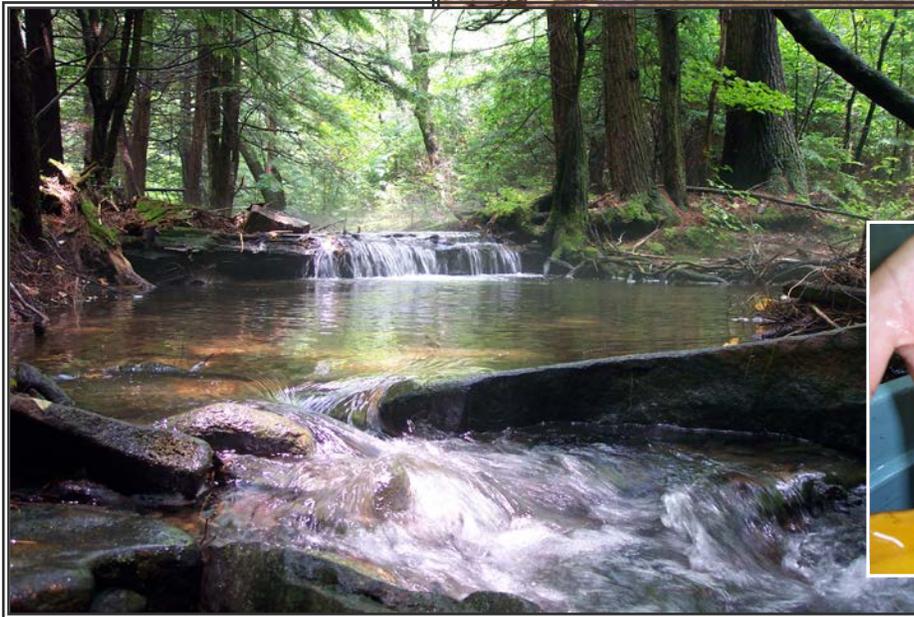
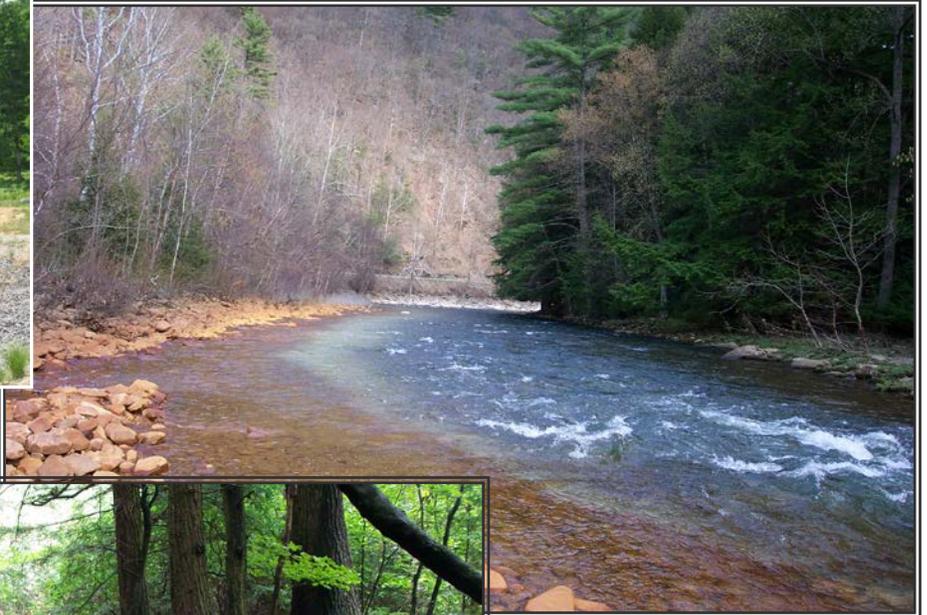


Kettle Creek Watershed, Clinton County, PA Abandoned Mine Drainage Projects 1998-2013 (updated April 2013)



