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DEPARTMENT OF ENVIRONMENTAL PROTECTION

BUREAU OF CLEAN WATER
HAMMER CREEK ADVANCE RESTORATION PLAN FIRST TRIENNIAL PROGRESS REPORT
LEBANON COUNTY
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Aside from the imagery used in mapping, all photographs by Michael Morris, DEP

INTRODUCTION

An "Alternate Restoration Plan (ARP[1])" was prepared by the Pennsylvania Department of Environmental Protection (DEP) for the "Hammer Creek Headwaters" watershed in Lebanon County (Figure 1, see also DEP 2021). This plan proposed the use of Best Management Practices (BMPs) such as stream restoration, riparian buffers, agricultural erosion and sediment plan implementation, conservation tillage, cover crops and precision-located grass filter strips to correct siltation impairments within the watershed. The Doc Fritchey Chapter of Trout Unlimited (DFTU) would serve as the lead partner to work with landowners on voluntary BMP implementation. This ARP has been accepted by both state and federal Nonpoint Source Management Programs as a Watershed Implementation Plan (WIP) eligible for Section 319 funding.

It was envisioned that it would take approximately a decade to implement the ARP, with triennial reports used over this time to evaluate progress, review monitoring data, make updates where necessary, and generally keep the project on track. These reports are to be submitted to USEPA and DEP's Section 319 programs, and then be followed by a public meeting. Since the ARP was accepted in 2021, this first triennial report is being developed in 2024.

This Triennial Report will be organized as follows. It will start by summarizing progress to date, including landowner outreach, project organization, grant submission, and calculations of possible sediment reductions from BMP implementation. The second major section be a review of monitoring and assessment information relevant to the project. The third major section will establish plans for the second triennial period. The fourth section will discuss clarifications and updates to the plan.

PROGRESS TO DATE

Landowner Outreach

DFTU engaged in landowner outreach efforts that preceded the development of the ARP and continue to the present. Their hard work and skill at gaining the trust and cooperation of landowners is foundational to the ARP, since nonpoint source BMP implementation is largely voluntary. Such outreach efforts have ranged from phone calls to door-to-door visits at critical streamside properties within the watershed. Once relationships are established, DFTU can serve as a trusted coordinator between landowners and the grant programs, contractors, and government agencies needed for BMP implementation.

One formal outcome of Trout Unlimited's work is the 2020 *Snapshot Assessment of Hammer Creek and Tributaries-Phase 1 Portion to Downstream Limit of Barry Property, Lebanon County* document. Based on numerous observations within study watershed, this document proposed a handful of high priority areas for stream restoration, as well as areas for riparian buffer establishment. This document is a valuable reference for the ARP efforts, and ongoing discussions continue with some of the landowners identified in the document.

[1]Rather than *Alternate* Restoration Plan USEPA now uses the term *Advance* Restoration Plan

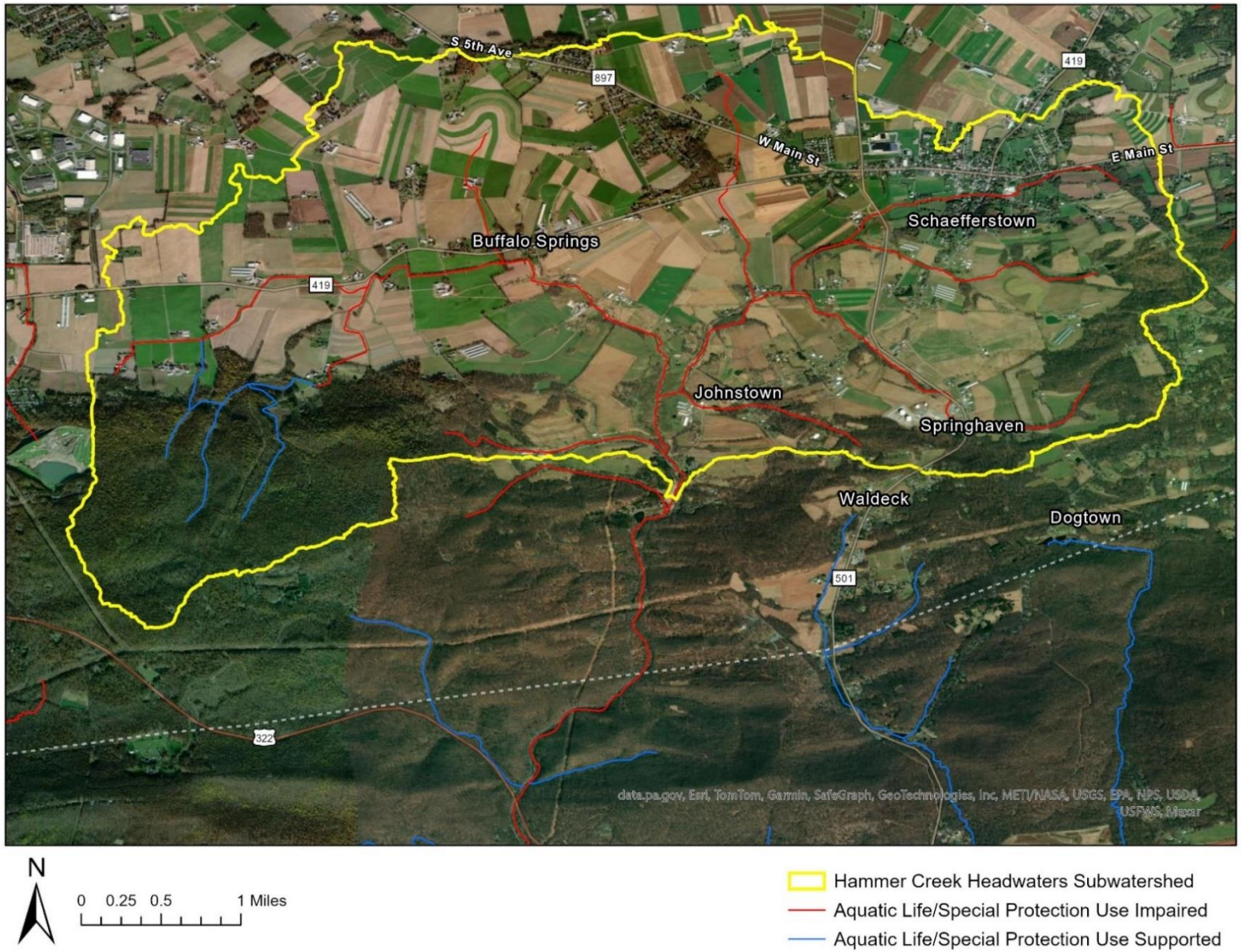

Figure 1. Hammer Creek headwaters watershed. Per the latest (2024) Integrated Report viewer, aquatic life impairments within the watershed, as well as within the downstream mainstem, were attributed to siltation from agriculture and habitat alterations (DEP 2024). Note that the lower mainstem impairment listings are new to the 2024 Integrated Report, and thus were not shown in the original ARP.

The first public meeting following the acceptance of the ARP was held on June 6, 2022 at the Heidelberg Township building located just outside of Schaefferstown (Figure 1). Note that this was delayed for over a year after the plan's acceptance due to the COVID 19 pandemic. In preparation for the meeting, approximately 180 invitation letters were mailed to residents within the study watershed as well as in some downstream areas. See Appendix A for an example of the letter. The meeting was also advertised on the Heidelberg Township webpage (see Appendix A). Invitation emails were also sent to contacts from potential partnering organizations including, the Lebanon County Conservation District (LCCD), The Nature Conservancy (TNC), The Donegal Chapter of Trout Unlimited, Pennsylvania Fish and Boat Commission, USDA-NRCS, and the Chesapeake Bay Foundation.

Out of concern for landowner privacy and to promote free discussion, no sign in sheet was used at the meeting. However, it is the author's recollection that dozens of people attended. The draft agenda is included in Appendix A. Russ Collins of DFTU gave an introduction and explained their role as the implementation organization. Jim Suleski, also of DFTU discussed native Brook Trout within Hammer Creek. Michael Morris of DEP gave a presentation on topics such as: why there is special interest in restoring Hammer Creek, the causes of the impairment, potential solutions, and the goals of the ARP. Scott Heidel of DEP's 319 section and Mary Kate Gallagher of LCCD attended to help answer questions about funding and BMP implementation. Attendees were also provided with a trifold pamphlet and map that explained the project (see Appendix A). The meeting generated discussion on topics that included: landowner interest in restoration, skepticism stemming from prior unsuccessful efforts, responsibility for long-term BMP maintenance, disapproval over the removal of the Rexmont Dams, and geomorphic changes since the dam removals.

Finally, another positive development for public outreach was a newspaper article written about the Hammer Creek ARP. See *Conservationists hope to boost Hammer Creek's wild trout potential with $5.2 million pollution mitigation plan* published May 2, 2021 in LNP LancasterOnline. The author of the ARP, Michael Morris of DEP, was interviewed for this article.

Project Organization

The original ARP envisioned two primary plan partners. DEP would take the lead on tasks such as writing the ARP, prescribing BMPs, modelling pollutant loads, tracking pollutant reductions, stream monitoring and, if necessary, compliance. As the primary implementation partner, DFTU would take the lead on tasks such as landowner outreach and education, applying for grant funding, and working with contractors and landowners to get BMPs installed. DEP would prepare triennial reports in cooperation with DFTU.

However, project structure has evolved significantly since the original ARP. Most notably, the partnership has expanded to include other regularly involved implementation partners that enhance effort, expertise and capabilities. Dr. Jonathan Niles and Su Fanok, professionals with TNC, take a lead role in project management. This includes general strategic planning, organizing regular project meetings, coordination and writing of grant applications, and communicating and coordinating among partners. Also, as professionals, TNC can also provide expertise in areas such as: GIS work, scientific and ecological restoration analysis, navigating funding programs, and project promotion/public

education. The LCCD has greatly increased their commitment to the project to the extent that they now serve as a regularly contributing core partner. They have been attending meetings, assisting with landowner outreach, providing advice on BMP implementation, working with landowners to promote BMP implementation, and helping to pursue funding. Finally, agricultural consultants have also emerged as core partners. Representatives from Ecosystem Planning & Restoration (EPR) regularly attend meetings; do site evaluations; provide expertise on design, permitting and funding; and help strategize the stream restoration efforts. LandStudies has also been involved with the design and permitting of a critical floodplain restoration project. In addition to the five core partners (DFTU, DEP, TNC, LCCD and consultants), other organizations, such as the Lancaster Farmland Trust, United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS), the United States Geological Survey (USGS), the Pennsylvania Fish and Boat Commission, the Susquehanna River Basin Commission, The Chesapeake Bay Foundation, the Donegal Chapter of Trout Unlimited and other consultants, may be included as appropriate.

Administrative Tasks

While not mentioned as a specific task in the ARP, TNC has been organizing regular project partner meetings, every other month, since March of 2023. The meetings are typically used for strategic planning among the core partners, as well as to make decisions about specific projects and grant applications. These meetings may also be used for other topics, such as reviewing the ARP or learning about monitoring efforts. In addition to these core team meetings, other meetings concerning specific issues relevant to subsets of project partners are held as needed.

TNC has also developed a Strategic Planning document for the Hammer Creek partnership. This document combines information from the original ARP with additional ecological information and analysis related to: potential wetland restoration areas, additional floodplain and stream restoration opportunities and other Agricultural BMP opportunities. This document serves as an additional complementary plan to the ARP. As part of this process, the partners under the guidance of TNC also recently completed an annual planning meeting in early November 2024 to discuss, coordinate, and plan restoration activities, opportunities, and grant funding over the next 18 months. The partners will have a yearly planning meeting over the course of the partnership and ARP. (Jonathan Niles, TNC).

There have been number of efforts to promote ARPs and our work in the Hammer Creek watershed to other organizations. For instance, Michael Morris of DEP has given presentations that include information on the Hammer Creek ARP to: The Donegal Chapter of Trout Unlimited, DEP’s Water Resources Advisory Committee; Chesapeake Bay Countywide Action Plan Coordinators, County Conservation Districts, and a Municipal Stormwater Forum. Given DEP’s role in public service, and the fact that such presentations may result in beneficial connections, the ARP’s author typically strives to accommodate presentation requests.

Much effort has been devoted toward the pursuit of grant funding during the first triennial period. Consider that ARP acceptance in of itself does not come with any up-front funding, nor does it guarantee that any future funding will be received. Rather, it allows implementation partners to pursue Section 319 funding on a project by project basis. But, it is also expected that other funding sources

will also be used where appropriate. Thus, pursuit of grant funding has been an essential initial step that should be considered in the evaluation of progress. The following provides a summary of fundraising efforts by various project partners dating back to around the time of ARP's acceptance.

Monies Received

Note that out of concern for landowner privacy, especially where there are ongoing negotiations, specific site names have been redacted in the public version of this document.

- *Lebanon County CAP.* Year: 2021. Applicant: Doc Fritchey Chapter of Trout Unlimited. Purpose: design and permitting of streambank stabilization project for the [redacted] property. Outcome: $36,200 awarded.

- *Lebanon County CAP*. Year: 2021. Applicant: Doc Fritchey Chapter of Trout Unlimited. Purpose: design and permitting of streambank stabilization project at the [redacted] Property. Outcome: $71,200 awarded.

- *Section 319 Grant.* Year: 2022. Applicant: Doc Fritchey Chapter of Trout Unlimited. Purpose: design and permitting of stream and floodplain restoration for the [redacted] project. Outcome: $457,645 awarded.

- *Consent Decree Money from Keystone Protein Settlement.* Year 2022. Recipient: Doc Fritchey Chapter of Trout Unlimited. Purpose: stream restoration in Hammer Creek. Amount: $238,800.

- *PA Council of Trout Unlimited Forever Wild mini-grant*. Year 2023. Purpose: purchase groundwater monitoring sensors for Hammer Creek on [redacted]. Applicant: Doc Fritchey Chapter of Trout Unlimited. Outcome: $1,700 awarded.

- *PA Council of Trout Unlimited Forever Wild mini-grant*. Year 2023. Purpose: purchase Tidbit temperature monitoring in Hammer Creek on [redacted]. Applicant: Doc Fritchey Chapter of Trout Unlimited. Outcome: $2,500 awarded.

- Lebanon County CAP Funding. Year 2024. Lebanon County Conservation District. Purpose: construction work for [redacted] stream and wetland restoration project. Outcome: $250,000 awarded.

- *SRBC Consumptive Use Grant.* Year 2024. Applicant: Doc Fritchey Chapter of Trout Unlimited. Purpose: floodplain and wetland restoration/legacy sediment removal design at [redacted] and [redacted] and construction of stream and wetland restoration project at [redacted]. Outcome: $740,401 awarded.

- NFWF Small Watershed Grant # 80098. Year 2024. Applicant: The Nature Conservancy. Purpose: use Lancaster Farmland Trust to do farmer outreach for agricultural erosion and sedimentation plans, other agricultural BMPs, and some stream work. Requested amount: $75,000 with matching contributions proposed of $10,000. Outcome: awarded.

- *NFWF Small Watershed Grant #83378***.** Year 2024. Applicant Doc Fritchey Chapter of Trout Unlimited. Purpose: construction of wetland and stream restoration and agricultural BMPs at [redacted]. Requested amount: $782,530 with matching contributions proposed of $727,743. Outcome: awarded.

Monies Not Received

- *NFWF Small Watershed Grant #83586.* Year 2024. Applicant: Lebanon County Conservation District. Purpose: construction for [redacted] floodplain restoration project. Requested amount $1,000,000. Outcome: not received.

- *NFWF Chesapeake Bay Innovative Nutrient and Sediment Reduction Grant #83107.* Year 2024. Applicant: Doc Fritchey Chapter of Trout Unlimited. Purpose: construction for [redacted] restoration project. Requested amount: $2,000,000 with matching contributions proposed of $561,054. Outcome: not received.

This fundraising summary illustrates several key points. For one, as evidenced by the number of grant applications submitted, the effort devoted to this task is considerable, especially given the complexity of various grant programs. When the time spent fundraising is added to the time needed for landowner negotiations, as well as the lengthy design and permitting processes often associated with stream restoration projects, substantial lag times between ARP acceptance and BMP implementation should be expected. This presents a real challenge for the much-discussed goal or rapid impairment delisting. In hindsight, the original ARP may have been too optimistic about what was feasible within the first triennial period. Secondly, there is concern about whether it is realistic to hope for sufficient funding for comprehensive floodplain restoration at a critical site within the Hammer Creek headwaters watershed. This is a massive site (over 11,000 ft of creek) where hundreds of livestock have direct access to the stream (Figure 2). Streambanks exhibit severe erosion, and the water quality degradation that occurs within this area is striking. This pollution likely contributes to impairments occurring well downstream, including within an area of public lands that is popular for trout fishing.

Figure 2. Photos illustrating the need for restoration at a critical site within the Hammer Creek headwaters watershed. The upper photo shows the main western tributary which appears as a nice-looking limestone stream before it enters the critical site. This water then enters a massive pasture area where hundreds of livestock have access to the stream.

Originally, it was proposed to fence livestock from the stream, establish riparian buffers, grade banks, and stabilize the stream using a natural channel design approach at this critical site. However, due to a series of historic milldams in the reach, DEP's Waterways and Wetlands and 319 sections advocated for a comprehensive floodplain wetland restoration approach focusing on legacy sediment removal, which would likely be considerably more expensive than what was originally proposed. A large Section 319 grant was awarded to design such a project, and indeed, subsequent geotechnical analysis indicates that there have been iterations of historic milldams that have caused the floodplain to be blanketed by legacy sediment.

A convincing argument can be made that legacy sediment removal would address the underlying cause of the problem, making it a better long-term solution. Plus, there may be various other benefits, such as: restoring habitat for wetland species, moderating flood pulses, and enhancing the sequestration of sediment and nutrients. However, excavating these sediments is extremely expensive, and no single funding source is likely to pay the multi-million dollar price tag. So far, the efforts to compile funding for construction, one and two million dollars per grant, have been unsuccessful. And, DEP's grant reviewers indicated that getting this quantity of funding from the 319 and Growing Greener programs is very unlikely. Thus, the future of this site is uncertain, and the risk that the project may collapse altogether may grow as time drags on. If so, there may be no riparian buffers, streambank fencing or bank stabilization work at all. Therefore, if generating the funding for such multi-million dollar projects is infeasible, the project partners must start considering a decision to revert back to plans for a more affordable, though less ecologically advantageous, restoration project.

