FINAL
Engineering Evaluation/Cost Analysis
KINZUA CREEK WATERSHED
THREEMILE RUN TAR SITE
MCKEAN COUNTY, PENNSYLVANIA

EPA CONTRACT NO.: 68HE0320D0003

TECHNICAL DIRECTION DOCUMENT NO.: T601-20-07-017

DOCUMENT CONTROL NO.: 0013

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October 2020

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LIST OF ACRONYMS AND ABBREVIATIONS

3D	three-dimensional
°F	degrees Fahrenheit
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society for Testing and Materials, International
bgs	below ground surface
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
cfs	cubic feet per second
CLP	Contract Laboratory Program
COC	contaminant of concern
DCNR	Pennsylvania Department of Conservation and Natural Resources
DEM	digital elevation model
DPT	direct push technology
EE/CA	Engineering Evaluation/Cost Analysis
EER	ecological effects ratio
EPA	U.S. Environmental Protection Agency
FBT	Freshwater Biology Team
FS	feasibility study
FSB	Field Services Branch
gpm	gallons per minute
GPS	global positioning system
IBI	Index of Biotic Integrity
I.D.	inside diameter
LIDAR	light detection and ranging
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Services
NTCRA	non-time-critical removal action
O&M	operations and maintenance
O.D.	outside diameter
OSHA	Occupational Safety and Health Administration
PADEP	Pennsylvania Department of Environmental Protection
PADER	Pennsylvania Department of Environmental Resources
PAH	polyaromatic hydrocarbon

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

PASDA	Pennsylvania spatial data access
PHMC	Pennsylvania Historical and Museum Commission
PNDI	Pennsylvania Natural Diversity Inventory
PPE	personal protective equipment
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act of 1986
SI	site inspection
SRE	streamlined risk evaluation
SVOC	semi-volatile organic compound
TBC	to be considered
TCLP	toxicity characteristic leaching procedure
Tetra Tech	Tetra Tech, Inc.
TMV	toxicity, mobility, and volume
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VOC	volatile organic compound
WESTON	Weston Solutions, Inc.
yd^3	cubic yard

1. INTRODUCTION, BACKGROUND, AND ENVIRONMENTAL SETTING

The Engineering Evaluation/Cost Analysis (EE/CA) was prepared to evaluate the response alternatives to address contaminated sediments in wetlands and on a waterway that drains to the Kinzua Creek, portions of which are considered a high-quality cold-water fishery. The preliminary draft EE/CA was originally developed by Weston Solutions, Inc. (WESTON) through United States Environmental Protection Agency (EPA) contract EP-S3-15-02, Technical Direction Document W501-20-04-004. This finalization of the draft EE/CA was assigned to Tetra Tech, Inc. (Tetra Tech) under EPA contract 68HE0320D0003, Technical Direction T601-20-07-017. For purposes of the EE/CA, the Threemile Run Tar Site in Mount Alton, McKean County PA, will be referred to as the Site.

The EE/CA was conducted because the four factors outlined in Section 300.415(b)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) are applicable:

(i) Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants;

(ii) High levels of hazardous substances or pollutants or contaminants near the surface that may migrate;

(iii) Weather conditions that may cause hazardous substances or pollutants or contaminants to migrate or be released; and,

(iv) The availability of other appropriate Federal or State response mechanisms to respond to the release;

Based on these factors, the conditions at the Site allow direct ecological impacts to macroinvertebrates and fish and impacts to humans via contact with the contaminant, due to no restrictive barriers. Flooding events have caused portions of the original tar source area to be transported downstream, and local and state governments do not possess the funding to take actions.

The primary goal of the EE/CA for the Site is to evaluate removal actions to mitigate contamination that is a threat to the current and future human populations using the area and to ecological populations using and inhabiting the area.

1.1 OBJECTIVES AND SCOPE OF THE EE/CA

1.1.1 Objectives

The Threemile Run Site is one of the Kinzua Creek Watershed Tar Sites with numerous observed exposed tar deposits. The Threemile Run site, located on the Three Mile Run tributary to Kinzua Creek, has occurrences of wood tar that have been observed flowing into the creek. Contamination from tar deposits in the stream and wetland sediments have been confirmed via sampling.

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (42 U.S.C. 9601) and the NCP (40 Code of Federal Regulations [CFR] 300.5) define removal actions as including "the cleanup or removal of released hazardous substances from the environment, such actions as may necessarily be taken in the event of the threat of release of hazardous substances into the environment, such actions as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances, the disposal of removed material, or the taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release" (EPA, 1993). EPA has classified removal actions into three types: emergency, time-critical, and non-time-critical, based on the type of situation, the urgency and threat of the release or potential release, and the subsequent time frame in which the action must be initiated.

The Data Transmittal Letter (WESTON, 2019) at the Site shows the existence of exposed tar deposits along the banks of Kinzua Creek. The sampling results show the exposed tar deposits pose an ecological risk to the environment, specifically that an ecological risk to macroinvertebrates and fish has been determined, as well as potential risk to future human receptors using the area for recreational activities such as fishing, hiking, hunting, and camping. The objectives of the Threemile Run Tar Site EE/CA are to: (1) summarize the field sampling activities/biological surveys completed since 2017, (2) present the results of the May 2020 characterization/sampling event, (3) evaluate alternatives, and (4) recommend as a removal action alternative a non-time-critical removal action (NTCRA) for soils along the banks of Kinzua Creek in the project area. The thresholds of significance and the removal goals for tar deposits in soils are presented in Section 3 of the EE/CA. The risk-based criteria were developed using both the current use and future use scenarios.

The Threemile Run Tar Site EE/CA was developed to support an NTCRA along Three Mile Run in the project area. An NTCRA is designed to be a response to releases requiring action, which can start later than six months after the determination that a response is necessary. Each response is unique and may require more expedited actions based on the threatened population, contaminants of concern (COCs), site characteristics, and other factors. The NCP Section 300.415(b)(2) factors were considered in determining the appropriateness of the removal action to abate, minimize, stabilize, mitigate, or eliminate the threat of a release from the Threemile Run Tar Site area.

1.1.2 Scope and Goals

The Threemile Run Site EE/CA was developed in accordance with *Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA*, EPA 540-R-93-057, August 1993 (EPA, 1993). Chapter 2 of the EPA document provides guidance for conducting an EE/CA to analyze removal action alternatives for a site. An EE/CA, which is required for an NTCRA under the NCP, Section 300.415(b)(4)(i), provides a structure for the evaluation and recommendation of an appropriate removal action and a vehicle for public involvement. The EE/CA process includes a streamlined risk evaluation (SRE) as an intermediate process to evaluate risk. The streamlined risk evaluation used for the Threemile Run Site EE/CA is a screening level risk assessment.

The goals of an EE/CA are to identify the removal action objectives; to compare the cost, effectiveness, and implementability of various alternatives that may be used to satisfy these objectives; and to determine an appropriate removal action. The Threemile Run Site EE/CA and resulting NTCRA are being performed to achieve timely remediation of exposed wood tar deposits and contaminated sediments in wetlands and on Three Mile Run that drains to the Kinzua Creek, portions of which are considered a high-quality cold-water fishery.

The EPA objective for the Threemile Run Site is to comply with Section 300.415(b) (4) of the NCP, EPA's implementing regulations for CERCLA, and to make the property suitable for current and future use.

1.1.3 Report Organization

The Threemile Run Site EE/CA is organized into the following sections:

- The remainder of Section 1 provides information about the site background, including site description and history and the environmental setting information.
- Section 2 provides the results from the May 2020 EE/CA site characterization, including descriptions of the investigation techniques and analytical data.
- The SRE is presented in Section 3.
- Section 4 presents the identification of the removal action goal and objectives, and the schedule.
- The removal action alternatives are described and evaluated in Section 5.
- Comparative analyses of the removal action alternatives are presented in Section 6.
- The recommended alternative is presented in Section 7.
- References are provided in Section 8.

Tables follow their first reference, and figures are presented at the end of each section. Supporting information from the field investigations, risk evaluation, and cost estimates is provided in the appendices to the Threemile Run Site EE/CA.

1.2 SITE BACKGROUND

The Kinzua Creek Watershed Tar Sites consist of an approximate 26-mile reach of Kinzua Creek and its associated watershed in McKean County, Pennsylvania, extending from the Allegheny Reservoir below Westline, Pennsylvania, upstream to Cyclone, Pennsylvania. The site is located in a primarily rural area that encompasses several small towns and portions of the Allegheny National Forest, Kinzua Bridge State Park, Kinzua Valley Trail, and State Game Lands, which are all used for numerous recreational activities such as fishing, hiking, hunting, and camping.

Approximately 70 wood chemical manufacturing plants are known to have operated throughout Pennsylvania in the late 1800s to early 1900s, primarily in western Pennsylvania counties such as McKean County, Elk County, Warren County, and Potter County (Taber, 1975). While there are other wood tar sites within the overall watershed including downgradient locations at Westline and Kushequa and at a cross gradient location on the named headwaters of Kinzua Creek at Backus, the focus of this EE/CA is on a chemical wood plant that was located in Mount Alton within the Kinzua Creek Watershed as shown on Figure 1-1. The Site consists of numerous abandoned wood tar deposits associated with the former wood chemical plant located near or adjacent to Threemile Run, (tributary to Kinzua Creek) and wood tar that has been observed flowing into the creek (Figure 1-2).

Historically, the chemical wood manufacturing facilities produced charcoal, methanol, and acetate lime. The basic process was to heat the hardwood in the absence of oxygen at a high temperature in large retorts which would drive off the wood's chemicals and turn the remaining wood to charcoal. The off-gases from charcoal production were distilled to produce methanol and acetic acid that was combined with quicklime to form acetate lime. The charcoal was then cooled and most of it subsequently sold to iron producers (Taber, 1975). A byproduct of the process was wood tar. The wood tar was a complex mixture that contained at least 200 different compounds. Generally, the wood tar byproduct was not a marketable commodity and was disposed of on ground surfaces, in pits and/or lagoons within the vicinity of the wood chemical plants and, in some instances, directly discharged to streams.

1.2.1 Threemile Run Site

The Threemile Run Site is located East of Ryan Road and South of Route 59 in Lewis Run, PA 16738. The Site encompasses portions of private land and the PA State Game Land #62, which is used for recreational activities such as fishing, hiking, and hunting. There are no remaining buildings or structures on the project site. The Pennsylvania Game Commission and a private landowner granted EPA access for investigations.

1.2.2 Previous Investigations

Several previous investigations and removal actions have been conducted at other former wood chemical plants located within the Kinzua Creek Watershed. In 1983, the Westline Superfund Site was listed on the National Priorities List and 2,000 tons of tar and contaminated soil were removed and disposed of at a regulated off-site facility. In 1998, an additional 2,340 tons of tar and soil were removed from the lagoons. In 1992, the Westline Superfund Site was delisted despite the presence of more than 4,000 tons of tar deposits remaining. Due to the tar deposits being more than 3 feet below ground surface (bgs), no further action was conducted as there was thought to be a minimal exposure threat to the surrounding population. However, the tar material continued to migrate and in 2017 and 2018, additional projects, including removal of over 454 tons of tar deposits and the stabilization of approximately 65 linear feet of the right descending bank of Kinzua Creek, were completed. The projects included streambank stabilization using geotextile and rip-rap armor to address erosion, and wetlands mitigation and restoration in the project area (WESTON, 2017).

1.3 SOILS

The Natural Resources Conservation Service (NRCS) Soil Survey of McKean County, Pennsylvania, indicates that the project area consists of Brinkerton silt loam with Atkins silt loam near the stream channel. The soils are described below.

Unit Name	Surface	Subsoil	Substratum	Drainage	Erosion Potential
At – Atkins silt loam	Dark grayish-brown silt loam	Mottled grayish-brown silt loam	Gray gravelly sand loam	poor	slight
BrA – Brinkerton silt loam	Dark grayish-brown silt loam	Mottled grayish-brown silty clay	Mottled light brownish-gray silt loam	moderate	slight

1.4 GEOLOGY

The Kinzua Creek Watershed Tar Sites are located in the Deep Valleys Section of the Appalachian Plateau Physiographic Province (Pennsylvania Department of Conservation and Natural Resources [DCNR] 2000). The Deep Valleys Section of the Appalachian Plateau is characterized by very deep, angular valleys with broad to narrow uplands (DCNR 2000). The geologic formations underlying the Site include the Shenango through Oswayo Formations undivided; the Catskill Formation and the Venango Formation, which forms the creek bed of Kinzua Creek; and the Pottsville Group, which forms the upland areas (Pennsylvania Department of Environmental Resources [PADER] 1980).

The Venango Formation is a complex unit consisting of siltstone and sandstone and has an approximate thickness of 80 feet (PADER 1982). The Catskill Formation consists of fine- to coarse-grained sandstone and conglomerate interbedded with siltstone and shale and has an approximate thickness of 850 feet (PADER 1982). The upper portion of the Shenango Formation consists of siltstone and limy siltstone, whereas the lower portion is characterized by fine-grained sandstone interbedded with shale and siltstone (PADER 1982). The maximum thickness of the Shenango Formation is approximately 190 feet (PADER 1982). The Pottsville Group is characterized by fine- to coarse-grained conglomeratic sandstone with minor amounts of shale, siltstone, limestone, and coal. The thickness of the Pottsville Group varies from 80 to 270 feet (PADER 1982).

During the May 2020 investigation, generally a fine to medium coarse-grained loose sand with silt was encountered from 0 feet bgs to about 5 feet bgs. The sand is underlain by a fine sand and clay which extends to about 10 feet bgs. The water table exists on-site approximately between 2 to 10 feet bgs. Weathered sandstone fragments were encountered below the sandy clay (approximately 3 -10 feet bgs) and direct push technology (DPT) refusal generally occurred in this strata. Soil boring logs are provided in Appendix A.

1.5 TOPOGRAPHY, SURFACE WATER DRAINAGE, AND HYDROGEOLOGY

1.5.1 Topography and Site Features

The area is primarily wooded with uneven terrain and generally slopes down towards Threemile Run at a 3% - 10% grade. The Site also slopes downward North to South, with the lower portion of site existing along Ryan Road. Threemile Run runs northwest to southeast across the Site and stream banks range from vertical soil walls to a vegetated slope. Land cover on top of the stream bank and in the riparian zone is a mixture of grasses, forbs, and more distantly, wooded shrubs and trees.

1.5.2 Hydrology

The Threemile Run Site is located in the Allegheny River basin. Surface waters include Threemile Run and associated floodplain and wetlands. Threemile Run is a headwater tributary of the Kinzua Creek Tributary of the Allegheny River. Threemile Run in the project area flows through a wide (approximately 300 feet) floodplain as a one- to two-foot deep braided channel under normal conditions. Beaver activity has created ponded areas where sparse vegetation reveals tar deposits in the water. The Threemile Run drainage area to the Site is 2.6 square miles (United States Geological Survey [USGS] Streamstats, 2020). The drainage area is more than 80% forested and includes portions of the Bradford Regional Airport and local rural residences. It conveys a bankfull stream flow of approximately 100 cubic feet per second (cfs) and a 100-year flood flow of approximately 400 cfs (USGS Streamstats, 2020). The nearest USGS gage is station 03011800 located downstream on Kinzua Creek near Guffey, PA (https://waterdata.usgs.gov/nwis/uv?site_no=03011800).

The Site is located in Special Flood Hazard Zone A, subject to inundation by the 1% Annual Chance (100-year return interval) Flood. No base flood elevations have been determined by special study; therefore, the Pennsylvania Department of Environmental Protection (PADEP) has defined the regulated floodway as 50 feet from the top of stream bank.

1.5.3 Hydrogeology

The hydrogeologic setting of McKean County, Pennsylvania is predominately siliciclastic forested Appalachian Plateau and surficial northwestern glaciated aquifers (USGS 2003). Regionally, McKean County is underlain by sandstone or sandstone and carbonate rock aquifers

Mississippian to Pennsylvanian in age. Aquifers underlying McKean County are typically unconsolidated sand and gravel aquifers with common depth ranges of 20 to 200 feet and sandstone to sandstone and shale aquifers with common depth ranges from 80 to 200 feet. Typical yields for unconsolidated sand aquifers range from 100 to 1,000 gallons per minute (gpm) and typical yields for sandstone aquifers range from 5 to 60 gpm (Penn State Extension, 1986).

1.6 SURROUNDING LAND USE, POPULATION, AND CLIMATE

The population of McKean County was estimated in 2019 to be 40,625 based on the 2019 US Census. The population density is 44.4 persons per square mile. Of the 17,169 households in McKean County, 19.7% include children under the age of 18. The average household size is 2.26 persons. Daily mean summer temperatures range from a low of 52 degrees Fahrenheit (°F) to a high of 80°F and daily mean winter temperatures range from a low of 15°F to a high of 37°F. The average annual precipitation is 44.97 inches, with the highest precipitation occurring in June, measuring an average of 4.9 inches. The average annual snowfall is 75.61 inches (The Pennsylvania State Climatologist).

1.7 ECOLOGICAL, CULTURAL, AND HISTORICAL RESOURCES

Before and during the implementation of the proposed wood tar remediation activities, consultation with the McKean County Conservation District, Pennsylvania Game Commission, Pennsylvania Fish and Boat Commission, PA DCNR, and US Fish and Wildlife Service will occur.

