



Abrahams Creek Coldwater Conservation Plan

2017-2018

Luzerne County, Pennsylvania

Prepared by:

Eastern Pennsylvania Coalition for Abandoned Mine Reclamation

101 South Main Street

Ashley, Pennsylvania

Report funded by:

Coldwater Heritage Partnership



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Glossary

pH- a measure of hydrogen ion concentration, a measure of the acidity or alkalinity of a solution

Dissolved oxygen (DO)-refers to microscopic bubbles of gaseous oxygen (O₂) that are mixed in water and available to aquatic organisms for respiration

Oxidative Reduction Potential (ORP)-is a measure of the tendency of a chemical species to acquire electrons and thereby be reduced

Specific Conductance- is a measure of how well water can conduct an electrical current

Total Dissolved Solids- are the total amount of mobile charged ions, including minerals, salts or metals dissolved in a given volume of water

Iron- Iron is a chemical element with symbol Fe and atomic number 26. It is a metal in the first transition series. It is by mass the most common element on Earth, forming much of Earth's outer and inner core. It is the fourth most common element in the Earth's crust

Alkalinity- the name given to the quantitative capacity of an aqueous solution to neutralize an acid

Sulfates- a salt or ester of sulfuric acid, containing the anion SO₄²⁻ or the divalent group —OSO₂O—

Dendritic- having a branched form resembling a tree.

Abandoned Mine Drainage (AMD)-or acid rock drainage (ARD) is the outflow of acidic water from metal mines or coal mines

Borehole-a deep, narrow hole made in the ground, especially to locate water or oil

Colliery- a coal mine and the buildings and equipment associated with it

US ACE- United States Army Corps of Engineers

EPCAMR- Eastern Pennsylvania Coalition for Abandoned Mine Reclamation

NAACC- North Atlantic Aquatic Connectivity Collaborative

Acknowledgements

Funding for the Abrahams Creek Coldwater Conservation Plan (CCP) was made possible by a \$5000 grant awarded to the Eastern Pennsylvania Coalition for Abandoned Mine Reclamation (EPCAMR) by the Coldwater Heritage Partnership (CHP). The Coldwater Heritage Partnership is a collaboration between governmental and non-governmental organizations dedicated to the conservation of cold water fisheries in the Commonwealth. Member organizations include Pennsylvania Department of Conservation and Natural Resources, Pennsylvania Fish and Boat Commission, Pennsylvania Council of Trout Unlimited, and the Foundation for Pennsylvania Watersheds. Thanks to the collaborative, organizations working in watersheds across the Commonwealth can continue to provide recommendations in the effort to protect and conserve cold water resources.

The Abrahams Creek CCP would not have been possible without the assistance of EPCAMR staff members and interns Gavin Pellitteri, Rachael Grube, Michael Hewitt, Robert Hughes, Gabby Zawacki, Shawnese Taylor, Laura Rinehimer, Denise Hernandez, Abbie Keefe, Spencer Zuraski, Joshua Rinehimer, and, Lewyllen Westrick.

EPCAMR staff, Trout Unlimited Technical Assistance staff, and landowners were critical in the creation of this plan through their efforts to assess and collect data on various segments of the watershed. Other key partners include the Forty Fort Municipal Borough, Exeter Borough, West Wyoming Borough, Luzerne Conservation District, Patagonia Outfitters, and the Novicki and Dimick families.

Technical reports and historical documents were also reviewed in the effort to provide additional supporting data and information in the composition of the Abrahams Creek Coldwater Conservation Plan. Supporting information includes Skelly & Loy's 2011 *Abrahams Creek Watershed Assessment and Project Prioritization* report, *The Hicks Creek and Abrahams Creek Detailed Feasibility Analysis* by Michael Baker Jr., Inc, The District of Natural Resources and Conservation Spatial Analyst Data, the Pennsylvania Spatial Data Access (PASDA), historic mine inspector reports, and the Pennsylvania Mine Map Atlas.

Introduction: EPCAMR & CHP Grant Program

Founded in 1996, the Eastern Pennsylvania Coalition for Abandoned Mine Reclamation is a public non-profit based out of Ashley, Pennsylvania. EPCAMR's mission is to promote and facilitate the reclamation and remediation of land and water adversely affected by past mining practices in Northeastern Pennsylvania. In addition to addressing the effects of abandoned mine lands (AMLs) and abandoned mine drainage (AMD), EPCAMR also practices conservation efforts focused on protecting land and water resources within the region that have not been directly affected by legacy mining practices. EPCAMR's goals are to reduce health and safety hazards, mitigate soil erosion, and to reclaim land/water resources effected by legacy mining practices for beneficial use.

The Coldwater Heritage Partnership (CHP) administers a grant program to develop Coldwater Conservation Plans (CCP) for the purpose of conserving and protecting the Commonwealth's coldwater ecosystems. CCP's are useful in creating local awareness and support for the long term conservation of coldwater streams and their encompassing watersheds. The plans are an effort to compile existing information pertaining to the health of the watershed, document field investigations detailing potential problems and opportunities for stream/riparian conservation practices, habitat improvements, and make recommendations for appropriate implementation projects.

EPCAMR felt that the Abrahams Creek watershed needed a compilation of information on water quality, land use, and overall watershed health and to provide specific recommendations focused on cost effective strategies to help conserve the ecological integrity of the watershed. More specifically, EPCAMR recognized the need to document and make recommendations concerning the subsequent effects of agricultural practices, mineral extraction, and urbanized development that has taken place in the watershed over the last century. It is our hope that this CCP will allow community leaders within the Abrahams Creek watershed to formulate a plan of action for proposed conservation and protection strategies while building community awareness and support for the conservation of Abrahams' coldwater resources.

Disclaimer

The Eastern Pennsylvania Coalition for Abandoned Mine Reclamation, its professional staff, and work performed by students, interns, and volunteers is to be used for educational and planning purposes only and makes no warranties, expressed or implied, regarding the quality of any product produced. Sponsor agrees to indemnify and hold harmless EPCAMR against any claims arising of the Sponsor's utilization, sale, or transfer of reports developed in whole or in part by EPCAMR, its professional staff, students, interns, and volunteers.

The Abrahams Creek Coldwater Conservation Plan is to be used as a tool that will help educate and build community consensus within the watershed with various stakeholders for the conservation of the coldwater ecosystem. The limits of this project were determined by the number of individuals involved, their knowledge and expertise of tasks outlined in the project plan, amount of funding available for staff time, equipment, etc., the timeline of the project, prevailing weather conditions during the project period, and the amount of existing data and research for the project location. Additionally, EPCAMR's referral to parts of the watershed as 'impaired' refer only to the findings as indicated in EPCAMR's visual habitat parameters including but not limited to: vegetation, sedimentation, water chemistry, macroinvertebrate surveys, and fish surveys. It does not refer to any classification of the watershed put forth by the Federal List of Impaired Waters and Section 303(d) listing.

Limitations

The limits of this project were determined by the number of individuals involved, their knowledge and expertise of tasks outlined in the project plan, amount of funding available for staff time, equipment, etc., the timeline of the project, prevailing weather conditions during the project period, and the amount of existing data and research for the project location.

Watershed Description

Location

The Abrahams Creek watershed is entirely located in Luzerne County, Pennsylvania. The watershed contains or partially contains the municipalities of Exeter, Swoyersville, Wyoming, West Wyoming, Forty Fort, Dallas, Kingston, and Franklin. A majority of the Abrahams watershed is located in the rural upland area of Dallas, Kingston, and Franklin townships. The lowland area of the watershed lies in the developed old Susquehanna floodplain, within the boroughs of West Wyoming, Wyoming, Exeter, and Swoyersville.