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Middle Branch Passive Treatment System and Rehabilitation

This passive treatment system was designed by DEP Bureau of Abandoned Mine Reclamation in 2000 and constructed by E.M. Brown Inc. to treat the primary source of AMD to Middle Branch, a tributary to Twomile Run. The cost of \$234,367 was funded by the Title IV AMD Set-Aside Fund. It functioned well in the beginning, but began to lose its effectiveness after 1 ½ years. TU and the KCWA received a Growing Greener grant to conduct an autopsy of the system in 2004 and then rehabilitate the system. The total cost for this was \$132,397 and was funded by grants from Growing Greener, Richard King Mellon Foundation, and the National Fish and Wildlife Foundation.

The autopsy revealed some short-circuiting problems in the vertical flow ponds, but the main issue was that the system was receiving, on average, more flow than it was designed to effectively treat. Nevertheless, the system was still generating approximately 40 g/m²/day of alkalinity – it was simply being overloaded with too much bad water.

The system was rehabilitated by Smith Excavating & Construction in 2007 using a design developed by Hedin Environmental. Rehabilitation included the collecting and rerouting of a portion of the most severe discharges to a location where the discharges will likely be eliminated as a result of a future reclamation and remining project. Other rehabilitation activities included replacement of compost in the upper vertical flow ponds, amendment of compost with limestone, conversion of limestone treatment beds to vertical flow ponds, and installation of flow control devices to limit flow of the severe discharge into system.

The treatment system is working very well. Beginning in June 2008, nearly one year after the rehabilitation, TU has documented the stream's recovery with recolonization of macroinvertebrates and finally, the finding of native brook trout for the first time in August 2010. Middle Branch now contains a thriving population of naturally reproducing brook trout from its headwaters to its mouth. The DEP is currently collecting data from Middle Branch to support delisting the stream, or removing it from the commonwealth's list of impaired streams.



Over 20 people representing 10 different agencies and organizations participated in the autopsy.



Aerial view of rehabilitated system.



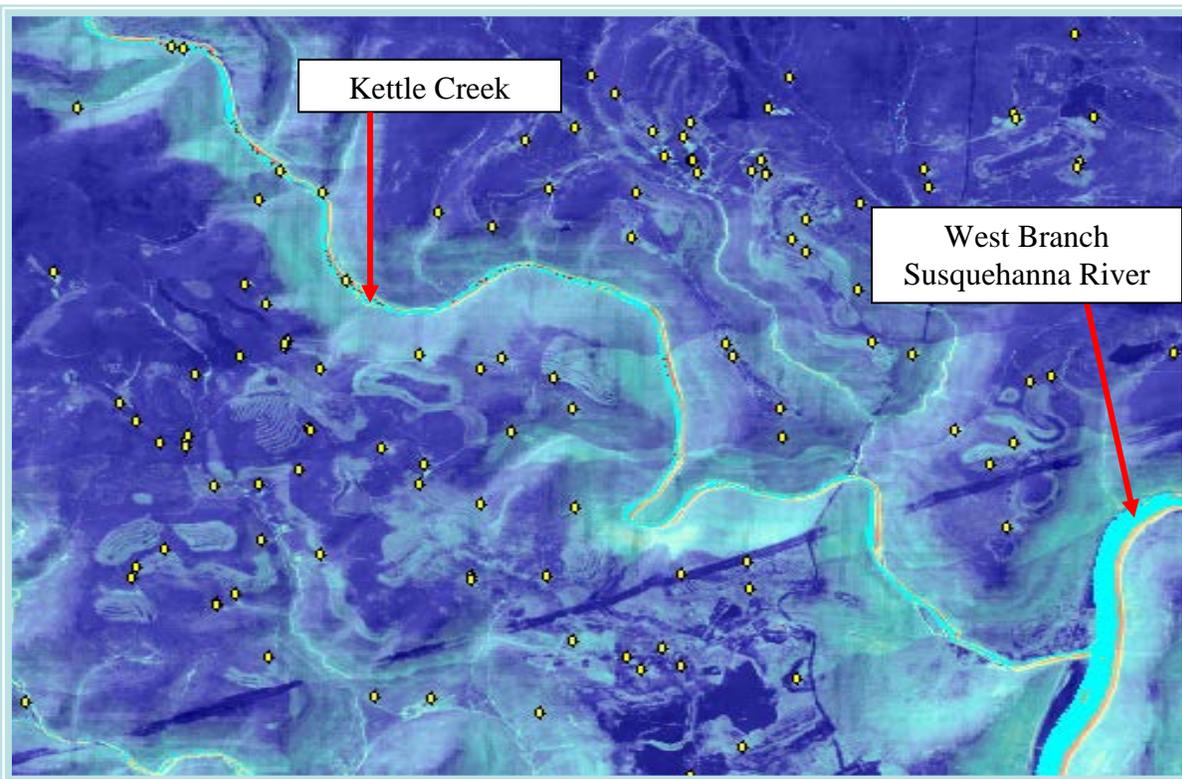
Middle Branch is coming back to life.