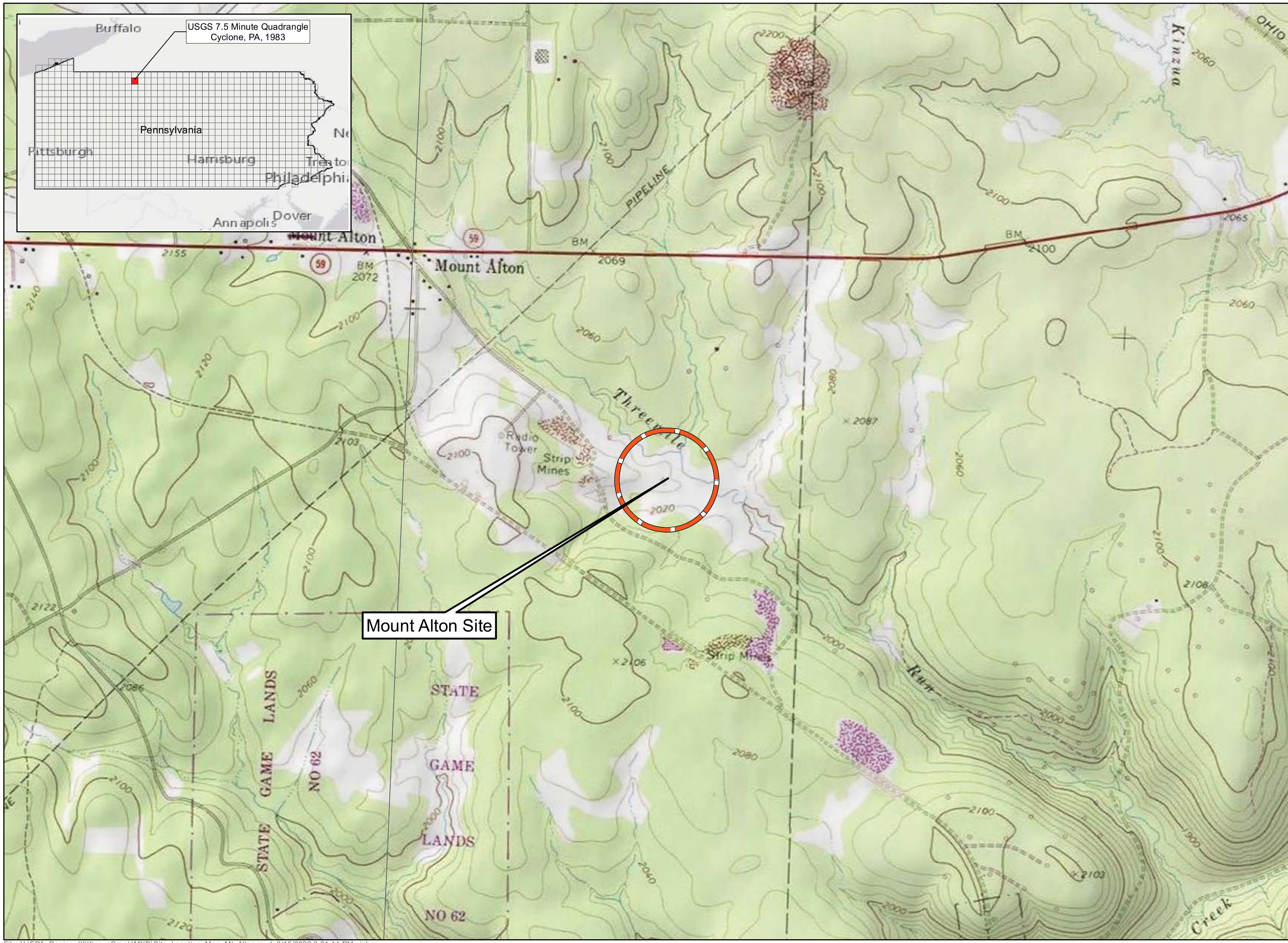
A Pennsylvania Natural Diversity Inventory (PNDI) screening was performed for the Threemile Run site (Project Search ID: PNDI-712468). The PNDI screening indicated further coordination with the PA DCNR is required. The screening indicates the project site could contain habitat for the Long Dash (*Polites mystic*) which is listed as a species of special concern.

A Project Review Form submittal to the Pennsylvania Historical and Museum Commission (PHMC) was submitted for the proposed project area on June 17, 2020. A response from PHMC was received on June 23, 2020 and confirmed that the project would have no effect on historic properties.

As noted in the “Viewing Wildlife” webpage of the United States Department of Agriculture (USDA) Forest Service’s website, within the Allegheny National Forest, there are over 70 species of game and non-game fish and over 300 species of mammals, including raccoon, gray squirrel, snowshoe hare, red and gray fox, beaver, mink, and muskrat as well as game species such as white-tailed deer, black bear and wild turkey, (USDA, 2020). Water-associated avian species include great blue heron and belted kingfisher.

Macrobenthic invertebrate and fish community surveys were conducted as part of the site investigation at the Threemile Run Tar Site, the adjacent Kinzua Creek Tar Site at Backus, and reference sites in the Kinzua Creek watershed and their respective reports include listings of the macrobenthic invertebrate and fish taxa encountered (EPA, 2020a and 2020b).

SECTION 1
FIGURES



Background: ESRI, USGS Mapping Service
The source of this map image is Esri, used by the EPA with Esri's permission

Coordinate System:
WGS84 UTM Zone 18N Feet

N

0 0.1 0.2 0.4 Miles

Kinzua Creek Watershed Tar Sites
McKean County, PA

Figure 1-1
Site Location Map

TDD#: W501-17-03-001
Contract: S3-15-02
Prepared: 6/15/2020

File: Y:\EPA_Region_III\KinzuaCreek\MXD\Site_Location_Map_Mt_Alton.mxd, 6/15/2020 3:31:14 PM, ricksc

Kinzua Creek Watershed Tar Sites
McKean County, PA

Figure 2
Soil Boring Grid Areas
Former Mount Alton Facility

TDD#: W501-17-03-001
Contract: S3-15-02
Prepared: 6/19/2020

File: Y:\EPA_Region_III\KinzuaCreek\MXD\Mount_Alton_Grid_Status_06192020.mxd, 6/19/2020 2:48:36 PM, johna

2. SITE CHARACTERIZATION

A detailed site characterization was completed in May 2020 to determine the environmental condition of the Threemile Run Site area. The characterization, as defined in the Threemile Run Site Field Sampling Plan Addendum 02, was to delineate the vertical and horizontal extent of wood tar deposits in surface soils and along the banks of Threemile Run. A total of 97 borings were drilled 0-10 feet bgs or until refusal. An additional four geotechnical borings were drilled to determine depth of bedrock. Waste Characterization samples of wood tar were collected and analyzed for Toxicity Characteristic Leaching Procedure (TCLP) volatile organic compounds (VOCs), TCLP semi-volatile organic compounds (SVOCs), TCLP pesticides, TCLP herbicides, TCLP metals + mercury, ignitability, corrosively, reactive sulfide, total sulfide, reactive cyanide, and total cyanide during the site characterization investigation to determine if the material is a Resource Conservation and Recovery Act (RCRA) characteristic waste. Prior to these activities, investigations were performed during July/August 2017, October/November 2018, and July 2019 at the Threemile Run Site, and included preliminary screening by collecting surface soil, surface water, and sediment samples from impacted locations within the watershed including the Threemile Run Tar Site. Results from the July/August 2017 investigation identified polyaromatic hydrocarbons (PAHs) as the primary COCs at the Threemile Run site. Subsequent sampling rounds further confirmed the presence of elevated PAHs in sediment and surface water at the Site. Benthic macroinvertebrate samples were collected during November 2018 and July 2019 sampling events. The fish community was surveyed in October 2018 and sediment and surface water samples were collected concurrently for chemical analysis and chronic toxicity testing.

2.1 PREVIOUS INVESTIGATION SUMMARY

The initial investigations took place July/August 2017, October/November 2018, and July 2019. A Data Transmittal Letter (WESTON, 2019) was developed, and sent to EPA in April 2019 with an overview of field activities. Additional data was sent once the July 2019 sampling was complete. All data can be found in Tables 2-1 through 2-41. All exceedances are highlighted in yellow.

2.1.1 2017-2019 Sampling Overview

The 2018 Final Site Inspection (SI) Report (WESTON, 2018a) found that concentrations of PAH compounds and metals in surface water and sediment samples collected from the site in 2017 exceeded Biological Technical Assistance Group (BTAG) screening criteria. Based on these findings, the project team determined that further investigation was required to adequately evaluate potential risks associated with the Threemile Run and Kinzua Creek-Backus tar waste sites. In conjunction with EPA's Freshwater Biology Team (FBT) of Wheeling, West Virginia and the USGS National Fish Health Research Laboratory, a technical approach was developed. Further investigation included collecting sediment, surface water, and crayfish samples to further characterize PAH concentrations for a broader range of constituents, performing laboratory toxicity testing on the crustacean *Ceriodaphnia dubia*, fathead minnow (*Pimephales promelas*), and an amphipod (*Hyalella azteca*), assessing the benthic macroinvertebrate and fish community conditions at the sites and selected reference locations, and performing histopathological examination of fish samples.

While Site surface water samples did not exceed screening criteria, Site sediment samples contained multiple PAH compounds that exceeded their respective compound-specific benchmarks and overall ecological effects ratios (EERs) much greater than 1.

Crayfish whole body samples from both sites contained detectable concentrations of acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene. Estimates of potential risks to upper trophic level aquatic-associated mammalian and avian receptors were prepared using the site crayfish tissue concentrations as the exposure point concentrations in dietary exposure models. Exposure and effects modeling for the belted kingfisher and mink at the Threemile Run and Backus sites indicate there is little to no risk potential for these receptors based on conservative modeling and effects assumptions. No potential risks from organic contaminants were identified and potential inorganics risks were limited to a few metals (i.e., aluminum, barium, copper, iron and selenium); none of which are expected to be site-related contaminants. With the exception of potential iron risk to the mink, Hazard Quotients resulting from site exposure were all <10 and typically comparable to background levels (Bluestone Environmental Group, 2020; Appendix B).

While chronic toxicity tests on tar site surface water samples did not demonstrate statistically significant differences in the survival of *Ceriodaphnia dubia* or fathead minnows relative to reference locations, the fathead minnow growth endpoints of dry weight at both the Threemile Run tar site at Mount Alton and the Kinzua Creek tar site at Backus were significantly lower than the Meade Run reference location. The developmental effects identified in the surrogate species exposed to Site surface water indicate potential risk to the fish community.

Chronic sediment toxicity tests on survival and growth with gammarid amphipod, *Hyalella azteca*, indicated significantly lower survival associated with exposures to Threemile Run and Kinzua Creek tar site at Backus sediment samples relative to the Meade Run reference sediment. Differences in growth endpoints were observed in Day 42 dry biomass in sediment samples from both tar sites relative to the Meade Run reference location sediment. Differences in reproduction endpoints between the Threemile Run tar site samples and the upstream reference sample location included Day 35 juvenile production, Day 42 total reproduction, and total juvenile production per female in a Threemile Run tar site sediment sample relative to the upstream Threemile Run reference sample.

The Field Services Branch (FSB) of the EPA Region 3 Laboratory Services and Applied Sciences Division sampled macroinvertebrates during the Winter and Summer index periods for the Pennsylvania wadeable freestone riffle-run macroinvertebrate assessment method (Appendix C). Threemile Run, which had the highest PAH contamination in sediments, scored consistently poor in both seasons with the lowest index of biological integrity (IBI) score in July. Biologists frequently found specimens with tar deposited on gills and body integument or internally, at contaminated sites. FSB believes these deposited and ingested contaminants could be affecting overall macroinvertebrate health. Ruling out overall habitat conditions and general physicochemical characteristics at contaminated sites (i.e., they should support an attaining macroinvertebrate community), the presence of wood tar deposits is likely limiting biological potential. (EPA, 2020a).

FSB sampled fish using the National Rivers and Streams Assessment (NRSA) fish sampling protocol (USEPA 2017) with a backpack electrofisher (Appendix D). Fish were collected at all sites over three days in October 2018. Fish assemblages in Threemile Run both show evidence of stress and a potential to be improved significantly with restoration of habitat as is evident in the reference site and the presence of some intolerant fish species within the Kinzua watershed. Cool water in these streams seems to ameliorate some of the stress. Removal of wood tar deposits will eliminate any stress due to contamination and enable regrowth of the riparian corridor, necessary for recovering this stream ecosystem.

The majority of microscopic abnormalities observed in this study were related to parasitic infections (Walsh et al. 2020; Appendix E). Microsporidia, myxozoan, and trematode parasites were observed in numerous fish in this study. The significance of these findings on the health of these fish populations is unknown. Parasitic infections in fish have been used as an indication of environmental health (Marcogliese, 2005) and there are environmental variables such as temperature, contaminants, stream drift, and water quality that affect parasite assemblages in fish (Landsberg and others, 1998; Blasco-Costa and others, 2013). EPA's statistical comparison of the prevalence of parasite infestation between reference and Threemile Run sites demonstrated that the contaminated sites have an elevated parasite burden, as shown in Table 2-40, (EPA, 2020c).

2.2 MAY/JUNE 2020 FIELD ACTIVITIES

A total of 101 soil borings were logged (see Appendix A) to determine the extent of the tar deposits both vertically and horizontally by visual examination for the presence or absence of waste tar deposits and tar-contaminated soil. Air monitoring and VOC screening was conducted with a MultiRAE Pro. All values were logged with the soil borings and can be found in Appendix A. Soil boring locations are shown on Figure 2-1. Out of the 101 borings, 4 geotechnical borings were drilled to determine the depth to bedrock. Due to rough terrain and elevated water levels, the proposed DPT borings using a Geoprobe®, as stated in the Kinzua Creek Watershed Tar Sites Field Sampling and Analysis Plan-Addendum 02, was not feasible and was changed to 2-inch outside diameter (O.D.) split spoon hand sampler. The 4 geotechnical borings were performed using the standard penetration test American Society for Testing and Materials, International (ASTM) D1586, using a 2-inch O.D. by 1-3/8-inch I.D. split tube sampler and a 140-pound weight free falling 30 inches. Originally 20 feet x 20 feet grid locations were proposed, but, due to a time constraint, the grids were changed to 40 feet x 40 feet. Each location was surveyed by a Pennsylvania-licensed surveyor and coordinates along with ground surface elevations were recorded. Prior to collecting soil borings, a grid of potential locations was established in the field. The location coordinate information was gathered with a global positioning system (GPS) instrument. For horizontal delineation, the decision to move to a new grid was based on whether any amount of wood tar was present in the boring. Vertical delineation was achieved by advancing the boring until clean material was recovered or refusal occurred.

2.3 EARTHVISION MODELING SUMMARY

The three-dimensional (3D) models of tar distribution beneath the former Mount Alton facility within the Threemile Run watershed were created using a geological modeling software called EarthVision® v.10 (Dynamic Graphics, 2017). The models were created from tables recording the observed tar intervals (or lack thereof) within borings for the respective facilities that were subsequently surveyed to provide horizontal and vertical coordinates in feet. The horizontal and vertical datums were NAD83 PA State Plane North and NAVD88, respectively. The tables of intervals were converted to a dense set of x,y,z data (i.e. easting, northing, and elevation above mean sea level) for each site containing points at a 0.1 foot vertical resolution in each boring from ground surface to the terminal depth. Points within the observed tar intervals were assigned a value of 1 and points where tar was absent were assigned a value of zero.

The resulting binary data were then interpolated separately for each site using the EarthVision® 3D minimum tension algorithm to produce corresponding 3D grid files. The site was interpolated using a vertical grid resolution of 0.1 feet and horizontal grid resolution of 5 feet. The interpolations yielded nodal decimal values for the grids ranging from 0 to 1 and a value of 0.5 was used as the threshold defining the extent of tar within and between the borings (i.e. >0.5 represent 3D regions where tar is present). The site was interpolated such that the 3D grid conformed to a highly smoothed version of topography to increase the degree of tar connection in the downhill direction.

The interpolated tar grids were then converted to 3D volume models for estimation of tar disposal costs, the volume of “clean” material above or between tar intervals that might be stockpiled for backfilling operations, and the excavation footprint that would require new topsoil. This conversion entailed vertical clipping of the 3D tar grid using upper and lower bounding surfaces formed by the ground surface and the minimum tar elevation (maximum tar depth), respectively.

The ground surface model was created by altering a digital elevation model (DEM) obtained for each site to honor site-specific survey data. The DEMs were obtained from the Pennsylvania Spatial Data Access (PASDA) website in the form of 1-meter resolution 2007 light detection and ranging (LIDAR) products of the PAMAP program. Despite the high resolution of these LIDAR surfaces, surveyed ground elevations were typically 0.5 to 2 feet different from the LIDAR predictions. The LIDAR surfaces were smoothed to reduce the triangular artifacts imposed by the LIDAR processing and the resulting surface was warped to honor the surveyed ground elevations. Figure 2-2 shows a side by side comparison of the original LIDAR and the refined surfaces for each site that were ultimately used in the tar volume models.

The bottom clipping surface for the volume model was produced using an EarthVision® "formula processor" function that returns minimum elevation for a given isoshell (i.e. 3D contour) threshold (0.5 in this case). Although it was not necessary for volume or area computations, a similar function was used to extract the maximum elevation for each 3D tar model. These minimum and maximum elevation surfaces were then subtracted from the refined ground elevation surface described above to produce minimum and maximum tar depth surfaces that are presented in Figure 2-3 for the Threemile Run site. A third surface was then created to reveal the interpolated distribution of tar thickness for each site. These surfaces are presented along with a 3D image of the tar model for the Threemile Run site in Figure 2-4. For the former Mount Alton facility model, the tar thickness is essentially the difference between the maximum and minimum predicted tar elevations. For the former Mt. Alton facility model, the tar thickness surface excludes the "clean" intervals between lenses of tar resulting from more than one interval that occur in a handful of borings.

2.4 MAY 2020 WOOD TAR SAMPLING

WESTON collected a total of three wood tar samples from various locations across the Threemile Run site at the surface for waste characterization purposes. WESTON packaged and shipped samples to the assigned EPA Contract Laboratory Program (CLP) laboratory and/or Tier IV laboratory, and samples were analyzed for TCLP VOCs, TCLP SVOCs, TCLP pesticides, TCLP herbicides, TCLP metals + mercury, ignitability, corrosivity, reactive sulfide, total sulfide, reactive cyanide, and total cyanide. Results are summarized in Table 2-41.

Sampling procedures at the Site were performed in accordance with the Kinzua Creek Watershed Tar Sites Field Sampling and Analysis Plan-Addendum 02. Samples were chosen at random at different tar seeps throughout the Site.

2.4.1 Analytical Results

In sample KCW-MA-TAR-001, pyridine, 2-methylphenol, 3-methylphenol, and 4- methylphenol were detected at elevated concentrations. In samples KCW-MA-TAR-002 and KCW-MA-TAR-003 2-methylphenol, 3-methylphenol, and 4-methylphenol were also elevated. No metals of concern were detected. Pesticides and herbicides were non-detect. Sample KCW-MA-TAR-001 had a pH of 5.32, KCW-MA-TAR-002 a pH of 5.07, and KCW-MA-TAR-003 a pH of 5.30. No samples tested positive for ignitability.