Finally, on a more positive note, more than $2.5 million, has already been raised for the ARP efforts. Most of this funding is proposed to be used for stream/floodplain/riparian restoration at the aforementioned critical site plus a few other smaller sites. Given the expense of the preferred floodplain restoration approach, far more funding will be needed to complete construction of these projects. Funding has also been received to contract with agricultural consultants to conduct site visits at approximately 50 farms within the watershed. The primary purpose of these visits is to verify Agricultural Erosion and Sedimentation Plans and promote agricultural BMPs, but also to explore for additional stream and wetland restoration opportunities.

Recent BMP Implementation and the Crediting of Sediment Reductions

The Hammer Creek ARP established very ambitious sediment reduction goals for the first triennial period. It was projected that during this time comprehensive restoration would occur at a major site within the watershed, there would be 34 acres of new precision grass filter strips and 30 acres of new forested buffers. Furthermore, due in part to the larger Chesapeake Bay restoration efforts, it was assumed that 95% implementation of agricultural erosion and sedimentation plans would be achieved. Together this would result in estimated sediment reductions of 2,645,138 lbs/yr. Virtually none of this has been accomplished.

This was the first ARP developed by the author, and based on lessons learned in the Hammer Creek watershed, it is now realized that the first triennial goals were unrealistic. Rather than BMP implementation, much of the initial efforts have focused on landowner outreach, partnership building, pursuit of funding, and design and permitting for stream restoration projects.

According to Table 1, no verified progress in Agricultural Erosion and Sedimentation Plan implementation has occurred within the last three years. This is partially explainable in that the table only reports implementation based on inspections since around the time that the ARP was developed in 2021, as reported in the Practice Keeper database. Looking further back into the database, sediment reductions associated with earlier plans may be 273,987 lbs/yr. Furthermore, farmers may be implementing plans regardless of confirmation by inspection. Nevertheless, it is realized that much additional work needs to be done in this area, and this will require more effort than simply taking credit

for the Chesapeake Bay efforts. Therefore, it is planned to utilize agricultural consultants (Lancaster Farmland Trust) to conduct farmer outreach beginning in January 2025. The LCCD indicated that they can develop such plans in-house where it is discovered that new or updated plans are needed. Therefore, significant progress in this area is expected for the next triennial period.

Table 1. Estimated sediment reductions associated with recent BMP implementation.

BMP	Unit of Measure	Reductions since 2021[1] (lb/yr)
Agricultural Erosion & Sedimentation Plan Implementation[2]	0 acres	0
Grass Waterway[3]	3.8 acres	9,454
Prescribed Grazing[4]	47.5 acres	2,481
Heavy Use Area protection[5]	0.3 acres	6
BMP A[6]	Not Specified	1,609
Cover Crop[7]	111 acres	31,802
Conservation Tillage[8]	See Table 2	-1,143,044
Stream Restoration[9]	1,040 feet	28,496
	Total	**-1,069,196**
First Triennial Reduction Goal		2,645,138
Total Reduction Goal		4,056,504
Percent of total goal		-26%

[1]since approximately 2021, or relative to longer term averages (2016-2024) in the case of conservation tillage and cover crops.

[2]While this may have occurred, recent inspection records for this watershed were lacking in Practice Keeper (PK).

[3]Based on recent records in PK; due to lack of details, credited simply using methodology for riparian buffers.

[4]Based on recent records in PK; credited based on "grazing land management" in ARP.

[5]Based on recent records in PK. Credited per CAST method of 10% reduction for offsite watering.

[6]PK BMP name not reported for confidentiality (< 5 landowners reported using in watershed).

[7]Based on data collected during Capital RC&D conservation till surveys for SE Lebanon Co. Data were available for even years, 2016 through 2024. Only high till sites where cover crop not harvested were considered. The progress reported above was based on compairing 2024 with the average of all years. The loading rate for croplands was based on the estimated conventional till rate. A reduction coefficient of 0.1 was used per the original ARP.

[8]Based on Capital RC&D transect data for SE Lebanon Co, comparing results from 2024 to the average of years 2016 through 2024; see also Figure 3 and Table 2.

[9]Based on two recent projects reported by Doc Fritchey Trout Unlimited.

An analysis of the Practice Keeper database suggests that there have been a limited number of other recent agricultural BMPs, such as grassed waterways, prescribed grazing, and heavy use area protection, though together, they are estimated to account for only minor reductions (Table 1). Note that these recent agricultural BMPs are not a direct result of the ARP efforts. However, it is hoped that the forthcoming farm visits will spur further implementation of agricultural BMPs. In addition, DFTU has been involved in two small stream restoration projects in the watershed, which together, may have

resulted in 1,040 feet of bank stabilization. If so, estimated reductions associated with these projects are 28,496 lbs/yr.

Given the vast acreage of croplands in the watershed, the high sediment loading rates associated with such lands, and the high effectiveness of conservation tillage type BMPs, field management practices are expected to be major drivers of sediment loading. Such practices may change greatly from season to season depending on individual decisions made by farmers, such as the field preparation practices that are used and the types of crops that are planted. Therefore, such “annual BMPs” are not compiled and reported in the Practice Keeper database. Rather, within the Pennsylvania portion of the Chesapeake Bay watershed, consultants drive specified road routes that wind through counties to observe and record field conditions. These observations are extensive. For instance, in 2024, information such as: the presence or not of crops; crop types; whether cover crops were used; crop residue levels; and whether “no-till” is used were considered at over 750 sampling locations for just Lebanon County. Note however, that not all of these points end up being “crop fields”, so the sample size of just crop fields is smaller, but still hundreds of points. Given the large number of sample points, an analysis was made of this data within just southeastern Lebanon County, in the vicinity of the study watershed. Such data were available for even years ranging from 2016 through 2024, and the sample sizes of crop fields ranged from about 150 to 200 sites per year. It was assumed that the proportion of sampling locations of each tillage class would directly translate to aerial proportions of tillage classes within the Hammer Creek headwaters watershed. It was also assumed that the total acreage of croplands remained the same from year to year.

The ARP’s crediting scheme for conservation tillage was based on the Chesapeake Bay Program (2022) methods. Conventional tillage, or 0 to 15% crop residues present on the soil surface at the time of planting, is not considered a BMP and thus receives no sediment reductions. Low (15 to 29%) residue receives an 18% sediment reduction. “Conservation tillage”, also referred to as medium residue (30-59%), receives a 41% reduction. Finally, high (≥ 60%) residue receives a 79% reduction. Figure 3 indicates that the distribution of estimated residue levels varies greatly among the years sampled. In 2020, the year before the ARP was accepted, it was estimated that 58% of crop fields had high residues at the time of planting. However, the estimated proportion of fields with high residue declined all the way down to 12% in 2024. Table 2 illustrates how changes in the distribution of tillage levels may be translated into changes in the estimated sediment load. Since the modelling for the ARP was based on long term annual averages, the background distribution of cropland tillage classes was assumed to reflect the average of the years for which we had such data (Figure 3). Thus, changes in the distribution of tillage classes from year to year were assumed to result in either increased or decreased sediment load relative to the longer-term average. Per Table 2, it was estimated that as a longer-term annual average, there are 692 acres of conventional till, 854 acres low residue, 862 acres of medium residue, and 1,194 acres of high residue till. Then, simple algebra was used to translate changing distributions into changes in sediment loads. For instance, let X = the sediment loading rate associated with conventional tillage. Then, the acreage of each tillage class multiplied by this loading rate and then by (1-the BMP efficiencies reported above) should sum to the total sediment load associated with croplands. Or, represented as an equation:

$Ac_{conv.}$* X*(1-0) + $Ac_{low\ res.}$*X*(1-0.18)+ $Ac_{med\ res.}$*X*(1-0.41) + $Ac_{high\ res.}$ *X*(1-0.79) = Cropland Sediment Load

According to the ARP, the long-term annual average cropland sediment load was estimated to be 6,164,580 lbs/yr, in which case X, the loading rate for conventional tillage, would be 2,865 (lbs*ac)/yr. This being the case, low residue tillage would load at 2,349 (lbs*ac)/yr; medium residue tillage at 1,690 (lbs*ac)/yr; and high residue at 602 (lbs*ac)/yr. Using these values, along with the changing acreage of tillage types per year, annual sediment loading changes for croplands can be calculated as in Table 2 and Figure 4.

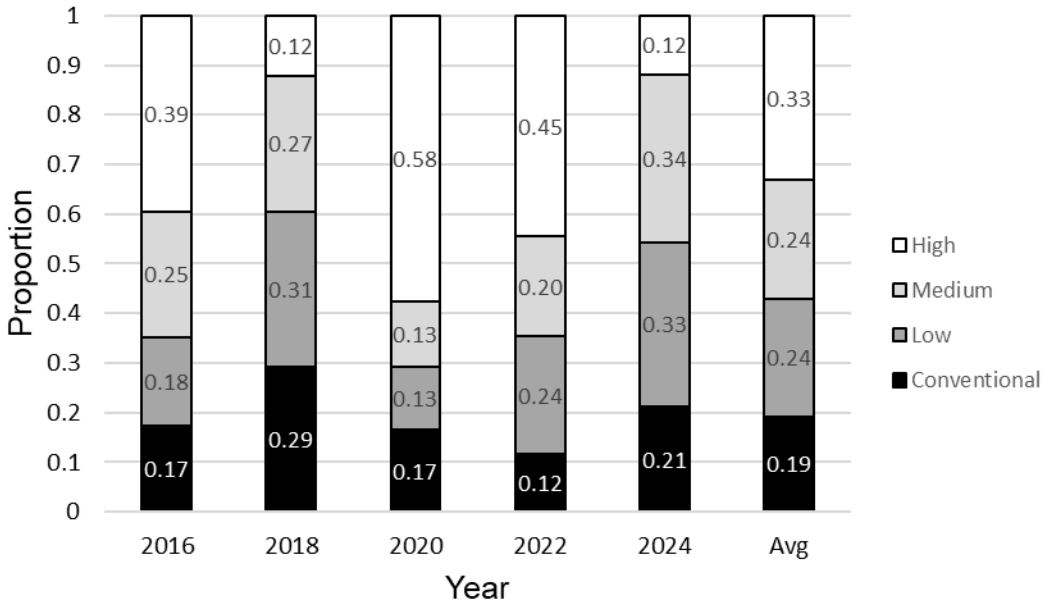

Figure 3. Estimated distribution of crop residue levels measured at the time of planting in southeastern Lebanon County for years 2016 through 2024, as well as the average of these years. High residue is defined as ≥60% at time of planting; medium is 30-59%; low is 15-29%; while conventional <15%.

Table. 2. Estimated sediment loading from croplands based on the 2024 tillage class distribution relative to the longer term average of tillage class distribution.

	Avg 2016-2024			**2024**		
	%	acres	lbs/yr	%	acres	lbs/yr
Conventional Till	19	692	1,982,743	21	765	2,192,739
Low Residue	24	854	2,006,735	33	1,193	2,802,836
Medium Residue	24	862	1,457,077	34	1,216	2,054,725
High Residue	33	1,194	718,025	12	428	257,324
		3,602	**6,164,580**		3,602	**7,307,624**

The results of this analysis are concerning, in that drastic declines in high residue crop fields since around the time the ARP was developed in 2020 may be leading to large increases in sediment loading.

If so, this would suggest that other BMP implementation reported in Table 1 may have been inconsequential in comparison (Table 1).

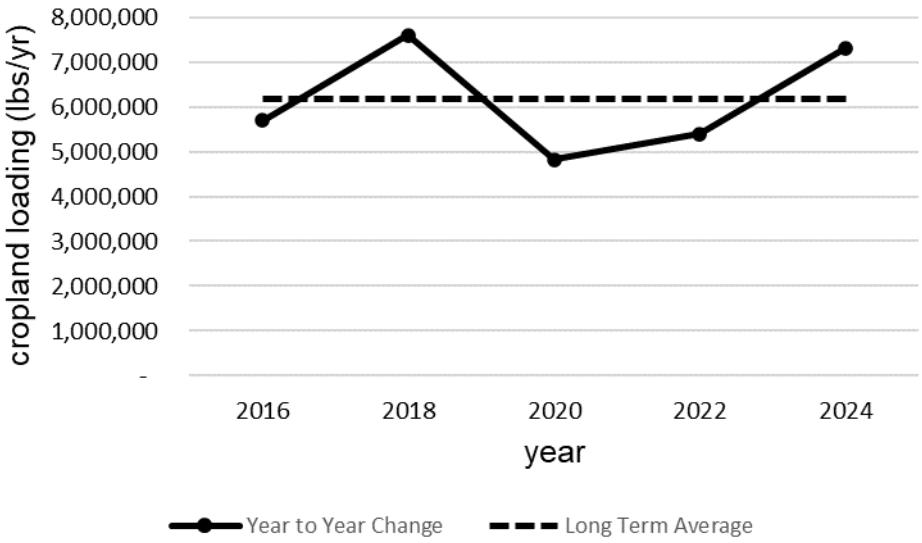

Figure 4. Estimated sediment load changes over time predicted by a changing distribution of tillage classes.

At present, the factors that may be driving this concerning recent trend are not well understood. Simply attributing such drastic swings to sampling error seems unlikely. The author observed a crew collecting such data in another county, and it was noted that they possessed a great deal of agricultural expertise and receive ongoing training. And, while the time spent at any given sample point was very brief, to the extent that many sites are just observed from the vehicle, sample sizes were very large, even when just southeastern Lebanon County is considered. Plus, a similar analysis was made using even more data collected across the entire county and the results were very similar. Thus, even if there may not be high confidence in the classification of any single field, the vast sample sizes suggest that such large changes in tillage type distributions reflect reality.

Based on very preliminary analysis of additional data, the amount of high residue tillage within a sampling year seems to be strongly positively correlated with estimates of no-till management and the percent of fields planted with soybeans, while at the same time being negatively correlated with percent of fields planted with corn. Interestingly, precipitation levels didn't seem to be driving the amount of residue levels. But, despite the strong correlations, use of no-till and crop choice seem unlikely to fully explain what is going on, since the interannual changes in these variables were quite small, while the amount of high residue levels changed drastically from year to year. Based on additional research and internal discussions, other hypotheses include: that soil disturbance associated with nutrient management techniques may be resulting in lesser soil residues; farmers may be selling crop residues for use as substrate in mushroom farming; and that farmers may be increasingly using in periodic tilling to address issues such as soil compaction and herbicide-resistant weed growth. Whatever the underlying cause may be, there is reason for optimism. Consider that, per Figure 3, 2018 was also a very low year for high residue fields, but this changed drastically by 2020. And, rather than simply hoping conditions will improve of their own accord, increased use of high residue conservation tillage

may be promoted by the forthcoming famer visits. These visits may also provide a greater understanding of what is driving these changes.

Finally, the appropriate starting year upon which to evaluate progress may be reconsidered in the future. Indeed, the ARP indicated progress dating all the way back to 2004 might be credited since this is when habitat data relevant to making sedimentation assessment decisions had been collected.

MONITORING AND ASSESSMENT UPDATES

The ARP proposed a monitoring plan that would focus both directly on the pollutant of concern (sediment) as well as the biotic community. The following will report results associated with this initial round of baseline sampling. The second round of sampling, which was scheduled for the second triennial period (2024 to 2027), has not been completed.

The Hammer Creek basin was initially sampled in 1997 using DEP's Statewide Surface Water Assessment Protocol (SSWAP), which was a qualitative evaluation of the benthic macroinvertebrate community and physical habitat. The watershed was subsequently sampled in 2003, 2004 and 2007 using semi-quantitative benthic macroinvertebrate methods, that, like the current methodology, incorporate a standardized Index of Biotic Integrity (IBI). Results of these prior efforts were variable, but generally indicative of an impaired benthic macroinvertebrate community in the valley area of the headwaters subwatershed. Physical habitat scores suggest siltation as a cause of the impaired community. Considering that even the most recent of these samples were more than a decade old at the time of ARP development, updated sampling was conducted in December 2021 using methodology described in Shull (2017) and Lookenbill (2017).

Benthic macroinvertebrate IBI scores are interpreted in the context of the designated uses found in at 25 Pa. Code § 93. The study subwatershed contains both High Quality – Cold Water Fishes and Cold Water Fishes stream designations, as shown in Figure 5. The results of the 2021 sampling indicate that the study subwatershed harbors an impaired benthic macroinvertebrate community, with the exception of a limited area of the forested, High Quality, headwaters (see site 1HC in Table 3 and Figures 5 and 6). Sites within the agricultural valley area exhibited IBI scores well below assessment thresholds. IBI scores improved further downstream, after the Hammer Creek mainstem passed through about 2 miles of the largely forested Furnace Hills. Even so, the IBI scores were still below the assessment threshold, as these reaches were designated High Quality.

As for physical habitat data, all sites within the study subwatershed, as well as the mainstem below it, exhibited sediment deposition plus embeddedness couplet scores that were consistent with impairment for siltation, except the one site on the main eastern tributary of the headwaters area. This atypical sample might be due to a localized effect. Higher stream gradient in this area may promote sediment export rather than accumulation; indeed, the same tributary is known to exhibit symptoms of sedimentation in other reaches. There were also indicators of habitat impairment at some sites, based on both the total habitat score, as well as the condition of banks plus the bank vegetative protection couplet scores (Table 4).

Table 3. Hammer Creek basin benthic macroinvertebrate metrics and IBI scores for the initial (2021) round of sampling.

METRICS	STATIONS[1] 1HC	2HC	3HC	4HC	5HC	1UNT
TAXA RICHNESS	30	13	18	19	15	14
EPT RICHNESS (PTV 0-4)	18	1	6	6	5	2
BECKS INDEX V3	39	1	5	7	5	0
HILSENHOFF INDEX	2.8	6.1	5.3	3.0	4.5	5.7
SHANNON DIVERSITY	2.8	1.9	2.3	1.9	2.1	1.9
% SENSITIVE INDIV. (PTV 0-3)	52.6	4.7	8.4	51.4	21.4	1.4
IBI	**88.9***	**27.8****	**38.7****	**53.5***	**41.8***	**28.8****

[1]Refer to Figure 5 for station locations.
*IBI scores < 63 are indicative of impairment for HQ stream segments
**IBI scores <43 are indicative of impairment for these limestone influenced CWF stream segments

Table 4. Hammer Creek basin physical habitat scores for the initial (2021) round of sampling.

