed.

Ten sampling sites were selected: four on Cush Creek mainstem and six on major tributaries (Figure 10). Tributary sites were sampled on UNT 27101, UNT 27102, Brady Run, Horton Run, UNT 27114 and UNT 27115 (West Branch Cush Creek), listed in order from closest to the mouth of Cush Creek to the headwaters. Sites were sampled in October and November 2021.

The data for all the monitoring sites was reviewed and summarized. Table 4 lists the data information that was collected on water quality. Much of the information showed expected trends and water quality fluctuations, but there were some areas where results varied. Some of these variations can be explained through weather events and other knowns about the surrounding area; however, there are some areas where without further monitoring, an explanation about the results cannot be done with any amount of certainty. Future efforts should include continued analysis of the current data while expanding the dataset through more monitoring.

FIGURE 10 – WATER QUALITY SITES

TABLE 4 - WATER QUALITY SAMPLING RESULTS

Site Name	Date	pH	Water Temperature	Dissolved Oxygen	Conductivity	TDS	Alkalinity
Cush-1	10/21/2021	7.19	10.9	10.51	414	276	58
Cush-1	11/17/2021	7.08	3.5	13.28	346	246	71
Cush-2	10/21/2021	7.5	10.6	11.2	333	237	62
Cush-2	11/17/2021	6.38	3.8	13.57	272	194	52
Cush-3	10/21/2021	7.51	9.8	10.97	331	238	58
Cush-3	11/17/2021	6.85	4.1	13.46	263	187	52
Cush-4	10/21/2021	7.23	10.1	10.86	388	275	89
Cush-4	11/17/2021	7.32	5.5	13.21	320	227	85
Brady-1	10/21/2021	7.24	10.7	10.71	422	299	28
Brady-1	11/17/2021	6.06	4.4	13.11	332	236	10
CushUNT-27101	10/21/2021	6.98	10.5	10.99	818	570	68
CushUNT-27101	11/17/2021	7.68	4	13.2	766	564	50
CushUNT-27102	10/21/2021	5.52	10.9	10.75	640	455	19
CushUNT-27102	11/17/2021	5.63	4.4	13.22	608	419	25
CushUNT-27114	10/21/2021	7.43	10.1	11.13	313	222	36
CushUNT-27114	11/17/2021	6.95	6.7	12.5	259	184	36
Hor-1	10/21/2021	7.49	10.2	11.11	359	254	40
Hor-1	11/17/2021	6.82	4.6	13.24	339	201	35
WBCush-1	10/21/2021	7.43	10.1	11.11	298	211	38
WBCush-1	11/17/2021	6.99	13.16	5.1	238	167	46

Seventeen stream segments are listed by the DEP's Integrated List as Impaired. This includes 1.6 miles of mainstem Cush Creek, 4.3 miles of Brady Run and its tributaries, and 4.25 miles from two unnamed tributaries. The impaired unnamed tributaries were UNT-27101 and UNT-27102, which were also sampled by WPC for this plan. Those sites had significantly higher results for Conductivity and TDS than other sites sampled. Even though they are listed as impaired, both Brady Run and UNT-27101 have been identified by the PFBC as supporting naturally reproducing trout populations.

Fish Survey Overview

In an effort to document current conditions in the Cush Creek watershed, WPC staff conducted five electrofishing surveys in May 2022. All sites were located on small unnamed tributaries to Cush Creek, which ranged in size from 0.8 m – 1.6 m in wetted width. WPC staff conducted all surveys following the PFBC Unassessed Waters sampling protocol, which requires minimum site lengths and water quality parameters to be measured before surveys are completed by trained staff. Three of the streams that we sampled were dry, which included UNT 27133, UNT 27137, and UNT 27136 to Cush Creek.

The other two streams sampled, UNT 27134 and UNT 27135 both had good water quality results including high levels of dissolved oxygen, low conductivity and total dissolved solids values, and excellent pH and alkalinity readings for a stream in the West Branch of the Susquehanna River watershed. The survey conducted on UNT 27135 to Cush Creek resulted in no fish collected in a 100 m reach of habitat sampled. Water quality values at this site were normal; WPC staff indicated that a lack of suitable fish habitat could be responsible for no fish being collected during the survey. UNT 27134 to Cush Creek contained four species of fish including Creek Chub, Slimy Sculpin, Blacknose Dace and a single wild Brown trout (Figure 11) which measured 162 mm (6.4 inches). The survey was extended from 100 m to 144 m in an effort to collect additional trout, but none were collected. Overall, the fish community that was identified in the Cush Creek watershed was average with no native Brook Trout identified during our survey efforts.

In addition to the historic fish surveys of Cush Creek completed by the PFBC prior to this plan, several tributaries have been surveyed in recent years. Those surveys documented mixed brook & brown trout populations in five streams and low-density brook trout populations in two streams. Horton Run is noteworthy within these survey results as it held a significant population of native brook trout and it's one of the few tributaries in the watershed flowing through public land. The total length of Horton Run is 2.4 miles; 1.2 miles of the stream lie adjacent to State Game Lands 262. This makes this reach of Horton Run a good opportunity for continued monitoring and habitat improvement, securing and enhancing the native brook trout population.

FIGURE 11 - WILD BROWN TROUT CAPTURED DURING ELECTROFISHING

Aquatic Organism Passage (AOP) Overview

Stream connectivity is important for all aquatic species, but especially important for salmonid species in a number of ways including access to thermal refuge, access to important spawning habitat, and for eliminating genetic isolation of populations. However, poor design of culverts and bridges (road-stream intersections) can negatively affect stream connectivity. Culverts can act as barriers to fish passage in a number of ways. A culvert can be perched above the stream bed, causing fish to have to jump large heights. Aquatic organisms have varying levels of mobility and passable culverts are essential for a connected ecosystem. High current velocities in culverts can make it impossible for organisms to move through them. Water depth within the culvert can be too shallow, or may not provide resting areas for organisms that are migrating upstream. In fact, properly designed and installed culverts also benefit other aquatic species that are less mobile than trout including mussels, hellbenders, other amphibians, reptiles and macroinvertebrates. Poorly designed and/or installed culverts also pose problems for stormwater runoff, infrastructure maintenance and public safety in the event of flooding. Often, an undersized culvert creates a blowout effect downstream, increasing water velocities and streambank erosion. A plugged culvert that cannot pass debris also acts as a dam during high water events, exacerbating flooding and becoming a public safety hazard.

The North Atlantic Aquatic Connectivity Collaborative (NAACC) is a collaboration of individuals from universities, conservation organizations, and state and federal natural resource and transportation departments focused on improving aquatic connectivity across a thirteen-state region, from Maine to West Virginia. NAACC has developed standardized protocols and training for assessing road-stream crossings (culverts and bridges) and developed a regional database for this field data. The information collected can be used to identify high priority bridges and culverts for upgrade and replacement. All field survey data was collected using the NAACC Stream Crossing Survey Data Form Instruction Guide (NAACC 2016). Data was collected on a Getac 600 tablet and uploaded into the NAACC online database. All data was checked for quality assurance by WPC's L1 Coordinator. Upon entry into the database, all crossings are automatically scored using two scoring systems.