Table 2-1
2017 Surface Water - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**BG1**-SW-001		KCW-**TR1**-SW-001		KCW-**TR2**-SW-001		KCW-**TR2**-SW-002		KCW-**TR2**-SW-003	
CLP Sample Number:		C0AG5		C0AA2		C0AB0		C0AB1		C0AB2	
Units:		µg/L		µg/L		µg/L		µg/L		µg/L	
Sample Date:		7/27/2017		7/30/2017		7/30/2017		7/30/2017		7/30/2017	
Sample Type:		Background		Background		Field		Field		Field	
VOCs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Benzene	160	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Ethylbenzene	61	0.5	U	0.5	U	0.5	U	0.42	J	0.59	
m,p-Xylene	27 (T)	0.5	U	0.5	U	0.5	U	0.67		0.48	J
o-xylene	27 (T)	0.5	U	0.5	U	0.5	U	0.61		0.4	J
Toluene	62	0.5	U	0.5	U	0.5	U	0.23	J	0.55	
SVOCs - SIM											
2-Methylnaphthalene	4.7	0.1	U	0.1	U	0.1	U	0.13		0.1	U
Acenaphthylene	13	0.1	U	0.1	U	0.1	U	0.03	J	0.04	J
Acenaphthene	15	0.1	U	0.1	U	0.1	U	0.03	J	0.1	U
Fluorene	19	0.1	U	0.1	U	0.1	U	0.09	J	0.06	J
Naphthalene	21	0.1	U	0.1	U	0.1	U	0.26		0.1	U
Phenanthrene	2.3	0.1	U	0.1	U	0.1	U	0.03	J	0.1	U
Pentachlorophenol	15	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
SVOCs											
2,4-Dimethylphenol	15	5.1	U	5	U	5	U	1.2	J	5	U
4-Chloro-3-methylphenol	NL	5.1	U	5	U	5	U	5.1	U	5	U
Dimethyl phthalate	NL	5.1	U	5	U	5	U	5.1	U	5	U

Notes:
BG1 = Reference Site; **TR1** = Three Mile Run Background; **TR2** = Three Mile Run Site
Data compared to EPA National AWQC (2020) for pentachlorophenol and EPA Region 4 Freshwater Chronic Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
µg/L= Micrograms per liter
J = Reported value is estimated; actual value may be higher or lower
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
NL = No listed value
Q = Qualifier
SIM = Selected Ion Monitoring
SVOC = Semi-volatile organic compound
(T) = Total Xylenes
UJ= The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise
VOC = Volatile organic compound

Table 2-2
2017 Surface Water - Benchmark Comparisons - Total Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**BG1**-SW-001		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR1**-SW-001		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-001		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-002		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-003	
CLP Sample Number:		MC0AG5			MC0AA2			MC0AB0			MC0AB1			MC0AB2	
Units:		µg/L			µg/L			µg/L			µg/L			µg/L	
Sample Date:		7/27/2017			7/30/2017			7/30/2017			7/30/2017			7/30/2017	
Sample Type:		Background			Background			Field			Field			Field	
Metals		Result	Q		Result	Q		Result	Q		Result	Q		Result	Q
Aluminum	87	92.5		87	118		87	106		87	943		87	157	
Antimony	190	2.0	U	190	0.1	J	190	0.10	J	190	0.14	J	190	0.093	J
Arsenic	150	1.0	U	150	1.0	U	150	1.4		150	2.2		150	1.1	
Barium	220	39.7		220	25.5		220	54.3		220	93.3		220	54.6	
Beryllium	11	1.0	U	11	1.0	U	11	1.0	U	11	1.0	U	11	1.0	U
Cadmium	0.18	1.0	U	0.22	1.0	U	0.34	1.0	U	0.603	1.0	U	0.47	1.0	U
Calcium	116,000	4300		116,000	6420		116,000	8580		116,000	21500		116,000	16600	
Chromium	11	2.0	UJ	11	2.0	U	11.0	2.0	U	11	2.0	U	11	2.0	U
Cobalt	19	1.0	U	19	1.0	U	19	2.7		19	5.9		19	3.5	
Copper	1.847	0.54	J	2.3	2.0	U	3.8	2.0	U	7.3	17.2		5	2.0	U
Iron	1,000	443		1,000	1880	J	1,000	6690	J	1,000	15500	J	1,000	5130	J
Lead	0.321	1.0	U	0.4339	1.0	U	0.84	1.0	U	2.0	7.4		1.3	1.0	U
Magnesium	82,000	1220		82,000	1100		82,000	3750		82,000	6200		82,000	3590	
Manganese	93	48.5		93	274		93	1340		93	963		93	1280	
Mercury	0.77	0.2	U	0.77	0.2	U	0.77	0.2	U	0.77	0.2	U	0.77	0.2	U
Nickel	11	1.7		14	2.2	J+	22.4	3.6	J+	43	6.8		32	4.3	J+
Potassium	53,000	867		53,000	559		53,000	1210		53,000	2240		53,000	1350	
Selenium	5	5.0	U	5.0	5.0	U	5	5.0	U	5	5.0	U	5	5.0	U
Silver	0.06	1.0	U	0.06	1.0	U	0.06	1.0	U	0.06	1.0	U	0.06	1.0	U
Sodium	680,000	3710		680,000	7340		680,000	2590		680,000	4600		680,000	5290	
Thallium	6	1.0	UJ	6	1.0	U	6	1.0	U	6	1.0	U	6	1.0	U
Vanadium	27	5.0	U	27	5.0	U	27	5.0	U	27	5.0	U	27	5.0	U
Zinc	25	3.7	J	31	6.9	J+	51	4.2	U	97	19.6		73	6.2	J+

Notes:
BG1 = Reference Site; **TR1** = Three Mile Run Background; **TR2** = Three Mile Run Site
Data compared to EPA National AWQC (2020) for Al,As,Cd,Cr,Cu,Fe,Pb,Ni,Se,Ag and Zn, and EPA Region 4 Freshwater Chronic Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
µg/L = micrograms per liter
Q = Data qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 2-3
2017 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**BG1**-SD-001		KCW-**TR1**-SD-001		KCW-**TR2**-SD-001		KCW-**TR2**-SD-001D		KCW-**TR2**-SD-002		KCW-**TR2**-SD-003		KCW-**TR2**-SD-004		KCW-**TR2**-SD-005		KCW-**TR2**-SD-006	
CLP Sample Number:		C0AG4		C0AA1		C0AA3		C0AA4		C0AA5		C0AA6		C0AA7		C0AA8		C0AA9	
Units:		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg	
Sample Date:		7/27/2017		7/30/2017		7/30/2017		7/30/2017		7/30/2017		7/30/2017		7/28/2017		7/28/2017		7/28/2017	
Sample Type:		Background		Background		Field		Dup of C0AA3		Field		Field		Field		Field		Field	
Analytes		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
VOCs																			
2-Butanone	7,604	12	U	14	U	30	U	35	U	18	U	21	UJ	12	U	33		16	U
Acetone	NL	65	U	28	U	30	U	47	U	18	U	21	UJ	12	U	210		21	
Ethylbenzene	290	6.1	U	7.1	U	15	U	18	U	9.1	U	11	UJ	6	U	12	U	8.2	U
m,p-Xylene	130 (T)	6.1	U	7.1	U	15	U	18	U	9.1	U	11	UJ	6	U	12	U	8.2	U
o-xylene	130 (T)	6.1	U	7.1	U	15	U	18	U	9.1	U	11	UJ	6	U	12	U	8.2	U
Toluene	10	6.1	U	7.1	U	15	U	18	U	9.1	U	11	UJ	11		12	U	8.2	U
SVOCs-SIM																			
2-Methylnaphthalene	20.2	5.0	U	6.4	U	10		13		490		7.9	U	42		140		590	J
Acenaphthene	6.7	3.4	J	5.9	J	10	U	9.9	U	66		7.9	U	6.3		31		62	
Acenaphthylene	5.9	5.0	U	6.5		10	U	9.9	U	37		7.9	U	2.7	J	17		26	
Anthracene	57	19		16		6.1	J	9.9	U	190		7.9	U	18		120		190	
Benzo(a)anthracene	108	37		79		4.5	J	6.3	J	98		2.5	J	15		140		76	
Benzo(a)pyrene	150	29		92		3.9	J	5.0	J	81		2.2	J	6.4		82		34	
Benzo(b)fluoranthene	190	32		94		3.1	J	9.9	U	84		7.9	U	7.1		80		27	
Benzo(g,h,i)perylene	170	11		47		10	U	9.9	U	31		7.9	U	4.5	U	28		11	
Benzo(k)fluoranthene	240	12		41		3.2	J	9.9	U	32		7.9	U	1.7	J	20		8.6	
Chrysene	166	35		86		4.3	J	6.2	J	110		2.5	J	15		140		74	
Dibenzo(a,h)anthracene	33	7.3		15		10	U	9.9	U	11		7.9	U	4.5	U	8.9		3.0	J
Fluoranthene	423	67		170		6.8	J	9.5	J	310		4.5	J	24		190		140	
Fluorene	77	8.0		8.1		7.4	J	9.8	J	400		4.8	J	26		110		330	
Indeno(1,2,3-cd)pyrene	200	13		50		10	U	9.9	U	34		7.9	U	2.3	J	35		11	
Naphthalene	176	5.0	U	6.4	U	10	U	9.9	U	280		7.9	U	17		53		180	
Pentachlorophenol	10	10	U	13	U	21	U	20	U	14	U	16	U	9.2	U	15	U	12	U
Phenanthrene	204	70		88		17		22		740	J	9.6		51		450		490	J
Pyrene	195	70		170		17	J+	21		410		8.9		42		350		250	

Table 2-3
2017 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**BG1**-SD-001		KCW-**TR1**-SD-001		KCW-**TR2**-SD-001		KCW-**TR2**-SD-001D		KCW-**TR2**-SD-002		KCW-**TR2**-SD-003		KCW-**TR2**-SD-004		KCW-**TR2**-SD-005		KCW-**TR2**-SD-006	
CLP Sample Number:		C0AG4		C0AA1		C0AA3		C0AA4		C0AA5		C0AA6		C0AA7		C0AA8		C0AA9	
Units:		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg	
Sample Date:		7/27/2017		7/30/2017		7/30/2017		7/30/2017		7/30/2017		7/30/2017		7/28/2017		7/28/2017		7/28/2017	
Sample Type:		Background		Background		Field		Dup of C0AA3		Field		Field		Field		Field		Field	
Analytes		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
SVOCs																			
1,1-Biphenyl	198	260	U	330	U	520	U	510	U	110	J	410	U	230	U	380	U	**100**	J
2-Methylnaphthalene	20.2	260	U	330	U	520	U	510	U	**430**		410	U	**49**	J	**170**	J	**590**	
2-Methylphenol	119	500	U	640	U	1000	U	990	U	100	J	790	U	450	U	740	U	580	U
2,4-Dimethylphenol	39	260	U	330	U	520	U	510	U	**340**	J	410	U	230	U	**260**	J	300	U
4-Methylphenol	93	500	U	640	U	1000	U	990	U	**190**	J	690	U	450	U	**140**	J	580	U
Acenaphthene	6.7	260	U	330	U	520	U	510	U	110	J	410	U	230	U	**120**	J	300	U
Acetophone	NL	500	U	640	U	1000	U	990	U	680	U	790	U	450	U	740	U	580	U
Anthracene	57	260	U	330	U	520	U	510	U	350	U	410	U	230	U	380	U	300	U
Benzo(a)anthracene	108	260	U	91	J	520	U	510	U	130	J	410	U	230	U	**180**	J	84	J
Benzo(a)pyrene	150	260	U	85	J	520	U	510	U	89	J	410	U	230	U	120	J	300	U
Bis(2-ethylhexyl)phthalate	180	260	U	330	U	520	U	510	U	350	U	410	U	230	U	380	U	300	U
Chrysene	166	260	U	97	J	520	U	510	U	130	J	410	U	230	U	**200**	J	81	J
Dibenzofuran	510	260	U	330	U	520	U	510	U	230	J	410	U	230	U	120	J	210	J
Dimethyl phthalate	NL	300		440		470	J	570		430		340	J	190	J	360	J	300	
Fluoranthene	423	83	J	210	J	1000	U	990	U	310	J	790	U	450	U	270	J	580	U
Fluorene	77.4	260	U	330	U	520	U	510	U	**390**		410	U	230	U	**160**	J	**390**	
Naphthalene	176	260	U	330	U	520	U	510	U	**250**	J	410	U	230	U	380	U	**190**	J
Phenanthrene	204	72	J	100	J	520	U	510	U	**680**		410	U	60	J	**560**		**520**	
Phenol	175	500	U	**180**	J	**210**	J	**230**	J	**210**	J	130	J	450	U	120	J	83	J
Pyrene	195	63	J	170	J	520	U	510	U	**320**	J	410	U	230	U	**440**		**240**	J
TOC (mg/kg)	NL	11,100	R	19,100	R	16,000	R	18,800	R	20,100	R	15,700	R	8,770	R	20,600	R	20,200	R

Notes:
BG1 = Reference Site; **TR1** = Three Mile Run Background; **TR2** = Three Mile Run Site
Data compared to EPA Region 4 Freshwater Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
Biphenyl is a synonym for 1,1-Biphenyl; mp-Cresol is a synonym for 2-Methylphenol; and o-Cresol is a synonym for 4-Methylphenol
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
µg/kg = micrograms per kilogram
NL = No listed value
Q = Qualifier
R = The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.
SIM = Selected Ion Monitoring
SVOC = Semi-volatile organic compound
(T) = Total Xylenes
TOC = Total organic carbon
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
VOC = Volatile organic compound

Table 2-4
2017 Sediment - Equilibrium Partitioning Sediment Benchmark Comparisons
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	$C_{OC,PAHi,FCVi}$ ($\mu g/g_{oc}$)	KCW-**BG1**-SD-001				KCW-**TR1**-SD-001				KCW-**TR2**-SD-001				KCW-**TR2**-SD-001D			
Sample Date:		7/27/2017				7/30/2017				7/30/2017				7/30/2017			
Units:		µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg
Analyte (PAH by SIM)		Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$
2-Methylnaphthalene	447	5.0	U			6.4	U			10		532	1.2	13		691	1.5
Acenaphthene	491	3.4	J	178	0.36	5.9	J	369	0.75	10	U			9.9	U		
Acenaphthylene	452	5.0	U			6.5		406	0.90	10	U			9.9	U		
Anthracene	594	19		995	1.7	16		1000	1.7	6.1	J	324	0.55	9.9	U		
Benzo(a)anthracene	841	37		1937	2.3	79		4938	5.9	4.5	J	239	0.28	6.3	J	335	0.40
Benzo(a)pyrene	965	29		1518	1.6	92		5750	6.0	3.9	J	207	0.21	5.0	J	266	0.28
Benzo(b)fluoranthene	979	32		1675	1.7	94		5875	6.0	3.1	J	165	0.17	9.9	U		
Benzo(g,h,i)perylene	1095	11		576	0.53	47		2938	2.7	10	U			9.9	U		
Benzo(k)fluoranthene	981	12		628	0.64	41		2563	2.6	3.2	J	170	0.17	9.9	U		
Chrysene	844	35		1832	2.2	86		5375	6.4	4.3	J	229	0.27	6.2	J	330	0.39
Dibenz(a,h)anthracene	1123	7.3		382	0.34	15		938	0.83	10	U			9.9	U		
Fluoranthene	707	67		3508	5.0	170		10625	15	6.8	J	362	0.51	9.5	J	505	0.71
Fluorene	538	8		419	0.78	8.1		506	0.94	7.4	J	394	0.73	9.8	J	521	0.97
Indeno(1,2,3-cd)pyrene	1115	13		681	0.61	50		3125	2.8	10	U			9.9	U		
Naphthalene	385	5.0	U			6.4	U			10	U			9.9	U		
Phenanthrene	596	70		3665	6.1	88		5500	9.2	17		904	1.5	22		1170	2.0
Pyrene	697	70		3665	5.3	170		10625	15	17	J+	904	1.3	21		1117	1.6
Total $\sum ESBTU_{FCV}$					30				83				6.9				7.9
Total Organic Carbon (TOC; mg/kg)		19100	R			16000	R			18800	R			18800	R		

Notes:
BG1 = Reference Site; **TR1** =Three Mile Run Background; **TR2** = Three Mile Run Site

2017 SIM PAH data represents concentrations of only 17 compounds and may underestimate toxic effects.

$C_{OC,PAHi,FCVi}$ = Final Chronic Value concentration normalized to organic carbon
C_{OC} = Concentration normalized to organic carbon
ESB = equilibrium partitioning sediment benchmark
$ESBTU_{FCVi}$ = Equilibrium partitioning benchmark toxic units (dimensionless)
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
PAH = polyaromatic hydrocarbon
Q = Data qualifier
SD = sediment
SIM = Selected Ion Monitoring

U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit

UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 2-4
2017 Sediment - Equilibrium Partitioning Sediment Benchmark Comparisons
Kinzua Creek Watershed Tar Sites
McKean County, PA

KCW-**TR2**-SD-002				KCW-**TR2**-SD-003				KCW-**TR2**-SD-004				KCW-**TR2**-SD-005				KCW-**TR2**-SD-006			
7/30/2017				7/30/2017				7/28/2017				7/28/2017				7/28/2017			
µg/kg		(µg/g_{oc})	µg/kg	µg/kg		(µg/g_{oc})	µg/kg	µg/kg		(µg/g_{oc})	µg/kg	µg/kg		(µg/g_{oc})	µg/kg	µg/kg		(µg/g_{oc})	µg/kg
Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$
490		24378	55	7.9	U			42		4789	11	140		6796	15	590	J	29208	65
66		3284	6.7	7.9	U			6.3		718	1.5	31		1505	3.1	62		3069	6.3
37		1841	4.1	7.9	U			2.7	J	308	0.68	17		825	1.8	26		1287	2.8
190		9453	16	7.9	U			18		2052	3.5	120		5825	9.8	190		9406	16
98		4876	5.8	2.5	J	159	0.19	15		1710	2.0	140		6796	8.1	76		3762	4.5
81		4030	4.2	2.2	J	140	0.15	6.4		730	0.76	82		3981	4.1	34		1683	1.7
84		4179	4.3	7.9	U			7.1		810	0.83	80		3883	4.0	27		1337	1.4
31		1542	1.4	7.9	U			4.5	U			28		1359	1.2	11		545	0.50
32		1592	1.6	7.9	U			1.7	J	194	0.20	20		971	1.0	8.6		426	0.43
110		5473	6.5	2.5	J	159	0.19	15		1710	2.0	140		6796	8.1	74		3663	4.3
11		547	0.49	7.9	U			4.5	U			8.9		432	0.38	3.0	J	149	0.13
310		15423	22	4.5	J	287	0.41	24		2737	3.9	190		9223	13	140		6931	9.8
400		19900	37	4.8	J	306	0.57	26		2965	5.5	110		5340	9.9	330		16337	30
34		1692	1.5	7.9	U			2.3	J	262	0.24	35		1699	1.5	11		545	0.49
280		13930	36	7.9	U			17		1938	5.0	53		2573	6.7	180		8911	23
740	J	36816	62	9.6		611	1.0	51		5815	9.8	450		21845	37	490	J	24257	41
410		20398	29	8.9		567	0.81	42		4789	6.9	350		16990	24	250		12376	18
			301				3.3				55				196				236
20100	R			15700	R			8770	R			20600	R			20200	R		