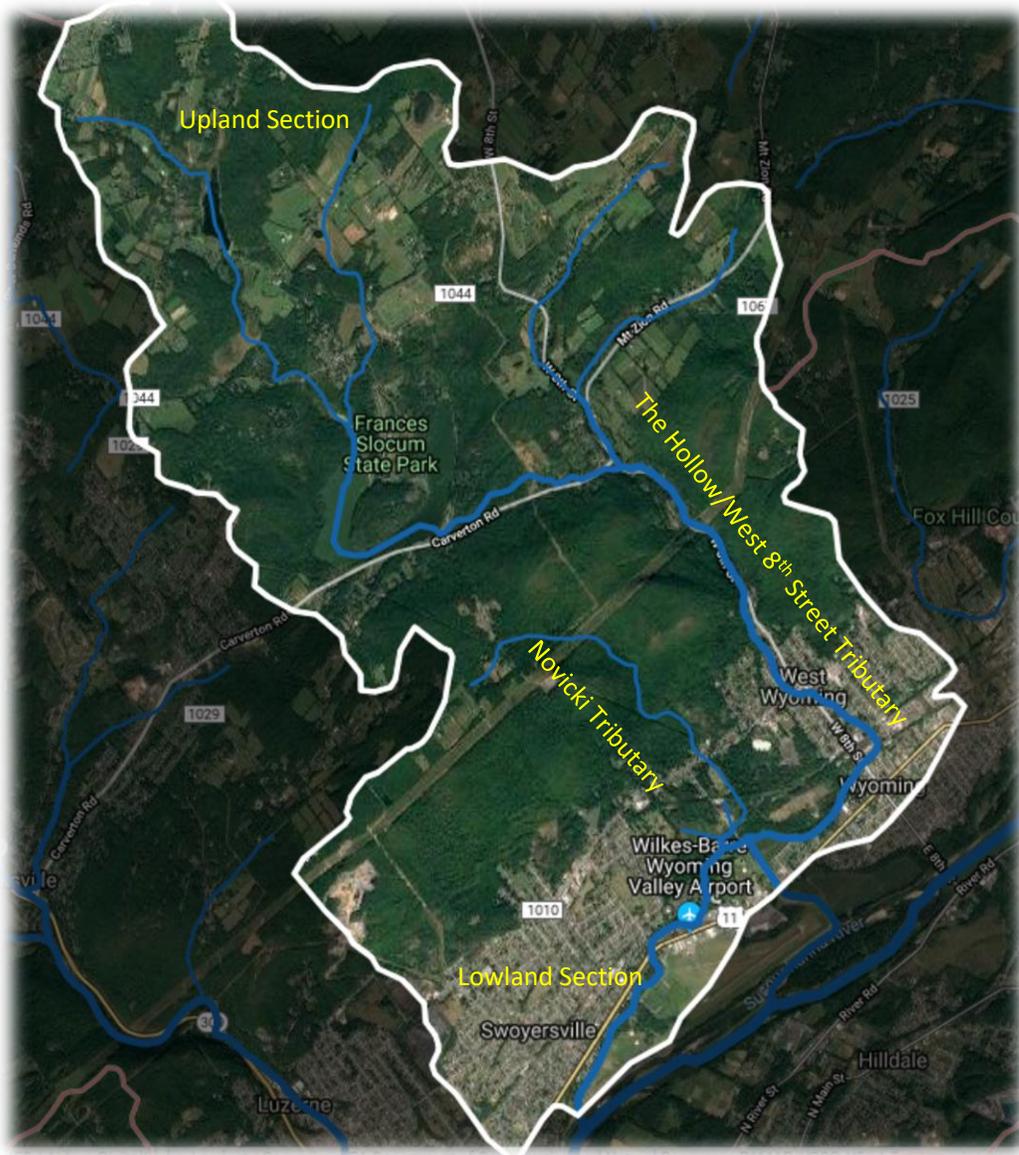


Figure 1. The Abrahams Creek watershed and the sections investigated.

Water Course

The Abrahams Creek headwaters begin in Dallas, Franklin and Exeter Townships. In the northwestern sector of the watershed, two unnamed tributaries flow approximately two miles south through rural residential properties, manmade ponds, and wooded wetlands before flowing underneath Mt. Olivet Road (41.344932, -75.899989 & 41.348003, -75.891675) and into the eastern arm of Frances Slocum Lake. In the northeastern sector of the watershed, an unnamed tributary drains from wooded wetlands and is partially channeled through private properties along West 8th Street then underneath Mt. Olivet Road (41.353188, -75.879017) and Parrish Lane (41.352655, -75.878907) and flows behind a series of private lots ~1,000ft into a ponded area called Burketts Pond. Approximately 1 mile northeast, another tributary forms from upland wetland habitat along Bidle Road and flows ~1 mile south to Burketts Pond.

Exiting Burketts Pond, the tributary flows through the property of Busy Beaver Tree Service and is shortly thereafter conveyed through ~800ft long narrow concrete channel above the confluence of the Mt. Zion Road tributary at West 8th Street and Mt. Zion Road in Wyoming, PA (41.342907, -75.869921). The Mt. Zion Road tributary is sourced from similar wooded wetland habitat and flows ~1 mile south until the confluence at West 8th Street. The combined tributaries then flow as one behind Carverton Auto Sales and beneath West 8th Street immediately below Carverton Auto Sales (41.340458, -75.868176). The tributary runs along West 8th Street ~ 1,400 feet before being culverted back under West 8th Street again- at the confluence of the drainage from Frances Slocum Lake. The West 8th Street section continues to flow in a southeast direction, through a steeply sloped canyon locally referred to as The Hollow. For the purpose of clarity in this report, the drainage area above The Hollow will be referred to as the upland section, while the drainage below (including the lower section of 'Novicki Tributary' located on Bunker Hill-Mt. Lookout Ridge) will be referred to as the lowland section. Abraham's continues down West 8th Street's narrow corridor ~1.5 miles and is culverted under West 8th Street two more times before reaching the sediment retention structure at the mouth of The Hollow. Immediately following the retention structure, Abrahams is funneled into a ~ 5,000ft concrete flood control channel through the West Wyoming borough. As Abrahams exits the concrete channel, it meanders ~5,000ft in a southeasterly direction through the mostly developed section of West Wyoming until it reaches Swetland Lane. It then parallels Swetland Lane for ~1,000ft as it flows through the USAACE flood protection gates, and into the Susquehanna River.

In the borough of Swoyersville, a ~250ft tall pile of anthracite coal refuse is cut in half by the Abraham's and Toby's Creek watersheds. No stream runs through the site, but the refuse pile redirects surface drainage into an open flood lot. The lot is connected to a concrete lined channel which is directed towards the Dennison Cemetery before it runs subsurface. A connection to the existing tributaries is not known.

Headwaters to the only naturally reproducing trout stream in the Abrahams Creek watershed begin in the upland section of Bunker Hill-Mt. Lookout Ridge. For the purpose of clarity, this unnamed tributary will be referred to as the Novicki tributary- dedicated to the family/landowners who granted EPCAMR access to their land during the duration of the assessment. Novicki tributary begins atop Bunker Hill – Mt. Lookout Ridge just above the Carverton Gate Station. Flowing in a northeasterly direction ~.5 miles before crossing a series of power lines, Novicki tributary then turns and begins a southeasterly descent down the steeply

sloped and forested section of Bunker Hill – Mt. Lookout Ridge. Novicki tributary flows down the forested ridge ~1 mile before running through the mine spoils of the old Westmoreland Colliery and (during higher flow events) under Shoemaker Avenue in the West Wyoming Borough (41.313980, -75.856408). After passing under Shoemaker Avenue in West Wyoming, Novicki tributary is conveyed along the northeastern property lines of the old Moonlight drive thru theatre. Novicki tributary, dependent on flow, runs into a swath of undeveloped manmade wetlands between Brady Street and Swetland Lane. Evidence of the historic stream path can be seen from historic mine maps, satellite imagery, and on-the-ground observations during leaf off periods on Swetland Lane. A surface connection between the Novicki tributary and the West 8th Street tributary is not evident by satellite imagery nor on-the-ground observations. Historic maps (circa 1892) do show a confluence between the West 8th Street and Novicki tributaries, but any remaining hydrologic connection between the two tributaries is likely subsurface.

*Coordinates were obtained either in the field or via satellite imagery on Google Earth.

Stream Characteristics

Abraham's Creek is a perennial stream in most of its tributaries but does have annual drainages that flow during periods of heavy precipitation. All of the tributaries predominately follow a dendritic drainage pattern. Peak elevation in the headwaters of Abrahams is ~1,200ft above sea level and ~500ft at the mouth. The watershed contains ~20 miles of total stream length with 10.7 miles of 1st order streams, 3.2 miles of 2nd order streams, and 6.2 miles of 3rd order streams (Wikiwatershed 2018). Altered stream channels, constricted stream channels, and/or bank erosion is evident throughout both the upland and lowland sections of the watershed, but is more prevalent in the West 8th Street section.