Airborne Remote Sensing Survey

TU and KCWA partnered with the Department of Energy's National Energy Technology Lab in Pittsburgh, PA to conduct an airborne remote sensing survey of the abandoned mine drainage in lower Kettle Creek watershed. This study used infrared and geophysical instruments to gather data on the location of abandoned mine drainage. The data collected provided useful information for selecting and prioritizing mine drainage treatment alternatives. The project cost of \$109,772 was funded by Growing Greener and the Army Corps of Engineers Section 206 Aquatic Ecosystem Restoration Program.

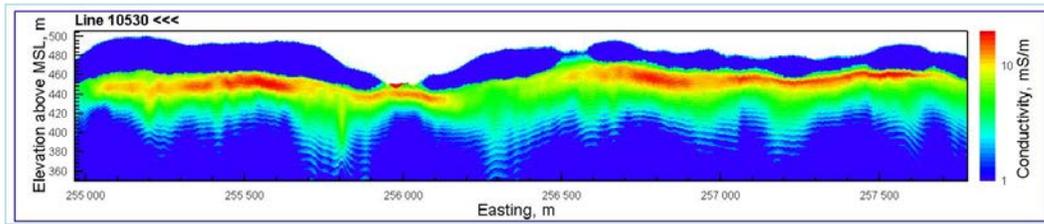
The thermal infrared component of the survey used heat or infrared radiation to locate groundwater seeps. This works on the principle that when the ground is frozen, groundwater will be relatively warmer and as a result will show up as a hot spot on the imagery. Although it cannot determine if the water is clean or polluted, it is a valuable tool in that it can help to locate the diffuse and often remote abandoned mine drainage seeps. This portion of the study was conducted via airplane in late March 2002 and an intensive groundtruthing effort was completed later in June 2002.

The geophysics portion of the project used an array of instruments (flown over via helicopter) that take advantage of the physical characteristics of abandoned mine drainage (i.e. electrical conductivity). Collected data helped to determine where the abandoned mine drainage is flowing and most importantly, the locations of deep mine pools. With this technology, mine pools can be located up to 300 feet underground. This information was particularly valuable because mine maps are not available for much of the study area.



Map of lower Kettle Creek watershed and part of Cooks Run watershed that shows potential AMD “hot spots” generated from thermal infrared imagery.

Airborne Remote Sensing Survey (continued)



Cross-section of portion of lower Kettle Creek watershed that shows contaminated plumes of groundwater, mine pools, and areas of recharge for AMD.