Notes:
BG1 = Reference Site; **TR1** =Three Mile Run Background; **TR2** = Three Mile Run Site

2017 SIM PAH data represents concentrations of only 17 compounds and may underestimate toxic effects.

$C_{OC,PAHi,FCVi}$ = Final Chronic Value concentration normalized to organic carbon
C_{OC} = Concentration normalized to organic carbon
ESB = equilibrium partitioning sediment benchmark
$ESBTU_{FCVi}$ = Equilibrium partitioning benchmark toxic units (dimensionless)
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
PAH = polyaromatic hydrocarbon
Q = Data qualifier
SD = sediment
SIM = Selected Ion Monitoring
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit

UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 2-5
2017 Sediment - Benchmark Comparisons - Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (mg/kg)**	KCW-**BG1**-SD-001		KCW-**TR1**-SD-001		KCW-**TR2**-SD-001		KCW-**TR2**-SD-001D		KCW-**TR2**-SD-002		KCW-**TR2**-SD-003		KCW-**TR2**-SD-004		KCW-**TR2**-SD-005		KCW-**TR2**-SD-006	
CLP Sample Number:		MC0AG4		MC0AA1		MC0AA3		MC0AA4		MC0AA5		MC0AA6		MC0AA7		MC0AA8		MC0AA9	
Units:		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg	
Sample Date:		7/27/2017		7/30/2017		7/30/2017		7/30/2017		7/30/2017		7/30/2017		7/28/2017		7/28/2017		7/28/2017	
Sample Type:		Background		Background		Field		Dup of MC0AA3		Field		Field		Field		Field		Field	
Metals		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Aluminum	25,000	4020		8210		12100		12000		5980		9470		6300		15900		10800	
Antimony	2	9.2	UJ	0.97	J	15.7	UJ	15.5	UJ	11.3	UJ	13.2	UJ	8.1	UJ	13.9	UJ	10.7	UJ
Arsenic	9.8	5.8		20.7	J	6.8	J	7.3	J	12.3	J	6.4	J	3.7		8.7		5.6	
Barium	20	66.0		67.1		132		142		112		100		99.1		89.2		52.3	
Beryllium	NL	0.85		0.97		1.4		1.5		1.4		1.1	UJ	0.78		2.3		0.56	J
Cadmium	1	0.41	J	2.2		2.3		2.3		3.0		2.0		0.85		2.3		0.89	UJ
Calcium	NL	768	UJ	1930		1310	U	1290	U	2250		1110		676	U	1150	U	891	U
Chromium	43.4	6.1	J	13.6	J	14.8	J	14.6	J	8.3	J	12.2	J	10.1		15.1		12.4	
Cobalt	50	7.5	J	13.7		21.0		20.2		31.4		17.3		11.0		21.8		8.9	UJ
Copper	31.6	6.1		35.9	J	25.1	J	24.9	J	203	J	17.8	J	23.4		42.9		13.5	
Iron	20,000	15700		43100	J	45000	J	45500	J	86200	J	43100	J	24100		46200		21600	
Lead	35.8	14.6		125	J	30.5	J	30.2	J	43.1	J	22.9	J	10.6		41.1		18.9	
Magnesium	NL	335	J	1080		1010	J	995	J	791	J	866	J	631	J	943	J	908	
Manganese	460	446	J	319	J	624	J	687	J	832	J	716	J	342		304		133	
Mercury	0.18	0.035	J	0.24		0.081	J	0.089	J	0.057	J	0.071	J	0.028	J	0.12	J	0.073	J
Nickel	22.7	15.0		25.1		24.4		22.3		33.7		17.2		8.8		20.8		7.8	
Potassium	NL	768	U	997		1310	U	1290	U	943	U	1100	U	971		1150	U	891	U
Selenium	0.72	5.4	U	4.2	J	1.3	J	1.4	J	0.68	J	0.90	J	0.49	J	1.1	J	0.53	J
Silver	1	0.10	J	0.39	J	0.12	J	0.18	J	1.9	U	0.17	J	0.14	J	0.19	J	0.15	J
Sodium	NL	768	U	876	U	1310	U	1290	U	943	U	1100	U	676	U	1150	U	891	U
Thallium	NL	3.8	UJ	4.4	U	6.5	U	6.4	U	4.7	U	5.5	U	3.4	U	5.8	U	4.5	U
Vanadium	NL	9.1		18.1		21.3		20.9		13.2		17.2		11.4		21.7		18.1	
Zinc	121	92.3		155		141		136		110		120		70.4		162		41.7	

Notes:
BG1 = Reference Site; **TR1** = Three Mile Run Background; **TR2** = Three Mile Run Site
Data compared to EPA Region 4 Freshwater Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of EPA Region 4 Screening Value
J = Reported value is estimated; actual value may be higher or lower
mg/kg = milligrams per kilogram
NL = No listed value
Q = Qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

Table 2-6
2018 Surface Water - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	Chronic Freshwater Benchmark (µg/L)	KCW-**BG1**-SW-002		KCW-**TR1**-SW-002		KCW-**TR1**-SW-002D		KCW-**TR2**-SW-007		KCW-**TR2**-SW-008		KCW-**TR2**-SW-008D	
CLP Sample Number:		MC0AL6		MC0AK3		MC0AK3D		MC0AJ6		MC0AJ7		MC0AJ8	
Units:		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L	
Sample Date:		10/1/2018		10/3/2018		10/03/218		10/2/2018		10/2/2018		10/3/2018	
Sample Type:		Background		Background		Background		Field		Field		Dup of MC0AJ7	
PAHs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
2-Methylnaphthalene	4.7	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
Acenaphthene	15	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
Acenaphthylene	13	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
Anthracene	0.02	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
Benzo(a)anthracene	4.7	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
Benzo(a)pyrene	0.006	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
Benzo(b)fluoranthene	2.6	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
Benzo(g,h,i)perylene	0.012	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
Benzo(k)fluoranthene	0.06	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
Chrysene	4.7	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
Dibenzo(a,h)anthracene	0.012	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
Fluoranthene	0.8	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
Fluorene	19	0.1	U	0.1	U			0.1	U	0.03	J	0.03	J
Indeno(1,2,3-cd)pyrene	0.012	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
Naphthalene	21	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
Pentachlorophenol	15	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U
Phenanthrene	2.3	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
Pyrene	4.6	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U
SVOCs													
Dimethyl phthalate	NL	8.7		2.2	J			5	U	2.3	J	1.9	J
Di-n-butyl phthalate	19	5	U	5	U			5	U	5	U	5	U
Di-n-octyl phthalate	250	10	U	10	U			10	U	10	U	10	U
Fluoranthene	0.8	10	U	10	U			10	U	10	U	10	U
Fluorene	19	5	U	5	U			5	U	5	U	5	U
Hexachlorobenzene	0.15	5	U	5	U			5	U	5	U	5	U
Hexachlorobutadiene	1	5	U	5	U			5	U	5	U	5	U
Hexachlorocyclopentadiene	0.45	10	U	10	U			10	U	10	U	10	U
Hexachloroethane	12	5	U	5	U			5	U	5	U	5	U
Isophorone	920	5	U	5	U			5	U	5	U	5	U
Nitrobenzene	230	5	U	5	U			5	U	5	U	5	U
N-Nitroso-di-n-propylamine	NL	5	U	5	U			5	U	5	U	5	U
N-Nitrosodiphenylamine	25	5	U	5	U			5	U	5	U	5	U
Phenol	160	10	U	2.2	J			10	U	10	U	2.1	J
Total Alkanes	NL			7.1									

Notes:
BG1 = Reference Site; **TR1** = Three Mile Run Background; **TR2** = Three Mile Run Site
Data compared to EPA National AWQC (2020) for pentachlorophenol and EPA Region 4 Freshwater Chronic Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
J = Reported value is estimated; actual value may be higher or lower
NL = No listed value
PAH = Polyaromatic hydrocarbon
Q = Qualifier
SVOC = Semi-volatile organic compound
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
µg/L = micrograms per liter

Table 2-7
2018 Surface Water - Benchmark Comparisons - Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**BG1**-SW-002		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR1**-SW-002		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR1**-SW-002D		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-007		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-008		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-008D	
CLP Sample Number:		MC0AL6			MC0AK3			MC0AK3D			MC0AJ6			MC0AJ7			MC0AJ8	
Units:		µg/L			µg/L			µg/L			µg/L			µg/L			µg/L	
Sample Date:		10/1/2018			10/3/2018			10/03/218			10/2/2018			10/2/2018			10/3/2018	
Sample Type:		Background			Background			Background			Field			Field			Dup of MC0AJ7	
Metals		Result	Q		Result	Q		Result	Q		Result	Q		Result	Q		Result	Q
Aluminum	87	242		87	135		87	113		87	39.1		87	241		87	181	
Antimony	190	2	U	190	2	U	190	0.34	J	190	2	U	190	2	U	190	2	U
Arsenic	150	0.58	J	150	0.34	J	150	0.31	J	150	0.27	J	150	0.53	J	150	0.44	J
Barium	220	50.5		220	18.9		220	17.5		220	20.2		220	23.6		220	22.6	
Beryllium	11	1	U	11	1	U	11	1	U	11	1	U	11	0.09	J	11	1	U
Cadmium	0.17	1	U	0.19	1	U	0.17	0.043	J	0.15	1	U	0.15	1	U	0.15	1	U
Calcium	116,000	4530		116,000	5500		116,000	4910		116,000	3710		116,000	3880		116,000	3820	
Chromium	11	2	U	11	2	U	11	0.26	J	11	2	U	11	2	U	11	2	U
Cobalt	19	1	U	19	1	U	19	0.43	J	19	1	U	19	1	U	19	1	U
Copper	1.8	2	U	1.96	2	U	1.8	0.96	J	1.5	2	U	1.6	2	U	1.5	2	U
Iron	1,000	966		1,000	652		1,000	581		1,000	446		1,000	1800		1,000	1370	
Lead	0	1	U	0.35	1	U	0.305	0.42	J	0.24	1	U	0.26	1	U	0.25	1	U
Magnesium	82,000	918		82,000	760		82,000	676		82,000	766		82,000	807		82,000	791	
Manganese	93	114		93	82.2		93	73.2		93	93.5		93	121		93	112	
Mercury	0.77	0.2	UJ	0.77	0.2	UJ	0.77	0.2	U	0.77	0.2	UJ	0.77	0.2	UJ	0.77	0.2	UJ
Nickel	11	1.5		12	1.3		10	1.2		8.9	1.6		9.3	1.9		9.1	2.1	
Potassium	53,000	1410		53,000	874		53,000	824		53,000	898		53,000	932		53,000	925	
Selenium	5	5	U	5	5	U	5	5	U	5	5	U	5	5	U	5	5	U
Silver	0.06	1	U	0.06	1	U	0.06	0.01	J	0.06	1	U	0.06	1	U	0.06	1	U
Sodium	680,000	16300		680,000	6790		680,000	6250		680,000	5940		680,000	6080		680,000	6030	
Thallium	6	1	U	6	1	U	6	1	U	6	1	U	6	1	U	6	1	U
Vanadium	27	5	U	27	5	U	27	5	U	27	5	U	27	5	U	27	5	U
Zinc	24	6.9		26	5.3	J+	24	5.1		20	4.3	J+	21	8.7		21	7.8	

Notes:
BG1 = Reference Site; **TR1** = Three Mile Run Background; **TR2** = Three Mile Run Site
Data compared to EPA National AWQC (2020) for Al,As,Cd,Cr,Cu,Fe,Pb,Ni,Se,Ag and Zn, and EPA Region 4 Freshwater Chronic Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
NL = No listed value
Q = Qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise
µg/L = micrograms per liter

Table 2-8
2018 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (µg/kg)**	KCW-**BG1**-SD-002		KCW-**TR1**-SD-002		KCW-**TR2**-SD-007		KCW-**TR2**-SD-008	
CLP Sample Number:		MC0AL7		MC0AK4		MCOAJ9		MC0AK0	
Units:		µg/kg		µg/kg		µg/kg		µg/kg	
Sample Date:		10/1/2018		10/3/2018		10/3/2018		10/03/218	
Sample Type:		Background		Background		Field		Field	
Analytes		Result	Q	Result	Q	Result	Q	Result	Q
PAHs									
2-Methylnaphthalene	20	4.1	U	7.4	U	410	J	190	
Acenaphthene	6.7	4.1	U	7.4	U	32		22	
Acenaphthylene	5.9	4.1	U	13		16		9.2	
Anthracene	57	4.1	U	24		110		55	
Benzo(a)anthracene	108	4.1	U	100		41		26	
Benzo(a)pyrene	150	4.1	U	98		25		15	
Benzo(b)fluoranthene	190	4.1	U	110		20		13	
Benzo(g,h,i)perylene	170	4.1	U	60		10		6.6	
Benzo(k)fluoranthene	240	4.1	U	38		5.1		2.9	J
Chrysene	166	4.1	U	110		34		25	
Dibenzo(a,h)anthracene	33	4.1	U	18		2.9	J	1.8	J
Fluoranthene	423	4.1	U	230		87		47	
Fluorene	77	4.1	U	18		190		120	
Indeno(1,2,3-cd)pyrene	200	4.1	U	55		9.1		6.3	
Naphthalene	176	4.1	U	7.4	U	150		66	
Pentachlorophenol	10	8.4	U	15	U	8.6	U	9.0	U
Phenanthrene	204	4.1	U	160		290		180	
Pyrene	195	4.1	U	240		120		71	
SVOCs									
.alpha.-Methyl stilbene	NL								
[1,1-Biphenyl]-4-carboxaldehyde	NL							140	J
1,1-Biphenyl	198	210	U	380	U	220	U	230	U
1,2,3-Trimethylindene	NL								
1,2,4,5-Tetrachlorobenzene	187	210	U	380	U	220	U	230	U
1,4-Dioxane	NL	84	U	150	U	86	U	90	U
1,7-Dimethyl-3-phenyltricyclo[4.1.	NL							330	J
1H-Benzimidazole, 2-ethyl-	NL					140	J	130	J
1H-Cyclopropa[l]phenanthrene,1a,9b	NL							100	J
1-Heptadecanol	NL							360	J
1H-Indazole, 3,6-dimethyl-	NL					220	J		
1H-Indene, 1,3-dimethyl-	NL					130	J		
2,2-oxybis(1-Chloropropane)	NL	410	U	740	U	420	U	440	U
2,3,4,6-Tetrachlorophenol	30	210	U	380	U	220	U	230	U
2,4,5-Trichlorophenol	34	210	U	380	U	220	U	230	U
2,4,6-Cycloheptatrien-1-one, 2-phe	NL					210	J		
2,4,6-Trichlorophenol	89	210	U	380	U	220	U	230	U
2,4-Dichlorophenol	57	210	U	380	U	220	U	230	U
2,4-Dimethylphenol	39	210	U	380	U	74	J	230	U
2,4-Dinitrophenol	223	410	U	740	U	420	U	440	U
2,4-Dinitrotoluene	290	210	U	380	U	220	U	230	U
2,5,6-Trimethylbenzimidazole	NL					120	J		
2,6-Dinitrotoluene	296	210	U	380	U	220	U	230	U
2-Chloronaphthalene	NL	210	U	380	U	220	U	230	U

Table 2-8
2018 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (µg/kg)**	KCW-**BG1**-SD-002		KCW-**TR1**-SD-002		KCW-**TR2**-SD-007		KCW-**TR2**-SD-008	
CLP Sample Number:		MC0AL7		MC0AK4		MCOAJ9		MC0AK0	
Units:		µg/kg		µg/kg		µg/kg		µg/kg	
Sample Date:		10/1/2018		10/3/2018		10/3/2018		10/03/218	
Sample Type:		Background		Background		Field		Field	
Analytes		Result	Q	Result	Q	Result	Q	Result	Q
SVOCs									
2-Chlorophenol	55	210	U	380	U	220	U	230	U
2-Methylphenol	119	410	U	740	U	420	U	440	U
2-Nitroaniline	NL	210	U	380	U	220	U	230	U
2-Nitrophenol	168	210	U	380	U	220	U	230	U
2-Propenal, 2-methyl-3-phenyl-	NL								
3-Nitroaniline	NL	410	U	740	U	420	U	440	U
3-Penten-2-one, 4-phenyl-	NL							120	J
3,3-Dichlorobenzidine	NL	410	U	740	U	420	U	440	U
4,6-Dinitro-2-methylphenol	NL	410	U	740	U	420	U	440	U
4-Bromophenyl-phenylether	47	210	U	380	U	220	U	230	U
4-Chloro-3-methylphenol	NL	210	U	380	U	220	U	230	U
4-Chloroaniline	0.9	410	U	740	U	420	U	440	U
4-Chlorophenyl-phenyl ether	NL	210	U	380	U	220	U	230	U
4-Methoxy-2-methyl-1-(methylthio)b	NL							450	J
4-Methylphenol	93	410	U	740	U	56	J	440	U
4-Nitroaniline	NL	410	U	740	U	420	U	440	U
4-Nitrophenol	153	410	U	740	U	420	U	440	U
5-tert-Butylpyrogallol	NL							550	J
6H-Dibenzo[b,d]-pyran	NL							130	J
9H-Fluoren-9-ol	NL					230	J		
9H-Fluorene, 2-methyl-	NL								
9H-Fluorene, 2,3-dimethyl-	NL					190	J	100	J
9H-Fluorene, 9-methyl-	NL					130	J		
9H-Fluorene, 9,9-dimethyl-	NL								
Acetophenone	NL	410	U	740	U	420	U	440	U
A-Norcholestan-3-one, 5-ethenyl-,	NL								
Atrazine	0.3	410	U	740	U	420	U	440	U
Benzaldehyde	59	410	U	740	U	420	U	440	U
Benzenamine, 4-chloro-N-(2-pyridin	NL								
Benzene, 4-ethyl-1,2-dimethyl-	NL					200	J		
PAHs by SIM									
Benzocycloheptatriene	NL								
Bis(2-Chloroethoxy)methane	NL	210	U	380	U	220	U	230	U
Bis(2-Chloroethyl)ether	NL	410	U	740	U	420	U	440	U
Bis(2-ethylhexyl)phthalate	180	210	U	380	U	220	U	230	U
Butylbenzyl phthalate	0.59	210	U	380	U	220	U	230	U
Caprolactam	NL	410	U	740	U	420	U	440	U
Carbazole	69	410	U	740	U	420	U	440	U
Dibenzofuran	510	210	U	380	U	110	J	64	J
Dibenzofuran, 4-methyl-	NL					270	J		
Diethyl phthalate	NL	210	U	380	U	220	U	230	U