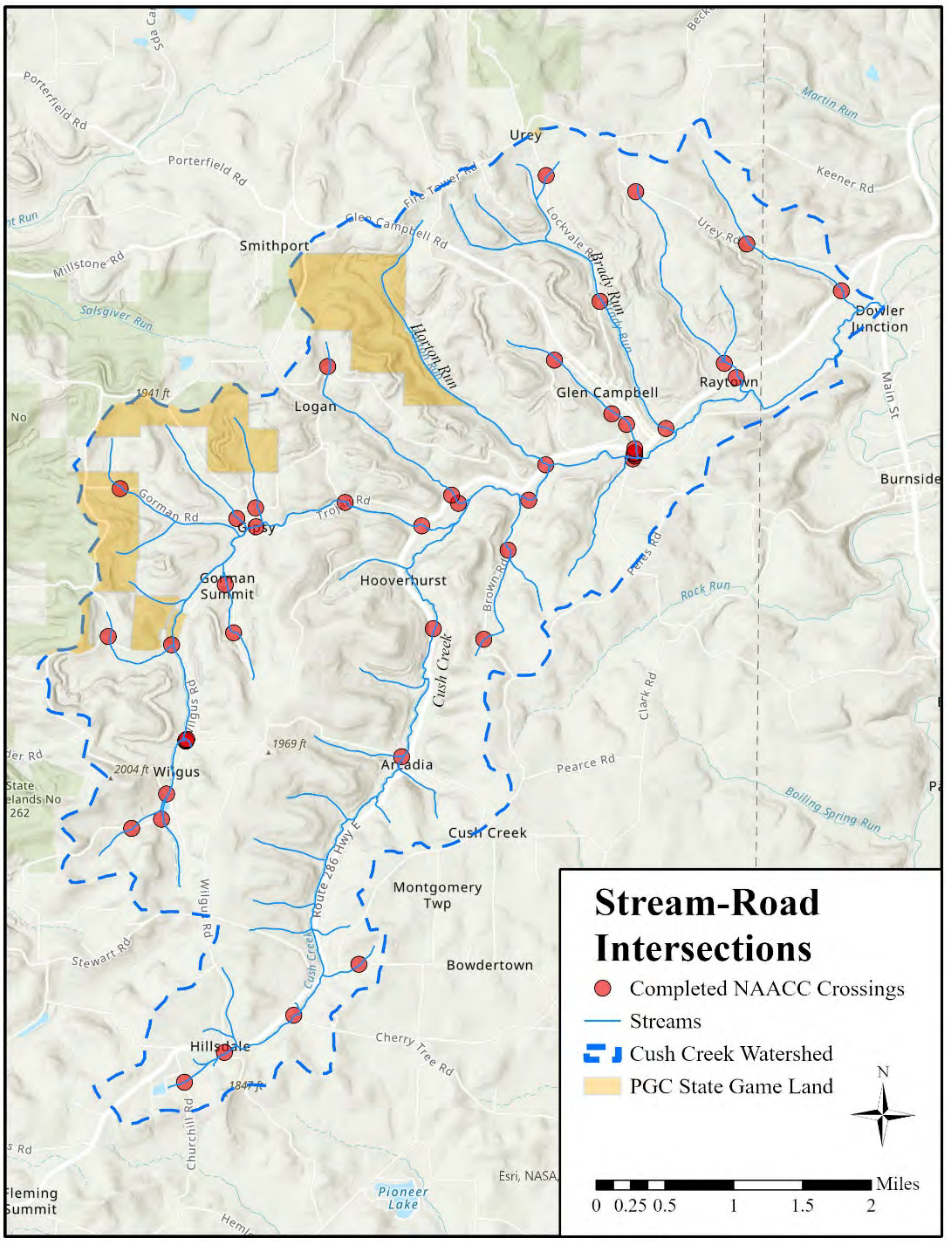

FIGURE 12 – ASSESSED CROSSINGS

Aquatic Organism Passage Assessment Results

A total of 42 road-stream intersections were evaluated for the Cush Creek CHP (Figure 12). Structures were scored using the NAACC protocol as referenced above. Only crossings that were located on public roadways were scored during the surveys. Structure types assessed included single culverts, box culverts, multiple pipe culverts, and bridges. Examples of these structure types can be found in the NAACC Stream Crossing Survey Data Form Instruction Guide available online (NAACC 2016). Numerous crossings that were assessed failed to provide adequate fish passage, which resulted in reduced or no-AOP rankings for 67% of all crossings surveyed. Many of the crossings that had a ranking of full AOP were large bridge structures often associated with main roads. This process has resulted in numerous crossings which would be priorities for replacement. The sixteen crossings in Table 5 are the worst barriers to AOP and would be worthwhile to evaluate further as restoration projects.

Table 5 - AOP Assessment Results

Survey ID	Crossing Type	AOP Score	Barrier Evaluation	Lat.	Long.	Road Name	Stream Name
81786	Culvert	No AOP	Severe barrier	40.82377	-78.8665	Spotts Rd	UNT to Cush Creek
81730	Culvert	No AOP	Severe barrier	40.79563	-78.8792	Lucas Rd	UNT to Cush Creek
81725	Culvert	No AOP	Significant barrier	40.77592	-78.8889	Blose Rd	UNT to Cush Creek
81723	Culvert	No AOP	Significant barrier	40.7952	-78.8445	Brown Rd	UNT to Cush Creek
81778	Culvert	No AOP	Moderate barrier	40.83711	-78.8085	Urey Rd	UNT to Cush Creek
81722	Culvert	No AOP	Moderate barrier	40.8046	-78.8412	Brown Rd	UNT to Cush Creek
81774	Culvert	No AOP	Moderate barrier	40.8245	-78.8115	Brink Rd	UNT to Cush Creek
81770	Culvert	No AOP	Moderate barrier	40.74881	-78.8853	Churchill Rd	Cush Creek
81790	Culvert	Reduced AOP	Moderate barrier	40.81804	-78.8249	1st Ave	UNT to Cush Creek
81718	Culvert	Reduced AOP	Moderate barrier	40.80767	-78.8789	Gorman Rd	UNT to Cush Creek
81729	Multiple Culvert	Reduced AOP	Moderate barrier	40.8007	-78.8804	Gipsy Rd	UNT to Cush Creek
81726	Culvert	Reduced AOP	Moderate barrier	40.77493	-78.893	Blose Rd	UNT to Cush Creek
81782	Multiple Culvert	No AOP	Moderate barrier	40.75531	-78.8703	Cherry Tree Rd	Cush Creek
81721	Multiple Culvert	No AOP	Moderate barrier	40.80992	-78.8385	Brown Rd	Cush Creek
81775	Culvert	Reduced AOP	Moderate barrier	40.82304	-78.8098	PA 286	UNT to Cush Creek
81717	Culvert	Reduced AOP	Moderate barrier	40.81071	-78.8951	Gorman Rd	UNT to Cush Creek

The AOP Score in the above table represents a coarse screening of AOP results. The primary objective of the coarse screen is to identify those crossings that are likely to be a barrier to most or all species and those that are likely to provide something close to full aquatic organism passage (Figure 13). If it is necessary to get a better feel for how bad those crossings are that are labeled as "reduced AOP" one can use the numeric scoring system, translated into the Barrier Evaluation column in the table.