PARAMETERS	STATIONS[1] 1HC	2HC	3HC	4HC	5HC	1UNT
1. INSTREAM COVER	16	6	10	15	16	12
2. EPIFAUNAL SUBSTRATE	16	8	11	16	15	16
3. EMBEDDEDNESS	8	3	8	9	5	10
4. VELOCITY/DEPTH REGIME	10	16	16	15	16	16
5. CHANNEL ALTERATIONS	15	15	13	16	15	16
6. SEDIMENT DEPOSITION	13	9	10	11	10	16
7. FREQ OF RIFFLES	16	13	12	15	16	16
8. CHANNEL FLOW STATUS	14	15	14	14	16	16
9. CONDITION OF BANKS	13	7	8	5	13	7
10. BANK VEGETATIVE PROTECTION	17	12	11	15	16	13
11. GRAZING OR OTHER DISRUPTIVE PRESSURE	16	14	10	15	16	15
12. RIPARIAN ZONE WIDTH	17	8	8	13	15	10
Total Score[2]	171	126	131	159	169	163
Rating[3]	SUB	MAR	MAR	SUB	SUB	SUB
EMBEDDEDNESS + SEDIMENT DEPOSITION[4]	21	12	18	20	15	26
CONDITION OF BANKS + BANK VEG PROTECTION[4]	30	19	19	20	29	20

[1]Refer to Figure 5 station locations.
[2]Scores ≤ 140 are indicative of impairment
[3]OPT = Optimal (≥ 192); SUB = Suboptimal (132-192); MAR = Marginal (72-132)
[4]Scores ≤24 are indicative of impairment

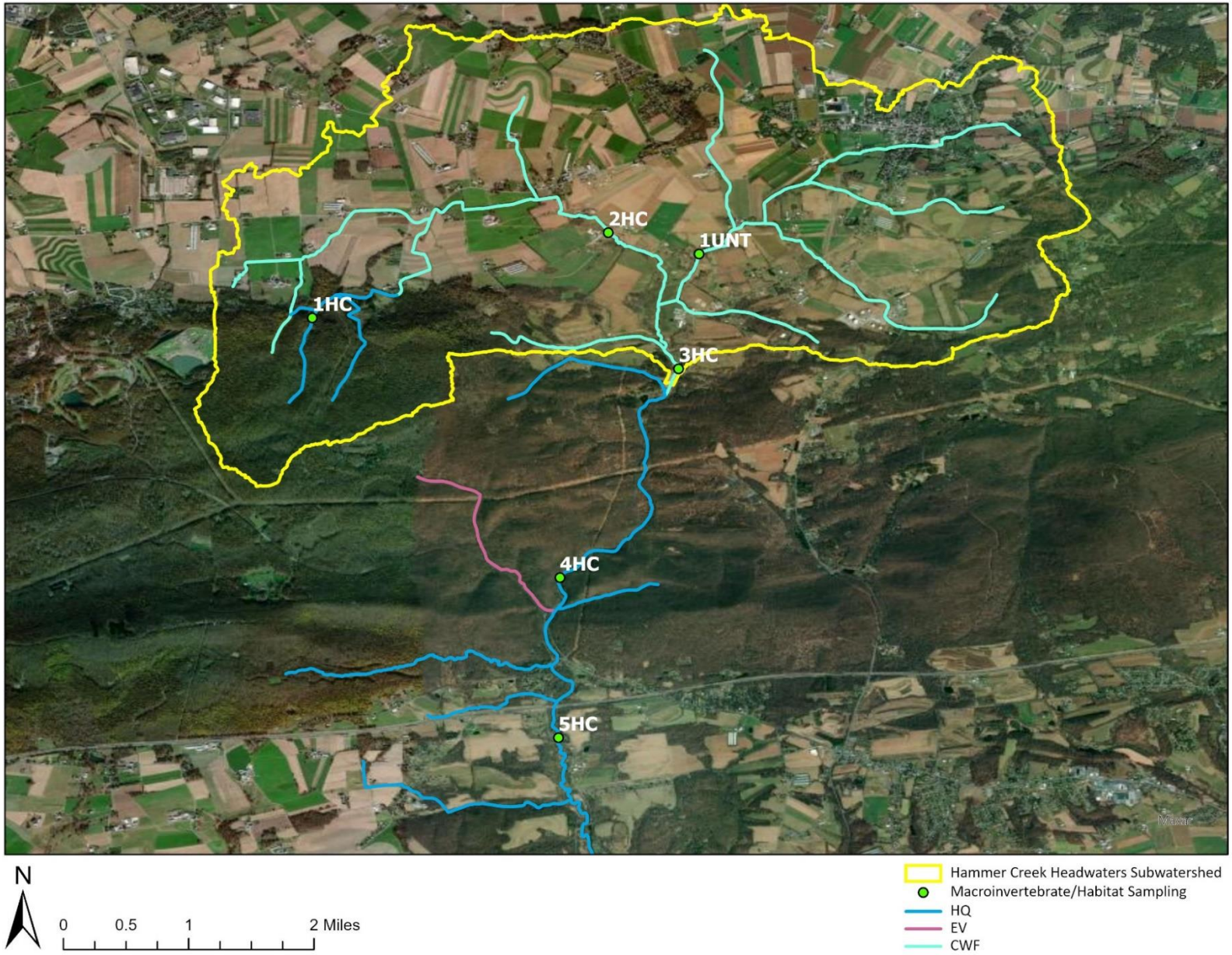

Figure 5. Macroinvertebrate/physical habitat sample stations and Chapter 93 stream designations in the Hammer Creek headwaters watershed and downstream mainstem. HQ = High Quality, CWF= Cold Water Fishes, EV = Exceptional Value.

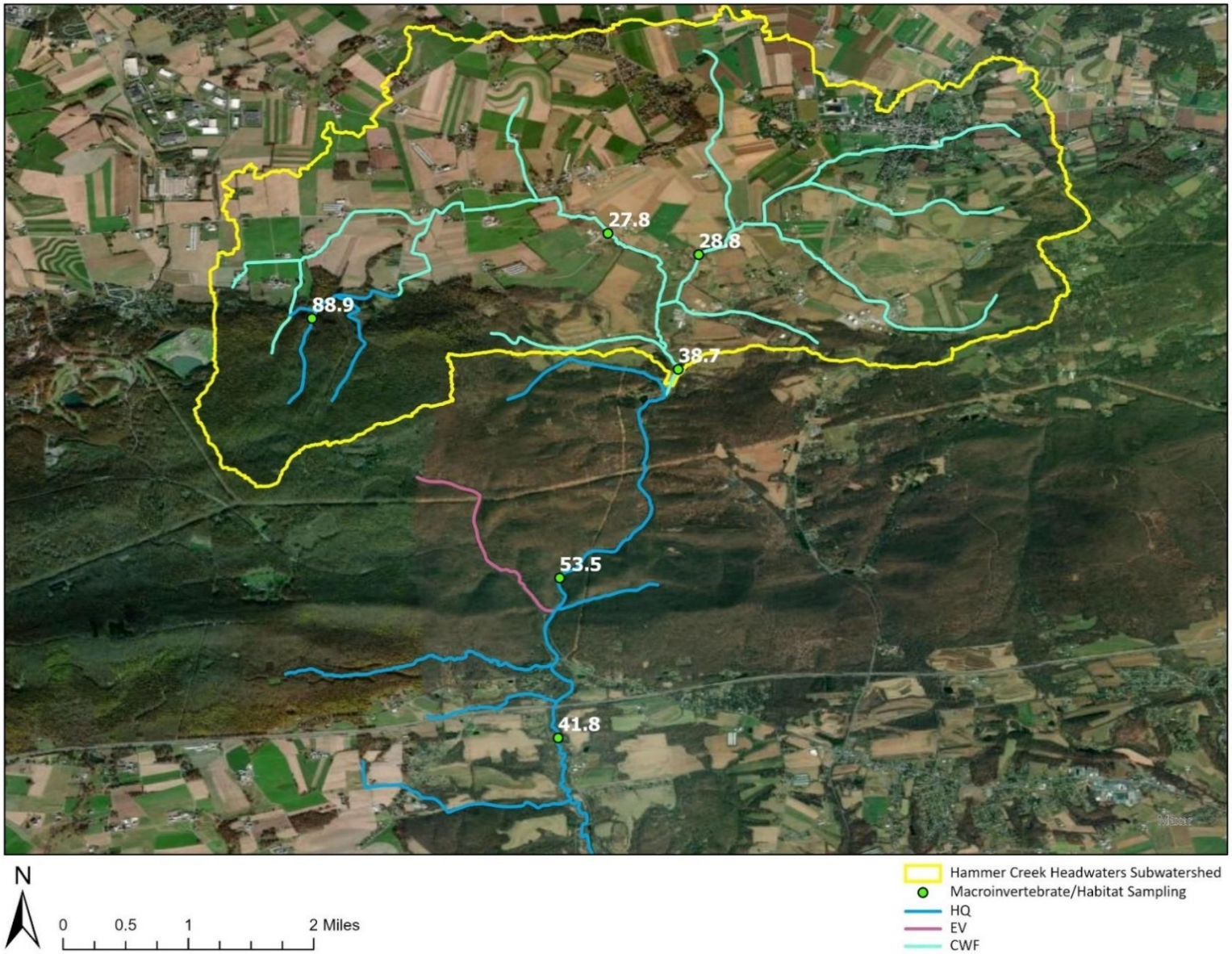

Figure 6. Benthic macroinvertebrate IBI scores for the Hammer Creek headwaters watershed and downstream mainstem. These scores are evaluated against thresholds of either 43 for stream segments designated Cold Water Fishes (CWF), or 63 for stream segments designated High Quality (HQ) (Shull 2017).

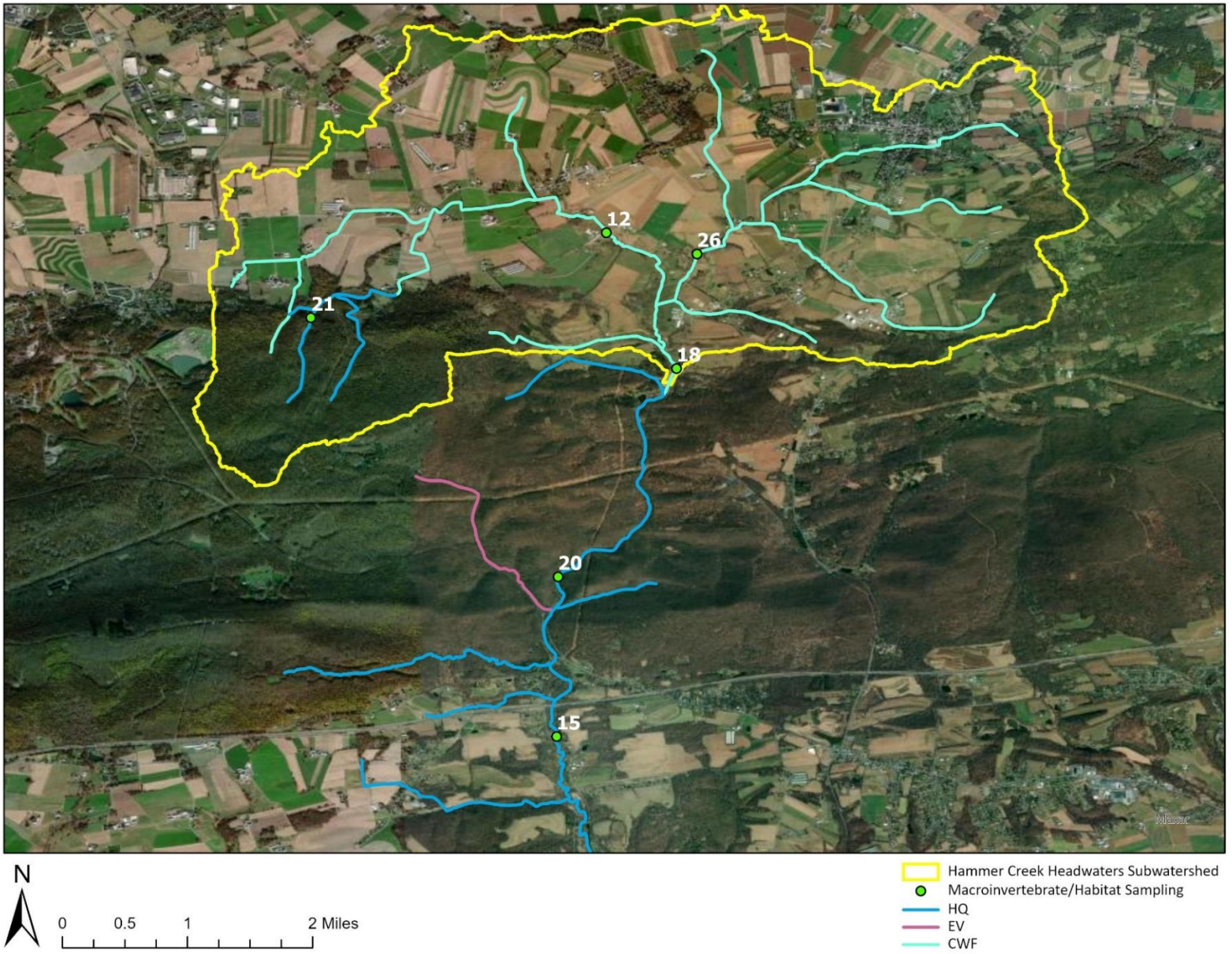

Figure 7. Sediment deposition plus embeddedness couplet scores in the Hammer Creek headwaters watershed. Scores ≤24 are indicative of impairment for siltation (Walters 2017).

Given the results of this sampling, DEP's assessment biologist has now determined that the mainstem of Hammer Creek, below the study subwatershed, is also impaired by siltation and habitat degradation. Its official status was updated accordingly in DEP's 2024 Integrated Report, and a copy of the biologist's assessment report is included in Appendix C. Despite this change, the ARP will continue to focus exclusively on the headwaters area as originally delineated. For one, much of the excessive sedimentation occurring in Furnace Hills area likely originates from the intensive agriculture located further upstream. And, while investigation of the downstream mainstem also suggests localized problems associated with legacy sediments from historic milldams, there is already more than enough work to do in the headwaters area during plan's ten-year time period. Also, other groups, such as The Donegal Chapter of Trout Unlimited and DEP's Waterways and Wetlands section have begun exploring the possibility of stream and floodplain restoration in the Furnace Hills area.

The aforementioned habitat scoring methodology done along with macroinvertebrate sampling is qualitative and somewhat subjective, as it relies on an observer rating habitat according to descriptions of optimal, suboptimal, marginal and poor conditions (Walters 2017). Thus, additional methodology was developed with the hopes of detecting sediment reductions in a more quantitative way. This methodology, as described in the ARP, seeks to evaluate fine sediment deposits within riffles using a modified pebble count procedure, and within pools by driving a rod into the streambed. The Hammer Creek mainstem near the outlet of the subwatershed was sampled using this methodology in October 2019 as part of ARP development. The main eastern and western branches were then sampled during December of 2021 using similar methodology (Figure 8). Results from this sampling indicates greater streambed fine sediments deposits in all three Hammer Creek samples sites versus a site near the outlet of the reference watershed that was used to prescribe the sediment reduction goals (Figures 9 and 10). Interestingly, consistent with the qualitative physical habitat screening, these more quantitative methods also suggest lesser fine sediment deposits at the site on the main eastern branch of the headwaters subwatershed versus the other Hammer Creek sites.

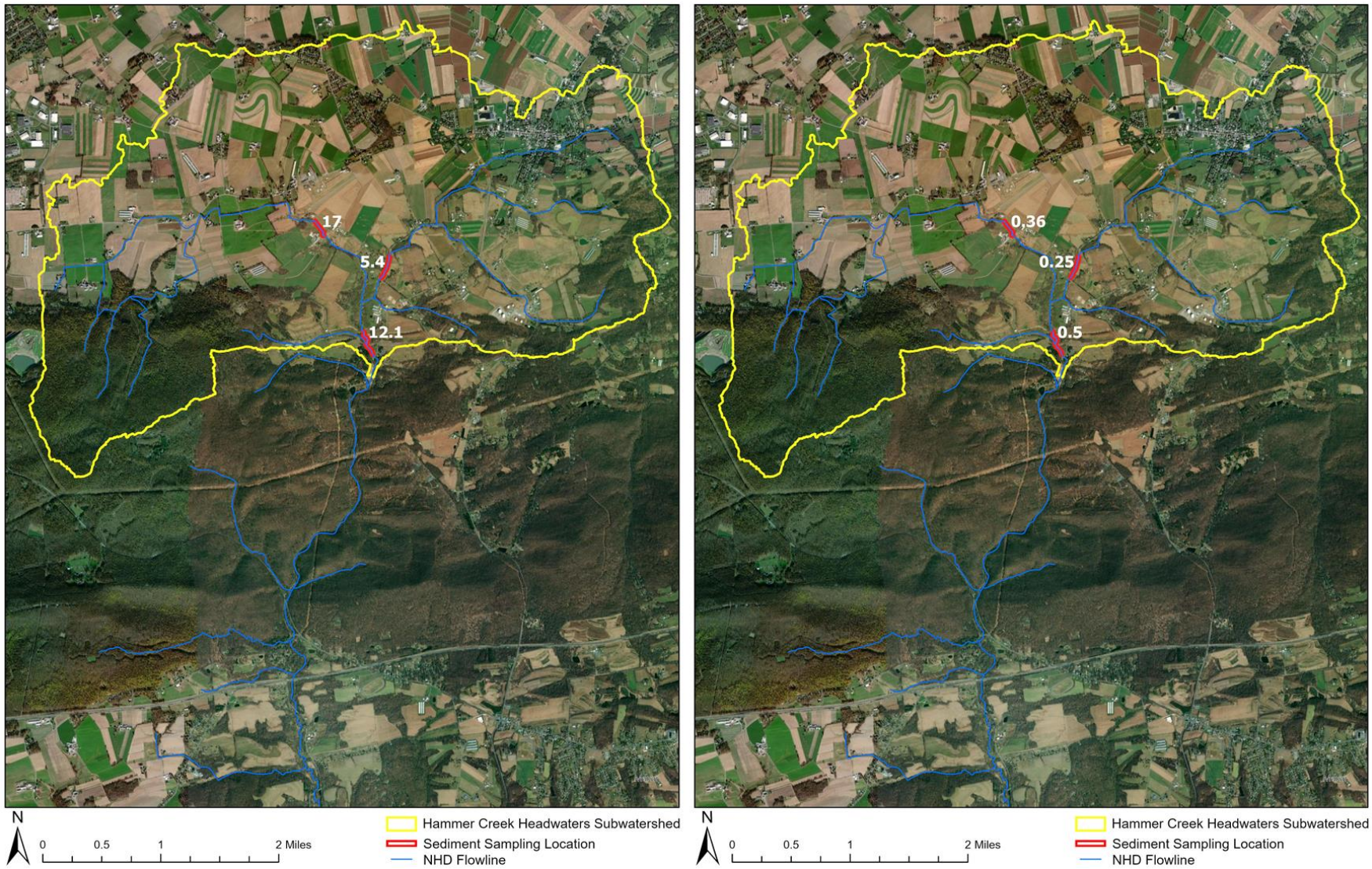

Figure 8. Fine sediment deposit sampling within the Hammer Creek headwaters watershed. The left panel shows estimated mean depth of fine sediment deposits in pools. Measurements were made by driving a probe into five consecutive, large, main channel pools within each study reach. The right panel shows mean proportion of sampling points dominated by <2mm (sieve size) deposits within riffles. Measurements were made using a modified pebble count procedure in five consecutive main channel riffles within each study reach. See the original ARP for more information on methods.