Ponds and wooded wetlands form the source of the headwaters in the upland section of the Abraham's watershed. The two tributaries that flow into the eastern arm of Frances Slocum Lake have relatively good stream corridor conditions given historic land use intensity within the area (Skelly & Loy 2010). The tributaries contain well rooted riparian vegetation and are moderately shaded with upland forested areas patched between open cultivated pastures and open properties (Skelly & Loy 2010). In-stream conditions worsen as Abraham's flows through The Hollow. Earthen and concrete channels make up much of the stream corridor as Abraham's Creek parallels West 8th Street. Evidence of deeply entrenched channels were observed in the non-hardened segments. These areas that have experienced deep entrenching of stream substrate also exhibit heavily eroded and steepened banks (Skelly & Loy 2011). Rock walls line segments of the stream channel as the West 8th Street tributary flows towards the sediment retention structure

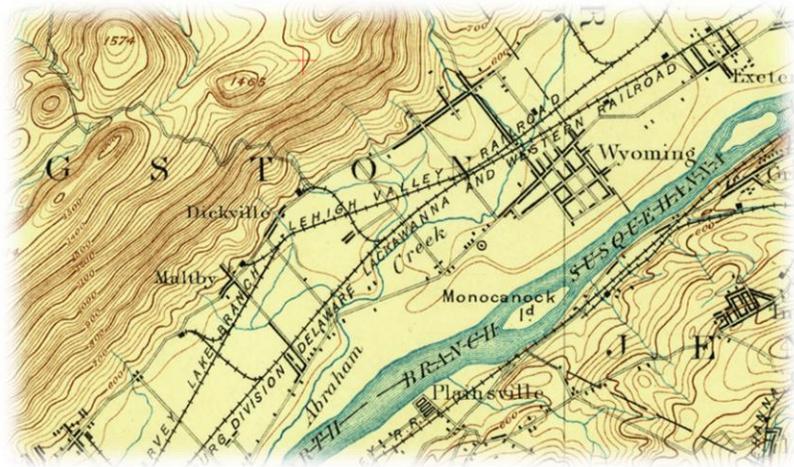


Figure 2. 1892 USGS topographical map showing historic confluence of Abraham's tributaries

above Shoemaker Avenue. Concrete channels and hardened walls dominate the lowland section of the West 8th Street tributary as it is conveyed through the Wyoming Flood Project. Stream corridor conditions improve after exiting the concrete channel of the flood project—with grassy banks and some woody vegetation in areas. But in-stream conditions remain severely impaired by sedimentation, warm/slow moving waters, and lack of natural stream sequence as the West 8th Street tributary exits the levee system at Wyoming Avenue (Figure 10).

Novicki tributary—the only naturally reproducing trout stream in the watershed, drains from two private ponds and a synclinal geologic formation atop Bunker Hill – Mt. Lookout Ridge. It is possible that Novicki tributary’s flow is partially spring/high elevation aquifer fed (Skelly & Loy 2011). Novicki tributary is far less impacted in the upper reaches than the lower. Being mostly contained on an undeveloped forested ridge, the upper reaches of Novicki tributary are the least physically and biologically degraded segments in the entire Abraham’s Creek watershed.

Characterized by predominantly steep streambanks, Novicki tributary is naturally narrow given the topography within the drainage. While narrow, the upper reaches of Novicki tributary’s riparian corridor and in-stream conditions exhibit that of a healthy cold water fishery. >75% of the tributary is shaded by mixed deciduous hardwoods, streambanks are narrow and steep in segments but conditions are good overall by the presence of leafy and woody vegetation. Instream conditions are good- most evident by the presence of mixed sized instream debris, consistent riffle-run-pool sequence, and low water temperatures—optimal habitat conditions for the Eastern Brook Trout. Moderately deep pools and varying stream velocities characterize the upper reaches, providing quality instream cover/habitat diversity for trout throughout different life stages. A series of waterfalls allows for an increase in water

velocities as Novicki tributary transitions into the degraded lowland section. Signs of anthracite coal strip mining are evident on the ridge at ~840ft above sea level. According to Griffith/Westmoreland Colliery mine maps, numerous manmade subsurface connections were created as the Marcy, Pittston, and rock veins were strip mined. Boreholes for measurement and airflow to the underground workings exist within the vicinity or directly within Novicki tributary. Historic mine maps also indicate a concrete channel and catch basin at least somewhat altered the stream path before flowing underneath Shoemaker Avenue. Given the intensity of land alteration, particularly strip mining and associated drilling, suggests possible stream loss to the mine voids throughout the year, especially during base flow periods. This hypothesis is supported by the fact that flows beneath Shoemaker Ave stop during dry periods while brook trout of various life stages were found in the upper reaches during our investigation. Much of Novicki tributary after Shoemaker Avenue was inaccessible by on-the-ground observation. As



Figure 3. Upper reaches of Novicki tributary atop Bunker Hill – Mt. Lookout Ridge.

per the Abrahams Creek Watershed Assessment and Project Prioritization by Skelly & Loy in 2011, “below Shoemaker Avenue, where gradients rapidly begin to flatten, the channel was routed along the Moonlight Drive-in site’s northeast property line. An opening in the abandoned railroad embankment allowed flow to continue into the gravel mining area. Surface water flow is no longer effectively conveyed along this ditched channel down to the abandoned gravel pits to the south. All the lines of evidence we were able to collect in this reconnaissance survey strongly suggest that the natural factors and historical land alterations discussed above are the chief cause of the presence of wetland on this property (Skelly & Loy 2011).”

Land Use

There are contrasting land uses in the upland and lowland sections of the Abrahams Creek watershed. As referred to earlier in this report, the upland section of the watershed is rural with a number of agricultural plots, neighborhoods, and stands of undeveloped second growth forest. The lowland section is heavily developed, with impervious surfaces dominating the old Susquehanna floodplain. According to National Land Cover Database, land cover within Abrahams Creek watershed is the following:

Cover Type	Cover Area (km ²)	Area %
Deciduous Forest	18.75	41.8
Cultivated Crops	5.06	11.3
Pasture/Hay	3.93	8.8
Developed, Open Space	3.00	6.7
Developed, Medium Intensity	2.90	6.5
Developed, Low Intensity	2.60	5.8
Evergreen Forest	2.09	4.7
Mixed Forest	1.76	3.9
Scrub/Shrub	1.42	3.2
Woody Wetlands	1.10	2.4
Open Water	.88	2.0
Developed, High Intensity	.7	1.5
Emergent Herbaceous Wetlands	.34	.8
Barren Land	.29	.6
Grassland/ Herbaceous	.07	.2

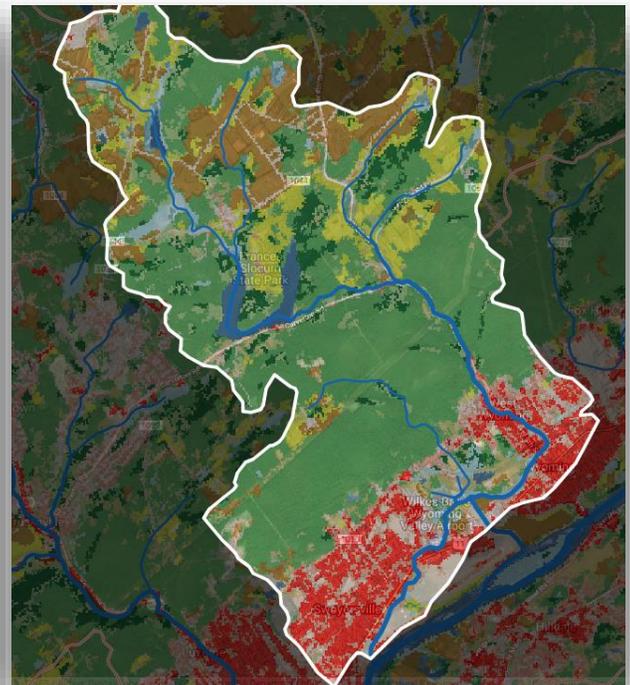


Figure 4. Land coverage in the Abraham’s Creek watershed. Forested areas are shaded in green, agricultural in yellow and brown, and urban in red.