FIGURE 13 - A MULTI PIPE CROSSING ON CUSH CREEK IS A SIGNIFICANT BARRIER TO AOP

Factors impacting the Barrier Evaluation score of an AOP structure include the position of the structure relative to the stream grade, physical barriers within the culvert, constriction of the natural stream channel, the depth and velocity of the water through the crossing and the presence of natural stream substrate within the structure. Specifically, the grade of the structure refers to the inlet and the outlet of the culvert as a perched or dropped inlet or outlet can significantly reduce the ability of aquatic organism to pass through. Channel constriction and the directly related water depth/velocity present challenges for fish movement upstream during high flows. Constricted crossings also often cause significant erosion, often referred to as the "fire hose effect" notable by an oversized pool at the outlet of the culvert caused by excessive erosion.

Figure 14 shows the Barrier Evaluation score for the crossings assessed in Cush Creek. Referencing the Survey ID, further information on each crossing can be found on the NAACC website (http://naacc.org).

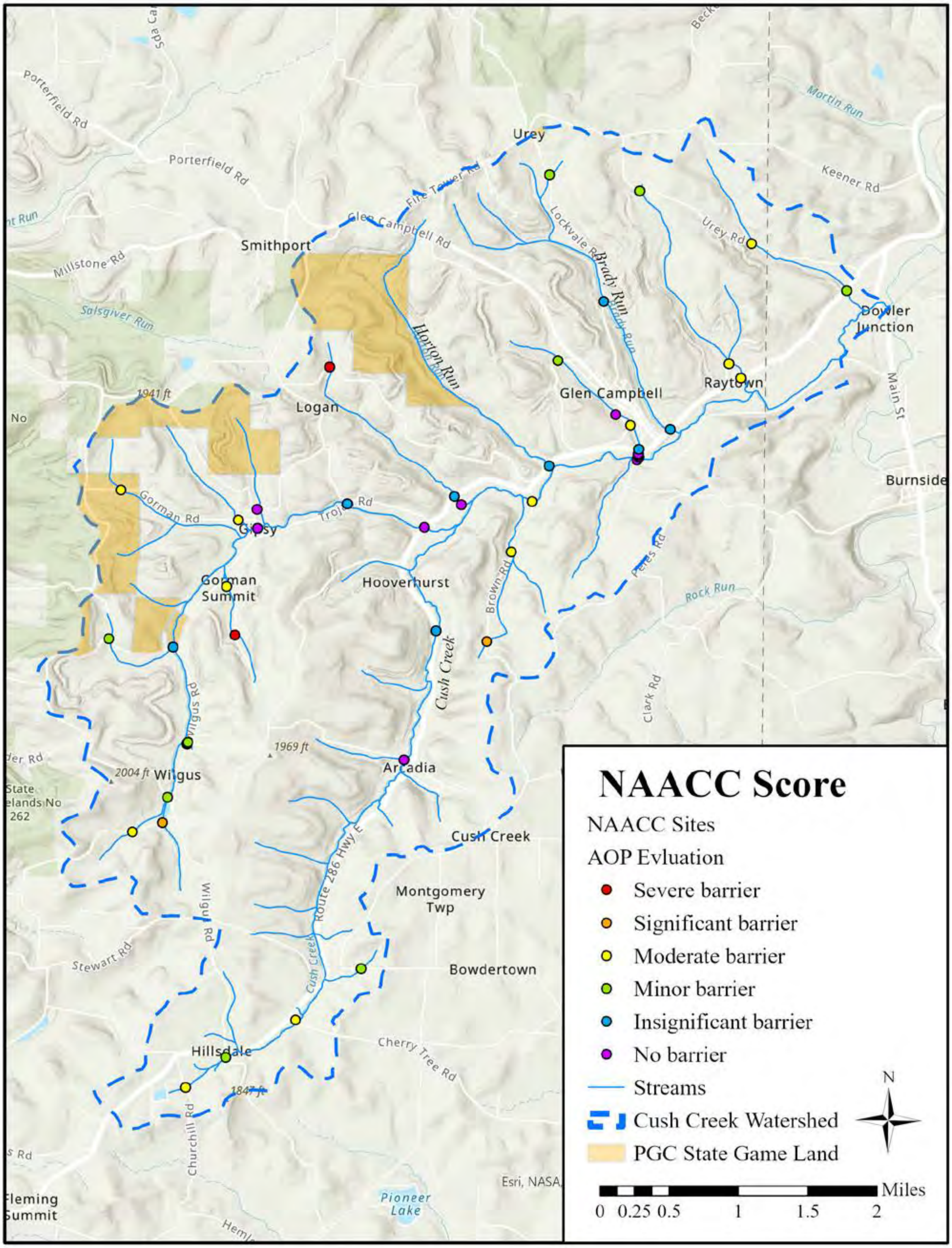

FIGURE 14 – AOP EVALUATION

Additional concerns with aquatic organism passage lie in the dams that bisect the mainstem of Cush Creek, greatly reducing and possibly eliminating movement for all but the most robust species. Another dam, while no longer standing constricts Cush Creek through some of its best habitat (Figure 15).

FIGURE 15 - OLD DAM ON CUSH CREEK WHICH CONSTRICTS THE STREAM

Riparian Buffer Restoration Opportunities

Overview

Significant research suggests that there are many long-term benefits from forested riparian buffers including protection from accelerated erosion, protection from pollutants and nutrients entering streams, creation of wildlife habitat, cooler stream temperatures and improvement of overall water quality through natural filtration. Forested buffers also help alleviate downstream flooding problems.

FIGURE 16 – MINIMAL RIPARIAN VEGETATION IN CUSH CREEK HEADWATERS

The establishment of forested riparian buffers is an essential component of water quality protection and the planting of trees in un-forested streamside areas is a recommended BMP for the Cush creek watershed. The establishment of native trees and shrubs along waterways is critical for the control of sedimentation and erosion, as well as being important habitat for both aquatic and terrestrial wildlife. WPC utilized several methods to determine opportunities for riparian buffer outreach. That data on buffer gaps can, such as the open area shown in Figure 16 can be referenced for riparian restoration.

Prime Prospects Analysis

Information geared towards nutrient reduction of waters that flow into the Chesapeake Bay has been developed for the Cush Creek watershed due to its location in the Chesapeake Bay drainage. This data is part of a Department of Conservation and Natural Resources (DCNR) partnership project known as Prime Prospects. The “Prime Prospects” landowners were found through the combination of data mining public consumer reports and mapping tracts of land with open riparian areas. The results of the data mining and mapping were compared to conservation efforts of individuals who have already installed riparian buffer plantings with similar data mining results. These comparisons lead to a list of landowners that can be ranked from highest to lowest likelihood of installing a riparian planting on their property.

WPC consulted with DCNR on the Prime Prospect data for Cush Creek and its tributaries, who generated a list of riparian landowners within in the watershed. There is a total of 46 Prime Prospect parcel owners. Ten properties had riparian buffer gaps greater than one acre. The total acreage that could be generated by planting those properties equals more than nine acres, however the average buffer size is 0.23 acres. Due to the average small size of the plantings, significant landowner buy-in throughout the watershed would be needed for measurable impact. Those landowners identified as Prime Prospects will be sent an informative postcard about riparian buffers. This postcard will encourage the landowners to contact WPC to discuss a potential project on their property. One weakness of this data is that it is unable to calculate data for commercially held parcels. There are multiple parcels in the watershed owned by oil & gas companies who may be open to BMPs on their lands.