Table 2-8
2018 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (µg/kg)**	KCW-**BG1**-SD-002		KCW-**TR1**-SD-002		KCW-**TR2**-SD-007		KCW-**TR2**-SD-008	
CLP Sample Number:		MC0AL7		MC0AK4		MCOAJ9		MC0AK0	
Units:		µg/kg		µg/kg		µg/kg		µg/kg	
Sample Date:		10/1/2018		10/3/2018		10/3/2018		10/03/218	
Sample Type:		Background		Background		Field		Field	
Analytes		Result	Q	Result	Q	Result	Q	Result	Q
PAHs by SIM									
Dimethyl phthalate	NL	390		620		270		290	
Di-n-butyl phthalate	11	210	U	380	U	220	U	230	U
Di-n-octyl phthalate	39	410	U	740	U	420	U	440	U
Ethanone, 1-(2,6-dihydroxy-4-metho	NL					700	J		
Ethanone, 1-(4-hydroxy-3,5-dimetho	NL					470	J		
Hexachlorobenzene	20	210	U	380	U	220	U	230	U
Hexachlorobutadiene	NL	210	U	380	U	220	U	230	U
Hexachlorocyclopentadiene	7	410	U	740	U	420	U	440	U
Hexachloroethane	27	210	U	380	U	220	U	230	U
Hydroquinone mono-trimethylsilyl e	NL								
Isophorone	876	210	U	380	U	220	U	230	U
Naphthalene, 1-methyl-	141					240	J	150	J
Naphthalene, 1,3-dimethyl-	NL								
Naphthalene, 1,4-dimethyl-	NL								
Naphthalene, 1,4,6-trimethyl-	NL					120	J		
Naphthalene, 1,6-dimethyl-	NL					150	J		
Naphthalene, 1,6,7-trimethyl-	NL					98	J		
Naphthalene, 2,3-dimethyl-	NL					360	J		
Naphthalene, 2,3,6-trimethyl-	NL							110	J
Naphthalene, 2,6-dimethyl-	NL							180	J
Naphthalene, 2,7-dimethyl-	NL								
Naphtho[2,1-b]furan, 1,2-dimethyl-	NL					270	J	170	J
Naphtho[2,3-b]norbornadiene	NL								
N-Hexadecanoic acid	NL	94	J	160	J	710	J	430	J
Nitrobenzene	407	210	U	380	U	220	U	230	U
N-Nitroso-di-n-propylamine	NL	210	U	380	U	220	U	230	U
N-Nitrosodiphenylamine	110	210	U	380	U	220	U	230	U
Octadecanoic acid	NL							100	J
Phenanthrene, 4-methyl-	NL					90	J		
Phenol	175	240	J	180	J	100	J	100	J
Phenol, 2-ethyl-4-methyl-	NL							100	J
Phenol, 2-methoxy-4-propyl-	NL					120	J		
Phenol, 2,6-dimethoxy-	NL					170	J	150	J
Phenol, 2,6-dimethoxy-4-(2-propeny	NL					120	J		
Phenol, 4-ethyl-2-methoxy-	NL					150	J	110	J
Tetradecanethiol	NL								
Squalene	NL								
Total Alkanes	NL	140		950		6300		2600	
Trichloroacetic acid, hexadecyl es	NL								

Notes:
BG1 = Reference Site; **TR1** = Three Mile Run; **TR2** = Three Mile Run Site
Data compared to EPA Region 4 Freshwater Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
J = Reported value is estimated; actual value may be higher or lower
NL = No listed value
PAH = Polyaromatic hydrocarbon
Q = Qualifier
SIM = Selective Ion Monitoring
SVOC = Semi-volatile organic compound
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
µg/kg = micrograms per kilogram

Table 2-9
2018 Sediment - Equilibrium Partitioning Sediment Benchmark Comparisons
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	$C_{OC,PAHi,FCVi}$	KCW-**BG1**-SD-002				KCW-**TR1**-SD-002				KCW-**TR2**-SD-007				KCW-**TR2**-SD-008			
Sample Date:	($\mu g/g_{oc}$)	10/1/2018				10/3/2018				10/3/2018				10/3/2018			
Units:		µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg
Analyte (PAH by SIM)		Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$
2-Methylnaphthalene	447	4.1	U			160		2985	6.7	290		18831	42	180		7143	16
Acenaphthene	491	4.1	U			7.4	U			32		2078	4.2	22		873	1.8
Acenaphthylene	452	4.1	U			13		243	0.54	16		1039	2.3	9.2		365	0.81
Anthracene	594	4.1	U			24		448	0.75	110		7143	12	55		2183	3.7
Benzo(a)anthracene	841	4.1	U			100		1866	2.2	41		2662	3.2	26		1032	1.2
Benzo(a)pyrene	965	4.1	U			98		1828	1.9	25		1623	1.7	15		595	0.62
Benzo(b)fluoranthene	979	4.1	U			110		2052	2.1	20		1299	1.3	13		516	0.53
Benzo(g,h,i)perylene	1095	4.1	U			60		1119	1.0	10		649	0.59	6.6		262	0.24
Benzo(k)fluoranthene	981	4.1	U			38		709	0.72	5.1		331	0.34	2.9	J	115	0.12
Chrysene	844	4.1	U			110		2052	2.4	34		2208	2.6	25		992	1.2
Dibenz(a,h)anthracene	1123	4.1	U			18		336	0.30	2.9	J	188	0.17	1.8	J	71	0.064
Fluoranthene	707	4.1	U			230		4291	6.1	87		5649	8.0	47		1865	2.6
Fluorene	538	4.1	U			18		336	0.62	190		12338	23	120		4762	8.9
Indeno(1,2,3-cd)pyrene	1115	4.1	U			55		1026	0.92	9.1		591	0.53	6.3		250	0.22
Naphthalene	385	4.1	U			7.4	U			150		9740	25	66		2619	6.8
Phenanthrene	596	4.1	U			160		2985	5.0	290		18831	32	180		7143	12
Pyrene	697	4.1	U			240		4478	6.4	120		7792	11	71		2817	4.0
Total $\sum ESBTU_{FCV}$									30				177				63
Total Organic Carbon (TOC; mg/kg)		5980				53600				15400				25200			

Notes:
BG1 = Reference Site; **TR1** = Three Mile Run Background; **TR2** = Three Mile Run Site
2017 SIM PAH data represents concentrations of only 17 compounds and may underestimate toxic effects.
$C_{OC,PAHi,FCVi}$ = Final Chronic Value concentration normalized to organic carbon
C_{OC} = Concentration normalized to organic carbon
$ESBTU_{FCVi}$ = Equilibrium partitioning benchmark toxic units (dimensionless)
ESB = equilibrium partitioning sediment benchmark
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
PAH = polyaromatic hydrocarbon
Q = Data qualifier
SIM = selective ion monitoring
SD = sediment
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 2-10
2018 Sediment - Benchmark Comparisons - Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (mg/kg)**	KCW-**BG1**-SD-002		KCW-**TR1**-SD-002		KCW-**TR1**-SD-002D		KCW-**TR2**-SD-007		KCW-**TR2**-SD-008	
CLP Sample Number:		MC0AL7		MC0AK4		MC0AK4D		MCOAJ9		MC0AK0	
Units:		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg	
Sample Date:		10/1/2018		10/3/2018		10/3/2018		10/3/2018		10/03/218	
Sample Type:		Background		Background		Background		Field		Field	
Metals		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Aluminum	25,000	3160	J	18000	J	13700		4900	J	4460	J
Antimony	2	0.51	J	1.8	J	1.6	J	0.67	J	1	J
Arsenic	9.8	4		12.1		10.1		5.2		7.1	
Barium	20	23	UJ	143	J	92.2		34.7	J	32.3	J
Beryllium	NL	0.58	UJ	1.9		1.4		0.63	UJ	0.98	
Cadmium	1	0.68	J	2.1	J	2.9		1.3	J	2.7	J
Calcium	NL	340	J	35800	J	2170		307	J	682	J
Chromium	43.4	4.4	J	15.1	J	17.4		9.5	J	7	J
Cobalt	50	6.4	J	18.2	J	19.6		10	J	8.2	J
Copper	31.6	3.6	J	21.6	J	30.4		9.5	J	17.8	J
Iron	20,000	11800	J	21100	J	26100		25500	J	52900	J
Lead	35.8	4.9	J	66.2	J	85		9.3	J	10.5	J
Magnesium	NL	359	J	7450	J	1290		603	J	346	J
Manganese	460	218	J	1140	J	294		312	J	359	J
Mercury	0.18	0.12	U	0.2	J	0.37		0.13	U	0.12	U
Nickel	22.7	5.2		21.4		24.2		10.5		7.8	
Potassium	NL	465	J	2070	J	1550		748	J	485	J
Selenium	0.72	4	U	8	U	8	U	4.4	U	4.4	U
Silver	1	1.2	UJ	2.3	UJ	2.3	U	1.3	UJ	1.3	UJ
Sodium	NL	3	J	567	J	182	J	32.5	J	12.5	J
Thallium	NL	2.9	UJ	5.7	UJ	5.7	U	3.1	UJ	3.1	UJ
Vanadium	NL	6.6	J	23	J	26.6		10.4	J	9.2	J
Zinc	121	43.1	J	164	J	225		74.4	J	101	J

Notes:

BG1 = Reference Site; **TR1** = Three Mile Run Background; **TR2** = Three Mile Run Site
Data compared to EPA Region 4 Freshwater Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of EPA Region 4 Screening Value
J = Reported value is estimated; actual value may be higher or lower
mg/kg = milligrams per kilogram
NL = No listed value
Q = Qualifier

U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit

UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 2-11
2019 Surface Water - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR1**-SW-003		KCW-**TR2**-SW-010		KCW-**TR2**-SW-010D		KCW-**TR2**-SW-009	
CLP Sample Number:		MC0AN9		MC0AN6		MC0AP0		MC0AN7	
Units:		µg/L		µg/L		µg/L		µg/L	
Sample Date:		7/31/2019		7/31/2019		7/31/2019		7/31/2019	
Sample Type:		Background		Field		Dup of MC0AN6		Field	
Analytes		Result	Q	Result	Q	Result	Q	Result	Q
PAHs									
1-Methylnaphthalene	6.1	0.019	U	0.019	U	0.019	U	0.019	U
1-Methylphenanthrene	NL	0.019	U	0.019	U	0.019	U	0.019	U
2,3,5-Trimethylnaphthalene	NL	0.019	U	0.0032	J	0.0028	J	0.003	J
2,6-Dimethylnaphthalene	26	0.0027	J	0.0052	J	0.0044	J	0.0035	J
2-Methylnaphthalene	4.7	0.019	U	0.019	U	0.019	U	0.019	U
Acenaphthene	15	0.019	U	0.019	U	0.019	U	0.019	U
Acenaphthylene	13	0.019	U	0.019	U	0.019	U	0.019	U
Anthracene	0.02	0.019	U	0.019	U	0.019	U	0.019	U
Benzo(a)anthracene	4.7	0.003	J	0.019	U	0.019	U	0.019	U
Benzo(a)pyrene	0.006	0.0031	J	0.019	U	0.019	U	0.019	U
Benzo(k)fluoranthene	0.06	0.003	J	0.019	U	0.019	U	0.019	U
Benzo[e]pyrene	0.9	0.019	U	0.019	U	0.019	U	0.019	U
Chrysene	4.7	0.0037	J	0.019	U	0.019	U	0.019	U
Fluoranthene	0.8	0.019	U	0.019	U	0.019	U	0.019	U
Fluorene	19	0.019	U	0.019	U	0.019	U	0.019	U
Indeno(1,2,3-cd)pyrene	0.012	0.019	U	0.019	U	0.019	U	0.019	U
Naphthalene	21	0.019	U	0.019	U	0.019	U	0.019	U
Perylene	0.9	0.019	U	0.019	U	0.019	U	0.019	U
Phenanthrene	2.3	0.019	U	0.019	U	0.019	U	0.019	U
Pyrene	4.6	0.019	U	0.019	U	0.019	U	0.019	U
SVOCs									
1,1,Biphenyl	6.5	5	U	5	U	5	U	5	U
1,2,4,5-Tetrachlorobenzene	8.3	5	U	5	U	5	U	5	U
1,4-Dioxane (P-Dioxane)	22,000	2	U	2	U	2	U	2	U
2-Chloronaphthalene	NL	5	U	5	U	5	U	5	U
2-Chlorophenol	18	5	U	5	U	5	U	5	U
2-Nitroaniline	17	5	U	5	U	5	U	5	U
2-Nitrophenol	73	5	U	5	U	5	U	5	U
2,2-oxybis (1-Chloropropane)	NL	10	U	10	U	10	U	10	U
2,3,4,6-Tetrachlorophenol	1	5	U	5	U	5	U	5	U
2,4-Dichlorophenol	11	5	U	5	U	5	U	5	U
2,4-Dimethylphenol	15	5	U	5	U	5	U	5	U
2,4- Dinitrophenol	71	10	U	10	U	10	U	10	U
2,4-Dinitrotoluene	44	5	U	5	U	5	U	5	U
2,6-Dinitrotoluene	81	5	U	5	U	5	U	5	U
2,4,6-Trichlorophenol	4.9	5	U	5	U	5	U	5	U
2,4,5-Trichlorophenol	1.9	5	U	5	U	5	U	5	U
3-Nitroaniline	NL	10	U	10	U	10	U	10	U
3,3-Dichlorobenzidine	4.5	10	U	10	U	10	U	10	U
4-Nitrophenol	58	10	U	10	U	10	U	10	U
4,6-Dinitro-2-methylphenol	NL	10	U	10	U	10	U	10	U
4-Bromophenyl-phenyl ether	1.5	5	U	5	U	5	U	5	U

Table 2-11
2019 Surface Water - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR1**-SW-003		KCW-**TR2**-SW-010		KCW-**TR2**-SW-010D		KCW-**TR2**-SW-009	
CLP Sample Number:		MC0AN9		MC0AN6		MC0AP0		MC0AN7	
Units:		µg/L		µg/L		µg/L		µg/L	
Sample Date:		7/31/2019		7/31/2019		7/31/2019		7/31/2019	
Sample Type:		Background		Field		Dup of MC0AN6		Field	
Analytes		Result	Q	Result	Q	Result	Q	Result	Q
SVOCs									
4-Chloro-3-methylphenol	NL	5	U	5	U	5	U	5	U
4- Chloroaniline	0.8	10	U	10	U	10	U	10	U
4-Chlorophenyl-phenylether	NL	5	U	5	U	5	U	5	U
4- Methylphenol	53	10	U	10	U	10	U	10	U
4-Nitroaniline	NL	10	U	10	U	10	U	10	U
Acetophenone	NL	10	U	10	U	10	U	10	U
Atrazine	0.03	10	U	10	U	10	U	10	U
Benzaldehyde	143	10	U	10	U	10	U	10	U
Bis(2-chloroethoxy)methane	NL	5	U	5	U	5	U	5	U
Bis(2-chloroisopropyl)ether	NL	10	U	10	U	10	U	10	U
Bis (2-ethylhexyl)phthalate	8	5	U	5	U	5	U	5	U
Butylbenzyl phthalate	23	5	U	5	U	5	U	5	U
Caprolactam	NL	10	U	10	U	10	U	10	U
Carbazole	4	10	U	10	U	10	U	10	U
Dibenzofuran	4	5	U	5	U	5	U	5	U
Diethyl phthalate	220	5	U	5	U	5	U	5	U
Dimethyl phthalate	1,100	4.6	J	5	U	5		1.1	J
Di-n-Butyl phthalate	19	5	U	5	U	5	U	5	U
Di-n-octyl phthalate	215	10	U	10	U	10	U	10	U
Fluorene	19	5	U	5	U	5	U	5	U
Hexachlorobenzene	0.15	5	U	5	U	5	U	5	U
Hexachlorobutadiene	1	5	U	5	U	5	U	5	U
Hexachlorocyclopentadiene	0.45	10	U	10	U	10	U	10	U
Hexachloroethane	12	5	U	5	U	5	U	5	U
Isophorone	920	5	U	5	U	5	U	5	U
Nitrobenzene	230	5	U	5	U	5	U	5	U
N-nitroso-di-n-propylamine	NL	5	U	5	U	5	U	5	U
N-Nitrosodiphenylamine	25	5	U	5	U	5	U	5	U
Phenol	160	10	U	1.7	J	10	U	2.3	J
Total Alkanes	NL	2		54		0		22	

Notes:
BG1 = Reference Site; **TR1** = Three Mile Run Background; **TR2** = Three Mile Run Site
Data compared to EPA National AWQC (2020) for pentachlorophenol and EPA Region 4 Freshwater Chronic Screening Values (2018
Yellow highlighted values indicate exceedance of benchmark value
J = Reported value is estimated; actual value may be higher or lower
NL = No listed value
PAH = Polyaromatic hydrocarbon
Q = Qualifier
SVOC = Semi-volatile organic compound
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limi
µg/L = micrograms per liter