The most valuable information we obtained from this study actually came several years later when airborne remote sensing data was used to help guide the hydrogeological assessments and drilling program conducted by Hedin Environmental to help develop the Twomile Run and West Side of Kettle Creek AMD Remediation Master Plans. First, Hedin Environmental identified the potential for a catastrophic mine blowout from the Kettle No. 1 Mine (addressed in KC204 Mine Pool Stabilization). Second, Hedin Environmental found that contaminated baseflow contributes 30-50% of the pollution loads to the Twomile Run watershed. As a result, it was realized that reliance upon only conventional "collect and treat" methods of the point source discharges would not lead to successful stream recovery. Reclamation must be part of the overall remediation strategy as it is the only way to effectively address the contaminated baseflow.



Helicopter-mounted
electromagnetivity survey (HEM)



Six agencies and organizations assisted with the week-long groundtruthing efforts to verify if "hot-spots" identified by the thermal imagery were polluted with AMD.

Huling Branch Collection System

The purpose of this project was to collect the main known sources of AMD inflows to Huling Branch so that the water quality and flows of AMD could be evaluated for treatment potential without the influence of clean surface water runoff. Huling Branch is a tributary to Twomile Run that contains a reproducing population of native brook trout in its headwaters above the AMD.

The first set of collection systems (French drains) was constructed in 2002. The first discharge collected was from an abandoned deep mine, which also happened to be the first major source of water to pollute Huling Branch. Because the AMD flow from this deep mine was collected and piped to a central location (for purposes of monitoring and ease of potential future treatment) approximately 2500 feet from where it emanated and originally entered the stream, this source of AMD was eliminated from this stretch of Huling Branch. As a result, brook trout and macroinvertebrates have successfully recolonized this section of stream as documented from an electrofishing survey TU conducted with the PA Fish and Boat Commission two years after the project was completed.

Two additional collection systems were installed in 2002 and three more in 2006 to collect and monitor the numerous, diffuse seeps of AMD that pollute Huling Branch. All collection systems were designed by Hedin Environmental and installed by Smith Excavating & Construction. Data from these collection systems will help to evaluate the success of future re-mining and reclamation projects in the Huling Branch watershed and to help determine if follow-up treatment is necessary. The total cost of \$76,360 from Growing Greener for the collection systems also included development of a remediation plan by Hedin Environmental for the Huling Branch mine complex.



The collection systems will also help to monitor the effectiveness of future reclamation and re-mining projects.



Well-preserved timber supports were found at some mine entries.



Brook trout quickly recolonized the stretch of Huling Branch where AMD was “removed.”

Twomile Run Surface Reclamation

The Twomile Run watershed is plagued with unreclaimed or poorly reclaimed surface mines and deep mines. Ground water emanating from one such mine created a large kill zone known as “The Swamp,” which is the first major source of AMD pollution to Twomile Run. A Class A native brook trout stream exists upstream of where these discharges enter.

The Twomile Run surface reclamation project, completed in 2005, was the first step to addressing the “Swamp” discharges. The project cost of \$626,712 was funded by Growing Greener and the Office of Surface Mining, designed by DEP BAMR and Gannett Fleming, and constructed by E.M Brown Inc. The project included recontouring 57-acres of abandoned surface mine to augment drainage and promote runoff. In addition, the soil was enhanced with WesTan soil, an alkaline byproduct of the vegetable leather tannery industry, to promote the growth of an elk food seed mix. The resulting new vegetation allows precipitation to more readily leave the site through evapotranspiration and inhibits the precipitation from infiltrating into the coal spoil and subsequently creating acidity. A collection system, designed by Hedin Environmental and constructed by Smith Excavating & Construction, was installed down gradient of the surface reclamation site to collect the remaining flows of AMD for the purpose of designing and constructing a follow-up treatment system.

The reclamation project has been a success as it has reduced flow and acidity and metals loadings to Twomile Run by 30-50%. The Swamp Area Passive Treatment System was constructed to treat the AMD that continues to flow from this site (see page 8.)



D-11 aids in regrading.



WesTan soil piles spread across site prior to being mixed in with surface material.



Trout Unlimited had the site limed and fertilized in 2006 and again in October 2009.