WPC Buffer Opportunity Analysis

Through a National Fish and Wildlife Foundation grant, WPC has been identifying and outreaching riparian buffer restoration to landowners in the Upper West Branch watershed. As an alternative to the Prime Prospects data, WPC completed a GIS analysis to evaluate riparian buffer restoration opportunities in Cambria, Clearfield and Indiana counties. This project utilized the Chesapeake Conservancy’s high-resolution land cover data, extracted within 100 feet on either side of a stream to determine the amount of non-forested land that could be open for riparian buffer restoration. The results of that process were intersected with county level parcel data, allowing the results to be targeted towards specific landowners with the best opportunities in terms of restorable acres. Those results are shown on Figure 17. Additional information on the GIS analysis is attached to this plan as Appendix 4.

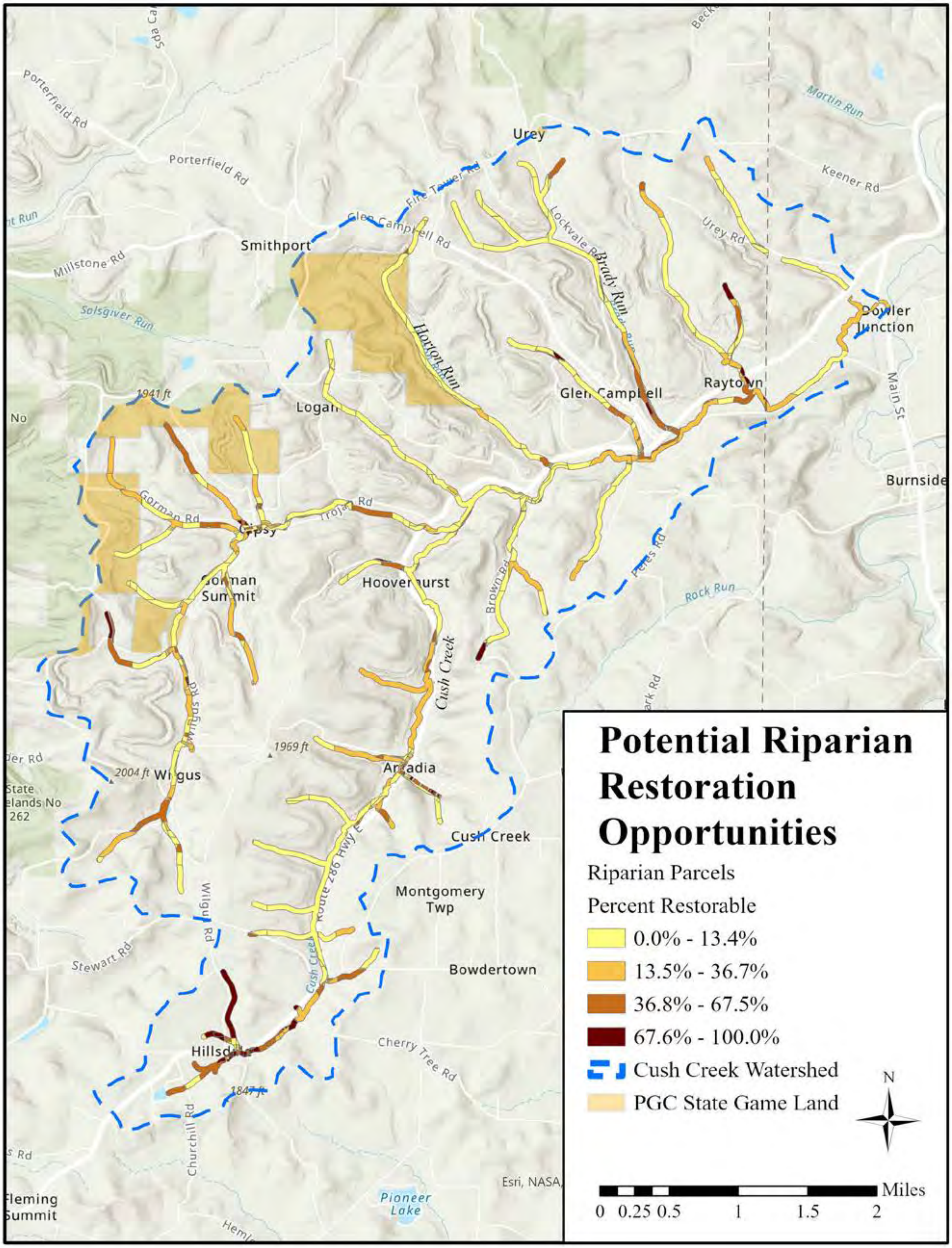

Figure 17 – Riparian Opportunity Areas

Unique and Outstanding Values in the Watershed

Cush Creek is home to one of the only Class A trout populations in Indiana County and most certainly one of the few comprised primarily of wild brown trout. The presence of these trout is due largely to the cold water that flows through forested reaches of the mainstem and its tributaries, despite substantial habitat degradation throughout the watershed.

The section of Horton Run which abuts State Game Lands 262 holds a Class C population of native brook trout. This is the only reach in the watershed were native trout are more prevalent than wild trout.

The PNHP County Inventory for Indiana County denotes a Natural Heritage Area nearby to the village of Glen Campbell, indicating a community of important ecological value. The specifics of the site are not public. More info from the PNHP states the species of concern was not named at the request of the jurisdictional agency overseeing its protection. The Inventory notes the species prefers early successional grasslands and shrublands and that efforts should be made to retain and enhance those habitats.

Areas of Concern and Opportunity

Cush Creek has both concentrations of high-quality habitat and degraded habitat. Currently, the scales are tipped in favor of supporting the wild trout populations in the watershed. Best management practices that work towards securing those populations should be implemented for long term resilience.

Climate change and its associated impacts are likely to impact native and wild trout and their habitat in a number of ways. Warmer temperatures and lower summer flows will increase stream temperatures and reduce habitat suitable for trout. More intense storm events could increase the rates of erosion and sedimentation, which can significantly alter stream channels. Excessive sedimentation can also reduce the aquatic insect community, fill in spawning gravel with fine sediments and form large bars and blockages which inhibit fish movement. Higher flows in the winter will scour stream beds, but also carry the added impact of destroying trout spawning redds, decreasing reproductive success. This will have an even greater impact on those populations that are on the cusp of recovery or at risk of decline.

Residential development, even in low concentrations and agricultural practices that alter the stream channel or riparian areas have negative impacts to aquatic ecosystems. This type of land use is most prevalent in the headwaters of Cush Creek, but occurs throughout the watershed. Impacts such as increased stream temperatures and erosion & sedimentation are carried through the tributaries to the mainstem. Many operators are resistant to changing their methods, especially at a time when operational expenses often outweigh profits. Additionally, they may be averse to working with agencies or accepting government funding. Partnering with non-profit organizations to leverage funding and working with conservation minded operators will be necessary to develop a concerted effort towards implementing agricultural best management practices in the watershed.

The lack of permissible public access to the mainstem of Cush Creek and the vast majority of its tributaries poses a problem for restoration efforts. While most funding sources do not require public access for implementation projects, many funders consider the overall value to recreational fishing in their decision making. Public access is also crucial in engaging local sportsmen's groups or Trout Unlimited chapters.