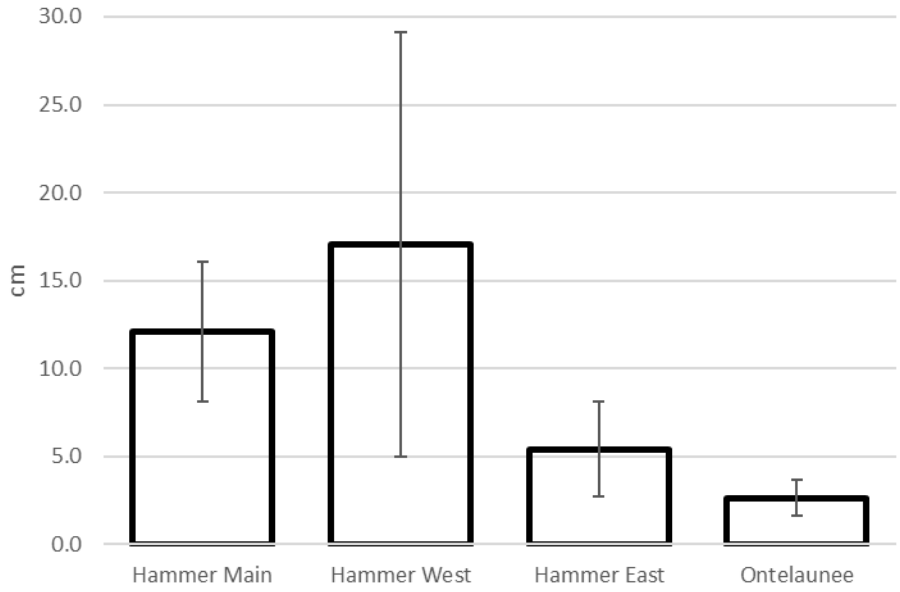

Figure 9. Mean (+/-sd) depth of fine sediment deposits in pools, as estimated by driving a probe into the streambed. Measurements were made on five consecutive, large, main channel pools within each study reach. See the original ARP for more information on methods. See Figure 8 for Hammer Creek sampling locations. “Ontelaunee” refers to the reference stream used to generate sediment load reduction goals in the original ARP.

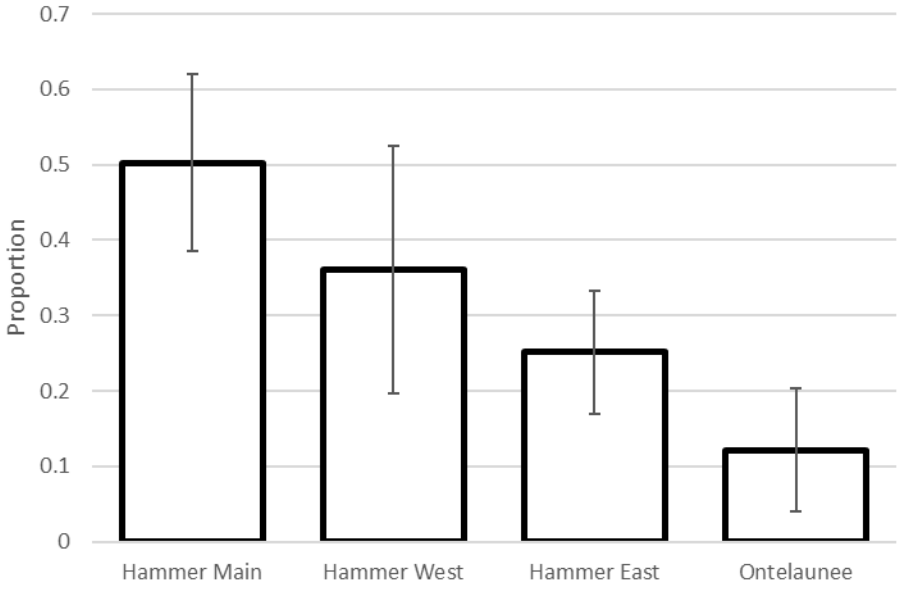

Figure 10. Mean (+/-sd) proportion of sampling points dominated by <2mm (sieve size) deposits within riffles. Measurements were made using a modified pebble count procedure in five consecutive main channel riffles within each study reach. See the original ARP for more information on methods. See Figure 8 for Hammer Creek sampling locations. Ontelaunee refers to the reference stream used to generate sediment load reduction goals in the original ARP.

One exciting development for the ARP is that the United States Geological Survey (USGS) has recently installed a continuous instream monitoring (CIM) station (also known as a super gage) near the outlet of the study subwatershed, near the Obie Road crossing (Figure 11). This is part of a local, state and

federal partnership project to carefully track pollution load reductions from BMP implementation, and this site was chosen in large part due to the Hammer Creek ARP. As of November of 2023, this monitoring station collects water level, dissolved oxygen, nitrate plus nitrite, pH, specific conductance, temperature and turbidity data at 15-minute intervals, and this data is posted online at USGS's website. The plan is to use this data, along with additional water sampling and model development, to calculate pollutant loads for sediment and nutrients. For instance, regression models can be developed to predict suspended sediment concentrations from turbidity, and this along with flow data allows for the calculation of sediment loads. By collecting such data before, during and after project implementation, it is hoped to relate BMP implementation directly to reduced sediment loads in the Hammer Creek headwaters watershed. USGS's sophisticated monitoring station should greatly increase the ability to detect changing pollutant loads. Figure 12 shows an example of turbidity and stream gage height data reported for this site. DEP considers this USGS data to be "Tier 2" per Shull and Pulkett (2021).

In addition to the USGS monitoring station, the Susquehanna River Basin Commission also maintains a monitoring station approximately two miles downstream of our study watershed (Figures 11 and 13). This station has been recording temperature, specific conductivity, pH, turbidity and dissolved oxygen levels every 15 minutes, dating back to July 2019. DEP considers this data to be "Tier 1" per Shull and Pulkett (2021). Further, a review of the turbidity data from this site indicates that it likely contains substantial errors associated with equipment fouling (for instance, single reading spikes of >2000 NTUs). Thus, this data would need to be screened and corrected before interpretation. Also, discharge data is not collected at this site, so it will not be useful for calculating loads. Still, this data may be useful for exploring whether turbidity may be declining as a result of the ARP.

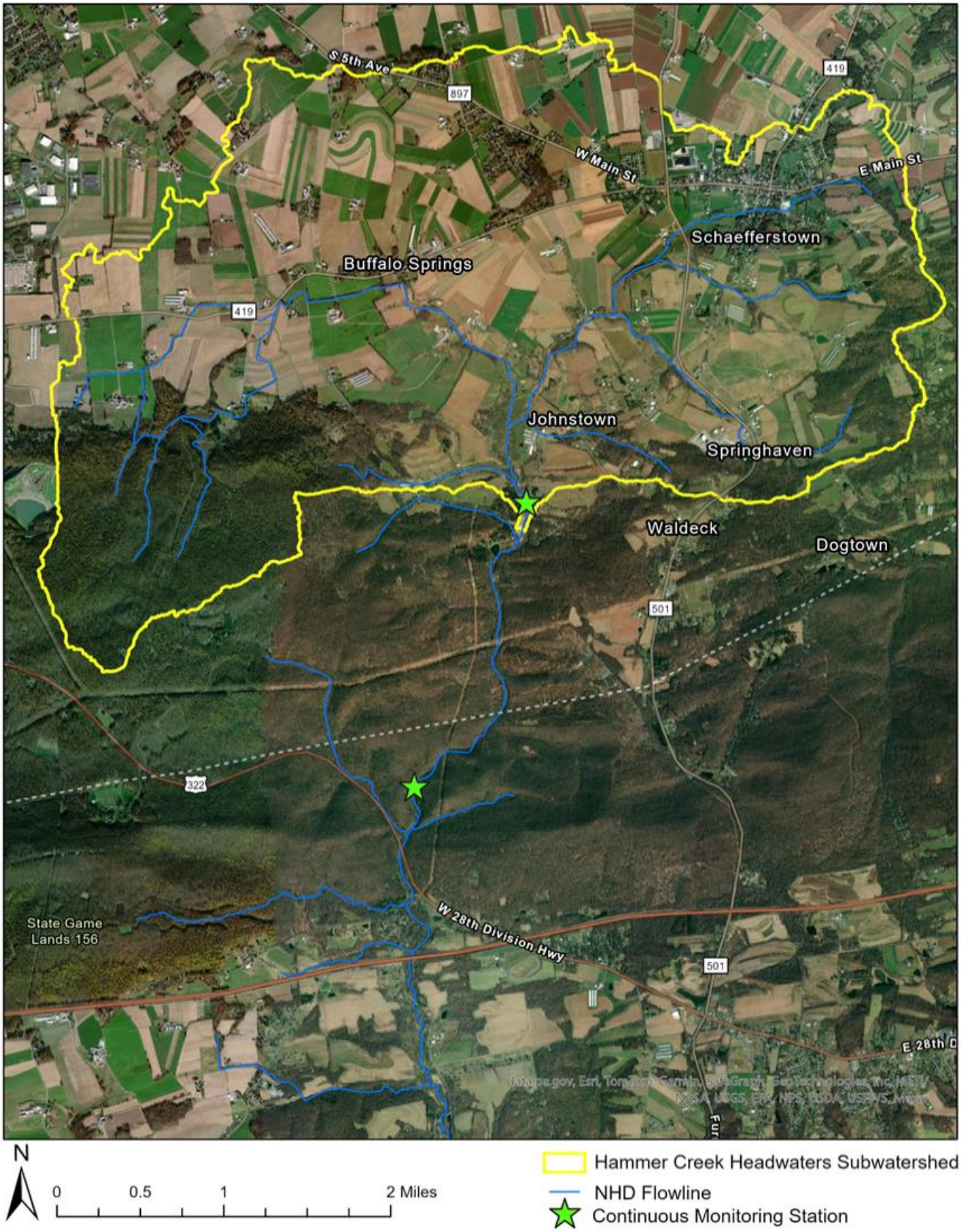

Figure 11. Locations of continuous instream monitoring stations that may be used to evaluate pollution reductions. USGS maintains a “supergage” near the outlet of the study watershed, while SRBC maintains a station within the Furnace Hills area approximately two miles downstream.

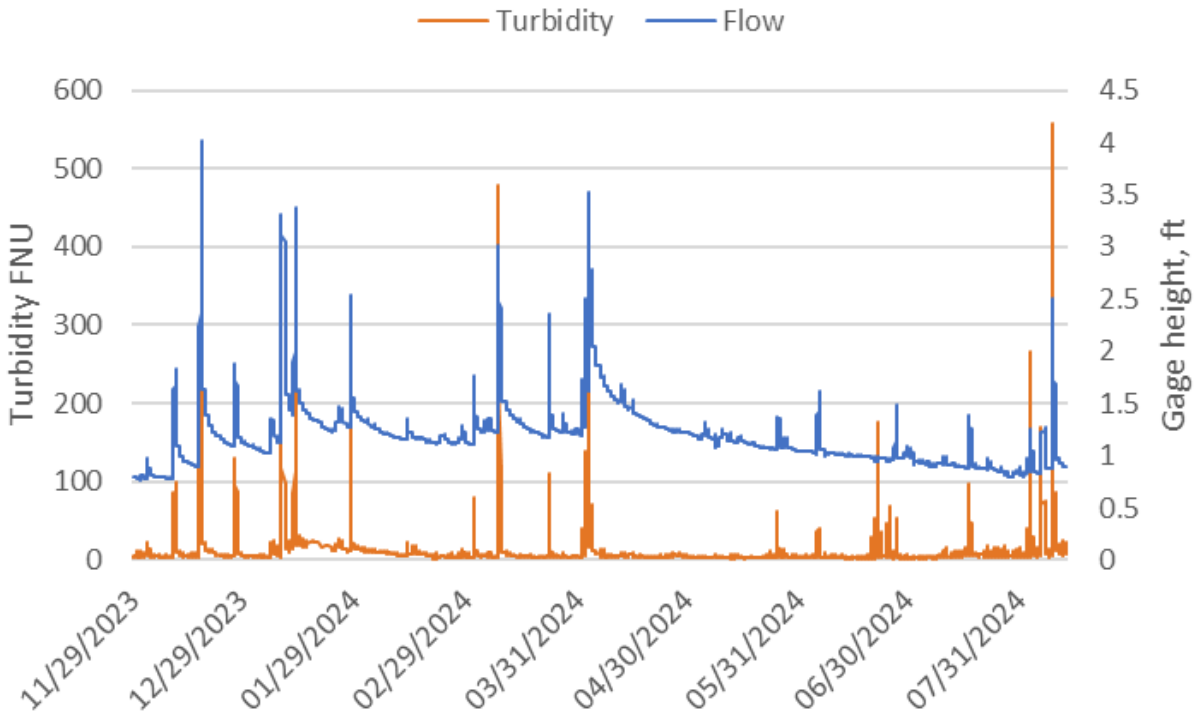

Figure 12. Summary of turbidity and stream gage height from the USGS supergage near the Hammer Creek study watershed outlet at Obie Road (see Figure 11). Note that DEP considers this to be Tier 2 data per Shull and Pulkett 2021. Also, this data is preliminary and subject to revision.

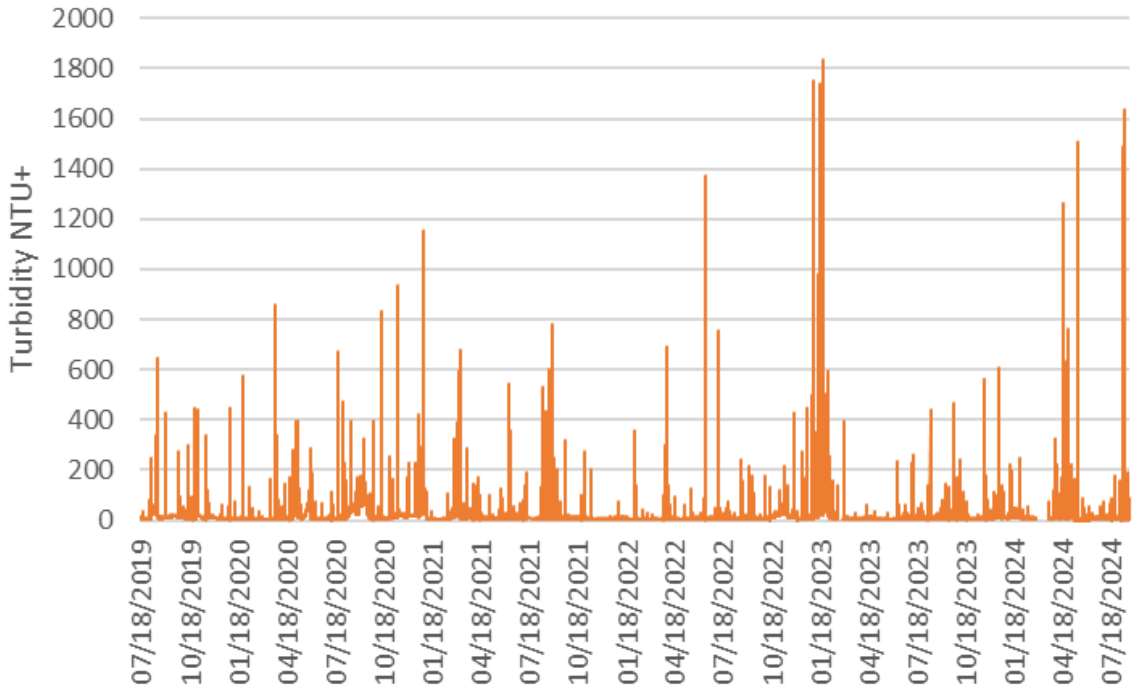

Figure 13. Summary of turbidity data from the SRBC gage located within the Furnace Hills reach approximately two miles downstream of the study watershed outlet (see Figure 11). Note that data were corrected to remove outliers of >2000 NTU. The presence of such high readings occurring at single15-minute interval points strongly suggests errors associated with equipment fouling. Note that DEP considers this to be Tier 1 data per Shull and Pulkett (2021).

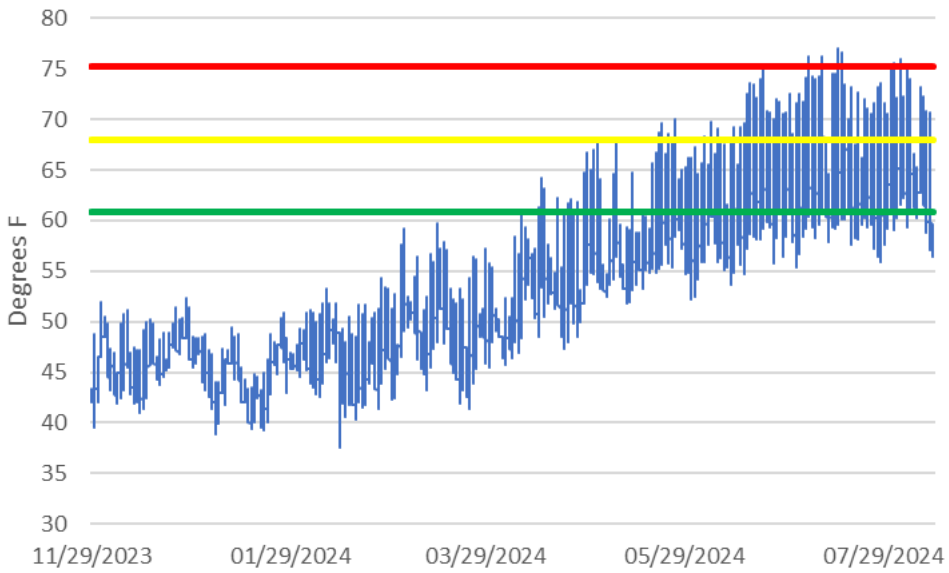

Figure 14. Temperature data from the USGS "super gage" near the Hammer Creek study watershed outlet at Obie Road (see Figure 11). The lower (green) horizontal line approximates the upper temperature limit for optimal Brook Trout growth, the middle (yellow) line approximates the point beyond which Brook Trout may not thrive, while the upper (red) line approximates the point where temperatures may become intolerable for Brook Trout (Raleigh 1982). Note that DEP considers this to be Tier 2 data per Shull and Pulkett 2021. Also, this data is preliminary and subject to revision.