Robbins Hollow Headwaters Passive Treatment System Complex

Robbins Hollow, a tributary to Twomile Run that emanates from an abandoned surface mine and an intact underground coal mine, was once completely polluted. In 2004, TU and the KCWA completed five passive “mini-passive systems” designed by Hedin Environmental. The total cost was \$314,175 and was funded by Growing Greener and the Office of Surface Mining, and constructed by E.M. Brown Inc. An AMD technical assistance project of \$11,800, administered by Stream Restoration, Inc. and completed by Hedin Environmental, was conducted in 2001 to investigate the headwaters AMD discharges and collect data for the design of the mini-passive systems.

Passive treatment methods utilized in the systems include vertical flow ponds with limestone and mushroom compost, vertical flow ponds with only limestone, settling ponds, an anoxic limestone drain, and open limestone beds. The treatment systems have successfully improved in-stream conditions and water quality in Robbins Hollow until additional sources of AMD enter the stream just 300-ft downstream. A population of blue gills has taken residence in the settling pond, as well as several other species of fish and amphibians yet to be identified.



Hedin Environmental and TU staff review design plans.



Wood frog (identification not confirmed) eggs and tadpoles have been observed in the settling pond.



The North Branch Robbins Hollow passive treatment system has been successfully treating AMD with high acidity, high aluminum, and high iron since going online in 2004. Maintenance in the form of replenishing the organic compost (with limestone fines) and washing the limestone in the two vertical flow ponds was conducted in 2012 as preventative maintenance to ensure the continued performance of the system.

Swamp Area Passive Treatment System

The Swamp Area passive treatment system is the last step to addressing the first major source of AMD to Twomile Run. The passive treatment system that was designed by Hedin Environmental consists of an intake screen with a high flow bypass, two settling ponds, three vertical flow ponds, a drainable limestone bed, and a wetland. The system is capable of removing, on average, 240 pounds per day of acidity will be removed. Additionally, the system is capable of removing up to 650 pounds per day of acidity under high flows, which represents the 95th percentile loading from the site.

The total project cost of just over \$1 million – which paid for the initial assessment and construction of collection systems, design, permitting, and construction – was funded by grants from Growing Greener, Title IV AMD Set-Aside Fund, the Office of Surface Mining, Richard King Mellon Foundation, Foundation for PA Watersheds, and in-kind services from the DCNR Bureau of Forestry. The project proposal was submitted to Growing Greener in April 2007 and was awarded a Growing Greener grant in March 2008. The project was delayed due to landowner liability concerns of the DCNR Bureau of Forestry. These concerns were subsequently resolved in late April 2009 when DCNR Bureau of Forestry entered into a Memorandum of Understanding with the DEP for the purpose of transferring project site jurisdiction to the DEP. Construction started in July 2011 and was completed in October 2012.



Aerial view of the Swamp Area treatment system.



Twomile Run is already showing noticeable improvement as evident here at its confluence with Huling Branch.



Swamp Area Kill Zone in April 2004.



Swamp Area Kill Zone in June 2009.

KC204 Mine Pool Stabilization

KC204 is the largest source of pollution that enters Kettle Creek from its western bank. The discharge has severe chemistry, averaging 700 mg/L acidity, 120 mg/L Fe, and 47 mg/L Al. Historically, the discharge from the No. 1 mine was through another nearby drain, KC204A, and through several entries that drain to Milligan Run, a tributary to the West Branch Susquehanna River that is polluted by AMD along its entire length. During the last 30 years, flow through KC204A and the Milligan Run entries has been blocked by subsidence, causing the mine pool to rise and discharge to Kettle Creek through KC204. Under high flow conditions the mine pool is estimated to contain approximately 38 million gallons of AMD. The failure of the KC204A blockage and the sudden release of the mine pool would be catastrophic for lower Kettle Creek and would impact the West Branch Susquehanna River.