Recommendations and Next Steps

This Coldwater Conservation Plan has identified a number of areas for partners seeking to implement restoration projects in the Cush Creek watershed. The completion of visual habitat assessment, aquatic organism passage evaluation and GIS analysis provide valuable information for focusing those efforts. WPC offers the following recommendations for future potential project implementation:

Project(s)	Issue Addressed	Partners
Landowner Outreach and Engagement for Public Access	**Work with PFBC and/or WPC easement experts to determine eligibility and incentive opportunities for landowners to open their properties for public fishing and/or restoration projects.**	**CCCD, ICCD, KSTU, PFBC, WPC**
Instream habitat improvement (including large woody material additions)	**Focus will be on identified reaches lacking deep pool habitat and minimal natural debris accumulation**	**CCCD, ICCD, KSTU, PFBC, PGC, WPC**
Culvert replacement projects	**Utilize NAACC evaluation results to strategically replace inadequate culverts**	**Townships, CCCD, ICCD, KSTU, WPC**
Dam Removal Projects	**Identify owners and function of existing dams on Cush Creek and determine if they can be removed**	**American Rivers, CCCD, ICCD. KSTU, WPC**
Public dirt and gravel road improvements	**Improve dirt and gravel roads and crossings contributing sediment to the streams**	**Townships, CCCD, ICCD, KSTU, WPC**
Access road improvements	**Evaluate access roads and partner with PGC and/or companies maintaining oil & gas wells**	**ICCD, KSTU, PGC, WPC, private landowners, resource companies**
Agricultural Best Management Practices	**Work with landowners/operators along Cush Creek and its tributaries to implement sediment and nutrient reduction BMPs (including installation of riparian buffers)**	**CCCD, ICCD, NRCS, KSTU, WPC, private landowners**
Abandoned Mine Restoration	**Address remaining AMD inputs and debris piles impacting the South Branch watershed**	**CCCD, ICCD, KSTU, SRBC, WPC**
Aquatic resource identification & monitoring	**Continue to monitor water quality and fisheries of Cush Creek, potentially including long term monitoring sites, trout redd surveys and additional electrofishing surveys of tributaries**	**CCCD, ICCD, IUP, KSTU, SRBC, WPC**

Conservation Partners and Potential Funding Sources

The following list is the names of possible conservation partners and/or potential funding sources *(list is not comprehensive and other public and private partners and sources may be applicable)* for the variety of improvement recommendations in this plan:

- Clearfield County Conservation District (CCCD)
- Department of Conservation and Natural Resources (DCNR)
- Department of Environmental Protection (DEP)
- Environmental Protection Agency (EPA)
- Farm Service Agency (FSA)
- Indiana County Conservation District (ICCD)
- National Fish and Wildlife Foundation (NFWF)
- Natural Resources Conservation Services (NRCS)
- Penn State Extension
- Penn State Center for Dirt and Gravel Road Studies
- Pennsylvania Game Commission (PGC)
- Pennsylvanian Fish and Boat Commission (PFBC)
- Susquehanna River Basin Commission (SRBC)
- Trout Unlimited (TU)
- United Stated Department of Agriculture (USDA)
- Western Pennsylvania Conservancy (WPC)

These conservation partners may be national, state, non-government organization (NGO) or private in nature, but all are dedicated to protecting and improving the environment. There may be funding for a wide variety of environmentally beneficial activities for communities, municipalities, and landowners, including farmers. For instance, installing dirt and gravel road best management practices (culverts, DSA, etc.) may make a road improvement project eligible for grant funding from the Coldwater Heritage Partnership, the DEP Growing Greener Program, and others, since it will also have benefits to the aquatic ecosystem. Coordinating with a variety of partners is likely to increase the chances of a particular project getting funded, as the initiating party can rely on a wide field of expertise. The Western Pennsylvania Conservancy is happy to partner with willing parties to assist in grant application and management. Those interested should contact the Watershed Conservation Program.

WPC utilized an ArcGIS.com Story Map to acquire public input for this plan. Unfortunately, it did not generate much interest. WPC outreached to the County Conservation District and the Ken Sink Chapter of Trout Unlimited and received good feedback and insight on the project. The project-closing meeting was held at the Ken Sink Trout Unlimited chapter's December 2022 meeting. Approximately 40 members and non-members were in attendance. The presentation provoked many thoughtful questions, opened discussion of next steps and reinforces the importance of these efforts.

Summary and Conclusions

The Cush Creek watershed sits as one of the few refuges for native and wild trout in Indiana County. It's fortunate to have cold, clean water for most of its length, along with tributaries that support quality aquatic resources. Even so, the watershed is at risk for degradation if impacts continue or increase.

Fortunately, there are basic best management practices, organizations, and funding that can be utilized to reduce these impacts, improving the quality of the Cush Creek watershed. The most important component to that work is local buy-in. Raising awareness of the wild trout populations within the watershed as well as informing landowners about BMPs could allow for implementing conservation practices. As those relationships develop and lead to restoration projects, hopefully efforts could lead to a concerted effort to ensure Cush Creek, its tributaries and aquatic species can thrive in to the future.

Literature Cited

Barbour, M.T., J. Gerritsen, B. D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

Pennsylvania Department of Environmental Protection. 2022 Intergrated Water Quality Report. https://www.dep.pa.gov/Business/Water/CleanWater/WaterQuality/IntegratedWatersReport/Pages/2022-Integrated-Water-Quality-Report.aspx

Pennsylvania Fish and Boat Commission. 2022 Pennsylvania Wild Trout Waters (Natural Reproduction) – November 2022. http://fishandboat.com/trout_repro.pdf

List of Resources for BMPs relating to Watershed Conservation

North Atlantic Aquatic Connectivity Collaborative
https://streamcontinuity.org/

Pennsylvania Center for Dirt and Gravel Roads
http://www.dirtandgravel.psu.edu/

PA Department of Environmental Protection
http://www.dep.pa.gov/Business/Water/Waterways/Pages/default.aspx

PA Fish and Boat Commission
http://www.fishandboat.com/Pages/default.aspx

Penn State Extension Service
http://extension.psu.edu/natural-resources/water

US Department of Agriculture: Natural Resource Conservation Service Field Office Technical Guide (FOTG)
https://efotg.sc.egov.usda.gov/

Appendices

Appendix 1: General Visual Assessment Field Data and Score Sheets

EXAMPLE ONLY – DATA WAS COLLECTED ELECTRONICALLY USING ARCGIS FIELD MAPS

Big Run Watershed; Jefferson County General Visual Assessment
PHYSICAL CHARACTERIZATION/WATER QUALITY FIELD DATA SHEET
(FRONT)

STREAM NAME:	GIS ID:
Start: LAT LONG	WATERSHED:
End: LAT LONG	AGENCY: Western Pennsylvania Conservancy
INVESTIGATORS:	REASON for SURVEY: *Big Run Visual Assessment Data Collection*
FORM COMPLETED by:	DATE:________ TIME:______ AM PM

WEATHER CONDITIONS

Now
- ☐ clear/sunny
- ☐ storm (heavy rain)
- ☐ rain (steady rain)
- ☐ showers (intermittent)
- ☐ % cloud cover (circle %) 25% - 50 % - 75% - 100%

Past 24 hours
- ☐ clear/sunny
- ☐ storm (heavy rain)
- ☐ rain (steady rain)
- ☐ showers (intermittent)
- ☐ % cloud cover (circle %) 25% - 50 % - 75% - 100%

Has there been a heavy rain in the last 7 days? ☐ Yes ☐ No

Other________________

STREAM CHARACTERIZATION

Stream Subsystem ☐ Perennial ☐ Intermittent

Stream Type *(This can be looked up via GIS)* ☐ Coldwater ☐ Warmwater

Stream Gradient ☐ High (riffle/run prevalent) ☐ Low (glide/pool prevalent)

Segment Type ☐ Main Stem ☐ Named Tributary ☐ Unnamed Tributary ☐ Other __________

IMPROVEMENT OPPORTUNITIES and FEATURES of NOTE

Describe significant features and/or impacts seen in section. Include GPS points when applicable.