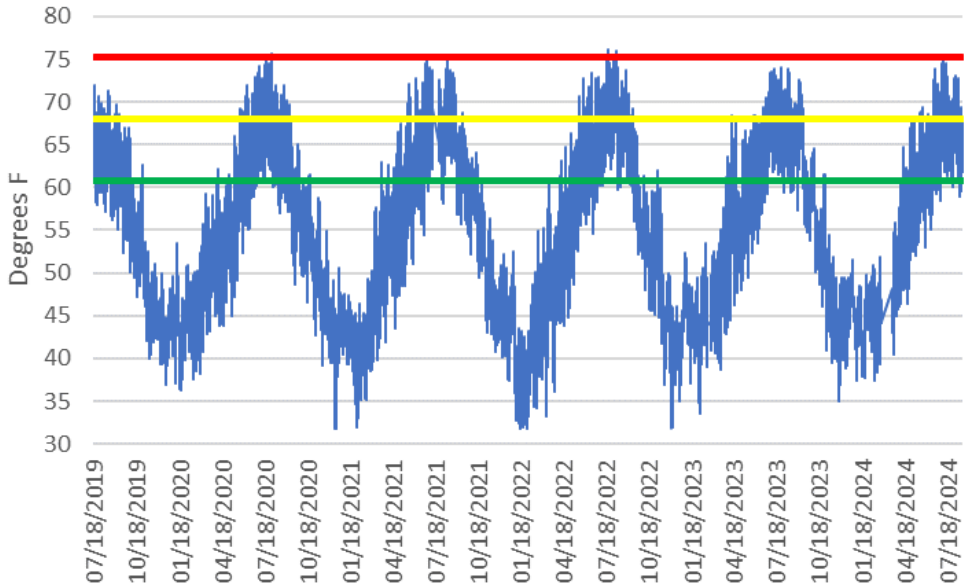

Figure 15. Continuous instream monitoring temperature data from the SRBC gage located within the Furnace Hills reach approximately two miles downstream of the study subwatershed outlet (see Figure 11). The lower (green) horizontal line approximates the upper temperature limit for optimal Brook Trout growth, the middle (yellow) line approximates the point beyond which Brook Trout may not thrive, while the upper (red) line approximates the point where temperatures may become intolerable for Brook Trout (Raleigh 1982). Note that DEP considers this to be Tier 1 data per Shull and Pulkett (2021).

Temperature is also of interest within this watershed, since many Pennsylvania streams get too warm during summer months to harbor trout. As explained in the ARP, the upper Hammer Creek watershed maintains wild trout populations, in large part due to cold water inputs from karst springs. In fact, the presence of wild trout and its popularity as a fishery were major reasons for ARP development. Thus, an analysis was made of existing temperature data at the two continuous instream monitoring stations. These results suggest that temperatures regularly exceed the upper limit beyond which Brook Trout (the natives species) may not thrive, and approach or even exceed the limit beyond which may be intolerable to Brook Trout (Figures 14 and 15, see also Raleigh 1982). The nonnative trout species commonly found in this watershed, Brown Trout, may be able to tolerate slightly higher temperatures (Raleigh 1986). Still, these results must be interpreted with caution, as the findings of temperature tolerance studies vary somewhat due to factors such as differing populations and acclimation conditions. And, even if the temperature at the monitoring stations did exceed tolerable temperatures, trout may persist by seeking cooler areas around tributaries and springs. It is hoped that best management practices such as riparian buffers, which may shade the stream, or floodplain restoration, which may enhance groundwater interactions, may reduce summer temperatures and make Hammer Creek more suitable for native Brook Trout.

In July of 2019, while plans for ARP development were being formed, the fish community within the Hammer Creek watershed was sampled and analyzed in accordance with protocols and methods that would become DEP's *Fish Data Collection Protocol* (Wertz 2021a) and DEP's *Stream Fish Assemblage Assessment Method* (Wertz 2021b). See Figure 16 for sampling locations and Table 5 for results. Thermal Fish Index (TFI) scores were calculated for each sample and then compared to drainage area group thresholds provided in Wertz (2021b). Given that the Hammer Creek watershed had sinkhole densities of >0.55 sinkholes/km^2 and drainage sizes were <1000km^2, TFI scores greater than 5.7 would indicate impairment. This being the case, the main western and eastern branches of the headwaters area, as well as the mainstem below in the Furnace Hills area, exhibited communities that would not be impaired by the TFI (Table 5 and Figure 16). However, the lower mainstem site was just below the impairment threshold. TFI scores are responsive not only to temperature changes, but also changes in habitat and water quality (Wertz 2021a). Thus, it is hoped that the ARP will result in improved TFI scores and the prevention of future impairment via both improved both water quality and cooler summer stream temperatures.

While the primary goal of the ARP is the remediation of siltation impairments, trout populations are also a motivating factor for restoration, particularly for Trout Unlimited and residents who enjoy Hammer Creek as a fishing resource. Thus, Figure 16 also shows the number of Brook and Brown Trout caught during the electrofishing survey, per approximately 100m sample reach. Multiple Brown Trout were found at all three sites, with the greatest numbers in the lower mainstem/Furnace Hills sampling area. As for the native species, a single Brook Trout was found in the western headwater branch and in the lower mainstem, while no Brook Trout were found in the eastern branch. Finally, the figure also shows that large numbers of slimy sculpins were also found in the headwaters area. This species is of particular interest because, like Brook Trout, it is assigned the lowest (1- cold) thermal preference value (Wertz 2021b). According to DEP's fish biologist, suitable sculpin habitat is rare in this part of the state due to agricultural practices, and most remaining populations are relegated to forested areas near

mountains (personal communication). The fact that slimy sculpins are able to persist in valley areas of Hammer Creek illustrates the importance of karst springs in maintaining a coldwater communities.

Table 5. Results of July 2019 fish community sampling in the upper Hammer Creek basin.

			STATIONS[1]		
THERMAL PREF.	**COMMON NAME**	**SCIENTIFIC NAME**	**20190703-1030-twertz**	**20190703-0900-twertz**	**20190703-1130-twertz**
	Hybrid sunfish (Lepomis)	Lepomis hybrids	-	1	-
Cold	Brook Trout	*Salvelinus fontinalis*	1	1	-
Cold	Slimy Sculpin	*Cottus cognatus*	134	-	32
Cold-Cool	Brown Trout	*Salmo trutta*	11	16	6
Cool	Creek Chub	*Semotilus atromaculatus*	1	-	3
Cool	Cutlip Minnow	*Exoglossum maxillingua*	-	3	-
Cool	Eastern Blacknose Dace	*Rhinichthys atratulus*	20	63	31
Cool	Longnose Dace	*Rhinichthys cataractae*	26	29	15
Cool	Northern Hog Sucker	*Hypentelium nigricans*	-	2	-
Cool	Tessellated Darter	*Etheostoma olmstedi*	-	8	-
Cool	White Sucker	*Catostomus commersonii*	8	5	2
Cool-Warm	Pumpkinseed	*Lepomis gibbosus*	-	1	-
		Taxa Richness	7	10	6
		Total Individuals	201	129	89
		TFI[2]	**3.2**	**5.7**	**4.4**

[1]Refer to Figure 16 for station locations.
[2]Given the karst geology of the Hammer Creek watershed, TFI scores > 5.7 are indicative of impairment.

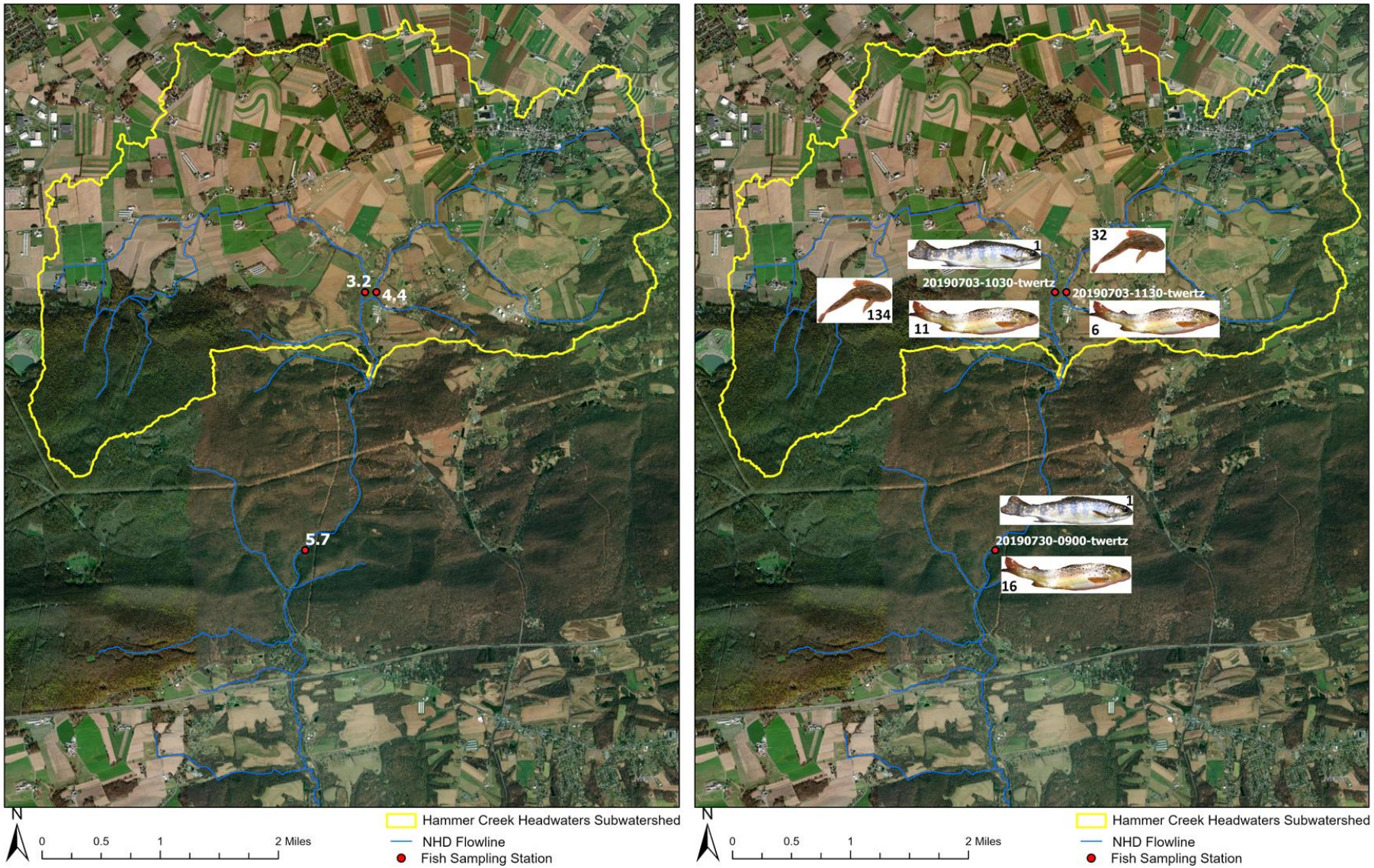

Figure 16. Summary of fish sampling results within and below the Hammer Creek headwaters watershed. The left panel shows Thermal Fish Index (TFI) scores. Per Wertz (2021a), values >5.7 indicate impairment for karst watersheds. The right panel shows the number of individuals captured within 100 m for three fish species of particular interest: Brook Trout, Brown Trout and slimy sculpins. For instance, within the western branch of the headwaters, 134 slimy sculpins, 11 Brown Trout and 1 Brook Trout were captured.

ACTIONS FOR THE SECOND TRIENNIAL PERIOD

Projects on the horizon

Depending on how the projects are broken up (by area, or by landowner, or family, etc) there should at least be about a half dozen stream restoration projects under development to some degree during the next triennial period. The “near future” sites shown in Figure 17 range from areas where parties have expressed repeated interest in stream restoration and discussions are ongoing, all the way to sites where design work is being completed. Out of concern for landowner privacy, especially where negotiations are ongoing, the use of specific site names will be avoided in the public version of this document. In total, these near future sites would restore about 17,000 feet of stream length on top of the approximately 1,040 feet that have already been restored (Figure 17). Thus, these projects, if completed, would account for most of the 22,000 feet of stream stabilization proposed in the ARP (see table 11 and Figure 16 of the original ARP). Also, while Figure 17 shows stream restoration areas, most sites will include other BMPs where appropriate, such as riparian buffers, livestock exclusion fencing, and upland agricultural BMPs. Since stream restoration tends to be popular with landowners, such projects may serve as a catalyst for the implementation of other BMPs.

The aforementioned progress so far in the implementation of agricultural BMPs is likely not a direct result of this ARP, but rather, more attributable to general trends within the county, the effort to restore the Chesapeake Bay, and the normal efforts of the LCCD. The progress that has been made however falls well short of the goals for the first triennial period. A reason for optimism, however, is that TNC received a $75,000 grant to utilize Lancaster Farmland Trust to conduct farmer outreach. Lancaster Farmland Trust employs agricultural experts who know how to talk to farmers about farming. Furthermore, as a third party without a compliance role, they can help farmers comply with legal requirements without the direct involvement of a government agency. After Lancaster Farmland Trust works with farmers to identify needs and opportunities, the ARP core partnership can then follow up with the farmers. For instance, the LCCD indicated that they can develop agricultural erosion and sedimentation plans in-house. The ARP partnership can also help coordinate between landowners, funding organizations, engineers, consultants and contractors to assist with BMP implementation. Initially, it is proposed to have Lancaster Farmland Trust make outreach visits to approximately 50 of the largest farms within the Hammer Creek headwaters watershed. In conclusion, while the ARP has not made progress on upland agricultural BMPs during the first triennial period, there now appears to be a plan and funding to initiate these efforts.

Monitoring Plans for the Next Triennial Period

The ARP proposed macroinvertebrate, fish and sediment sampling for the second triennial period. Macroinvertebrate sampling should be done sometime from November through May, especially since parts of the Hammer Creek watershed are designated High Quality (see Shull 2017). For consistency with the prior (2021) samples, ideally, such sampling would occur in December. The electrofishing data summarized in this document was from 2019. However, at the request of ARP partners, DEP again electrofished the main eastern branch, the main western branch, and the mainstem just below during June of 2023. These data are not included herein, as the data has not yet been processed by DEP. Thus, with a second sampling taken before the major implementation projects, additional

electrofishing may not be needed at this time. An additional baseline sample could be taken from the lower mainstem in Furnace Hills area, as this was not sampled in 2023, but there isn't really a strong need for this. As for sediment sampling, physical habitat screening would occur at the same time as the second round of benthic macroinvertebrate sampling, as this is DEP's normal practice. The first quantitative streambed sediment sampling in the mainstem was conducted during preparation of the ARP in October of 2019, while the main eastern and western branches were sampled in the December following ARP acceptance (2021). Thus, streambed sediment sampling should be conducted again, perhaps in late 2024 or early 2025. Note that this would be done with very similar, though somewhat improved methodology, as detailed in other recent draft ARPs. Despite the minor updates, it is expected that the newer methodology should produce very similar results. Given that few BMPs have been installed yet, these samples will largely represent additional baseline data. But, with that said, a stream restoration project has occurred at the mainstem sediment sampling site near the watershed outlet, so localized improvement is possible. Finally, barring any unforeseen developments, the USGS continuous instream monitoring station is expected to continue to operate during the next triennial period, and the project partners are not aware of any plans to discontinue the SRBC monitoring station. Finally, to explore for localized improvements, the ARP proposed additional sampling at sites where there will be major restoration projects. Such additional sampling is on hold while project plans are finalized.

Administrative Plans for the Next Triennial Period

The ARP proposed a public meeting following the release of the second triennial report. This meeting would be used to update the public on the ARP efforts and encourage additional participation. While it is hoped to have a final triennial report available during fall of 2024, the next public meeting may be delayed, for perhaps a year, with the following justification. While the original ARP was finalized in April of 2021, the first public meeting was delayed until June of 2022, in part because of the COVID-19 pandemic. It is desired to keep meetings interesting and informative, and thus not too frequent. Based on internal discussions among the project partners, it is tentatively planned to have a meeting in June of 2025.