Geology

The Abrahams Creek watershed lies in the Ridge and Valley Province of central Appalachia. In the upland section of the watershed, the sandstones of the Catskill Formation make up a majority of the underlying geology. The Bunker Hill – Mt. Lookout Ridge section contains the Pocono Formation, Mauch Chunk Formation, and the Pottsville Formation. The lowland section contains the coal rich Llewellyn Formation, which essentially makes up the entire Northern Anthracite field of the Wyoming and Lackawanna Valleys (PA DCNR Geological Spatial Analyst Database 2018).

Historic Uses

The Abraham's Creek watershed has experienced intensive land use changes since European settlement. Damming, clearcutting, and agricultural practices were most extensive in the upland section of the watershed while coal/gravel extraction, road/railroad construction, and general urbanization characterized usage in the lowlands. Extensive land use changes in the lowland section led to the obliteration of stream channels and confluence of the Novicki and West 8th Street tributaries, as well as the separation of the Hick's and Abraham's Creek watersheds. The Griffith/Westmoreland Colliery operated in the lower section of the Novicki tributary. Per the Abrahams Creek Watershed Assessment and Project Prioritization report, Skelly & Loy stated “(Novicki) Tributary's flow was at one time flumed down from the mountain and through this area in a structure consisting of end-to-end barrels. This water was presumably used for gravel washing in the gravel mining area (Skelly & Loy 2008).”



Figure 5. The Westmoreland Colliery during the early 20th century. Notice the small flume-like structure between in front of the breaker. It is possible that this contained flow from Novicki tributary.



Figure 6. 1939 aerial photo of the Westmoreland Colliery. The blue arrows represents the existing stream path of Novicki tributary at the time.



Figure 7. Mine entry to Westmoreland Colliery workings. The elevated structure on the left of the coal carts is the steel flume used to convey a portion of Novicki tributary.

Records indicate that mining in this specific location occurred from 1898-1966 (northernfield.info 2017). First operating as the Griffith Colliery in 1898, it was then named the Westmoreland Colliery in a 1904 press release after being purchased by the Lehigh Valley Coal Company. At the height of its production in 1942, the Westmoreland Colliery employed almost 800 employees and produced nearly 600,000 tons of anthracite coal. Mining inspector notes from 1905 confirm that the veins that outcrop on the side of Bunker Hill were extracted and drilled extensively. It is safe to assume that by at least 1900 Novicki tributary was at least partially obliterated by the Griffith/Westmoreland Colliery and the railroad grade that extended up the Wyoming Valley. This suggests that the brook trout population that was surveyed in the upper reaches of Novicki tributary has been completely isolated from the rest of Abraham's tributaries for well over a century. Detailed genetic studies are needed to confirm this hypothesis.



Figure 8. 1904 AP release concerning the purchase of the Griffith Colliery by the Lehigh Valley Coal Company.

Sections Investigated

EPCAMR's investigation into the Abraham's Creek watershed focused on two areas previously discussed in this document- the West 8th St. tributary and the Novicki tributary. The basis for the investigation in the two sections stemmed from 1) preexisting knowledge of general issues observed along West 8th Street and 2) lack of fisheries information on Novicki tributary combined with EPCAMR's knowledge of anthracite coal extraction in the lowland section and observations of periodic dry times in the channel underneath Shoemaker Avenue. The West 8th Street section will include information from the upland section of the watershed. All upland tributaries drain through The Hollow/West 8th Street section and as such is included within the West 8th Street investigation.

West 8th Street Section



Figure 9. Abraham's Creek headwaters off Ryman Road in Dallas Township (41.365973, -75.922754). Headwater sources in the Abraham's Creek watershed are almost exclusively sourced from private ponds and upland wetland habitats.

In the upland section, many sources of the headwaters to Abraham's Creek begin as private ponds and wetland habitats like Figure 5. Erosion issues are not as visible in the upland section as they are in The Hollow and stretches of the lowland section. While the upland section does not experience the same rate of erosion than other areas, there are stretches of stream corridor in the upland section that would benefit from riparian plantings in an effort to alleviate erosion, limit downstream sedimentation, and help maintain water temperatures. Areas like Figure 10 represent good opportunities for best management practices in the upland section. Coordination with the Luzerne Conservation District for riparian planting events will be pursued.

The vast majority of erosion, sedimentation, and downstream management risks were observed on West 8th Street and The Hollow. With steep confined slopes and narrow channels—high precipitation events will continue to exacerbate downstream sedimentation and flooding issues. Bank and culvert instability was observed along West 8th in The Hollow. The rehabilitation of culverts and other manmade structures within the stream corridor will be critical for alleviation of flooding and sedimentation, as well as the promotion aquatic organism passage. The confined nature of the stream channel has allowed for the undercutting of banks, especially during heavy precipitation events. Old culverts were observed with signs of serious dilapidation. Collapsing wing/head walls, erosion, and bank instability can be seen in the steepest sections of The Hollow. The culvert seen in Figure 12 & 13 represent the most immediate need for rehabilitation. If these culverts are not addressed in the immediate future, serious flooding over West 8th Street is distinctly possible. Coordination with municipal officials will be imperative to the rehabilitation of these structures. Other culverts were observed with relatively strong bank conditions on the road-side of the stream channel and degrading conditions on the landowner side. It also appears that culverts that have had recent rehab measures taken have experienced some degradation from the multitude of heavy precipitation events seen in Northeast Pennsylvania this year. Information on assessed culverts can be found on the North Atlantic Aquatic Connectivity Collaborative.

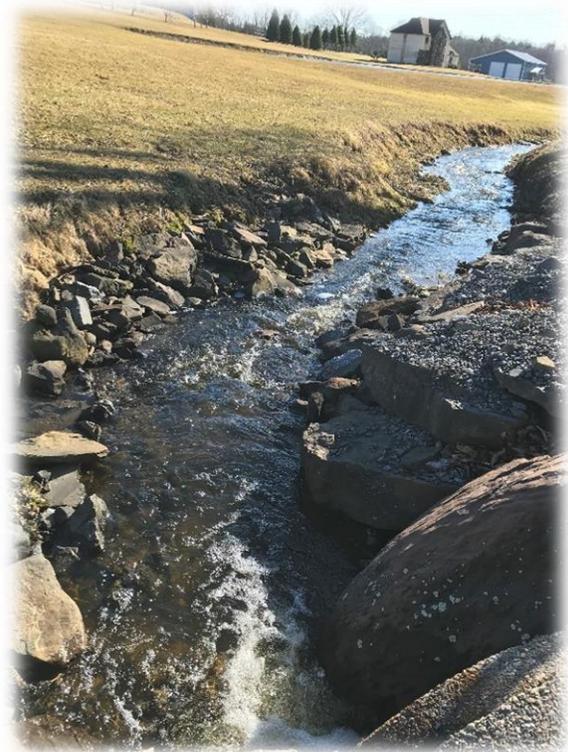


Figure 10. Headwaters along Coon Road in Wyoming Township (41.360701, -75.895737).



Figure 11. Concrete channel along West 8th Street above the Mt. Zion Trib confluence. This channel was likely constructed ~1930's.

The Union of Concerned Scientists projections indicate the possibility of more heavy rain seasons in the Commonwealth over the next century, similar to what we've experienced in 2018 (UCS 2008). With the risk of similar seasons like this, it is essential that proactive measures are taken to mitigate the effects of increased torrential rain events.



Figure 12. Dilapidated culvert where Mt. Zion trib flows underneath West 8th Street in The Hollow. This represents an extreme barrier to fish passage and significant infrastructure failure/flooding risk.



Figure 13. Wingwall on the verge of collapse in the West 8th Street section at Carverton Auto Sales. This culvert is in immediate need of rehabilitation to mitigate risk of flooding over West 8th Street.