☐ Check box if stream is dry

☐ Check box if native/wild trout were observed in segment

Stream Segment Flows through the following Land Type *(Check One)*: ☐ Public ☐ Private ☐ Both

POINT TYPE

☐ **Reference Photo(s)**

	Ref Photo	Latitude (North)	Longitude (West)	Notes
1				
2				

Possible BMP's- None (N) Agriculture (Ag) Abandonded Mine Drainage (AMD) Bank Stablization (BS) Culvert Replacement (CR) Dam Removal (DR) Dirt & Gravel Road (DGR) Habitat Improvement (HI) Mine Belt Deflector (MBD) Riparian Planting (RP) Stormwater (SW) Other (O)

☐ **BMP(s)** *Describe improvement needs and improvement recommendations:*

	BMP	Latitude (North)	Longitude (West)	Notes
1				
2				
3				
4				
5				

☐ **Feature(s) of Note (FoN)**

	FoN	Latitude (North)	Longitude (West)	Notes
1				
2				
3				
4				

Segment Accessibility for Implementing Possible BMP's: ☐ Excellent ☐ Good ☐ Poor ☐ In-Accessible

Describe:________________

Segment was Assessed: ☐ Entirely ☐ Partially

Describe:________________

This sheet was printed on 3/31/2021

WATERSHED FEATURES (within ~100 ft. (~30 m) buffer)	**Predominant Surrounding Land-Use** (Must = 100%) ☐ Forest ____% ☐ Field/Pasture ____% ☐ Agricultural ____% ☐ Open space (i.e., parks/golf courses) ____% ☐ Commercial/Industrial ____% ☐ Residential ____% ☐ Paved Roads ____% ☐ Dirt and Gravel Roads ____% (TWP, Gas & Logging) ☐ Rail Line ____% ☐ Wetland ____% ☐ Other ________ ____%	**Stormwater Inputs** ☐ None ☐ Tile Drain ☐ Road Ditch ☐ Urban Stormwater Pipe ☐ Field Ditch ☐ Overland Flow **D&GR Sediment Contribution (Runoff)**: ☐ None ☐ Minimal ☐ Moderate ☐ Heavy **Bank revetments:** ☐ None ☐ Rip-rap ☐ Gabion ☐ Concrete ☐ Other ______
VEGETATION INFORMATION NOTE: Bank side determined when facing DOWN Stream	**Riparian Zone Width** **Riparian Zone Encroachment** ☐ Yes ☐ No Right Bank: ☐ 0 – 15 feet ☐ 16 – 50 feet ☐ 51 – 150 feet ☐ 150 – 300 feet ☐ Greater than 300 feet Left Bank: ☐ 0 – 15 feet ☐ 16 – 50 feet ☐ 51 – 150 feet ☐ 150 – 300 feet ☐ Greater than 300 feet **Indicate dominant vegetation type within riparian zone (~18 meter buffer),and record dominant species present:** ☐ Trees ☐ Shrubs ☐ Grasses ☐ Herbaceous ☐ Invasive - Dominant species present: ________ **Bank Canopy Vegetation:** Right Bank ☐ 100% (Shaded) ☐ 75% ☐ 50% ☐ 25% ☐ 0% (No Cover) Left Bank ☐ 100% (Shaded) ☐ 75% ☐ 50% ☐ 25% ☐ 0% (No Cover) **Presence of Large Woody Debris (LWD):** ☐ Significant ☐ Moderate ☐ Minimal ☐ None **Presence of aquatic vegetation:** ☐ None ☐ Normal ☐ Excessive - Describe: ________	**Channel Canopy:** ☐ Open ☐ Closed
INSTREAM FEATURES Average Number of Riffles in section: ________	**Average Stream Width** ______ ft **Active Streambank Erosion for Segment** ☐ None ☐ Minimal ☐ Moderate ☐ Heavy **Surface Velocity:** ☐ Slow ☐ Moderate ☐ Fast **Flow Status:** ☐ Low ☐ Moderate ☐ High **Springs/Seeps:** ☐ Abundant ☐ Minimal ☐ None **Adjacent Wetlands:** ☐ Abundant ☐ Minimal ☐ None **Proportion of Stream Morphology Types** ☐ Riffle____% ☐ Run____% ☐ Pool____%	**Channelization** ☐ No ☐ Yes: Length of Straightening ____ ft. **Dam Present (Beaver or Human)** ☐ Yes ☐ No **Constrictions Present:** ☐ None ☐ Culvert ☐ Bridge ☐ Old Abutment ☐ Bedrock Outcrop ☐ Other ______ **Stream Ford or Animal Crossing Present** ☐ Yes ☐ No **Debris Jam Present** ☐ Yes ☐ No **Connectivity to Flood Plain** (Zero percent equals not connected to flood plain) Right Bank: ☐ 100% ☐ 75% ☐ 50% ☐ 25% ☐ 0% Left Bank: ☐ 100% ☐ 75% ☐ 50% ☐ 25% ☐ 0%
WATER QUALITY (During visual assessment use pH and conductivity meters to take reading.)	*ToR = top of reach / BoR = bottom of reach* **pH** ToR______/______BoR **H2O Temp** ToR______/______BoR (°F or °C) **Conductivity** ToR______/______BoR (µs) **Turbidity (if not measured)** ☐ Clear ☐ Slightly turbid ☐ Turbid ☐ Opaque ☐ Stained ☐ Other____ **Water Odors** ☐ Normal/None ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Fishy ☐ Other______	**Water Surface Oils** ☐ None ☐ Slick ☐ Sheen ☐ Globs ☐ Flecks ☐ Other________ **Overall Water Quality** ☐ Excellent ☐ Good ☐ Fair ☐ Poor **Primary source(s) of water quality impact** ☐ None ☐ Agriculture ☐ Active Pasture ☐ Sedimentation ☐ Gas Wells ☐ Development ☐ Sewage ☐ Bank Erosion ☐ Pipeline Crossing ☐ AMD ☐ Timber ☐ Other________

INORGANIC SUBSTRATE COMPONENTS (Should add up to 100%)			**Invasive Species Observations (note any invasive species in reach and list details if possible)**	
Substrate Type	**Diameter**	**% Composition in Sampling Reach**	Flora	Fauna
Bedrock			☐ None	☐ None
Boulder	> 256 mm (10")		☐ Barberry	☐ Asiatic clam (Corbicula)
Cobble	64-256 mm (2.5"-10")		☐ Knotweed	☐ Emerald ash borer
Gravel	2-64 mm (0.1"-2.5")		☐ Multiflora rose	☐ Round goby
Sand	0.06-2mm (gritty)		☐ Mile-a-minute weed	☐ Wooly adelgid
Silt	0.004-0.06 mm		☐ Purple loosestrife	☐ Zebra mussel
Clay	< 0.004 mm (slick)		☐ ______ ☐ Other(s) ______ ______	☐ Other(s) ______ ______

This sheet was printed on 3/31/2021

Big Run Watershed; Jefferson County

General HABITAT ASSESSMENT FIELD DATA SHEET

High or Low Gradient Streams

This sheet can be used for high or low gradient streams, please specify which was scored on score sheet page.