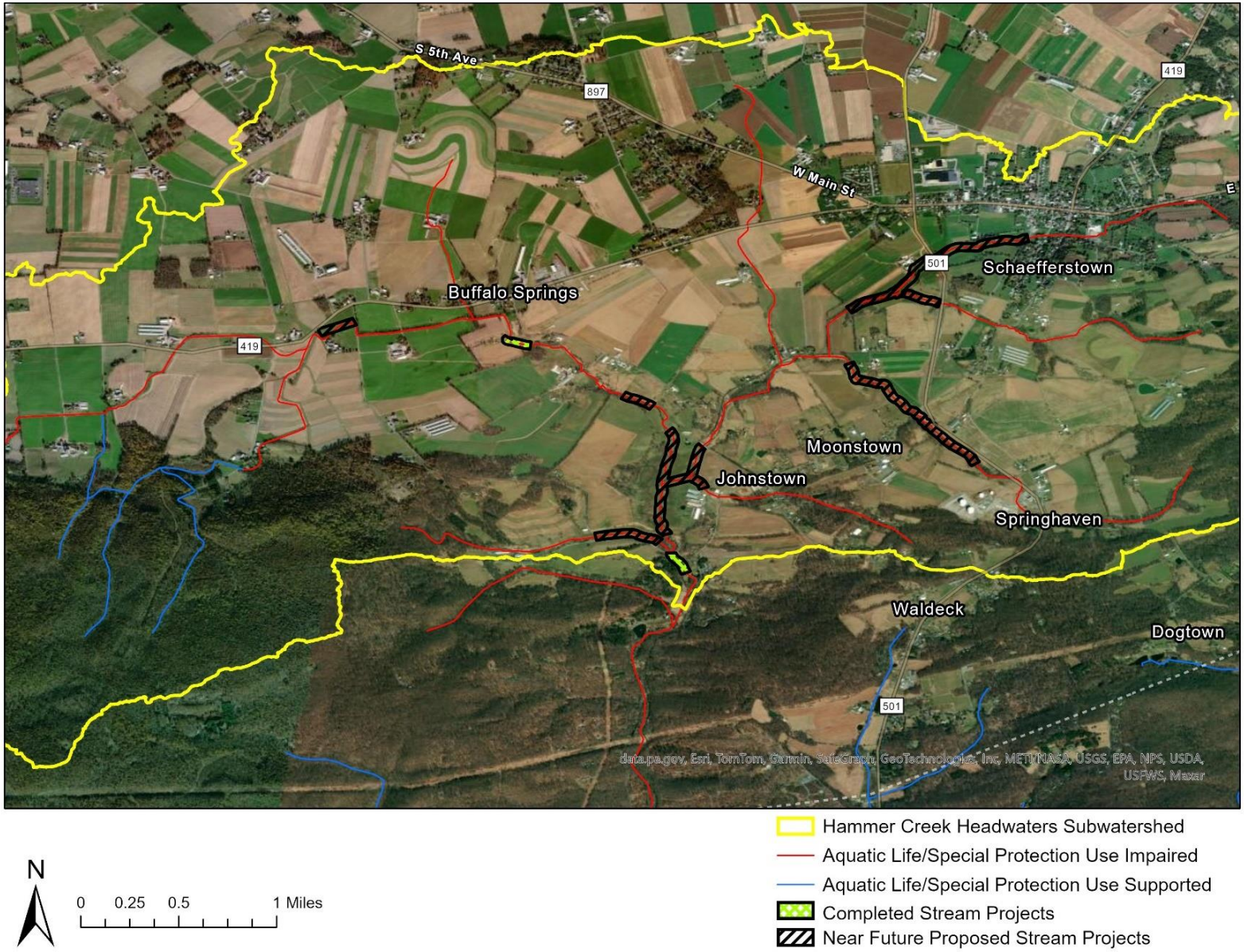

Figure 17. Summary of potential near-term stream restoration projects. The proposed sites shown above range from areas where parties have expressed serious interest in multiple discussions, all the way to sites where design work is underway. The map also shows two recently completed small stream restoration sites.

UPDATES TO THE ARP

Firstly, as was explained previously in the “Project Organization” section, the core partnership that administers the ARP has grown to consist of five major groups (DFTU, DEP, TNC, the LCCD and consultants). Project structure may continue to evolve at the discretion of the lead implementation partner, DFTU.

Secondly, the original ARP proposed a much simpler scheme to credit conservation tillage, with fields being classified generically as conservation tillage or not, and with one sediment reduction coefficient of 41%. However, given the availability of detailed tillage practice transect data, it is now proposed to credit tillage practices in a more sophisticated manner that considers the distribution of conventional, low, medium and high residue classes, as was detailed in the “Recent BMP Implementation and the Crediting of Sediment Reductions” section. Future crediting maybe based on data that is being collected for Chesapeake Bay restoration crediting, but there has also been discussion of collecting such data specifically within the Hammer Creek headwaters watershed. In a similar manner, cover crop crediting is proposed to use a slightly more sophisticated method than proposed in the original ARP, including that it will now be based on the estimated loading rate for crop fields using conventional tillage.

With regard to BMP implementation, the ARP was intentionally written to be flexible and allow for “adaptive management”. For instance, the caption for Figure 16 of the original ARP, which shows physical BMP opportunities, states: “note that other BMP opportunities may exist in other areas and it is not intended to limit physical BMPs to only those opportunities shown on this map”. Page 31 states: “it should be noted that there are likely be other BMP opportunities beyond what is envisioned here, and what is ultimately implemented will be largely dependent on the landowner’s preferences”. Figure 23, which shows a timeline of goals, includes a caption that says: “the above are “target goals” rather than firm commitments. Furthermore, other BMPs may be substituted in as opportunities arise.” As project partners form relationships with landowners and more sites are visited, better information about BMP opportunities becomes available. For instance, potential stream restoration sites have now been identified in the western part of the watershed, and these were not included in the original ARP.

As the project has developed, there has been discussion among the partners about the greater potential for ecological uplift associated with a full floodplain rather than a bank stabilization approach to stream restoration. Furthermore, the floodplain wetland restoration approach was strongly advocated for by DEP’s Section 319 and Waterways and Wetlands programs.

TNC conducted a watershed-wide spatial data analysis that evaluated a variety of stream and landcover condition datasets, nutrient loading rates, topographic wetness, and the extent and condition of existing and restorable wetlands to develop a more holistic list of potential floodplain/wetland project sites. Where feasible and when warranted by geotechnical analysis, a comprehensive process-based approach via legacy sediment removal is now preferred. Such an approach may: 1) Improve water quality by reducing bank and bed erosion; 2) restore critical wetland

floodplain wildlife habitat; and 3) re-establish floodplain functional processes, such as sediment and nutrient sequestration as well as stream, hyporheic, floodplain hydrogeologic interactions. Results of the desktop analysis of potential project sites were coupled with practitioner and landowner insights to create a list of restoration opportunities, which was then prioritized into tiers. Lead outreach partners were identified for each priority parcel, and additional site visits were initiated across targeted watersheds. Efforts are being coordinated among partner organizations through regular communication and the use of an online database that tracks: landowner outreach efforts, the role of each partner in these efforts, and property-specific needs and opportunities. (Jonathan Niles, TNC)

In the original ARP, there was only one major critical site where more expensive (projected $350/ft capital cost) comprehensive stream restoration was proposed. The other areas were proposed to use a simpler bank stabilization approach with an assumed $75/ft capital cost (See Figure 16 of the original ARP). Favoring a more comprehensive restoration approach is now expected to increase project costs. For instance, the total capital cost of the 14,067 feet originally proposed for streambank stabilization was estimated to be $1,051,460. But, this cost estimate increases to $4,923,450 if a legacy sediment removal approach is used for all of these areas. Use of legacy sediment removal at all these sites is probably an unrealistic assumption though, so the true cost may lie somewhere in between. Given the flexible language used in the original ARP, the partners have already adapted their plans without the need to formally update the ARP. Nevertheless, this triennial report presents a convenient time to explain these changes. Thus, updated mapping of stream restoration opportunities is shown in Figure 17. But, as was the case in the original ARP, this is in no way meant to limit the pursuit of or crediting of other BMP opportunities that may be discovered but are not shown in this map.

CONCLUSIONS

- There has been much landowner education and outreach, including phone calls, site visits, a mailing, a pamphlet, a newspaper article and a public meeting.
- Expertise, capabilities and devotion has grown with the inclusion of additional partners. There are now 5 core partners, including: DFTU, DEP, TNC, LCCD, and consultants. Partners remain engaged through regular bimonthly meetings.
- Much effort has been devoted to fundraising, resulting in more than 2.5 million dollars available for the project. However, it remains to be seen whether sufficient construction funding can be generated for large-scale legacy sediment removal projects.
- The need for fundraising plus lengthy design, permitting, and landowner negotiation processes result in lag times between ARP development and project implementation. Thus, the original BMP implementation goals were too ambitious for the first triennial period.
- Two small stream restoration projects have been completed. Some progress has also been made with agricultural BMPs, though not as a direct result of the ARP.
- Recent declines in crop residue levels in the county may have led to large increases in sediment loading during the first triennial period. The underlying cause(s) of this has not been definitively determined, but such a trend has occurred and reversed itself in the past. Farmer

outreach visits and the promotion of Agricultural Erosion and Sedimentation Plans may help reverse this trend.

- Baseline monitoring data has been collected for: benthic macroinvertebrate and fish communities, habitat and sediment deposits.
- Based on new assessment information, the mainstem below the study watershed is now listed as impaired.
- USGS has installed a “supergage” continuous instream monitoring station near the study watershed outlet. This may allow pollutant load monitoring with outstanding levels of accuracy and precision. This, and the Susquehanna River Basin Commission station further downstream, will also allow for the monitoring of temperature and turbidity.
- Landowners have shown substantial interest in stream restoration projects, and several are now “in progress”. This ranges from discussions and negotiations all the way to design work. If these projects all go forward, they would constitute most of the stream restoration/bank stabilization proposed in the original ARP.
- While the agricultural BMP goals of the first triennial period have not been met, there is now funding to have Lancaster Farmland Trust visit farms for the promotion of agricultural and other BMPs. The LCCD can provide farmers with agricultural erosion and sedimentation plans.
- While the ARP was purposely written to be flexible, updates to what was originally envisioned include: additional core partners, a more sophisticated crediting scheme for tillage practices, an expansion of stream restoration opportunities, and a focus on legacy sediment removal rather than simpler bank stabilization projects.
- While the project has fallen well behind on the BMP original implementation goals for the first triennial period, the project is now gaining momentum, with plans shaping up for both stream restoration and agricultural BMPs. Thus, continuation of the ARP is strongly recommended.

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APPENDIX A: PUBLIC EDUCATION MATERIALS

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

May 19, 2022

Dear resident of the Hammer Creek watershed or other interested party:

We are writing to invite you to a public meeting that will be held on June 6, 2022 at 7pm at the Heidelberg Township building. The meeting will be hosted by the Doc Fritchey Chapter of Trout Unlimited and the Pennsylvania Department of Environmental Protection. The purpose of the meeting will be to discuss the watershed restoration efforts for the headwaters of Hammer Creek in Lebanon County.

Topics for discussion will include: why Hammer Creek has tremendous potential as a wild trout fishery, current water quality problems, funding for best management practice implementation, and opportunities for landowner involvement.

If you are interested, you may access a copy of the restoration plan for this watershed by typing “Hammer Creek ARP” into an internet search engine.

All people interested in this watershed are welcome to attend.

The address of the Heidelberg Township Building is 111 Mill Road, Newmanstown, PA 17073.

If you have questions in advance of the meeting, feel free to call me at 717.772.5670.

Sincerely,

Michael Morris
Water Program Specialist

Hammer Creek Watershed Restoration Meeting

A public meeting will be held on
June 6, 2022 at 7pm
to discuss watershed restoration efforts
in the headwaters of Hammer Creek
in Lebanon County.

Hosted by the Doc Fritchey Chapter of Trout Unlimited
&
Pennsylvania Department of Environmental Protection

An overview will be given of a recent comprehensive restoration plan that has been developed for this watershed.

The plan is available for review, click below
https://files.dep.state.pa.us/Water/BWEW/Watershed%20Management/WatershedPortalFiles/NonpointSourceManagement/ProgramInitiatives/ImplementationPlans/Hammer_Creek_ARP_Final_EPA_Accepted_Draft.pdf

Topics for discussion will include: Why Hammer Creek has tremendous potential as a Native brook trout fishery; current water quality problems; proposed solutions to those problems; funding for Best Management Practice (BMP) implementation; and opportunities for landowner involvement.

All people interested in this watershed are welcome to attend.

Hammer Creek Headwaters Public Meeting

June 1, 2022

7:00 pm Brief Introduction and explanation of Doc Fritchey Chapter TU……Russ Collins, DFTU

7:10 pm Overview of the Hammer Creek ARP……..Mike Morris, PA DEP

7:40 pm Native Brook Trout potential in Hammer Creek……..Jim Suleski, DFTU

7:55 pm Federal and State Funding Opportunities……Scott Heidel, PA DEP

8:05 pm Role of the Lebanon CCD and funding opportunities…..……MaryKate Gallagher, Lebanon CCD

8:15 pm Questions and Discussion

What are some key BMPs?

Proposed Best Management Practices (BMPs) designed to keep these precious soils on the farm and out of the stream were chosen for feasibility and **cost-effectiveness. Suggested key locations** for structural BMPs are shown on the included map, but implementation **will ultimately depend on landowner preferences.** The following explains some of the key BMPs.

Conservation Tillage- no-till and low-till practices maintain high amounts of crop residues that shield soils from erosion. These practices also improve soil health and promote water retention, which decreases runoff. It is suggested that these practices be used wherever feasible.

Riparian Buffers- keeping a strip of forest or other natural vegetation along the stream is perhaps the most important BMP of all. In addition to filtering pollutants such as sediment, nutrients and pesticides from runoff, riparian buffers help create good stream habitat.

Precision Grass Filter Strips- Exposed soils travel to streams via drainage networks that are normally dry but flow after heavy rains. If unprotected, these drainage networks then discharge muddy water to streams at concentrated locations. Tall grass buffers along these drainageways may filter out most of the eroded soils before they reach the stream.

Stream Restoration-seeks to repair eroding streambanks and degraded stream habitat resulting from a legacy of stressors such as the clearing of streamside forests and wetlands, the grazing and cropping along stream banks, the construction of historic milldams, and the streamside deposition of soils.

We need help!

If you are interested in implementing BMPs or helping with these efforts, please contact:
Russ Collins of **Doc Fritchey Trout Unlimited**
phone: 717-580-3958; email: russ@dftu.org

Other contacts:
Mike Morris, **PA DEP:** 717-772-5670
Lebanon Co. Cons. Dist: 717-277-5275
NRCS Service Center: 717-376-3513

USFWS Public Domain Image by Duane Raver

Hammer Creek Headwaters

Restoration Plan

TROUT UNLIMITED
DOC FRITCHEY CHAPTER

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Clean Water

Hammer Creek has the potential to be a great trout stream in a part of the state that doesn't have a lot of wild trout…

What makes Hammer Creek special? For one, much of the valley areas of the Hammer Creek headwaters are underlain by limestone and dolomite bedrocks. These "karst" formations create features like sinkholes, caves, underground streams and ***cold, clear springs***.

Spring-channel off of Old Mill Rd

These springs provide the ***cold water that trout need***. A second key factor is terrain. After the valley tributaries converge, Hammer Creek turns south and cuts through the Furnace Hills. These forested hills make for a swifter, shadier stream, thus providing ***wilder habitat where trout could thrive***.

Hammer Creek in the Furnace Hills

When combined, these two factors are known to create ***some of the best trout streams in Pennsylvania.***

So what is the problem then?

Karst geology not only makes some of the best trout streams, but also **some of the best agricultural soils**. Thus, the Hammer Creek headwaters watershed has harbored thriving agriculture for centuries. This has been great for us, as we all benefit from being well fed and having a prosperous economy.

However, the clearing of forests, the tilling of croplands and the grazing of livestock exposes soils. Once uncovered, these precious soils can be washed to the stream during storms, causing the stream to be muddy. So much mud can settle out on the stream bottom that many aquatic invertebrates, which are the most important part of a trout's diet, may die off. Furthermore, trout may lose the rocky streambed that they need to lay their eggs.

While agriculture is often the biggest source of stream siltation, additional factors such as historic milldams, that have ponded the stream, and urbanization, which can increase bank erosion, contribute as well.

Hammer Creek near Obie Road

The good news is that Hammer Creek still harbors a limited wild trout population. The bad news is that some areas are so severely degraded by siltation that the water is murky and streambed is blanketed with thick layers of mud and sand, as in the above photo.

And then there is Speedwell…

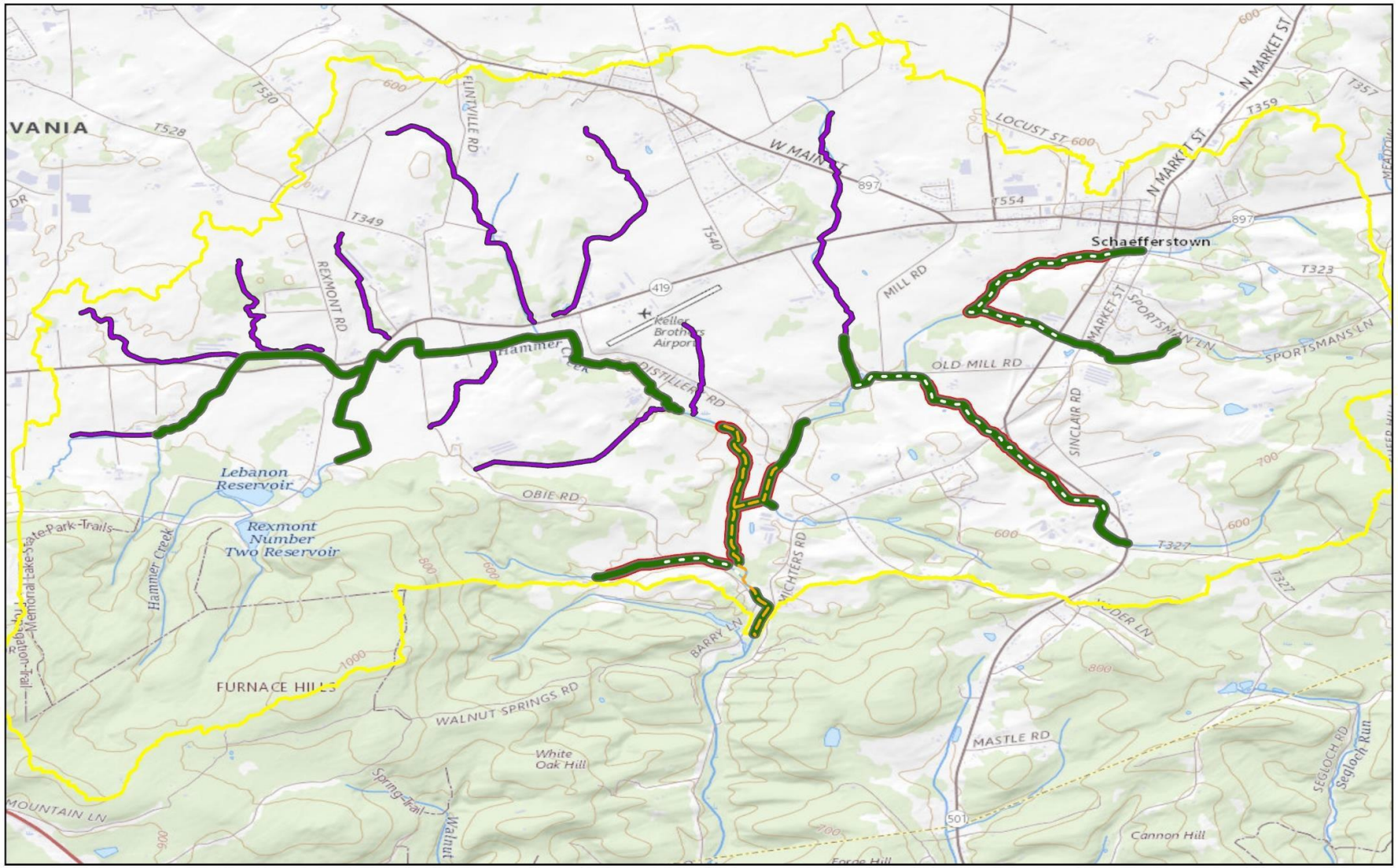
Soils eroded from the headwaters area can cause expensive problems downstream in Speedwell Forge Lake. Excessive sediment loading accelerates the filling of such reservoirs, which over time, may make the lake shallow, muddy, and result in poor water quality and fish habitat. The Speedwell Forge dam was recently rebuilt at a cost of over 4 million dollars. In addition to this, more than $400,000 was spent to remove just a small amount of the mud that had accumulated on the lake bottom. It would likely have cost millions of dollars to get it all.