Table 2-12
2019 Surface Water - Benchmark Comparisons - Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR1**-SW-003		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-010		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-010D		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-009	
CLP Sample Number:		MC0AN9			MC0AN6			MC0AP0			MC0AN7	
Units:		µg/L			µg/L			µg/L			µg/L	
Sample Date:		7/31/2019			7/31/2019			7/31/2019			7/31/2019	
Sample Type:		Background			Field			Dup of MC0AN6			Field	
Metals		Result	Q		Result	Q		Result	Q		Result	Q
Aluminum	87	427		87	39.7		87	37.5		87	38.8	
Antimony	190	2	U	190	2	U	190	2	U	190	2	U
Arsenic	150	0.78	J	150	0.72	J	150	0.7	J	150	0.65	J
Barium	220	32.4		220	45.6		220	48.2		220	44.8	
Beryllium	11	1	U	11	1	U	11	1	U	11	1	U
Cadmium	0.28	1	U	0.29	1	U	0.304	1	U	0.28	1	U
Calcium	116,000	9020		116,000	7580		116,000	7890		116,000	7270	
Chromium	11	0.48	J	11	0.21	J	11	2	U	11	2	
Cobalt	19	1.4		19	1.9		19	2		19	1.7	
Copper	3.05	1	J	3.3	2	U	3.4	0.33	J	3.1	0.38	J
Iron	1,000	2930		1,000	4410		1,000	4700		1,000	4320	
Lead	0.62	1.2		0.68	0.43	J	0.71	0.43	J	0.64	0.43	J
Magnesium	82,000	1410		82,000	2830		82,000	2960		82,000	2650	
Manganese	93	597		93	623		93	619		93	590	
Nickel	18	2.9		19	3		20	3.2		18	3.1	
Potassium	53,000	723		53,000	1060		53,000	1110		53,000	1040	
Selenium	5	5	U	5	5	U	5	5	U	5	5	U
Silver	0.06	1	U	0.06	1	U	0.06	1	U	0.06	1	U
Sodium	680,000	10800		680,000	5650		680,000	5860		680,000	5340	
Thallium	6	1	U	6	1	U	6	1	U	6	1	U
Vanadium	27	5	U	27	5	U	27	5	U	27	5	U
Zinc	41	13.3		43	2.2		45	2	U	41	2	U

Notes:
BG1 = Reference Site; **TR1** = Three Mile Run Background; **TR2** = Three Mile Run Site
Data compared to EPA National AWQC (2020) for Al,As,Cd,Cr,Cu,Fe,Pb,Ni,Se,Ag and Zn, and EPA Region 4 Freshwater Chronic Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
J = Reported value is estimated; actual value may be higher or lower
NL = No listed value
Q = Qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
µg/L = micrograms per liter

Table 2-13
2019 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (µg/kg)**	KCW-**TR1**-SD-003		KCW-**TR2**-SD-009		KCW-**TR2**-SD-010	
CLP Sample Number:		MC0AM6		MC0AM4		MC0AM5	
Units:		µg/kg		µg/kg		µg/kg	
Sample Date:		7/31/2019		7/31/2019		7/31/2019	
Sample Type:		Background		Field		Field	
PAHs		Result	Q	Result	Q	Result	Q
1-Methylnaphthalene	NL	20	U	200		2400	
1-Methylphenanthrene	NL	10	J	39		360	
2-Methylnaphthalene	20	20	U	180		3200	
2,3,5-Trimethylnaphthalene	NL	20	U	160		1600	
2,6-Dimethylnaphthalene	NL	20	U	170		2000	
Acenaphthene	6.7	20	U	42		370	
Acenaphthylene	5.9	8.3	J	15		140	
Anthracene	57	14	J	73		760	
Benzo(a)anthracene	108	100		38		260	
Benzo(a)pyrene	150	92		23		140	
Benzo(b)fluoranthene	190	82		18		77	J
Benzo(g,h,i)perylene	170	48		3.6	J	44	J
Benzo(k)fluoranthene	240	95		15		64	J
Chrysene	166	100		32		210	
Dibenzo(a,h)anthracene	33	16	J	6.5	U	99	U
Fluoranthene	423	210		66		360	
Fluorene	77	8.4	J	150		1500	
Indeno(1,2,3-cd)pyrene	200	49		4.2	J	45	J
Naphthalene	176	20	U	65		1100	
Perylene	NL	620		17		47	J
Phenanthrene	204	85		180		1600	
Pyrene	195	160		100		590	
C1- Benzo(a)anthracenes/Chrysenes	NL	34	J	42	J	390	J
C2- Benzo(a)anthracenes/Chrysenes	NL	20	U	30	J	350	J
C3- Benzo(a)anthracenes/Chrysenes	NL	20	U	6.5	U	240	J
C4- Benzo(a)anthracenes/Chrysenes	NL	20	U	6.5	U	99	U
C1-Fluoranthenes/pyrene	NL	77	J	230	J	1700	J
C1-Fluorenes	NL	20	U	250	J	2800	J
C2-Fluorenes	NL	20	U	280	J	3100	J
C3-Fluorenes	NL	20	U	250	J	2400	J
C2-Naphthalenes	NL	20	U	790	J	9200	J
C3-Naphthalenes	NL	20	U	800	J	8400	J
C4-Naphthalenes	NL	20	U	620	J	6200	J
C1-Phenanthrenes/Anthracenes	NL	41	J	310	J	2900	J
C2-Phenanthrenes/Anthracenes	NL	25	J	270	J	2300	J
C3-Phenanthrenes/Anthracenes	NL	20	U	130	J	1300	J
C4-Phenanthrenes/Anthracenes	NL	20	U	160	J	1500	J

Table 2-13
2019 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (µg/kg)**	KCW-**TR1**-SD-003		KCW-**TR2**-SD-009		KCW-**TR2**-SD-010	
CLP Sample Number:		MC0AM6		MC0AM4		MC0AM5	
Units:		µg/kg		µg/kg		µg/kg	
Sample Date:		7/31/2019		7/31/2019		7/31/2019	
Sample Type:		Background		Field		Field	
PAHs		Result	Q	Result	Q	Result	Q
SVOCs							
.alpha.-Methylstilbene	NL						
[1,1-Biphenyl]-4-carboxaldehyde	NL						
1,1-Biphenyl	198	250	U	240	U	300	
SVOCs							
1,2,3-Trimethylindene	NL						
1,2,4,5-Tetrachlorobenzene	187	250	U	240	U	220	U
1,4-Dioxane	NL	98	U	93	U	88	U
1,7-Dimethyl-3-phenyltricyclo[4.1.	NL						
1H-Benzimidazole, 2-ethyl-	NL						
1H-Cyclopropa[l]phenanthrene,1a,9b	NL						
1-Heptadecanol	NL						
1H-Indazole, 3,6-dimethyl-	NL						
1H-Indene, 1,3-dimethyl-	NL					440	JN
2,2-oxybis(1-Chloropropane)	NL	480	U	460	U	430	U
2,3,4,6-Tetrachlorophenol	30	250	U	240	U	220	U
2,4,5-Trichlorophenol	34	250	U	240	U	220	U
2,4,6-Cycloheptatrien-1-one, 2-phe	NL						
2,4,6-Trichlorophenol	89	250	U	240	U	220	U
2,4-Dichlorophenol	57	250	U	240	U	220	U
2,4-Dimethylphenol	39	250	U	240	U	450	
2,4-Dinitrophenol	223	480	U	460	U	430	U
2,4-Dinitrotoluene	290	250	U	240	U	220	U
2,5,6-Trimethylbenzimidazole	NL						
2,6-Dinitrotoluene	296	250	U	240	U	220	U
2-Chloronaphthalene	NL	250	U	240	U	220	U
2-Chlorophenol	55	250	U	240	U	220	U
2-Methylphenol	119	480	U	460	U	76	U
2-Nitroaniline	NL	250	U	240	U	220	U
2-Nitrophenol	NL	250	U	240	U	220	U
2-Propenal, 2-methyl-3-phenyl-	NL						
3-Nitroaniline	NL					430	U
3,3-Dichlorobenzidine	NL	480	U	460	U	430	U
3-Penten-2-one, 4-phenyl-	NL						
4,6-Dinitro-2-methylphenol	NL	480	U	460	U	430	U
4-Bromophenyl-phenylether	47	250	U	240	U	220	U
4-Chloro-3-methylphenol	NL			240	U	220	U
4-Chloroaniline	0.9	480	U	460	U	430	U
4-Chlorophenyl-phenylether	NL	250	U	240	U	220	U
4-Methoxy-2-methyl-1-(methylthio)b	NL						
4-Methylphenol	93	480	U	460	U	120	J
4-Nitroaniline	NL	480	U	460	U	430	U
4-Nitrophenol	153	480	U	460	U	430	U
5-tert-Butylpyrogallol	NL						

Table 2-13
2019 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (µg/kg)**	KCW-**TR1**-SD-003		KCW-**TR2**-SD-009		KCW-**TR2**-SD-010	
CLP Sample Number:		MC0AM6		MC0AM4		MC0AM5	
Units:		µg/kg		µg/kg		µg/kg	
Sample Date:		7/31/2019		7/31/2019		7/31/2019	
Sample Type:		Background		Field		Field	
PAHs		Result	Q	Result	Q	Result	Q
6H-Dibenzo[b,d]-pyran	NL						

Table 2-13
2019 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (µg/kg)**	KCW-**TR1**-SD-003		KCW-**TR2**-SD-009		KCW-**TR2**-SD-010	
CLP Sample Number:		MC0AM6		MC0AM4		MC0AM5	
Units:		µg/kg		µg/kg		µg/kg	
Sample Date:		7/31/2019		7/31/2019		7/31/2019	
Sample Type:		Background		Field		Field	
PAHs		Result	Q	Result	Q	Result	Q
SVOCs							
9H-Fluoren-9-ol	NL						
9H-Fluorene, 2-methyl-	NL						
9H-Fluorene, 2,3-dimethyl-	NL						
9H-Fluorene, 9-methyl-	NL						
9H-Fluorene, 9,9-dimethyl-	NL						
Acetophenone	NL	480	U	460	U	430	U
A-Norcholestan-3-one, 5-ethenyl-,	NL						
Atrazine	0.3	480	U	460	U	430	U
Benzaldehyde	59	480	U	460	U	430	U
Benzenamine, 4-chloro-N-(2-pyridin	NL						
Benzene, 4-ethyl-1,2-dimethyl-	NL						
PAHs by SIM							
Benzocycloheptatriene	NL						
Bis(2-Chloroethoxy)methane	NL	250	U	240	U	220	U
Bis(2-Chloroethyl)ether	NL	480	U	460	U	430	U
Bis(2-ethylhexyl)phthalate	180	250	U	240	U	220	U
Butylbenzylphthalate	NL	250	U	240	U	220	U
Caprolactam	NL			460	U	430	U
Carbazole	69	480	U	460	U	74	J
Dibenzofuran	510	250	U	240	U	440	
Dibenzofuran, 4-methyl-	NL						
Diethyl phthalate	NL	250	U	240	U	230	U
Dimethyl phthalate	NL	280		120	J	230	
Di-n-butylphthalate	11	250	U	240	U	220	U
Di-n-octyl phthalate	39	480	U	460	U	430	U
Ethanone, 1-(2,6-dihydroxy-4-metho	NL			110	JN		
Ethanone, 1-(4-hydroxy-3,5-dimetho	NL						
Hexachlorobenzene	20	250	U	240	U	220	U
Hexachlorobutadiene	NL			240	U	220	U
Hexachlorocyclopentadiene	7	480	U	460	U	430	U
Hexachloroethane	27	250	U	240	U	220	U
Hydroquinone mono-trimethylsilyl e	NL						
Isophorone	876	250	U	240	U	220	U
Naphthalene, 1-methyl-	141						
Naphthalene, 1,3-dimethyl-	NL						
Naphthalene, 1,4-dimethyl-	NL					480	JN
Naphthalene, 1,4,6-trimethyl-	NL						
Naphthalene, 1,6-dimethyl-	NL					260	JN
Naphthalene, 1,6,7-trimethyl-	NL					320	JN
Naphthalene, 2,3-dimethyl-	NL					920	JN

Table 2-13
2019 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (µg/kg)**	KCW-**TR1**-SD-003		KCW-**TR2**-SD-009		KCW-**TR2**-SD-010	
CLP Sample Number:		MC0AM6		MC0AM4		MC0AM5	
Units:		µg/kg		µg/kg		µg/kg	
Sample Date:		7/31/2019		7/31/2019		7/31/2019	
Sample Type:		Background		Field		Field	
PAHs		Result	Q	Result	Q	Result	Q
PAHs by SIM							
Naphthalene, 2,3,6-trimethyl-	NL					380	JN
Naphthalene, 2,6-dimethyl-	NL						
Naphthalene, 2,7-dimethyl-	NL						
Naphtho[2,1-b]furan, 1,2-dimethyl-	NL						
Naphtho[2,3-b]norbornadiene	NL						
n-Hexadecanoic acid	NL	98	JN	160	JN		
Nitrobenzene	407	250	U	240	U	220	U
N-Nitroso-di-n-propylamine	NL	250	U	240	U	220	U
N-Nitrosodiphenylamine	110	250	U	240	U	220	U
Octadecanoic acid	NL						
Phenanthrene, 4-methyl-	NL						
Phenol	175	59	J	460	U	74	J
Phenol, 2-ethyl-4-methyl-	NL						
Phenol, 2-methoxy-4-propyl-	NL						
Phenol, 2,6-dimethoxy-	NL					290	JN
Phenol, 2,6-dimethoxy-4-(2-propeny	NL						
Phenol, 4-ethyl-2-methoxy-	NL						
Tetradecanethiol	NL						
Squalene	NL						
Total Alkanes	NL			2200		10000	
Total Alkanes	NL						
Trichloroacetic acid, hexadecyl es	NL						
unknown-01	NL			230	J	680	J
unknown-02	NL					360	J
unknown-03	NL						

Notes:
BG1 = Reference Site; **TR1** = Three Mile Run Background; **TR2** = Three Mile Run Site
Data compared to EPA Region 4 Freshwater Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of EPA Region 4 Screening Value
J = Reported value is estimated; actual value may be higher or lower
JN = The analyte has been "tentatively identified" at the reported value
NL = No listed value
PAH = Polyaromatic hydrocarbon
Q = Qualifier
SIM = Selective Ion Monitoring
SVOC = Semi-volatile organic compound
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
µg/kg = micrograms per kilogram

Table 2-14
2019 Sediment - Equilibrium Partitioning Sediment Benchmark Comparisons
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**$C_{OC,PAHi,FCVi}$ ($\mu g/g_{oc}$)**	KCW-**TR1**-SD-003				KCW-**TR2**-SD-009				KCW-**TR2**-SD-010			
Sample Date:		7/31/2019				7/31/2019				7/31/2019			
Units:		µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg
Analyte (PAH by SIM)		Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$
1-Methylnaphthalene	446	20	U			200		24907	56	2400		104348	234
1-Methylphenanthrene	670	10	J	1502	2.2	39		4857	7.2	360		15652	23
2-Methylnaphthalene	447	20	U			180		22416	50	3200		139130	311
2,3,5-Trimethylnaphthalene	584	20	U			160		19925	34	1600		69565	119
2,6-Dimethylnaphthalene	513	20	U			170		21171	41	2000		86957	170
Acenaphthene	491	20	U			42		5230	11	370		16087	33
Acenaphthylene	452	8.3	J	1246	2.8	15		1868	4.1	140		6087	13
Anthracene	594	14	J	2102	3.5	73		9091	15	760		33043	56
Benzo(a)anthracene	841	100		15015	18	38		4732	5.6	260		11304	13
Benzo(a)pyrene	965	92		13814	14	23		2864	3.0	140		6087	6.3
Benzo(b)fluoranthene	979	82		12312	13	18		2242	2.3	77	J	3348	3.4
Benzo(e)pyrene	967	57		8559	8.9	13		1619	1.7	72	J	3130	3.2
Benzo(g,h,i)perylene	1095	48		7207	6.6	3.6	J	448	0.41	44	J	1913	1.7
Benzo(k)fluoranthene	981	95		14264	15	15		1868	1.9	64	J	2783	2.8
Chrysene	844	100		15015	18	32		3985	4.7	210		9130	11
Dibenz(a,h)anthracene	1123	16	J	2402	2.1	6.5	U			99	U		
Fluoranthene	707	210		31532	45	66		8219	12	360		15652	22
Fluorene	538	8.4	J	1261	2.3	150		18680	35	1500		65217	121
Indeno(1,2,3-cd)pyrene	1115	49		7357	6.6	4.2	j	523	0.47	45	J	1957	1.8
Naphthalene	385	20	U			65		8095	21	1100		47826	124
Perylene	967	620		93093	96	17		2117	2	47	J	2043	2.1
Phenanthrene	596	85		12763	21	180		22416	38	1600		69565	117
Pyrene	697	160		24024	34	100		12453	18	590		25652	37
C1- Benzo(a)anthracenes/Chrysenes	929	34	J	5105	5.5	42	J	5230	5.6	390	J	16957	18
C2- Benzo(a)anthracenes/Chrysenes	1008	20	U			30	J	3736	3.7	350	J	15217	15
C3- Benzo(a)anthracenes/Chrysenes	1112	20	U			6.5	U			240	J	10435	9.4
C4- Benzo(a)anthracenes/Chrysenes	1214	20	U			6.5	U			99	U		
C1-Fluoranthenes/pyrene	770	77	J	11562	15	230	J	28643	37	1700	J	73913	96
C1-Fluorenes	611	20	U			250	J	31133	51	2800	J	121739	199
C2-Fluorenes	686	20	U			280	J	34869	51	3100	J	134783	196
C3-Fluorenes	769	20	U			250	J	31133	40	2400	J	104348	136
C2-Naphthalenes	510	20	U			790	J	98381	193	9200	J	400000	784
C3-Naphthalenes	581	20	U			800	J	99626	171	8400	J	365217	629
C4-Naphthalenes	657	20	U			620	J	77210	118	6200	J	269565	410
C1-Phenanthrenes/Anthracenes	670	41	J	6156	9.2	310	J	38605	58	2900	J	126087	188
C2-Phenanthrenes/Anthracenes	746	25	J	3754	5.0	270	J	33624	45	2300	J	100000	134
C3-Phenanthrenes/Anthracenes	829	20	U			130	J	16189	20	1300	J	56522	68
C4-Phenanthrenes/Anthracenes	913	20	U			160	J	19925	22	1500	J	65217	71
Total $\sum ESBTU_{FCV}$					344				1179				4381
Total Organic Carbon (TOC; mg/kg)		6660				8030				23000			

Notes:
TR1 = Three Mile Run Background; **TR2** = Three Mile Run Site
2017 SIM PAH data represents concentrations of only 17 compounds and may underestimate toxic effects.
$C_{OC,PAHi,FCVi}$ = Final Chronic Value concentration normalized to organic carbon
C_{OC} = Concentration normalized to organic carbon
$ESBTU_{FCVi}$ = Equilibrium partitioning benchmark toxic units (dimensionless)
ESB = equilibrium partitioning sediment benchmark
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
PAH = polyaromatic hydrocarbon
Q = Data qualifier
SD = sediment
SIM = selective ion monitoring
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and
may be inaccurate or imprecise