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/Available Cover (high and low gradient)	Greater than 70% (50% for low gradient streams) 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% (30-50% for low gradient streams) 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% (10-30% for low gradient streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% (10% for low gradient streams) 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
Score A or B only, not both. **2a. Embeddedness** (high gradient)	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
2b. Pool Substrate Characterization (low gradient)	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 submerged vegetation.
SCORE ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Score A or B only, not both. **3a. Velocity/Depth Regimes** (high gradient)	All 4 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
3b. Pool Variability (low gradient)	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 (high and low gradient)	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) 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% (80% for low-gradient) 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 (high and low gradient)	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 Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration **(high and low gradient)**	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
Score A or B only, not both. **7a. Frequency of Riffles (or bends)** **(high gradient)**	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
7b. Channel Sinuosity **(low gradient)**	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 2 to 3 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) Note: determine left or right side by facing downstream (high and low gradient)	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** **(high and low gradient)**	More than 90% of the streambank surfaces and immediate riparian zones 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) (high and low gradient)	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

Big Run Watershed; Jefferson County
General HABITAT ASSESSMENT SCORE SHEET
High or Low Gradient Streams

STREAM NAME:	GIS ID:
Start: LAT LONG	WATERSHED:
End: LAT LONG	AGENCY: Western Pennsylvania Conservancy
INVESTIGATORS:	REASON for SURVEY: *General Visual Assessment Data Collection*
FORM COMPLETED by:	DATE:__________ TIME: _______ AM PM

Stream Gradient (Select one) ☐ High (riffle/run prevalent) or ☐ Low (glide/pool prevalent)

**Note: If a parameter has an "a" or "b" only score for one or the other, not both.*

Habitat Parameter	Score		Explanation of Score Given *(Please provide details, especially for lower ratings!)*
1. Epifaunal Substrate /Available Cover			
*2a. Embeddedness (High) or 2b. Pool Substrate Characterization (Low)			
*3a. Velocity/Depth Regimes (High) or 3b. Pool Variability (Low)			
4. Sediment Deposition			
5. Channel Flow Status			
6. Channel Alteration			
*7a. Frequency of Riffles (or bends) (High) or 7b. Channel Sinuosity (Low)			
8. Bank Stability **(score each bank)** ***Note: determine left or right side by facing downstream***	LB & RB Total	(RB)	
		(LB)	
9. Vegetative Protection **(score each bank)** ***Note: determine left or right side by facing downstream***	LB & RB Total	(RB)	
		(LB)	
10. Riparian Vegetative Zone Width **(score each bank riparian zone)**	LB & RB Total	(RB)	
		(LB)	
Total Score			**Add all scores and divide by the number of scores given.**

Please include additional notes of back of this sheet.

☐ Check box when data entered

Date entered: __________

APPENDIX 2: WATER QUALITY FIELD DATA SHEET

EXAMPLE ONLY – DATA WAS COLLECTED ELECTRONICALLY USING ARCGIS FIELD MAPS

Western Pennsylvania Conservancy
Field Data Sheet
Big Run; Jefferson County

Site ID: ______________________ Date: ________________ Time: __________________

Site Location: (North) __________________________ (West) ___________________________

Collector(s) Name(s): ____

Weather Notes (i.e. temp., cloud cover): ____

Stream Flow Status (circle): Normal High Low Dry Other: __________

Field Notes: ____

____

	Parameter	Data	Units	Notes
Multi-Parameter	pH		SU	
	Total Dissolved Solids		ppm	
	Conductivity		µS/cm	
Colorimeter	Turbidity		FAU	
	Phosphates (PO_4)		mg/L	
	Nitrates (NO_3)		mg/L	
Dissolved Oxygen Meter	Dissolved Oxygen		mg/L	
	Temperature		°C	
Titration Kit	Alkalinity		mg/L	

Were water samples collected from this site and taken to a lab? Yes No

Were macroinvertebrate samples collected from this site? Yes No

Date data was entered into database: ____________, data enter by: ________________

2013/2014 Mapped 1-meter Resolution Land Use Classes

This document describes the 1m classification scheme applied to the 1m land use data mapped for the Chesapeake Bay watershed and intersecting counties using 2013 (DE, NY, PA, and MD) and 2014 (WV and VA) aerial imagery. These data have also been aggregated to 10m resolution with a condensed classification scheme. The 10m land use data include a more complete representation of streams and differentiate between cropland and pasture throughout the watershed- these distinctions are largely absent in the 1m data. The aggregated 10m data currently inform the Chesapeake Bay Program's Phase 6 watershed model, the Bay Total Maximum Daily Load (TMDL), and Phase III Watershed Implementation Plans. The 10m land use data consist of thirteen separate 10m-resolution raster datasets which can be viewed and downloaded from: http://chesapeake.usgs.gov/phase6/map/.

High-resolution Land Use Classification

Impervious Roads (IR) = paved and unpaved roads, bridges, and some driveways.

Impervious Non-Roads (INR) = buildings, driveways, sidewalks, parking lots, runways, and some private roads. Note that portions of some quarries and other extractive lands may be mistakenly included in this class.

Tree Canopy over Impervious Surfaces (TCI) = trees over roads and non-road impervious surfaces.

Water (WAT) = wide streams and canals, large ponds and swimming pools, wet detention basins, reservoirs, etc. mapped from the high-resolution imagery, National Wetlands Inventory (NWI) ponds and lakes, and large waterbodies identified in the 1:24,000-scale National Hydrography Dataset. Note that small-to-medium width (< 20-30m) streams and other waterbodies and heavily eutrophic ponds could not be consistently detected from NAIP imagery and are therefore mostly absent from this class.

Tidal Wetlands (WLT) = wetlands classified as marine and estuarine wetland systems (E2EM, ESFO, W2SS) according to the NWI Wetlands and Deepwater Habitats Classification chart (https://www.fws.gov/wetlands/Documents/Wetlands-and-Deepwater-Habitats-Classificationchart.pdf), NWI palustrine wetlands (PEM, PFO, PSS) with water regime modifiers associated with tidal hydrological conditions (e.g., saltwater tidal or freshwater tidal), and all wetlands mapped from imagery that could be influenced by tidal characteristics/processes by having an elevation less than or equal to 2 meters above sea level according to the 10m-resolution NED (downloaded July 2015). Note that Tidal Wetlands are excluded from the watershed model but are being mapped for input to the hydrodynamic water quality model.

Floodplain Wetlands (WLF) = National Wetlands Inventory (NWI) non-pond, non-lake wetlands, emergent wetlands mapped from high-resolution imagery outside Virginia, state designated wetlands, and state identified potential non-tidal wetlands located within the FEMA designated 100-year floodplain or on frequently flooded soils (SSURGO).

Other Wetlands (WLO) = National Wetlands Inventory (NWI) non-pond, non-lake wetlands, emergent wetlands mapped from high-resolution imagery outside Virginia, state designated wetlands, and state identified potential non-tidal, non-floodplain wetlands. These are typically headwater or isolated wetlands.

1

Forest (FOR) = all standing trees and areas of tree harvest farther than 30' to 80' from non-road impervious surfaces and forming contiguous patches >=1-acre in extent. The variable range of distances result from the application of multiple filtering algorithms (e.g., focal moving windows) to identify areas covered by tree canopy with an undisturbed/unmanaged understory.[1]

Tree Canopy over Turf Grass (TCT) = trees within 30' to 80' of non-road impervious surfaces where the understory is assumed to be turf grass or otherwise altered through compaction, removal of surface organic material, and/or fertilization.