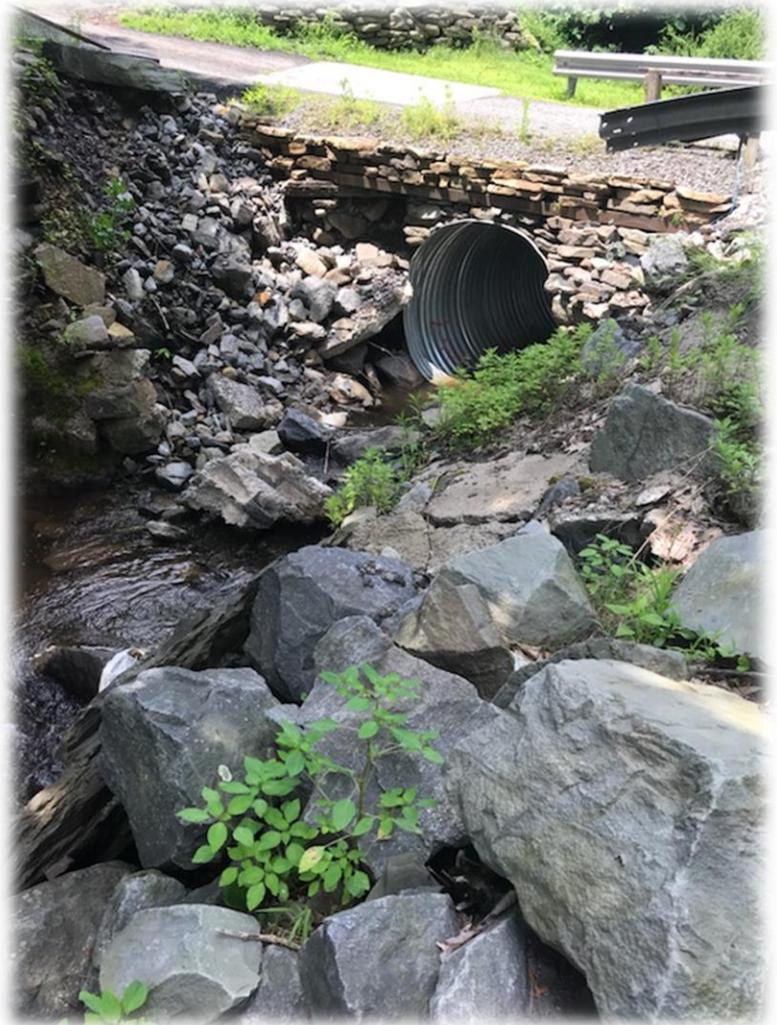


Figure 14. Degrading culvert headwall along West 8th Street. Notice the roadside bank is well armored while the landowner side is showing signs of degradation.



Figure 15. Concrete cinder blocks can be found up and down The Hollow's stream channel. The presence of this indicates heavy bank erosion and the potential for blocked culverts.



Figure 16. West 8th Street tributary as it flows to the Wyoming Avenue flood gates. Notice the complete lack of instream habitat, riffle-run-pool sequencing, and absence of instream gradient.



Figure 17. Seasonal flows occasionally fill the concrete channel that conveys surface water off of the Swoyersville pile and adjacent mountainside. Concrete lined channels characterize much of the lowland section of Abraham's.

Bunker Hill – Mt. Lookout Ridge Section: Novicki tributary

Flow loss in 1st order streams like Novicki tributary is common in the Wyoming and Lackawanna Valleys. Extensive historic extraction of anthracite coal has created a unique situation in the region. The nature of underground mining has allowed for numerous stream loss points as mountain sourced streams transition into the Valleys. This is the situation facing the Novicki tributary. Historic mine maps indicate that Novicki tributary's stream channel was significantly altered by the Westmoreland Colliery operation and suggest the potential for multiple stream loss points within or near the stream channel. From both on the ground and historic mine map

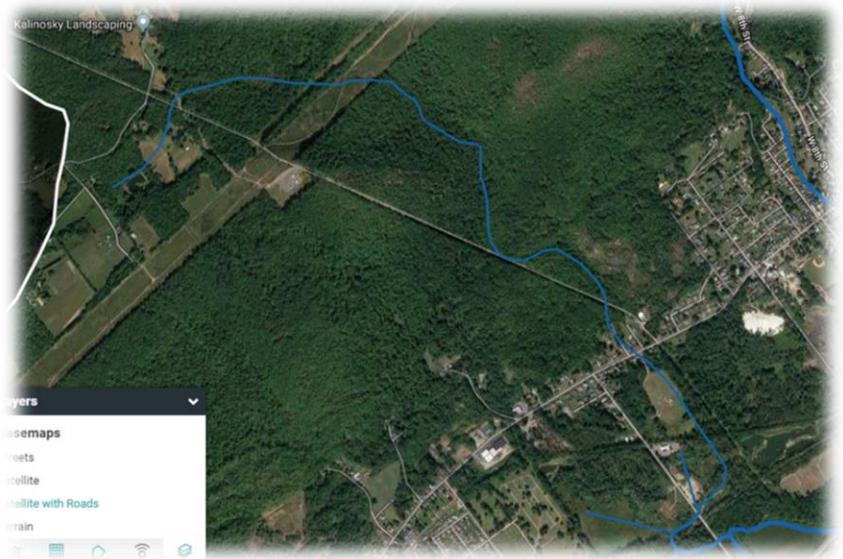
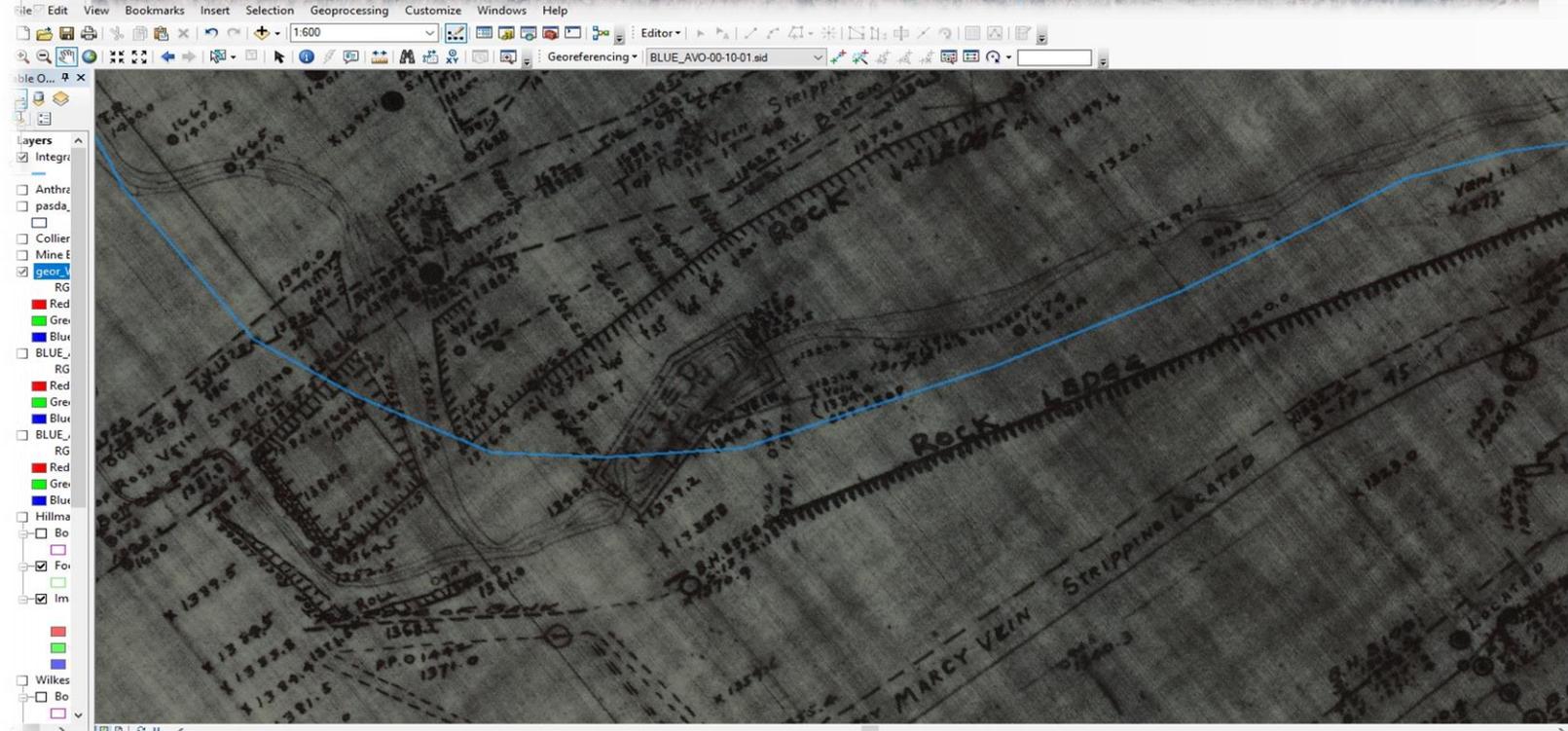
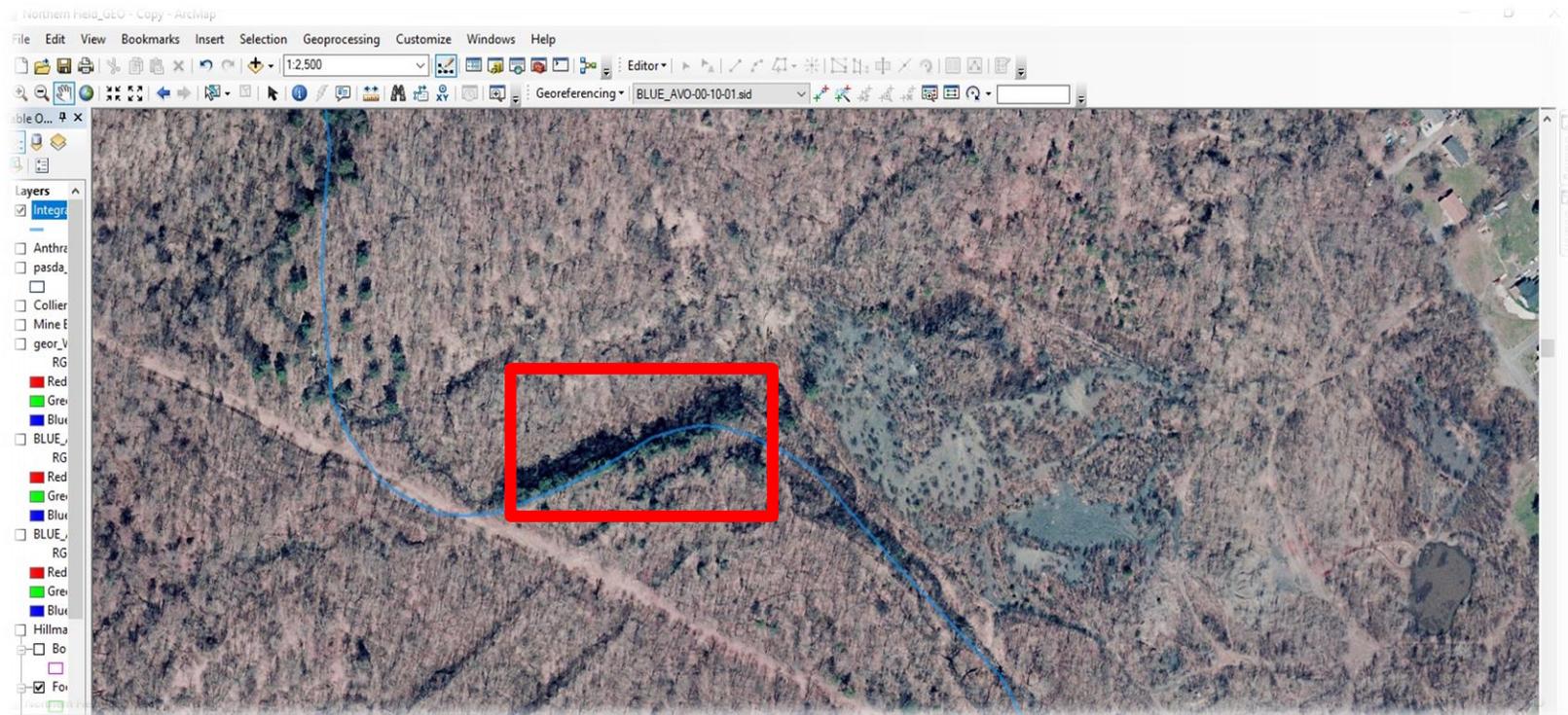