What is the solution?

The Doc Fritchey Chapter of Trout Unlimited is partnering with the PA DEP for the implementation of a comprehensive restoration plan for the Hammer Creek headwaters. The goal is to reduce the sediment load by about half. The plan itself ***does not*** **create new legal requirements for landowners.** Rather, it hinges on **voluntary cooperation.**

> *"I really think we can have thriving agriculture and a great trout stream and that's what we are after here"*
>
> -Mike Morris of PA DEP in LNP article by Ad Crable, May 2, 2021

This plan was recently accepted by EPA and grant funding is available to support the implementation of BMPs within the watershed. The full plan can be accessed by typing "Hammer Creek ARP" into an internet search engine.



USGS The National Map: National Boundaries Dataset, 3DEP Elevation Program, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; USGS Global Ecosystems; U.S. Census Bureau TIGER/Line data; USFS Road Data; Natural Earth Data; U.S. Department of State Humanitarian Information Unit; and NOAA National Centers for Environmental Information, U.S. Coastal Relief Model. Data refreshed August, 2021.

N

0 0.5 1 2 Miles

- Hammer Creek Headwaters Subwatershed
- Precision Grass Filter Strip
- Streambank Stabilization
- Stream Restoration
- Streambank Fencing
- Forested Buffer

Proposed locations for physical BMPs in the Hammer Creek Headwaters subwatershed. Practice type BMPs such as agricultural erosion and sedimentation plans, conservation tillage, and use of cover crops are not shown.

APPENDIX B: HAMMER CREEK ASSESSMENT REPORT

COMMONWEALTH OF PENNSYLVANIA
Department of Environmental Protection
March 1, 2023

Stream File 2.14.3
Stream Codes 7664

SUBJECT: Hammer Creek Watershed Assessment
Hammer Creek-Lebanon/Lancaster County HUC 20503060903
Subbasin 07J
Lebanon and Lancaster County

TO: Stream File
Clean Water Program
Southcentral Regional Office

FROM: Jeremy Miller
Aquatic Biologist 2
Clean Water Program - Operations
Southcentral Regional Office

Executive Summary

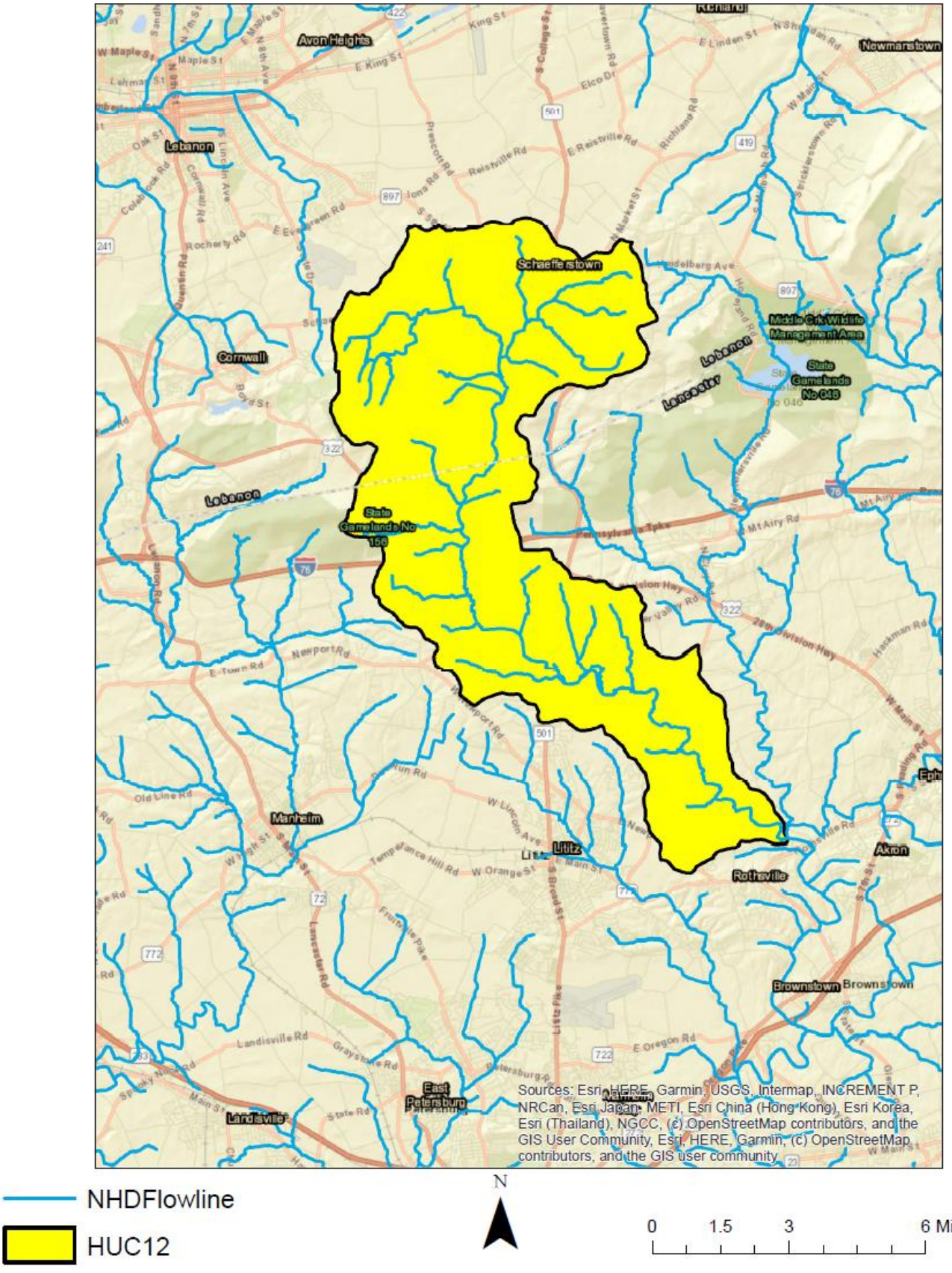
In December 2021, Southcentral Region biologists conducted an aquatic life use (ALU) reassessment of Hammer Creek in the Hydrologic Unit (HUC) 20503060903 in the Lower Susquehanna Subbasin of the Susquehanna Basin. The purpose of the reassessment was to update the previous ALU assessment determination of Hammer Creek per the requirements of Sections 305(b) and 303(d) of the Federal Clean Water Act with the current more rigorous assessment methodology (PA DEP 2021).

The Hammer Creek-Lebanon/Lancaster County HUC occupies portions of Ephrata, Clay, Elizabeth, Heidelberg, and South Lebanon Townships within Lebanon and Lancaster County, Pennsylvania (PA Quad: Ephrata, Lititz, and Richland). Figure 1 provides a locational overview of the HUC. The subject watershed is situated within the Gettysburg Newark Lowland Section and Piedmont Lowland Section- Piedmont Province physiographic province of Pennsylvania. All streams in the Hammer Creek-Lebanon/Lancaster County HUC have designated water uses of Trout-Stocked Fishes (TSF), High Quality-Cold Water Fishes (HQCWF), Cold-Water Fishes (CWF) and Migratory Fishes (MF) in Title 25 Pa. Code Department of Environmental Protection Chapter 93, Section 93.9o. Hammer Creek headwaters to just above Speedwell Forge Lake is listed in PFBC Natural Trout Reproduction List.

According to USGS Stream Stats, the Hammer Creek basin is approximately 35 square miles with land use being approximately 37% forested and 14% land development (including 2.5% urban). Land uses in the basin are a mix of rural roadways, single-family residences, some

Aquatic Life Use
HUC 20503060903

Fig. 1 Hammer Creek Location Map



NHDFlowline

HUC12

N

0 1.5 3 6 Miles

development, agriculture, and forest. The watershed has a no public municipal wastewater treatment facilities but does have a few MS4 outfalls.

A total of 47.23 miles of stream in the Hammer Creek-Lebanon/Lancaster County HUC were assessed for ALU in 2021. The assessment resulted in five new assessment units which will be listed in the 2024 Pennsylvania Integrated Water Quality Monitoring and Assessment Report. Approximately 4.65 miles of stream were found to be attaining the ALU. Watershed conservation, including but not limited to increased forested riparian corridor, management of stormwater events from impervious surfaces and development, agricultural best management practices (bmps), preservation of wetlands and forested lands will help the watershed towards complete attained status.

Methods and Materials

The Freestone Riffle-Run Stream Macroinvertebrate Assessment Method was chosen to reassess the ALU for the Hammer Creek watershed. Eight sample stations were identified for the ALU reassessment following a thorough reconnaissance of the watershed. Detailed field observations on land use and potential sources of pollution were recorded on the Department's standard Flowing Waterbody Field Data Forms. Field chemistry parameters were measured, habitat was assessed, and benthic macroinvertebrates were collected at each sample station.

A YSI ProDSS multi-probe portable field meter was utilized to measure temperature, specific conductivity, dissolved oxygen (DO), and pH in the field. Prior to sampling, the meter was calibrated following the manufacturer's instructions. These parameters were used for general characterization of water quality conditions. Water samples for lab analysis were collected (SAC 87 & 610).

The Wadeable Freestone Riffle-Run protocol and field data sheets were used to conduct habitat assessments at each 100-meter reach of stream at the selected stations (PA DEP 2021). Twelve parameters were used, and each rated as optimal, suboptimal, marginal, or poor using a numeric value (range of 20-0) based on the protocol. The parameters were: instream fish cover, epifaunal substrate, embeddedness, velocity/depth regime, channel alteration, sediment deposition, riffle frequency, channel flow status, conditions of banks, bank vegetative protection, grazing or other disruptive pressures, and riparian vegetative zone widths.

Benthic macroinvertebrates were collected, processed and analyzed following methods outlined in the Pennsylvania Department of Environmental Protection Biological Data Collection Methods (PA DEP 2021) and the index of biotic integrity (IBI) provided in the Department's Wadeable Freestone Riffle-Run Stream Macroinvertebrate Assessment Method (PA DEP 2021). A 500-micron mesh D-frame net was used to collect six kick samples distributed throughout a 100-meter stream reach which were combined to create a single composited sample for each site. An equal amount of sampling effort was exerted at each station. The samples were preserved in 95 percent ethyl alcohol for further processing in the laboratory. Macroinvertebrates were processed and identified in the laboratory according to the Department's protocol (PA DEP 2021). The Department's Index was used to calculate an IBI score for each station. The multi-tiered benchmark decision process for wadeable freestone riffle-run streams in PA were then

used to guide the assessment determination made for the Integrated Report listing status (PA DEP 2021).

Results and Discussion

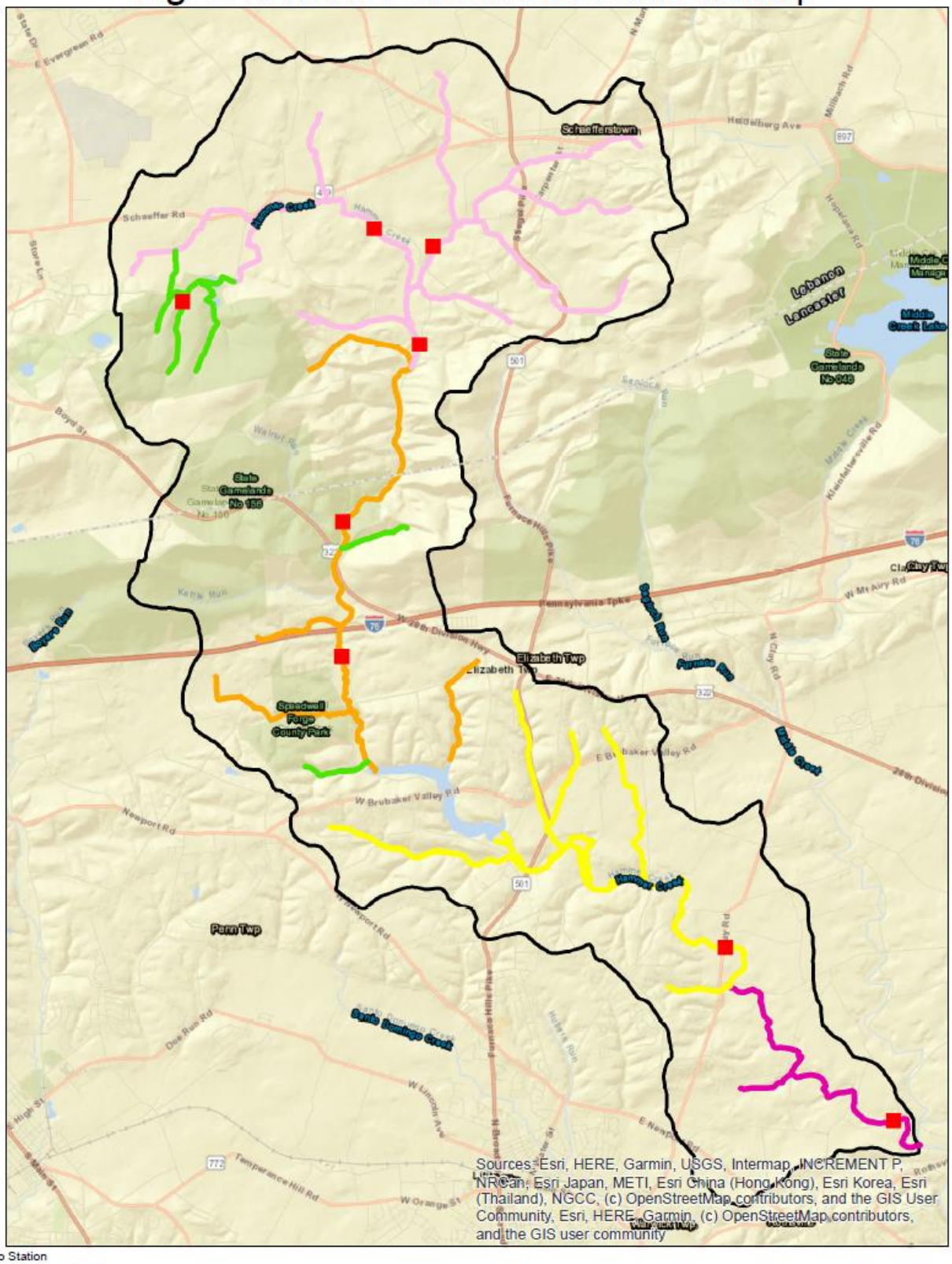
The collection results for each station are found in the following table. Table 1. Hammer Creek-Lebanon/Lancaster County HUC Assessment Stations lists each station, stream site, Chapter 93 Designated Use, location, IBI score, overall habitat assessment score, and whether the station was found to be attaining the ALU. Site specific field water chemistry readings, individual habitat parameter scores, station taxa lists, and individual IBI metric values can be found in the PEARLS database, the Sample Information System (SIS) or in the Department Stream File.

Table 1. Hammer Creek-Lebanon/Lancaster County HUC Assessment Stations

Station ID	Stream Site	Ch. 93 Designation	Latitude	Longitude	IBI Score	Habitat Score	Attaining (Y/N)
20211214-1515-jeremmille	**Hammer Ck @ Millway Rd**	**TSF**	**40.1649**	**-76.2369**	**52.3**	**119**	**N**
20211214-1415-jeremmille	**Hammer Ck @ Clay Rd**	**TSF**	**40.1884**	**-76.2670**	**53.2**	**132**	**N**
20211214-1245-jeremmille	**Hammer Ck @ Speedwell Forge Rd**	**HQCWF**	**40.2277**	**-76.3352**	**41.8**	**169**	**N**
20211206-1000-jeremmille	**Hammer Ck @ Pumping Station Rd**	**HQCWF**	**40.2464**	**-76.3350**	**53.5**	**159**	**N**
20211206-1200-jeremmille	**Hammer Ck @ Obie Rd**	**CWF**	**40.2704**	**-76.3216**	**38.7**	**131**	**N**
20211214-1130-jeremmille	**UNT 07680 Hammer Ck @ Old Mill Rd**	**CWF**	**40.2825**	**-76.3193**	**28.8**	**163**	**N**
20211206-1245-jeremmille	**Hammer Ck @ Ridge Ln**	**CWF**	**40.2862**	**-76.3294**	**27.8**	**126**	**N**
20211206-1330-jeremmille	Hammer Ck @ Rexmont Rd	HQCWF	40.2765	-76.3630	88.9	171	Y

The Department implements a multi-tiered benchmark decision process for wadeable freestone riffle-run streams for determining ALU attainment and impairment based on the benthic macroinvertebrate sampling. Sample stations were located at various locations throughout the watersheds to characterize the respective land uses or previous ALU assessments. As a result, five assessment units were created. A descriptive assessment list is found in Table 2. Hammer Creek-Lebanon/Lancaster County HUC Assessment Unit, and an illustrative assessment map is provided by Figures 2 & 3. Figures 2 & 3 provide an overview of the assessment in the Hammer Creek-Lebanon/Lancaster County HUC. Table 2 lists all streams, assessed stream miles, previous assessment unit IDs, and any new or previous impairment (source-cause) for each assessment unit created.