Table 2-15
2019 Sediment - Benchmark Comparisons - Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (mg/kg)**	KCW-**TR1**-SD-003		KCW-**TR2**-SD-009		KCW-**TR2**-SD-010	
CLP Sample Number:		MC0AM6		MC0AM4		MC0AM5	
Units:		mg/kg		mg/kg		mg/kg	
Sample Date:		7/31/2019		7/31/2019		7/31/2019	
Sample Type:		Background		Field		Field	
Metals		Result	Q	Result	Q	Result	Q
Aluminum	25,000	3430	J	2870	J	2300	J
Antimony	2	6.7	U	7	U	7.9	U
Arsenic	9.8	2.4		6.4		4.1	
Barium	20	30.3		31.4		57.4	J
Beryllium	NL	0.28	J	0.47	J	0.62	J
Cadmium	1	0.27	J	0.42	J	0.47	J
Calcium	NL	296	J	340	J	885	
Chromium	43.4	4.9		5.5		3.8	
Cobalt	50	4.3	J	8.1		7.5	
Copper	31.6	4.8		5.7		6.7	
Iron	20,000	14400	J	22400	J	19900	J
Lead	35.8	6.6		9		7.3	J
Magnesium	NL	576		504	J	298	J
Manganese	460	125		360		406	J
Nickel	22.7	5.7		8.4		6.5	
Potassium	NL	309	J	338	J	311	J
Selenium	0.72	3.9	U	4.1	U	4.6	U
Silver	1	1.1	U	1.2	UJ	1.3	UJ
Sodium	NL	559	U	586		659	U
Thallium	NL	2.8	U	2.9	U	3.3	U
Vanadium	NL	6.4		5.4	J	1.9	J
Zinc	121	33.8		53		46	

Notes:
BG1 = Reference Site; **TR1** = Three Mile Run Background; **TR2** = Three Mile Run Site
Data compared to EPA Region 4 Freshwater Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of EPA Region 4 Screening Value
J = Reported value is estimated; actual value may be higher or lower
mg/kg = milligrams per kilogram
NL = No listed value
Q = Qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit

UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 2-16
Crayfish Analytical Results Summary
Kinzua Creek Watershed Tar Sites
McKean County, PA

CLP Sample Numer: Sample ID: Sample Date: Sample Type:	Units	C0AM3 KCW-**BG1**-CF-001 10/1/2018 Background		C0AM6 KCW-**TR2**-CF-001 10/3/2018 Field	
PAHS					
Acenaphthylene	ug/kg	0.24	U	9.3	
Anthracene	ug/kg	10.3		8.83	
Benzaldehyde	ug/kg	745	JV	2820	V
Benzo(a)anthracene	ug/kg	0.966	J	0.32	U
Chrysene	ug/kg	1.12	J	0.35	U
Fluorene	ug/kg	0.35	U	2.52	
Naphthalene	ug/kg	0.26	U	5.33	
Phenanthrene	ug/kg	0.44	U	7.12	
Metals					
Aluminum	mg/kg	22.9	J	30.9	J
Antimony	mg/kg	6	U	6	U
Arsenic	mg/kg	1	UJ	1	UJ
Barium	mg/kg	151		75.9	
Beryllium	mg/kg	0.5	UJ	0.5	UJ
Cadmium	mg/kg	0.49	J	0.23	J
Calcium	mg/kg	41400		26700	
Chromium	mg/kg	0.19	J	0.22	J
Cobalt	mg/kg	0.26	J	0.97	J
Copper	mg/kg	13		21.1	
Iron	mg/kg	59		1060	
Lead	mg/kg	1	U	1	U
Magnesium	mg/kg	500	U	500	U
Manganese	mg/kg	73.7	J	152	J
Mercury	mg/kg	0.019	J	0.029	J
Nickel	mg/kg	0.39	J	0.55	J
Potassium	mg/kg	1590		1660	
Selenium	mg/kg	0.59	J	0.56	J
Silver	mg/kg	1	U	1	U
Sodium	mg/kg	1930		1850	
Thallium	mg/kg	2.5	U	2.5	U
Vanadium	mg/kg	5	U	0.078	J
Zinc	mg/kg	32.6		23.1	

Notes:
BG1 = Reference Site; **TR1** = Three Mile Run Background; **TR2** = Three Mile Run Site
J = Reported value is estimated; actual value may be higher or lower
mg/kg = milligrams per kilogram
NL = No listed value
Q = Qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise
μg/kg = micrograms per kilogram

Table 2-17
Exposure Point Concentrations - Aquatic Food Chain Modeling - Surface Water
Kinzua Creek Watershed Tar Sites
McKean County, PA

	Concentration mg/L	
COPEC	**Reference**	**Three Mile Run**
PAHs		
Acenaphthylene	ND	4.00E-05
Anthracene	ND	ND
Benzo(a)anthracene	ND	ND
Chrysene	ND	ND
Fluorene	ND	9.00E-05
Naphthalene	ND	2.60E-04
Phenanthrene	ND	3.00E-05
SVOCs		
Benzaldehyde	ND	ND
Metals		
Aluminum	0.24	0.94
Barium	0.050	0.093
Cadmium	ND	ND
Calcium	4.5	22
Chromium	ND	0.002
Cobalt	ND	0.0059
Copper	0.0012	0.017
Iron	0.97	16
Lead	ND	0.0074
Manganese	0.11	1.3
Mercury	ND	ND
Nickel	0.0017	0.0068
Potassium	1.40	2.2
Selenium	ND	ND
Silver	ND	ND
Sodium	16	6
Vanadium	0.0011	ND
Zinc	0.0069	0.020

mg/L = Milligrams per liter.

Table 2-18
Exposure Point Concentrations - Aquatic Food Chain Modeling - Sediment
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Concentration mg/kg dw	
	Reference	Three Mile Run
PAHs		
Acenaphthylene	ND	1.40E-01
Anthracene	1.90E-02	7.60E-01
Benzo(a)anthracene	3.70E-02	1.80E-01
Chrysene	3.50E-02	2.10E-01
Fluorene	8.00E-03	1.50E+00
Naphthalene	ND	1.10E+00
Phenanthrene	7.20E-02	1.60E+00
SVOCs		
Benzaldehyde	ND	ND
Metals		
Aluminum	4000	16000
Barium	66	130
Cadmium	0.68	2.7
Calcium	340	2200
Chromium	6.1	15
Cobalt	7.5	31
Copper	6.1	200
Iron	16000	86000
Lead	15	41
Manganese	450	830
Mercury	0.035	0.12
Nickel	15	34
Potassium	460	970
Selenium	ND	1.4
Silver	0.1	0.19
Sodium	3	590
Vanadium	9.1	22
Zinc	92	140

mg/kg dw = Milligrams per kilogram dry weight.

Table 2-19
Exposure Point Concentrations - Aquatic Food Chain Modeling - Crayfish
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Concentration mg/kg ww	
	Reference	Three Mile Run
PAHs		
Acenaphthylene	ND	9.30E-03
Anthracene	1.00E-02	8.80E-03
Benzaldehyde	7.40E-01	2.80E+00
Benzo(a)anthracene	9.70E-04	ND
Chrysene	1.10E-03	ND
Fluorene	ND	2.50E-03
Naphthalene	ND	5.30E-03
Phenanthrene	ND	7.10E-03
SVOCs		
Benzaldehyde	7.40E-01	2.80E+00
Metals		
Aluminum	23	31
Barium	150	76
Cadmium	0.49	0.23
Calcium	41000	27000
Chromium	0.19	0.22
Cobalt	0.26	0.97
Copper	13	21
Iron	59	1100
Lead	1.0	1.0
Manganese	74	150
Mercury	0.019	0.029
Nickel	0.39	0.55
Potassium	1600	1700
Selenium	1	1
Silver	1	1
Sodium	1900	1800
Vanadium	5	0
Zinc	33	23

mg/kg ww = Milligrams per kilogram wet weight.

Table 2-20
Receptor-specific Life History Exposure Parameters
Kinzua Creek Watershed Tar Sites

Receptor	Parameter							
	FIR[a] (kg WW/kg BW-day)	Fraction Moisture in Diet[b]	FIR[c] (kg DW/kg BW-day)	SIR (fraction of FIR DW)	SIR Source	SIR[d] (kg DW/kg BW-day)	WIR[e] (L/kg BW-day)	FT[f] (unitless)
Belted kingfisher	0.59	0.833	0.100	0.033	Mallard value; Beyer et al. 1994	0.0033	0.11	1
Mink	0.16	0.833	0.030	0.028	Fox value; Beyer et al. 1994	0.0008	0.10	1

Definitions:
FIR = Food Ingestion Rate.
FT = Fraction of Foraging Time at the Site.
NA = Not applicable
SIR = Sediment Ingestion Rate.
WIR = Water Ingestion Rate.

[a]Table 22.

[b]Moisture in diet as follows:

Dietary Item	Fraction Moisture	Source
Crayfish	0.833	EPA, 1999; benthic invertebrate value

[c]FIR DW calculated as FIR WW * (1-Fraction Moisture in Diet)

[d]SIR on body weight basis calculated as FIR DW times fraction SIR.

[e]EPA, 1993a. Birds = Equation 3-15 and Mammals = Equation 3-17.

[f]Conservative default value.

Table 2-21
Food Ingestion Rates
Kinzua Creek Watershed Tar Sites

$$\mathrm{FIR\ (kg\ ww/kg\ BW\text{-}day)} = \frac{\mathrm{FMR}}{\sum_{i=1}^{n}\left(AE_i \times GE_i \times P_i\right)}$$

Parameter	Definition	Value		Reference
FIR	Body weight normalized field ingestion rate (kg WW/kg BW-day equals g WW/g BW-day)	Belted kingfisher	0.59	Calculated
		Mink	0.16	
FMR	Field metabolic rate (kcal/g BW-day)	Species-specific		Table 22
AE_i	Assimilation efficiency of the i^{th} food item (unitless)	Species- and food item-specific		Table 23
GE_i	Gross energy of the i^{th} food item (kcal/g)	Food item-specific		Table 23
P_i	Proportion of diet comprised of the ith food item (unitless)	1		Professional judgment

Table 2-22
Calculation of Field Metabolic Rates*
Kinzua Creek Watershed Tar Sites

$$\text{FMR (kcal/g BW - day)} = a \times BW^{b} \times \frac{1\,\text{kcal}}{4.1876\,\text{kJ}} \div BW$$

Target Receptor	Allometric Equation Basis	a	b	Body Weight (g)	Body Weight Reference	FMR (kcal/g BW-day)
Belted Kingfisher	Birds - All Birds	10.5	0.681	150	Mean body weight based on means from Dunning, 1993; Alexander, 1977; Salyer and Lagler, 1946; Brooks and Davis, 1987; and Hamas, 1994	0.51
Mink	Mammals - Carnivora	1.67	0.869	946	Mean adult body weight based on male and female means in spring; Mitchell, 1961 as in EPA, 1995	0.16

*From Nagy et al., 1999.

Table 23
Assimilation Efficiency (AE) and Gross Energy (GE) of Anticipated Prey Items
Kinzua Creek Watershed Tar Sites

	Predator/Prey Item	Assimilation Efficiency (unitless)	Basis of Value	Gross Energy (kcal/g WW)	Basis of Value
Belted kingfisher	Birds/Crayfish	0.79	Eagles/seabirds - fish	1.1	Shrimp
Mink	Mammals/Crayfish	0.91	Mammals - fish	1.1	Shrimp

*Source: EPA, 1993a.

Table 2-24
Estimated Daily Intake - Mink - Reference Location
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Intake (mg/kg bw-day)			
	Crayfish	Sediment	Surface Water	Total
PAHs				
Acenaphthylene	NA	NA	NA	NA
Anthracene	1.60E-03	1.60E-05	NA	1.60E-03
Benzo(a)anthracene	1.60E-04	3.10E-05	NA	1.90E-04
Chrysene	1.80E-04	2.90E-05	NA	2.10E-04
Fluorene	NA	6.70E-06	NA	6.70E-06
Naphthalene	NA	NA	NA	NA
Phenanthrene	NA	6.00E-05	NA	6.00E-05
SVOCs				
Benzaldehyde	1.20E-01	NA	NA	1.20E-01
Metals				
Aluminum	3.70E+00	3.40E+00	2.40E-02	7.10E+00
Barium	2.40E+01	5.50E-02	5.00E-03	2.40E+01
Cadmium	7.80E-02	5.70E-04	NA	7.90E-02
Calcium	6.60E+03	2.90E-01	4.50E-01	6.60E+03
Chromium	3.00E-02	5.10E-03	NA	3.50E-02
Cobalt	4.20E-02	6.30E-03	NA	4.80E-02
Copper	2.10E+00	5.10E-03	1.20E-04	2.10E+00
Iron	9.40E+00	1.30E+01	9.70E-02	2.20E+01
Lead	1.60E-01	1.30E-02	NA	1.70E-01
Manganese	1.20E+01	3.80E-01	1.10E-02	1.20E+01
Mercury	3.00E-03	2.90E-05	NA	3.00E-03
Nickel	6.20E-02	1.30E-02	1.70E-04	7.50E-02
Potassium	2.60E+02	3.90E-01	1.40E-01	2.60E+02
Selenium	9.40E-02	NA	NA	9.40E-02
Silver	1.60E-01	8.40E-05	NA	1.60E-01
Sodium	3.00E+02	2.50E-03	1.60E+00	3.00E+02
Vanadium	8.00E-01	7.60E-03	1.10E-04	8.10E-01
Zinc	5.30E+00	7.70E-02	6.90E-04	5.40E+00

Note: Results rounded to two significant digits.
mg/kg bw-day = Milligrams per kilogram body weight/day.
NA = Not applicable.

Table 2-25
Estimated Daily Intake - Belted Kingfisher - Reference Location
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Intake (mg/kg bw-day)			
	Crayfish	**Sediment**	**Surface Water**	**Total**
PAHs				
Acenaphthylene	NA	NA	NA	NA
Anthracene	5.90E-03	6.30E-05	NA	6.00E-03
Benzo(a)anthracene	5.70E-04	1.20E-04	NA	6.90E-04
Chrysene	6.50E-04	1.20E-04	NA	7.70E-04
Fluorene	NA	2.60E-05	NA	2.60E-05
Naphthalene	NA	NA	NA	NA
Phenanthrene	NA	2.40E-04	NA	2.40E-04
SVOCs				
Benzaldehyde	4.40E-01	NA	NA	4.40E-01
Metals				
Aluminum	1.40E+01	1.30E+01	2.60E-02	2.70E+01
Barium	8.80E+01	2.20E-01	5.50E-03	8.80E+01
Cadmium	2.90E-01	2.20E-03	NA	2.90E-01
Calcium	2.40E+04	1.10E+00	5.00E-01	2.40E+04
Chromium	1.10E-01	2.00E-02	NA	1.30E-01
Cobalt	1.50E-01	2.50E-02	NA	1.80E-01
Copper	7.70E+00	2.00E-02	1.30E-04	7.70E+00
Iron	3.50E+01	5.30E+01	1.10E-01	8.80E+01
Lead	5.90E-01	5.00E-02	NA	6.40E-01
Manganese	4.40E+01	1.50E+00	1.20E-02	4.60E+01
Mercury	1.10E-02	1.20E-04	NA	1.10E-02
Nickel	2.30E-01	5.00E-02	1.90E-04	2.80E-01
Potassium	9.40E+02	1.50E+00	1.50E-01	9.40E+02
Selenium	3.50E-01	NA	NA	3.50E-01
Silver	5.90E-01	3.30E-04	NA	5.90E-01
Sodium	1.10E+03	9.90E-03	1.80E+00	1.10E+03
Vanadium	3.00E+00	3.00E-02	1.20E-04	3.00E+00
Zinc	1.90E+01	3.00E-01	7.60E-04	1.90E+01

Note: Results rounded to two significant digits.
mg/kg bw-day = Milligrams per kilogram body weight/day.
NA = Not applicable.

Table 2-26
Estimated Daily Intake - Mink - Three Mile Run
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Intake (mg/kg bw-day)			
	Crayfish	Sediment	Surface Water	Total
PAHs				
Acenaphthylene	1.50E-03	1.20E-04	4.00E-06	1.60E-03
Anthracene	1.40E-03	6.40E-04	NA	2.00E-03
Benzo(a)anthracene	NA	1.50E-04	NA	1.50E-04
Chrysene	NA	1.80E-04	NA	1.80E-04
Fluorene	4.00E-04	1.30E-03	9.00E-06	1.70E-03
Naphthalene	8.50E-04	9.20E-04	2.60E-05	1.80E-03
Phenanthrene	1.10E-03	1.30E-03	3.00E-06	2.40E-03
SVOCs				
Benzaldehyde	4.50E-01	NA	NA	4.50E-01
Metals				
Aluminum	5.00E+00	1.30E+01	9.40E-02	1.80E+01
Barium	1.20E+01	1.10E-01	9.30E-03	1.20E+01
Cadmium	3.70E-02	2.30E-03	NA	3.90E-02
Calcium	4.30E+03	1.80E+00	2.20E+00	4.30E+03
Chromium	3.50E-02	1.30E-02	2.00E-04	4.80E-02
Cobalt	1.60E-01	2.60E-02	5.90E-04	1.90E-01
Copper	3.40E+00	1.70E-01	1.70E-03	3.60E+00
Iron	1.80E+02	7.20E+01	1.60E+00	2.50E+02
Lead	1.60E-01	3.40E-02	7.40E-04	1.90E-01
Manganese	2.40E+01	7.00E-01	1.30E-01	2.50E+01
Mercury	4.60E-03	1.00E-04	NA	4.70E-03
Nickel	8.80E-02	2.90E-02	6.80E-04	1.20E-01
Potassium	2.70E+02	8.10E-01	2.20E-01	2.70E+02
Selenium	9.00E-02	1.20E-03	NA	9.10E-02
Silver	1.60E-01	1.60E-04	NA	1.60E-01
Sodium	2.90E+02	5.00E-01	6.10E-01	2.90E+02
Vanadium	1.20E-02	1.80E-02	NA	3.00E-02
Zinc	3.70E+00	1.20E-01	2.00E-03	3.80E+00

Note: Results rounded to two significant digits.
mg/kg bw-day = Milligrams per kilogram body weight/day.
NA = Not applicable.