Figure 18. Map showing Novicki tributary's general stream course

investigations, it is clear that Novicki tributary exhibits manmade alterations for the purpose of anthracite coal mining. Drilling was commonplace when exploring for extents of coal seams and providing air to the underground workings. As previously noted, Novicki tributary was at least partially conveyed from its stream channel for the purpose of mining anthracite coal. The fact that a flume was constructed to draw from Novicki tributary indicates the effort to minimize surface water infiltration to the underground workings. This likely allowed for the increased speed at which the lower sections of were obliterated.



Figures 19 & 20. ArcGIS snapshot of Novicki tributary's stream path through the Top Ross, Marcy, and Pittston Vein outcrops.



Figures 21 & 22. The contrasting habitats between the upper and lower reaches of Novicki tributary can be seen clearly. The challenge here is to conserve upper reaches while not exacerbating downstream flooding issues seen between East Brady & Swetland Lane in the West Wyoming Borough.

Methodology

Water Quality Monitoring and Data Collection

In the summer of 2018 EPCAMR staff monitored 4 points within the Abrahams watershed. Water quality monitoring consisted of the use of a YSI Professional Series Water Quality Probe, Swiffer 3000 Flow Monitor, and a YSI Professional Series Photometer. Parameters measured are the following: pH, temperature, dissolved oxygen, oxidative reduction potential, specific conductance, total dissolved solids, iron, alkalinity and sulfates. Due to gear and limited carrying capacity- iron, alkalinity, and sulfates were not taken in the Novicki tributary. Flows were measured on the same day that water quality was measured. Water quality and flows were measured on July 11th & 13th in the historic stream channel of Abraham's below the Forty Fort Airport, Abraham's outlet at the Wyoming Avenue flood gates, and West 8th Street in The Hollow.

Biological Sampling

In the summer of 2018 EPCAMR staff conducted a total of four biological surveys. Three of which were macroinvertebrate surveys and one was a fish survey. The macroinvertebrate surveys were conducted on July 11th 2018 and the fish survey was conducted on August 1st 2018, October 11th 2018, and October 16th 2018. The macroinvertebrate survey used a 6' kick net setup in riffle (or most riffle-like) habitat in each stretch of Abraham's. Two staff members anchored the kick net in the riffle section while four staff members kicked the stream substrate upstream to dislodge the surveyed benthic macroinvertebrates. Macroinvertebrate sampling was conducted in accordance with Trout Unlimited's Macroinvertebrate Survey and Assessment standards- groups of tolerant, somewhat tolerant, and intolerant were represented by a scoring method and the abundance of each group is reflected in the final scoring. Sampling was conducted after water quality and flow monitoring. Trout Unlimited staff assisted EPCAMR staff in the fish surveys along Novicki tributary. Using an electrofisher, TU and EPCAMR staff waded through various lowland and upland reaches of Novicki tributary. As fish were captured, they were placed in a 5 gallon holding bucket, measured, and marked in a field book for length and age estimation. Trout Unlimited will provide EPCAMR with a survey report following the completion of the CCP and it will be added as an Appendix.