Fig. 2 Hammer Creek Assessment Map

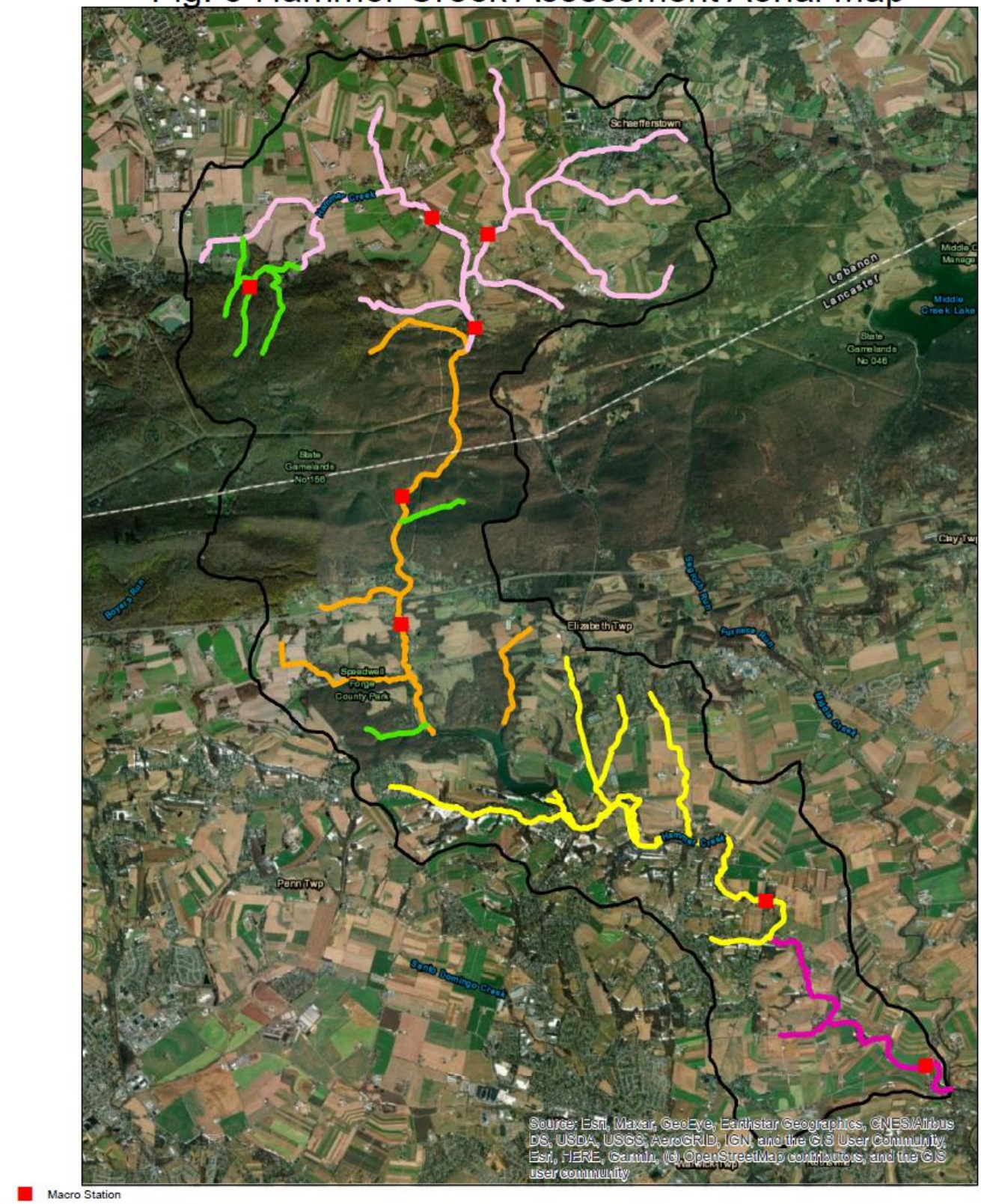


Macro Station
Assessment Unit ID 23194
Assessment Unit ID 23195
Assessment Unit ID 23198
Assessment Unit ID 23205
Assessment Unit ID 23206
HUC12

N

0 0.75 1.5 3 Miles

Fig. 3 Hammer Creek Assessment Aerial Map



Macro Station
Assessment Unit ID 23194
Assessment Unit ID 23195
Assessment Unit ID 23198
Assessment Unit ID 23205
Assessment Unit ID 23206
HUC12

N

0 0.75 1.5 3 Miles

Table 2. Hammer Creek-Lebanon/Lancaster County HUC Assessment Unit

Assessment Unit ID and Associated Station IDs	Attaining (Y/N)	Source - Cause	Streams	Previous Assessment Unit ID (Yr)	Previous Source-Cause	Total Miles
23206 20211206-1000-jeremmille 20211214-1245-jeremmille	N	Ag- Siltation; Habitat Modification- Habitat Alterations	UNT 07671, 07673, 07674, 07678 Hammer Creek	15507 (2010) 8593 (1997)		9.64
23198 20211206-1200-jeremmille 20211206-1245-jeremmille 20211214-1130-jeremmille	N	Ag- Siltation; Habitat Modification- Habitat Alterations	UNT 07679, 07681 Hammer Ck, UNT 07685, 07686 Hammer Ck, UNT 07682, 07683, 07684 Hammer Ck	15504 (2002)	Ag- Siltation	16.69
23195 20211214-1415-jeremmille	N	Ag- Siltation; Habitat Modification- Habitat Alterations	UNT 07666, 07667, 07668, 07669, 07670 Hammer Ck	8593 (1997)		12.42
23194 20211214-1515-jeremmille	N	Ag- Siltation; Habitat Modification- Habitat Alterations	UNT 07665 Hammer Ck	8624 (2002)	Grazing in Riparian or Shoreline Zones- Nutrients, Siltation; Crop Production- Nutrients, Siltation	3.83
23205 20211206-1330-jeremmille	Y		UNT 07677, 07672, 07687, 07688 Hammer Ck	15503 (2010) 15507 (2010)		4.65

Assessment Unit ID 23206 includes Hammer Creek and tributaries just downstream from Obie Road to Speedwell Forge Lake. This assessment unit's land use is single-family residences, rural roadways, residential ponds, some agriculture, and forest (mostly public). The assessment unit's physical habitat parameters including conditions of bank, bank vegetative protection, sediment deposition, and embeddedness scoring in a range from low suboptimal to poor. Most of this section is forested but impacts from agricultural activities upstream and along UNTs were observed throughout. Incised streambanks and sediment deposition were frequently observed within this section. This unit was previously assessed in 2010 (Assessment Unit ID 15507) and 1997 (Assessment Unit ID 8593) and listed as attaining ALU. After the reassessment, this unit is impaired for source-cause: Agriculture- Siltation; Habitat Modifications- Habitat Alterations. This reassessment is based off the results from the IBI metrics, Habitat Impairment Thresholds, water chemistry results, and the physical habitat parameter scores. These values suggest impairment to the streams included in this assessment unit. This assessment unit includes two sampling stations. The stations did not meet IBI and/or habitat attainment thresholds, therefore results indicate non-attainment for ALU.

Assessment Unit ID 23198 includes Hammer Creek and tributaries just downstream from Rexmont Road to just downstream from Obie Road. This assessment unit's land use is single-family residences, town of Schaefferstown, rural roadways, residential ponds, and agriculture. The assessment unit's physical habitat parameters including vegetative riparian zone, conditions of bank, grazing or other disruptive pressures, sediment deposition, and embeddedness scoring in a range from low suboptimal to poor. There is limited forested riparian/floodplain habitat width throughout this assessment unit. This unit was previously assessed in 2002 (Assessment Unit ID 15504) and listed as non-attaining ALU. Previous source-cause was Ag- Siltation. After the reassessment, this unit is impaired for source-cause: Agriculture- Siltation; Habitat Modifications- Habitat Alterations. This reassessment is based off the results from the IBI metrics, Habitat Impairment Thresholds, water chemistry results, and the physical habitat

parameter scores. These values suggest impairment to the streams included in this assessment unit. This assessment unit includes three sampling stations. The stations did not meet IBI and/or habitat attainment thresholds, therefore results indicate non-attainment for ALU.

Assessment Unit ID 23195 includes Hammer Creek and tributaries just downstream from Speedwell Forge Lake to Lincoln Road. This assessment unit's land use is single-family residences, some development, rural roadways, residential ponds, and agriculture. The assessment unit's physical habitat parameters including vegetative riparian zone, conditions of bank, sediment deposition, and embeddedness scoring in a range from suboptimal to poor. There is limited forested riparian/floodplain habitat width throughout this assessment unit. This unit was previously assessed in 1997 (Assessment Unit ID 8593) and listed as attaining ALU. After the reassessment, this unit is impaired for source-cause: Agriculture- Siltation; Habitat Modifications- Habitat Alterations. This reassessment is based off the results from the IBI metrics, Habitat Impairment Thresholds, water chemistry results, and the physical habitat parameter scores. These values suggest impairment to the streams included in this assessment unit. This assessment unit includes one sampling station. The station did not meet habitat attainment thresholds, therefore results indicate non-attainment for ALU.

Assessment Unit ID 23194 includes Hammer Creek just downstream from Lincoln Road to the confluence with Cocalico Creek near Cocalico Road. This assessment unit's land use is single-family residences, rural roadways, residential ponds, and predominantly agriculture. The assessment unit's physical habitat parameters including vegetative riparian zone, conditions of bank, sediment deposition, and embeddedness scoring in a range from marginal to poor. There is limited forested riparian/floodplain habitat width throughout this assessment unit. This unit was previously assessed in 2002 (Assessment Unit ID 8624) and listed as non-attaining ALU with source-cause Grazing in Riparian or Shoreline Zones- Nutrients, Siltation; Crop Production- Nutrients, Siltation. After the reassessment, this unit is impaired for source-cause: Agriculture- Siltation; Habitat Modifications- Habitat Alterations. The source-cause Grazing in Riparian or Shoreline Zones- Nutrients can be removed (delisted) from previous assessment because water chemistry results and field observations did not reflect this source-cause. The recommended new source-cause is a more accurate depiction of this assessment unit. The delisting will be included in more detail within Appendix A. This reassessment is based off the results from the IBI metrics, Habitat Impairment Thresholds, water chemistry results, and the physical habitat parameter scores. These values suggest impairment to the streams included in this assessment unit. This assessment unit includes one sampling station. The station did not meet habitat attainment thresholds, therefore results indicate non-attainment for ALU.

Assessment Unit ID 23205 includes the headwaters and tributaries of Hammer Creek from headwaters to just downstream of Rexmont Road and UNTs 07677, 07672 Hammer Creek. Land use in this section is forest, two abandoned/naturally restored Lebanon Reservoirs, and State Game Land 156. Previous Assessment Unit IDs 15503 (2010), 15507 (2010) had this section attaining ALU. After reassessment, this unit will remain attaining ALU. This decision was based on the results from IBI metrics, Habitat Impairment Thresholds, water chemistry results, and the physical habitat parameter scores. These values suggest all attainment criteria was met in the streams included in this assessment unit. This assessment unit includes one sampling station.

Delisting

The last assessment before the 2021 reassessment was conducted in 2002 (Assessment Unit ID 8624) for a portion of lower mainstem Hammer Creek (TSF) and associated tributaries. This section includes Hammer Creek from just downstream from Lincoln Road to the confluence with Cocalico Creek. Since then, a more rigorous and robust sampling protocol has been developed by DEP to maximize assessment decisions and accurately identify the specific source-cause of impairments. One sampling station: 20211214-1515-jeremmille (IBI- 52.3) was used to assess this segment. Water chemistry parameters were collected and submitted to DEP Bureau of Labs for analysis (SAC 610) from sampling station. Previous impairment source-cause was Grazing in Riparian or Shoreline Zones- Nutrients, Siltation; Crop Production- Nutrients, Siltation. After the reassessment, this unit is impaired for source-cause: Ag- Siltation; Habitat Modifications- Habitat Alterations. After review of the macroinvertebrate IBIs, habitat impairment thresholds, physical habitat parameters, and water chemistry data the results suggest non-attaining Aquatic Life status. Therefore, DEP SCRO is recommending using the WQS_New_Data Delisting Reason to remove the previous 2002 source-cause Grazing in Riparian or Shoreline Zones- Nutrients; Crop Production- Nutrients because water chemistry results and field observations did not reflect this source-cause. The delisted section will be approximately 3.83 miles of stream.

Conclusion

The PADEP developed new, more rigorous assessment methods to make ALU assessment determinations and an IBI for benthic macroinvertebrate communities in Pennsylvania's wadeable freestone riffle-run streams. The Assessment Book (PA DEP 2021) contains several methods that "focus on biological and physical aspects of water quality that have shown to be scientifically acceptable indicators for assessments." This reassessment utilized the Wadeable Freestone Stream Macroinvertebrate Assessment Method with accompanying IBI and the Physical Habitat Assessment Method. "Through direct quantification of biological attributes along a gradient of ecosystem conditions, the IBI measures the extent to which anthropogenic activities compromise a stream's ability to support healthy aquatic communities (Davis and Simon 1995)" (PA DEP 2021). When those anthropogenic activities result in impacts where the IBI score fails to meet attainment benchmarks, streams or stream segments are listed as impaired and the source and cause of the impairment must be determined. For most cases involving benthic macroinvertebrate samples from wadeable freestone riffle-run streams in Pennsylvania using the protocols previously described, the assessment procedures described in the IBI will lead to tenable ALU assessment decisions (PA DEP 2021).

Figures 2 & 3 illustrate the stream segments and the respective ALU attainment/non-attainment status and assessment unit ID for the reassessment conducted in Hammer Creek and its tributaries. The upper (headwaters) portion and a few tributaries of Hammer Creek were found to be attaining the ALU. The majority of Hammer Creek was found to be non-attaining the ALU.

In conclusion, five new assessment units will be listed in the 2024 Pennsylvania Integrated Water Quality Monitoring and Assessment Report. Approximately 4.65 miles of stream were found to be attaining the ALU. Approximately 42.58 miles of stream were found to be non-attaining the ALU.

References

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Pennsylvania Department of Environmental Protection. 2021. *Water Quality Monitoring Protocols for Streams and Rivers.* http://files.dep.state.pa.us/Water/Drinking%20Water%20and%20Facility%20Regulation/WaterQualityPortalFiles/Technical%20Documentation/MONITORING_BOOK.pdf

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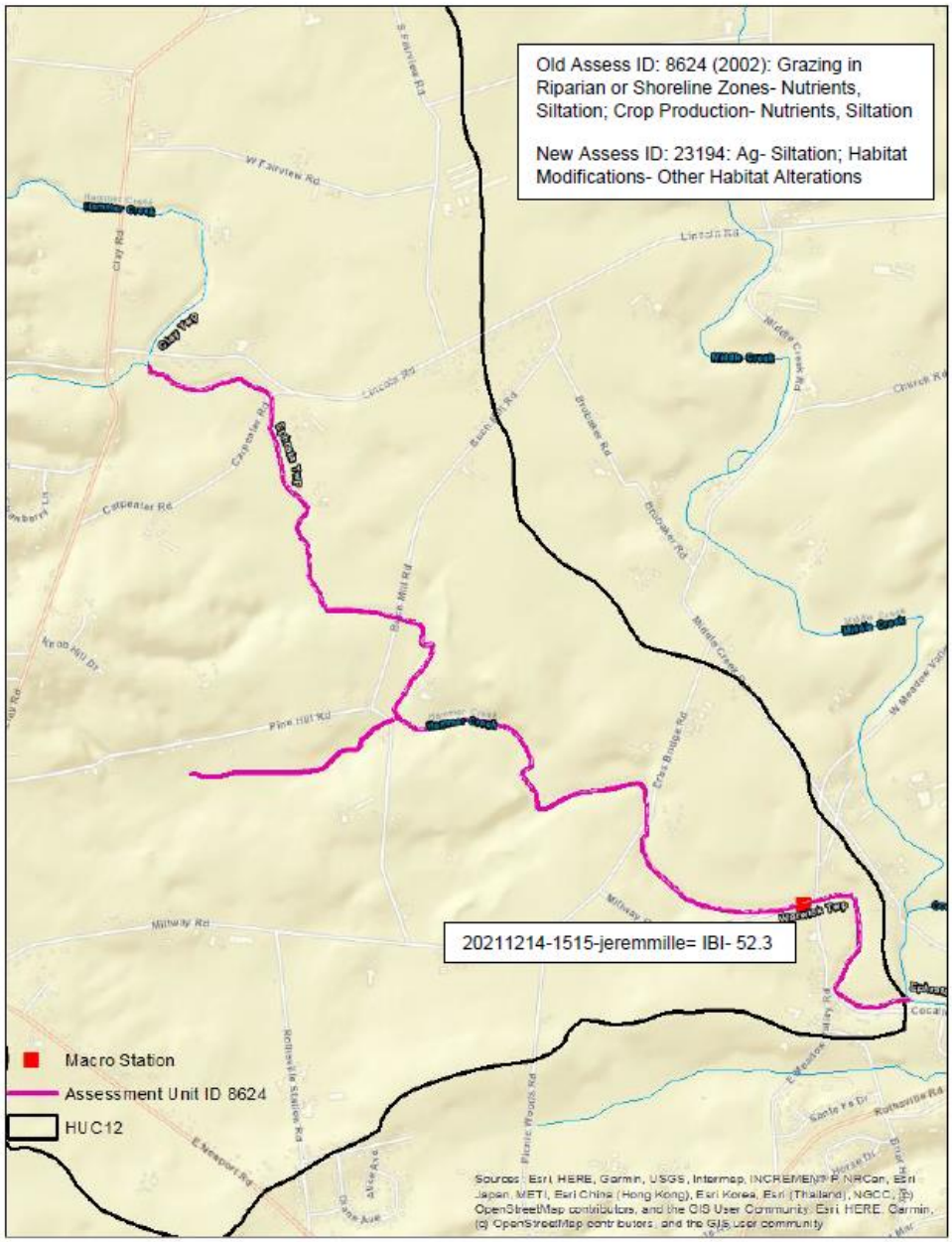
Appendix A
HUC: 20503060903
Assessed Use Category: Aquatic Life Use
Delisting Reason: WQS_New_Data

Hammer Creek Delisting



Comments

The last assessment before the 2021 reassessment was conducted in 2002 (Assessment Unit ID 8624) for a portion of lower mainstem Hammer Creek (TSF) and associated tributaries. This section includes Hammer Creek from just downstream from Lincoln Road to the confluence with Cocalico Creek. Since then, a more rigorous and robust sampling protocol has been developed by DEP to maximize assessment decisions and accurately identify the specific source-cause of impairments. One sampling station: 20211214-1515-jeremmille (IBI- 52.3) was used to assess this segment. Water chemistry parameters were collected and submitted to DEP Bureau of Labs for analysis (SAC 610) from sampling station. Previous impairment source-cause was Grazing in Riparian or Shoreline Zones- Nutrients, Siltation; Crop Production- Nutrients, Siltation. After the reassessment, this unit is impaired for source-cause: Ag- Siltation; Habitat Modifications- Other Habitat Alterations. After review of the macroinvertebrate IBIs, habitat impairment thresholds, physical habitat parameters, and water chemistry data the results suggest non-attaining Aquatic Life status. Therefore, DEP SCRO is recommending using the WQS_New_Data Delisting Reason to remove the previous 2002 source-cause Grazing in Riparian or Shoreline Zones- Nutrients; Crop Production- Nutrients because water chemistry results and field observations did not reflect this source-cause. The delisted section will be approximately 3.83 miles of stream.

ComIDs Assessment Unit ID 23194

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