This project was completed in December 2010. It involved installing monitoring wells into the deep mine, excavating the collapsed Milligan Run entries, and installing five collection trenches (French drains) to facilitate free drainage for the purpose of reducing the potential for a mine blowout. Long-term measuring of water levels within the mine pool via the monitoring wells will ensure the project is working.

It appears the project may have been completed just in time because during Spring 2011, flows from the deep mine were more than five times higher than previously measured flows and the mine pool level was still only approximately one foot lower than previous maximum mine pool levels measured. While it can never be known for certain that the project prevented a catastrophic mine blowout, the conditions in Spring 2011 were representative of those that could have caused a mine blowout.

The total cost of \$113,914 was funded by grants from Growing Greener, Richard King Mellon Foundation, and Foundation for PA Watersheds. The project proposal was submitted to Growing Greener in April 2007 and was awarded a Growing Greener grant in March 2008.



Weir at KC204 discharge to measure flow from the deep mine.



Kill zone below collapsed mine entry at KC204A.

Area 7 (Three-Fingered Devil) Reclamation

The intent of this project is to reclaim 96 acres of hazardous and AMD-producing abandoned mine lands (AML) in the Huling Branch subwatershed of Twomile Run. This site contains two abandoned underground mines and extensive unreclaimed surface mine spoils. The project will regrade and revegetate spoils so that surface water flows off the AML and does not enter the underground mines. The spoil will be amended with over 41,000 tons of alkaline materials to lessen the generation of AMD. Subsurface drains will also be installed to collect groundwater and will also help to monitor the effectiveness of the reclamation for any follow-up treatment that might be necessary.

This project is based upon recommendations from the Twomile Run Watershed AMD Remediation Master Plan developed by Hedin Environmental. The original technical specifications and design drawings were also provided by Hedin Environmental, with some modifications made later by the DEP Moshannon District Mining Office. However, the DEP Bureau of Abandoned Mine Reclamation has since made multiple technical changes to the project plans as the current project sponsor and is planning to move forward with the reclamation project in 2013.



Abandoned mine features, such as this dangerous high wall, will be reclaimed.



This area also happens to be part of the Whiskey Springs ATV trail system, the DCNR Bureau of Forestry's largest ATV riding area in the state.