NAACC Culvert Assessments

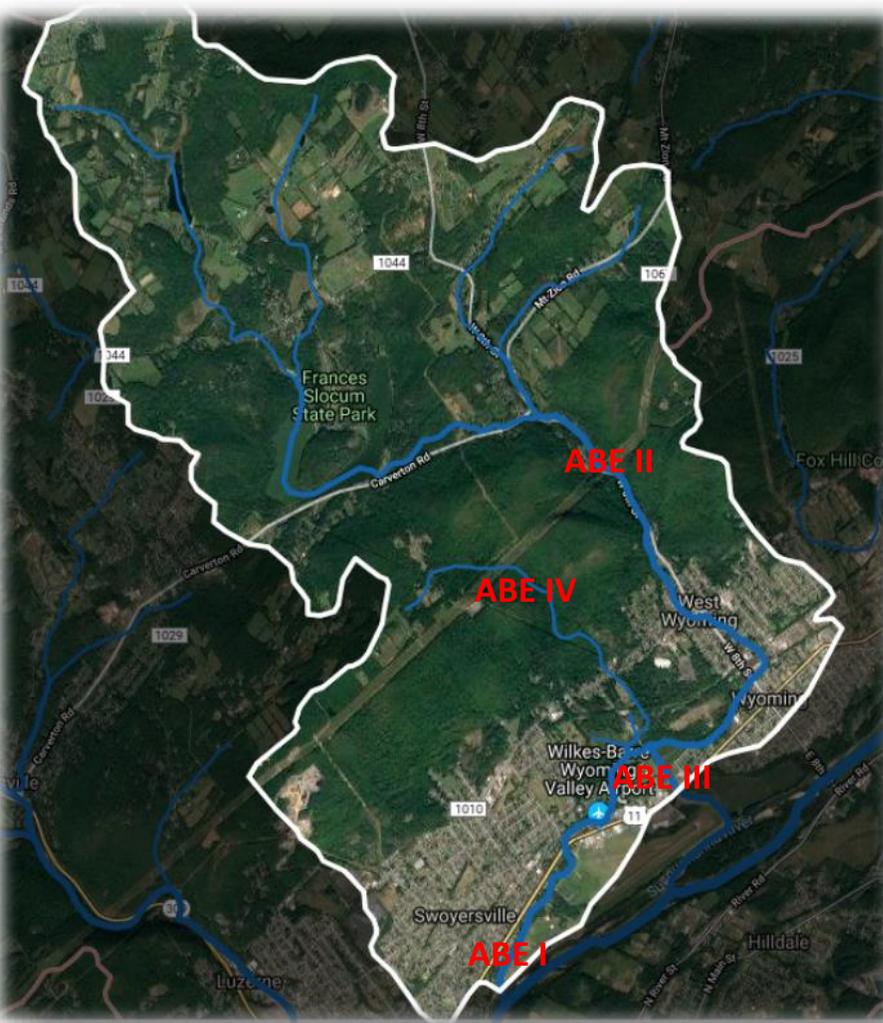
Throughout the summer of 2017 EPCAMR staff conducted culvert assessments and uploaded each assessed culvert and corresponding information to the North Atlantic Aquatic Connectivity Collaborative database. Using a paper copy, clipboard, and cell phone- culverts were checked for structural integrity, aquatic and dry passage, and were documented with photos. Each culvert can be individually found on NAACC's stream continuity website. Culverts that exist on private properties were not assessed without permission from the landowner. This report will focus on the most degraded culverts with low passage scores. Additional data regarding NAACC culvert assessment for Abraham's Creek will be made available at the Stream Connectivity website as they become approved.

Visual Habitat Assessment

Visual habitat assessments were completed the same times as the water quality monitoring and biological sampling events. Assessments were based on the EPA's Rapid Bioassessment Protocol, which include the following habitat parameters: Instream Cover, Epifaunal Substrate, Embeddedness, Velocity/Depth Regimes, Channel Alteration, Sediment Deposition, Frequency of Riffles, Channel Flow, Condition of Banks, Bank Vegetative Protection, Grazing or Disruptive Pressures, and Riparian Vegetative Zone Width. Each habitat parameter has a range of scores whose sum represents the total score. If total the habitat scores sum is less than 140, the stream channel is considered impaired. Combined scores for embeddedness and sediment deposition below 24 indicate impairment. Combined scores for condition of banks and bank vegetation below 24 indicate impairment.

Results

Water Quality Monitoring



Station	Date	Water Quality & Flow (CFS)
ABE I	8/11/18	pH- 6.47 Temp- 21.9°C DO- 4.20 mg/L ORP- 51.0 mV Conductance- 294µS TDS- 147 mg/L Iron- .7 mg/L Alkalinity- 45 mg/L Sulphates- 19 mg/L Flow: Not measurable
ABE II	8/11/18	pH- 7.14 Temp- 20.7°C DO- 8.25 mg/L ORP- 40.1 mV Conductance- 175 µS TDS- 87 mg/L Iron- .5 mg/L Alkalinity- 185 mg/L Sulphates- 12 mg/L
ABE III	10/5/18	Flow- 37.59 CFS
ABE III	8/13/18	pH- 6.61 Temp- 19.3°C DO- 6.62 mg/L ORP- 44.4 mV Conductance- 225 µS TDS- 112 mg/L Iron- .7 mg/L Alkalinity- 115 mg/L Sulphates- 8 mg/L
ABE III	10/5/18	Flow- 45.31 cfs
ABE IV	10/16/18	pH- 7.37 Temp- 10.9°C DO- 10.72 mg/L ORP- 137.0 mV Conductance- 63µS TDS- 31 mg/L Flow (upstream)- 2.8 CFS Flow (downstream)- 2.3 CFS

Figure 23. Watershed map detailing the sampling points for water quality and biological sampling and water quality sampling results.

Biological Sampling

Station	I. Sensitive	II. Somewhat Sensitive	III. Tolerant	Total Water Quality Score
ABE I	0	2 (rare) – Dragonfly Nymphs, Scuds	2 (rare)- Aquatic Worms, Midge Larvae 1 (common)- Lunged Snails	9.9
ABE II	2 (rare)- Water Penny Larvae, Hellgrammites 1 (common)- Stonefly Nymphs	3 (rare)- Crayfish, Dragonfly Nymphs, Alderfly Larvae 1 (common)- Net Spinning Caddisfly Larvae	1 (rare)- Aquatic Worms	29.8
ABE III	1 (rare)- Water Penny Larvae	3 (rare)- Scuds, Alderfly Larvae, Net Spinning Caddisfly Larvae	1 (common)- Aquatic Worms 1 (rare)- Lunged Snails	16.9

Figure 24. Results from macroinvertebrate sampling. Due to time constraints with the trout survey, macroinvertebrates were not sampled at station ABE IV. Sampling was conducted in July and August of 2018.

Visual Habitat Assessments

Station ID	Location	Land Use	Embeddedness + Sediment Deposition	Condition of Banks + Bank Vegetation	Total Habitat Score (if < 140 generally impaired)
ABE I	41.2965,-75.8614	Residential	10	17	66
ABE II	41.3338,-75.8586	Forested/Residential	26	25	127
ABE III	41.3037,-75.8485	Residential/Flood control	10	31	77
ABE IV Upstream	41.320921,-75.866285	Forested Ridge	33	28	203
ABE IV Downstream	41.316257,-75.857891	Forested/Residential	11	19	118

Figure 25. Habitat assessments with corresponding scores and locations. Total scores compared against the general impairment metric of 140. If total scores' sum is less than 140, general impairment can be expected.