Mixed Open (MO) = Small patches of trees (< 1 acre) outside developed areas, and all scrub-shrub, herbaceous, and barren lands that have been minimally disturbed (e.g., periodically bush hogged, meadows, etc.), reclaimed, or that have internal and/or regulated drainage (e.g., served by combined sewer systems). Mixed Open areas include active, abandoned and reclaimed mines, landfills, unconventional oil and gas pads, beaches, waterbody margins, natural grasslands, and utility rights-of-way.

Fractional Turf (small) = "Small" contiguous patches of herbaceous and barren land <= 10 acres that fall within local land use polygons designated as mixed open, institutional, universities, colleges, monuments, or within non-agricultural protected/public lands (e.g., PADUS) and federal facilities. Also included are herbaceous and barren lands within medium-to-large developed parcels (> 10 acres with >= 10% impervious cover). When aggregated to 10m resolution, these areas were designated as 70% Turf Grass and 30% Mixed Open.

Fractional Turf (med) = "Medium" contiguous patches of herbaceous and barren land > 10 acres and <= 1000 acres that fall within local land use polygons designated as mixed open, institutional, universities, colleges, monuments, or within non-agricultural protected/public lands (e.g., PADUS) and federal facilities. When aggregated to 10m resolution, these areas were designated as 50% Turf Grass and 50% Mixed Open.

Fractional Turf (large) = "Large" contiguous patches of herbaceous and barren land > 1000 acres that fall within local land use polygons designated as mixed open, institutional, universities, colleges, monuments, or within non-agricultural protected/public lands (e.g., PADUS) and federal facilities. When aggregated to 10m resolution, these areas were designated as 60% Mixed Open, 30% Turf Grass, 5% Cropland, and 5% Pasture.

Fractional Impervious = Herbaceous and barren lands designated by local land use data as junk yards, warehouses/storage, industrial, railyards, and transitional, or vehicle related. When aggregated to 10m resolution, these areas were designated as 30% Impervious Non-Road and 70% Mixed Open. This class excludes rail rights-of-way because the spatial accuracy of the rail data is insufficient to align with the

[1] Developed areas are mapped using a series of four circular focal filters corresponding to 10-acre, 1-acre, ¾-acre, and ½-acre areas with respective radii of 113m, 37m, 27m, and 18m. These represent different concentrations of non-road impervious surfaces and serve to create variable width buffers around developed areas. The largest filter, 10-acres, is only applied to Census Urbanized Areas and Clusters and helps to fill gaps created by the smaller filters. The smaller filters help define the interface between densely developed and rural areas. Large filters over-generalize and therefore have high commission errors, e.g., classifying forests as tree canopy over turf or cropland as turf grass. Small filters under-generalize and may not fully cover areas maintained as turf grass or trees over turf grass. Therefore, all four filters are needed. Many different filter sizes, combinations of filters, and filter density thresholds were evaluated. Through trial and error, observing the effect of each set of filters and decision rules on resultant forest vs non-forest classifications in Prince George's county, we settled on the above set of four. The exact filter sizes are not as important as having a set that captures a range of relevant scales.

1m-resolution land cover data informing the land use classification.

Turf Grass (TG) = Herbaceous and barren lands that have been altered through compaction, removal of organic material, and/or fertilization. These include all herbaceous and barren lands within road rights-of-way, residential, commercial, recreational, other turf-dominated land uses (e.g., cemeteries, shopping centers, golf courses, airports, hospitals, amusement parks, etc.), and small developed parcels (<= 10 acres with >= 93 m^2 of total impervious cover). The 93 m^2 (1000 ft^2) threshold is meant to represent the average size of a single-wide mobile home.

Cropland (CRP) = This class was only mapped at 1-meter resolution in Virginia. The Virginia Department of Conservation and Recreation has a spatial dataset of points and polygons to differentiate between cropland and pasture. These data were overlaid on the land cover to classify herbaceous lands as either cropland or pasture at 1-meter resolution. Outside of Virginia, all herbaceous and barren lands that are not classed as turf grass or mixed open are simply classed as "agriculture". This explains why there are 17 classes in the Virginia portion of the dataset compared to outside Virginia, where there are only 16 classes.

Note that cropland is mapped everywhere as part of the aggregated 10m land use dataset. In Virginia, the 1m cropland and 1m pasture cells are simply aggregated to each overlaying 10m cell. Outside Virginia, the portion of a 10m cell that is classed as "agriculture" at 1m is reclassed as part cropland and part pasture using eight years of the annual, 30m-resolution NASS Cropland Data Layer (CDL 2008 through 2015). The frequency at which each 30m CDL cell was classified as crops over the eight-year period determines the proportion of crops in each of the nine underlying 10m cells. For example, if a 10m cell (100 m^2) includes 80 1-m "agriculture" cells (i.e., it's 80% agriculture) and the overlaying 30m CDL cell was classed as some form of crop in 2 out of 8 years, 25% of the portion of the 10m cell that is agriculture would be considered to be cropland and the remaining 75% of the portion that is agriculture would be considered to be pasture. Therefore, this cell would have $20m^2$ (25% of $80m^2$) of crop, $60m^2$ of pasture, and $20m^2$ of some other land use.

Pasture/Hay (PAS) = This class was only mapped at 1-meter resolution in Virginia. Outside of Virginia, all herbaceous and barren lands that are not classed as turf grass or mixed open are simply classed as "agriculture". Pasture is mapped everywhere as part of the aggregated 10m land use dataset (see the more detailed description of the "Cropland" class). Note that hay is grouped with pasture because they are difficult to differentiate through image interpretation.

3

Appendix 4: Riparian Opportunity Areas GIS Analysis Methodology

Input Data

Chesapeake Conservancy High Resolution (1 meter) Land Cover – County Scale, not the data buffered to 100ft of flow path

DEP 305b Streams

County Parcel Data

Methods

- Select and export streams by watershed of interest, in this case the West Branch Susquehanna River
- Create 100 foot buffer of extracted streams
- Intersect buffer and county parcels – "parcelbuffint"
- Spatial Analyst Tabulate Area (Zonal toolbox)
    - Input Zone data - parcelbuffint
    - Zone field is Unique ID for individual parcels
    - Input raster is county level land cover raster
    - Class field is Value – or land cover categories
    - Result is an attribute table
- Join Tabulate Area table to parcelbuffint and export to new feature class
- Add attribute field to feature class "ROA_Sum", type = long integer
- ROA_Sum Field Calculator, sum [VALUE_4] + [VALUE_5] + [VALUE_6]
- Add attribute field to feature class "TotalLCValues", type = long integer

    [VALUE_1] + [VALUE_2] + [VALUE_3] + [VALUE_4] + [VALUE_5] + [VALUE_6] + [VALUE_7] + [VALUE_8] + [VALUE_9] + [VALUE_10] + [VALUE_11] + [VALUE_12]

  *this is useful for filtering out false positives when there is a large landowner with minimal restoration opportunity

- Add attribute field to feature class Percent ROA to better understand those results. The smaller the percentage, the less potential plantable area there is for the size of the parcel/buffer.
- Convert values to acres for additional information:
    - Buffer Acres (calculate geometry of feature) this is the total acreage of the 100 foot parcel buffer
    - HRLC ROA Acres (x 0.000247105) (convert ROA Sum to acres)
    - HRLC Acres (x 0.000247105) (convert TotalLCValues to acres)