Robbins Hollow 10A/10B Passive Treatment System

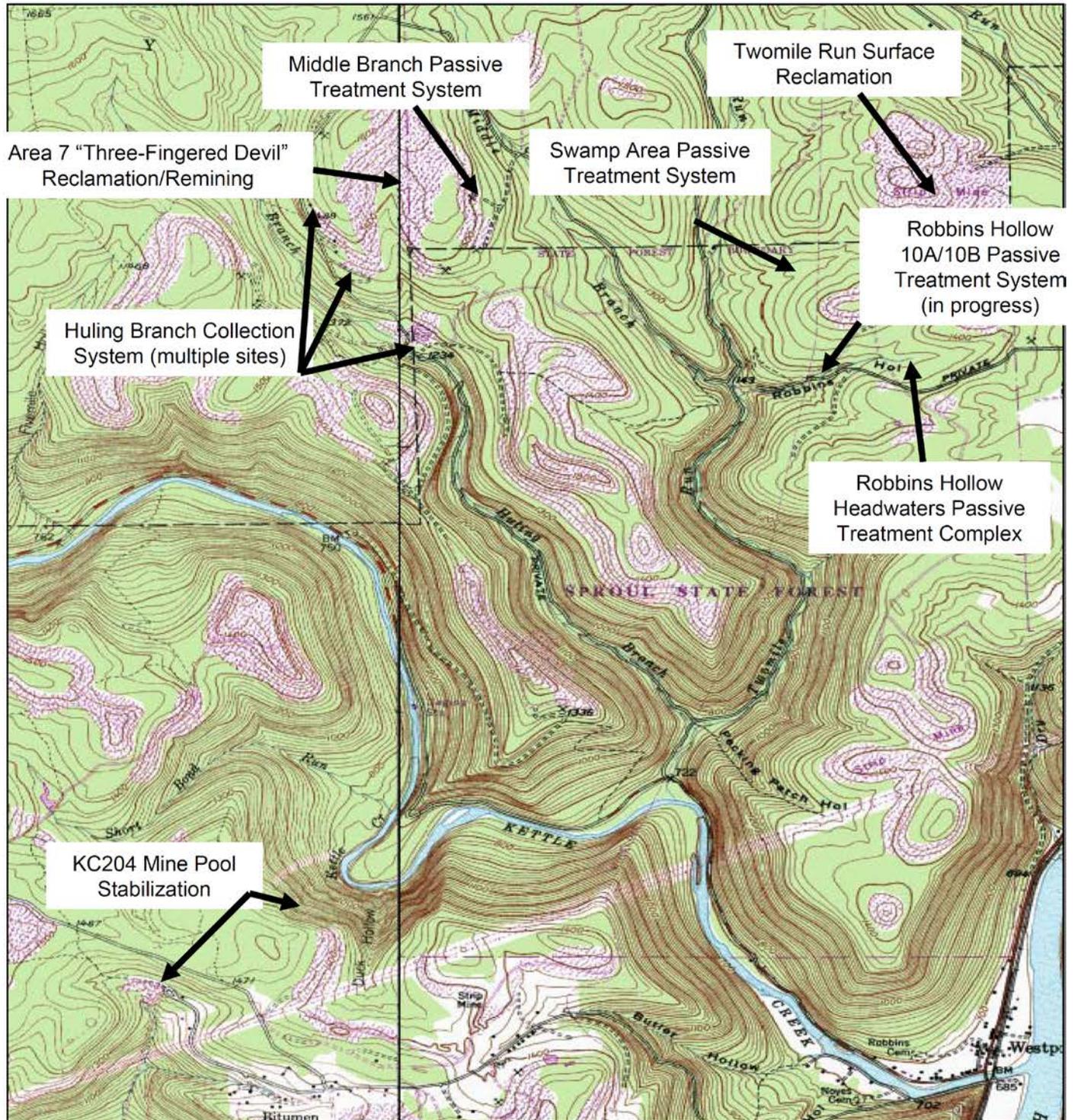
Reclamation and re-mining, wherever and whenever possible, are always the preferred option instead of treatment. Under the most aggressive reclamation and deep mine removal scenario it may be possible to eliminate or reduce the remaining Robbins Hollow discharges to insignificance; however this has been estimated to cost \$2.9 million (Area 4). Anything less than this effort will leave behind AMD that will require treatment. Since it is highly unlikely that a \$2.9 million project will be funded to completely eliminate the remaining discharges, the proposed Robbins Hollow 10A-10B Passive Treatment System becomes a critical component in the overall restoration strategy for Twomile Run.

The main objective for treatment of the Robbins Hollow discharges is to reduce the acidity and metals loadings and to add alkalinity to Twomile Run so that it can be restored to a native brook trout fishery along its entire length. Twomile Run is classified as a Class A native brook trout stream above the AMD pollution. This project, as designed by Hedin Environmental, will consist of two drainable limestone beds and two settling ponds. The system will remove 44.9 pounds of acidity per day, and will generate an excess of 6.2 pounds of alkalinity per day. The total cost of \$236,808 has been secured in grants from Growing Greener, the Richard King Mellon Foundation, the Office of Surface Mining, and the National Fish and Wildlife Foundation. Construction of the treatment system began in December 2012 and is scheduled for completion by August 2013.



Robbins Hollow just downstream of proposed 10A/10B passive treatment system.

Kettle Creek Watershed AMD Project Locations



- Map is not to scale; provided for general location purposes only.
- Keating and Renovo West quads - USGS topo maps
- All projects are located on Commonwealth state forest land managed by the DCNR Bureau of Forestry.

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For more information on projects, please contact Amy Wolfe, Director of Trout Unlimited's Eastern Abandoned Mine Program at awolfe@tu.org or (570) 786-9562.