North Atlantic Aquatic Connectivity Collaborative

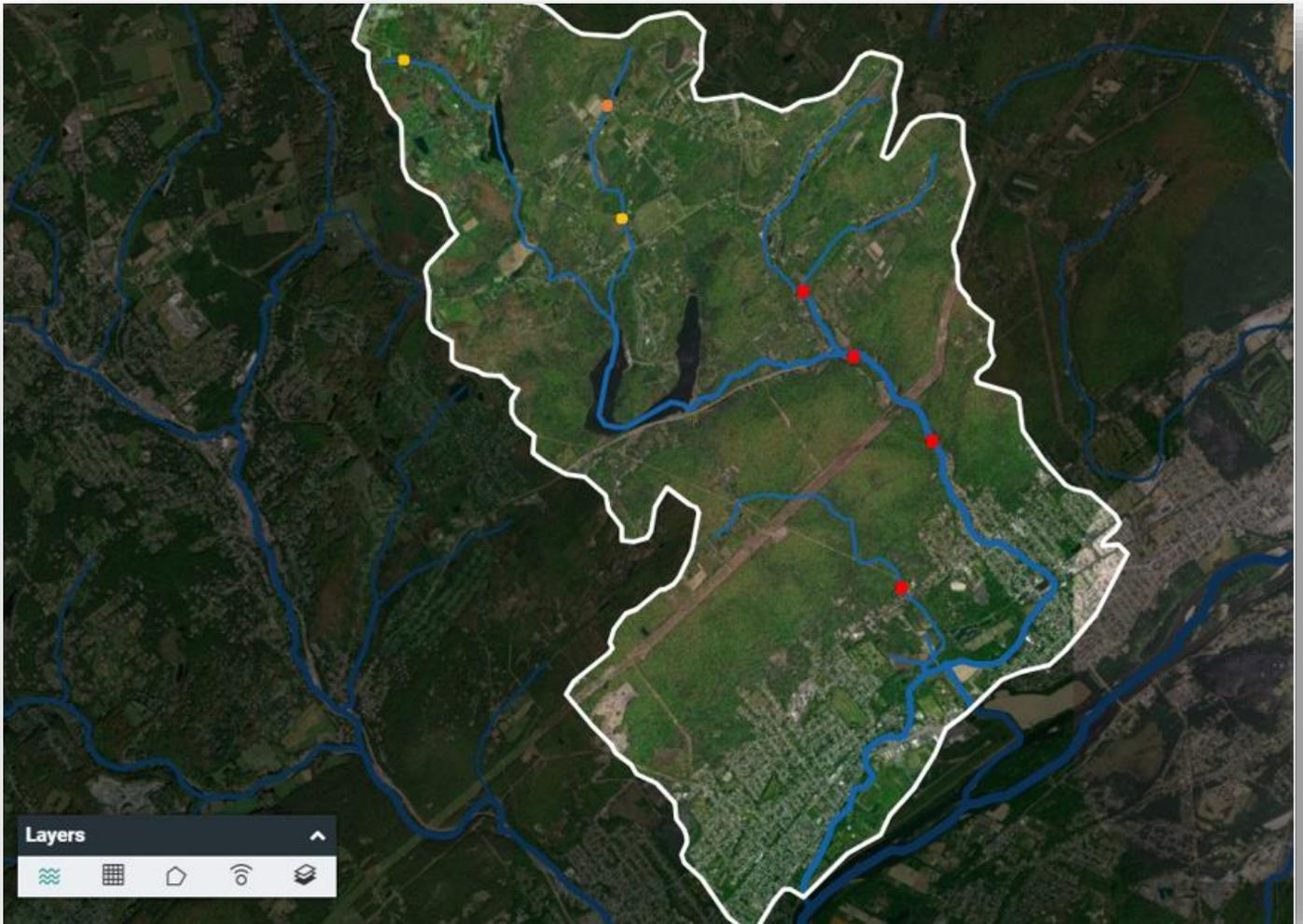


Figure 26. Culverts in the Abraham's watershed in need of replacement. Yellow indicates minor barrier to aquatic organisms, orange indicates moderate barrier to aquatic organisms, and red indicates severe barriers to aquatic organisms.

Recommendations & Discussion

1) Source water protection in the upland section of the Abraham's Creek watershed: The Abraham's Creek watershed is an altered and populated watershed that has many opportunities to increase water quality and mitigate risk to both people and the environment. It is imperative that source water protection practices are exercised in the upland section of the watershed. Protection of source waters begins with conserving habitats like seen in Figure 9. If source waters are protected, the risk for future flooding and sedimentation is mitigated.

2) Coordination with private landowner along Coon Road for bank stabilization and riparian corridor restoration: In terms of projects that represent relatively easily implementation, none in the watershed are more available than the stretch of unnamed tributary along Coon Road as seen in Figure 10. Coordination with the landowner to implement some sort of bank protective measures other than rock armoring would be hugely beneficial to hundreds of feet of streambank exposed to continuous flowing water. Ideally, a riparian tree planting project can be implemented to retain the landowners' bank and maintain water temperatures.

3) West 8th Street section for stream channel and streambank restoration: The highest rate of stream channel and streambank degradation is occurring in the West 8th Street section of The Hollow. Figures 12 & 13 represent opportunities for rehabilitation and improvement that would dramatically reduce the risk of heavy debris falling into the stream and reduce the risk of catastrophic flooding. Exploration of Trout Unlimited's program dedicated to planning and design of culverts is recommended to assist local municipalities in their efforts to replace dilapidated culverts and their associated banks. The Luzerne Conservation District also has funding available for streambank stabilization and riparian corridor restoration projects that could be applied for to begin project implementation once a design plan is put in place for the restoration projects to be proposed. Again, it is imperative and recommended that culverts like seen in Figure 12 and 13 be addressed as soon as possible to avoid complete infrastructure failure and inevitable flooding that would result.

4) Conservation of the upper reaches of Novicki tributary: In the upper reaches of Novicki tributary, the conservation of the forested habitat will be crucial to the continued presence of the local brook trout population. Given the relief of slopes near Novicki tributary, there are opportunities for selective tree plantings along the banks to ensure soil retention and limit in-stream embeddedness. Given the nature of downstream issues in the Novicki tributary lowland

section, it will be difficult to immediately pursue returning all of Novicki tributary back to the surface.

5) Coordination with the Airport Sand & Gravel to further investigate the hydrology and potential surface manifestation of the underground mine pool: The undeveloped gravel pits between East Brady and Swetland Lane represent a challenge to both the residents of West Wyoming and the population of native brook trout in the upper reaches on Bunker Hill – Mt. Lookout Ridge. This area is effectively a manmade wetland now and has a high mosquito population density and activity in the area, which could become a public health concern. This undeveloped wetland could prove as an adversary to the West Wyoming Borough in their effort to reduce Total Suspended Solids (TSS) in accordance with the new Chesapeake Bay Commission standards. It is conceivable that restoration of the wetland features into more of a functioning wetland and the encouragement of surface water flowing into the area would allow for a massive reduction in TSS to the Susquehanna River and ultimately the Chesapeake Bay. EPCAMR is interested in investigating the surface water within the gravel pits for potential hydrologic connections to the underground mine pool.

6) Mine Pool Mapping for the Abraham's Creek Watershed: Abraham's Creek and its unnamed tributaries both experience mining impacts and stream flow loss as a result of historic anthracite coal mining. Development of a model of the underground mine pool connections for this watershed would help determine where flows are lost. Mine pool mapping of this watershed would add to EPCAMR's understanding of the mine pool and allow for more detailed mine pool related information to provide the municipalities within the watershed. An investigation into the mining voids may lead to a better understanding of potential weak points in storm water infrastructure.

7) Coordination with municipalities, community organizations, and stakeholders with the Abraham's Creek watershed: EPCAMR recommends that continued coordination with municipalities, watershed organizations, community leaders, and stakeholders in the Abraham's Creek watershed will be vital to the implementation of on the ground projects. EPCAMR will send a copy of this report to each municipality and community groups that were interested in the development of the Abraham's Creek watershed CCP. EPCAMR recommends working with each municipality to determine ongoing or new issues they find within the Abraham's Creek watershed to develop future implementation projects to mitigate these issues. It is imperative that the organizations in the area coalesce to promote the 1) conservation of wild reproducing brook trout atop Bunker Hill – Mt. Lookout Ridge 2) reduction of sedimentation and flooding issues to the most at risk sections of Abraham's Creek 3) effort to help reduce surface water run-off and investigate potential mine pool manifestation in the undeveloped wetlands between East Brady and Swetland Lane.

8) Identification of private landowners with culverts located on their property: EPCAMR also recommends working with the local municipalities to identify those private landowners where we were not able to reach and access private drives where existing culverts are located that were not assessed to request permission to conduct the proper culvert assessments under the NAACC.

9) Flow Monitoring: EPCAMR recommends performing additional seasonal flow monitoring in Novicki tributary.

10) Stream Cleanups and Community Outreach: EPCAMR noted minor illegal dumping and woody debris buildup throughout the urbanized section of Abraham's Creek. EPCAMR recommends holding stream cleanups in order to mitigate these issues. Furthermore, cleanups would allow community members to be more aware of their surroundings and promote responsible use of local streams.

11) Utilizing TU's Dirt & Gravel Road Program: Using the dirt & gravel road program established by Trout Unlimited will allow for culvert replacements, bank projects, and other relevant best management practices adjacent to tributaries of Abraham's Creek. It is important to note that Dirt & Gravel funds are only applicable when working on municipal roads.

Additional community outreach would include public access to materials regarding Abraham's Creek as well as general environmental stewardship information. EPCAMR would achieve this by updating materials on our website and continuing to share information through our social media pages, email initiatives, and volunteer programs.

Citations

- Skelly and Loy, Inc. (June 2012), Abrahams Creek Watershed Assessment and Project Prioritization.
- Michael Baker, Jr., Inc. (November 2013), Hicks Creek and Abrahams Creek Detailed Feasibility Analysis Exeter Borough, Luzerne County, PA Final Report.
- “Westmoreland Colliery.” Northernfield.info, www.northernfield.info/Collieries/Westmoreland/20Inspector20Narratives.pdf.
- “Climate Change In Pennsylvania: Impacts and Solutions (2008).” Union of Concerned Scientists, 1 Sept. 2008, www.ucsusa.org/global_warming/science_and_impacts/impacts/climate-change-pa.html#.W81bI0tKiM8.
- “PA.Gov.” Geology, www.dcnr.pa.gov/Geology/Pages/default.aspx.
- Model My Watershed, app.wikiwatershed.org/analyze.