Table 2-27
Estimated Daily Intake - Belted Kingfisher - Three Mile Run
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Intake (mg/kg bw-day)			
	Crayfish	**Sediment**	**Surface Water**	**Total**
PAHs				
Acenaphthylene	5.50E-03	4.60E-04	4.40E-06	6.00E-03
Anthracene	5.20E-03	2.50E-03	NA	7.70E-03
Benzo(a)anthracene	NA	5.90E-04	NA	5.90E-04
Chrysene	NA	6.90E-04	NA	6.90E-04
Fluorene	1.50E-03	5.00E-03	9.90E-06	6.50E-03
Naphthalene	3.10E-03	3.60E-03	2.90E-05	6.70E-03
Phenanthrene	4.20E-03	5.30E-03	3.30E-06	9.50E-03
SVOCs				
Benzaldehyde	1.70E+00	NA	NA	1.70E+00
Metals				
Aluminum	1.80E+01	5.30E+01	1.00E-01	7.10E+01
Barium	4.50E+01	4.30E-01	1.00E-02	4.50E+01
Cadmium	1.40E-01	8.90E-03	NA	1.50E-01
Calcium	1.60E+04	7.30E+00	2.40E+00	1.60E+04
Chromium	1.30E-01	5.00E-02	2.20E-04	1.80E-01
Cobalt	5.70E-01	1.00E-01	6.50E-04	6.70E-01
Copper	1.20E+01	6.60E-01	1.90E-03	1.30E+01
Iron	6.50E+02	2.80E+02	1.80E+00	9.30E+02
Lead	5.90E-01	1.40E-01	8.20E-04	7.30E-01
Manganese	8.80E+01	2.70E+00	1.40E-01	9.10E+01
Mercury	1.70E-02	4.00E-04	NA	1.70E-02
Nickel	3.20E-01	1.10E-01	7.50E-04	4.30E-01
Potassium	1.00E+03	3.20E+00	2.40E-01	1.00E+03
Selenium	3.30E-01	4.60E-03	NA	3.30E-01
Silver	5.90E-01	6.30E-04	NA	5.90E-01
Sodium	1.10E+03	1.90E+00	6.70E-01	1.10E+03
Vanadium	4.60E-02	7.30E-02	NA	1.20E-01
Zinc	1.40E+01	4.60E-01	2.20E-03	1.40E+01

Note: Results rounded to two significant digits.
mg/kg bw-day = Milligrams per kilogram body weight/day.
NA = Not applicable.

Table 2-28
Mammalian Toxicity Reference Values (TRVs)
Kinzua Creek Watershed Tar Sites
McKean County, PA

Analyte	Test Species	Study Duration	Effect	Dose (mg/kg-day)		TRV (mg/kg-day)		Toxicity Value Comment	Initial Value Source
				NOAEL	LOAEL	NOAEL	LOAEL		
PAHs									
Low Molecular Weight PAHs	Rat	Subchronic	Growth	65.6	328	65.6	328		EPA, 2007d
High Molecular Weight PAHs	Mouse	Chronic	Survival	0.615	3.07	0.615	3.07		EPA, 2007d
SVOCs									
Benzaldehyde	Rat	Subchronic	Kidney Toxicity	143		14.3	71.5		IRIS, 2008
Metals									
Aluminum	Mouse	Chronic	Reproduction		19.3	3.86	19.3	Aluminum chloride	EPA, 1999 and Sample et al., 1996
Barium	Rat	Multiple	Reproduction and Growth	51.8		51.8	259	Geomean of NOAELs; Eco SSL TRV	EPA, 2005e
Cadmium	Rat	Chronic	Growth	0.77	7.7	0.77	7.7		EPA, 2005d
Calcium						NTV	NTV		
Chromium	Rat	Chronic	Growth	8.09		8.09	40.45	Chromium III	EPA, 2008
Cobalt	Rat	Chronic	Reproduction	5.45	10.9	5.45	10.9		EPA, 2005c
Copper	Mink	Chronic	Reproduction	3.4	6.79	3.4	6.79	Lowest bounded LOAEL - Aquatic	EPA, 2007a
Iron	Rat	Subchronic	Liver, Heart	31.5	315	3.15	31.5		Whittaker et al., 1994
Lead	Rat	Chronic	Growth	4.7	8.9	4.7	8.9		EPA, 2005b
Manganese	Multiple	Multiple	Reproduction and Growth	51.5		51.5	257.5	Geomean of NOAELs	EPA, 2007b
Mercury	Mink	Chronic	Reproduction	1.01		1.01	5.05	Mercuric chloride - Terrestrial	EPA, 1999 and Sample et al., 1996
Nickel	Mouse	Chronic	Reproduction	1.7	3.4	1.7	3.4		EPA, 2007c
Potassium						NTV	NTV		
Selenium	Mouse	Chronic	Reproduction	0.072	0.145	0.072	0.145		EPA, 2007e
Silver	Rat	Chronic	Growth		80.2	16.04	80.2	Lowest rodent LOAEL	EPA, 2006
Sodium						NTV	NTV		
Vanadium	Mouse	Chronic	Growth, Reproduction, and Survival	4.16	8.31	4.16	8.31		EPA, 2005a
Zinc	Rat	Chronic	Reproduction	181	452	181	452	Reproduction, growth, or survival study with lowest bounded LOAEL (non livestock)	EPA, 2007f

LOAEL = Lowest observed adverse effect level.
mg/kg-day = Milligrams per kilogram per day.
NOAEL = No observed adverse effect level.

Table 2-29
Avian Toxicity Reference Values (TRVs)
Kinzua Creek Watershed Tar Sites
McKean County, PA

Analyte	Test Species	Study Duration	Effect	Dose (mg/kg-day) NOAEL	Dose (mg/kg-day) LOAEL	TRV (mg/kg-day) NOAEL	TRV (mg/kg-day) LOAEL	Toxicity Value Form or Surrogate	Initial Value Source
PAHs									
Low Molcular Weight PAHs	Mallard	Chronic	Reproduction	211		211	1055	Weathered crude	Stubblefield et al., 1995
High Molecular Weight PAHs	Mallard	Chronic	Reproduction	211		211	1055	Weathered crude	Stubblefield et al., 1995
SVOCs									
Benzaldehyde						NTV	NTV		
Metals									
Aluminum	Ringed Dove	Chronic	Reproduction	110		110	550	Aluminum sulfate	EPA, 1999 and Sample et al., 1996
Barium	1-day old chick	Subchronic	Mortality	208.26	416.53	20.826	41.653		EPA, 1999 and Sample et al., 1996
Cadmium	Chicken	Chronic	Reproduction	0.593	2.37	0.593	2.37		EPA, 2005d
Calcium						NTV	NTV		
Chromium	Black Duck	Chronic	Reproduction and Growth	0.5	2.78	0.5	2.78	Chromium III	EPA, 2008
Cobalt	Multiple	Multiple	Growth And Mortality	7.61		7.61	38.05	Geomean of NOAELs	EPA, 2005c
Copper	Chicken	Chronic	Reproduction	4.05	12.1	4.05	12.1		EPA, 2007a
Iron						NTV	NTV		
Lead	Chicken	Chronic	Reproduction	1.63	3.26	1.63	3.26	Lead acetate	EPA, 2005b
Manganese	Multiple	Multiple	Reproduction, Growth, and Survival	179		179	895	Geomean of NOAELs	EPA, 2007b
Mercury	Japanese Quail	Chronic	Reproduction	0.45	0.9	0.45	0.9	Mercuric chloride - Terrestrial	Sample et al., 1996
Nickel	Multiple	Multiple	Reproduction and Growth	6.71		6.71	33.55	Geomean of NOAELs	EPA, 2007c
Potassium						NTV	NTV		
Selenium	Mallard	Chronic	Reproduction	0.5	1	0.5	1	Sodium selinite	EPA, 1999 and Sample et al., 1996
Silver	Turkey	Subchronic	Growth	2.02	20.2	2.02	20.2		
Sodium						NTV	NTV		
Vanadium	Mallard	Chronic	Mortality, Body Weight, Blood Chemistry	11.38		11.38	56.9		Sample et al., 1996
Zinc	Multiple	Multiple	Reproduction and Growth	66.1		66.1	330.5	Geomean of NOAELs	EPA, 2007f

Note: Avian TRV not available for benzaldehyde.
LOAEL = Lowest observed adverse effect level.
mg/kg-day = Milligrams per kilogram per day.
NOAEL = No observed adverse effect level.

Table 2-30
Hazard Quotients - Mink - NOAEL-based - Reference Location
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Acenaphthylene	NA	NA	NA	NA	NA	NA	0
Anthracene	0.000024	99	0.00000024	1	NA	NA	0.000025
Benzo(a)anthracene	0.00026	84	0.000050	16	NA	NA	0.00031
Chrysene	0.00029	86	0.000047	14	NA	NA	0.00034
Fluorene	NA	NA	0.00000010	100	NA	NA	0.00000010
Naphthalene	NA	NA	NA	NA	NA	NA	0
Phenanthrene	NA	NA	0.00000091	100	NA	NA	0.00000091
SVOCs							
Benzaldehyde	0.0084	100	NA	NA	NA	NA	0.0084
Metals							
Aluminum	0.96	52	0.88	48	0.0062	0	1.8
Barium	0.46	100	0.0011	0	0.00010	0	0.46
Cadmium	0.10	99	0.00074	1	NA	NA	0.10
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0
Chromium	0.0037	85	0.00063	15	NA	NA	0.0043
Cobalt	0.0077	87	0.0012	13	NA	NA	0.0089
Copper	0.62	100	0.0015	0	0.000035	0	0.62
Iron	3.0	42	4.1	58	0.031	0	7.1
Lead	0.034	92	0.0028	8	NA	NA	0.037
Manganese	0.23	97	0.0074	3	0.00021	0	0.24
Mercury	0.0030	99	0.000029	1	NA	NA	0.0030
Nickel	0.036	82	0.0076	17	0.00010	0	0.044
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	1.3	100	NA	NA	NA	NA	1.3
Silver	0.010	100	0.0000052	0	NA	NA	0.010
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.19	99	0.0018	1	0.000026	0	0.19
Zinc	0.029	99	0.00043	1	0.0000038	0	0.030

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.

Table 2-31
Hazard Quotients - Belted Kingfisher - NOAEL-based - Reference Location
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Acenaphthylene	NA	NA	NA	NA	NA	NA	0
Anthracene	0.000028	99	0.00000030	1	NA	NA	0.000028
Benzo(a)anthracene	0.0000027	83	0.00000057	17	NA	NA	0.0000033
Chrysene	0.0000031	84	0.00000057	16	NA	NA	0.0000036
Fluorene	NA	NA	0.00000012	100	NA	NA	0.00000012
Naphthalene	NA	NA	NA	NA	NA	NA	0
Phenanthrene	NA	NA	0.0000011	100	NA	NA	0.0000011
SVOCs							
Benzaldehyde	NTV	NTV	NA	NA	NA	NA	0
Metals							
Aluminum	0.13	52	0.12	48	0.00024	0	0.25
Barium	4.2	100	0.011	0	0.00026	0	4.2
Cadmium	0.49	99	0.0037	1	NA	NA	0.49
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0.0
Chromium	0.22	85	0.04	15	NA	NA	0.26
Cobalt	0.020	86	0.0033	14	NA	NA	0.023
Copper	1.9	100	0.0049	0	0.000032	0	1.9
Iron	NTV	NTV	NTV	NTV	NTV	NTV	0
Lead	0.36	92	0.031	8	NA	NA	0.39
Manganese	0.25	97	0.0084	3	0.000067	0	0.25
Mercury	0.024	99	0.00027	1	NA	NA	0.025
Nickel	0.034	82	0.0075	18	0.000028	0	0.042
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.7	100	NA	NA	NA	NA	0.70
Silver	0.29	100	0.00016	0	NA	NA	0.29
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.26	99	0.0026	1	0.000011	0	0.27
Zinc	0.29	98	0.0045	2	0.000011	0	0.29

Shading indicates HQ >1.0.

Note: Results rounded to two significant digits.

NA = Not available, COPEC not detected in medium.

Table 2-32
Hazard Quotients - Mink - LOAEL-based - Reference Location
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Acenaphthylene	NA	NA	NA	NA	NA	NA	0
Anthracene	0.0000049	99	0.000000049	1	NA	NA	0.0000049
Benzo(a)anthracene	0.000052	84	0.000010	16	NA	NA	0.000062
Chrysene	0.000059	86	0.0000094	14	NA	NA	0.000068
Fluorene	NA	NA	0.000000020	100	NA	NA	0.000000020
Naphthalene	NA	NA	NA	NA	NA	NA	0
Phenanthrene	NA	NA	0.00000018	100	NA	NA	0.00000018
SVOCs							
Benzaldehyde	0.0017	100	NA	NA	NA	NA	0.0017
Metals							
Aluminum	0.19	52	0.18	48	0.0012	0	0.37
Barium	0.093	100	0.00021	0	0.000019	0	0.093
Cadmium	0.010	99	0.000074	1	NA	NA	0.010
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0
Chromium	0.00074	85	0.00013	15	NA	NA	0.00087
Cobalt	0.0039	87	0.00058	13	NA	NA	0.0044
Copper	0.31	100	0.00075	0	0.000018	0	0.31
Iron	0.30	42	0.41	58	0.0031	0	0.71
Lead	0.018	92	0.0015	8	NA	NA	0.019
Manganese	0.047	97	0.0015	3	0.000043	0	0.048
Mercury	0.00059	99	0.0000057	1	NA	NA	0.00060
Nickel	0.018	82	0.0038	17	0.000050	0	0.022
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.65	100	NA	NA	NA	NA	0.65
Silver	0.0020	100	0.0000010	0	NA	NA	0.0020
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.096	99	0.00091	1	0.000013	0	0.10
Zinc	0.012	99	0.00017	1	0.0000015	0	0.012

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.

Table 2-33
Hazard Quotients - Belted Kingfisher - LOAEL-based - Reference Location
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Acenaphthylene	NA	NA	NA	NA	NA	NA	0
Anthracene	0.0000056	99	0.000000060	1	NA	NA	0.0000057
Benzo(a)anthracene	0.00000054	83	0.00000011	17	NA	NA	0.00000065
Chrysene	0.00000062	84	0.00000011	16	NA	NA	0.00000073
Fluorene	NA	NA	0.000000025	100	NA	NA	0.000000025
Naphthalene	NA	NA	NA	NA	NA	NA	0
Phenanthrene	NA	NA	0.00000023	100	NA	NA	0.00000023
SVOCs							
Benzaldehyde	NTV	NTV	NA	NA	NA	NA	0
Metals							
Aluminum	0.025	52	0.024	48	0.000047	0	0.049
Barium	2.1	100	0.0053	0	0.00013	0	2.1
Cadmium	0.12	99	0.00093	1	NA	NA	0.12
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0.0
Chromium	0.040	85	0.0072	15	NA	NA	0.047
Cobalt	0.0039	86	0.00066	14	NA	NA	0.0046
Copper	0.64	100	0.0017	0	0.000011	0	0.64
Iron	NTV	NTV	NTV	NTV	NTV	NTV	0
Lead	0.18	92	0.015	8	NA	NA	0.20
Manganese	0.049	97	0.0017	3	0.000013	0	0.051
Mercury	0.012	99	0.00013	1	NA	NA	0.012
Nickel	0.0069	82	0.0015	18	0.0000057	0	0.0084
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.35	100	NA	NA	NA	NA	0.35
Silver	0.029	100	0.000016	0	NA	NA	0.029
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.053	99	0.00053	1	0.0000021	0	0.053
Zinc	0.057	98	0.00091	2	0.0000023	0	0.058

Shading indicates HQ >1.0.

Note: Results rounded to two significant digits.

NA = Not available, COPEC not detected in medium.

Table 2-34
Hazard Quotients - Mink - NOAEL-based - Three Mile Run
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Acenaphthylene	0.000023	92	0.0000018	7	0.000000061	0	0.000025
Anthracene	0.000021	69	0.0000098	31	NA	NA	0.000031
Benzo(a)anthracene	NA	NA	0.00024	100	NA	NA	0.00024
Chrysene	NA	NA	0.00029	100	NA	NA	0.00029
Fluorene	0.0000061	23	0.000020	76	0.00000014	1	0.000026
Naphthalene	0.000013	47	0.000014	51	0.00000040	1	0.000027
Phenanthrene	0.000017	46	0.000020	54	0.000000046	0	0.000037
SVOCs							
Benzaldehyde	0.0315	100	NA	NA	NA	NA	0.0315
Metals							
Aluminum	1.3	28	3.4	72	0.024	1	4.7
Barium	0.23	99	0.0021	1	0.00018	0	0.23
Cadmium	0.048	94	0.0030	6	NA	NA	0.051
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0
Chromium	0.0043	73	0.0016	27	0.000025	0	0.0060
Cobalt	0.029	86	0.0048	14	0.00011	0	0.034
Copper	1.0	95	0.050	5	0.00050	0	1.1
Iron	57	71	23	28	0.51	1	81
Lead	0.034	82	0.0072	17	0.00016	0	0.041
Manganese	0.47	97	0.014	3	0.0025	1	0.48
Mercury	0.0046	98	0.000099	2	NA	NA	0.0047
Nickel	0.052	75	0.017	25	0.00040	1	0.069
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	1.3	99	0.017	1	NA	NA	1.3
Silver	0.010	100	0.000010	0	NA	NA	0.010
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.0029	40	0.0043	60	NA	NA	0.0072
Zinc	0.020	97	0.00066	3	0.000011	0	0.021

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.

Table 2-35
Hazard Quotients - Belted Kingfisher - NOAEL-based - Three Mile Run
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Acenaphthylene	0.00002607	92	0.0000022	8	0.000000021	0	0.000028
Anthracene	0.000025	68	0.000012	32	NA	NA	0.000036
Benzo(a)anthracene	NA	NA	0.0000028	100	NA	NA	0.0000028
Chrysene	NA	NA	0.0000033	100	NA	NA	0.0000033
Fluorene	0.000007	23	0.000024	77	0.000000047	0	0.00003085
Naphthalene	0.000015	46	0.000017	53	0.00000014	0	0
Phenanthrene	0.000020	44	0.000025	56	0.000000016	0	0.000045
SVOCs							
Benzaldehyde	NTV	NTV	NA	NA	NA	NA	0
Metals							
Aluminum	0.16	25	0.48	75	0.00091	0	0.65
Barium	2.2	99	0.021	1	0.00048	0	2.2
Cadmium	0.24	94	0.015	6	NA	NA	0.25
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0.0
Chromium	0.26	72	0.10	28	0.00044	0	0.36
Cobalt	0.075	85	0.013	15	0.000085	0	0.088
Copper	3.0	95	0.16	5	0.00047	0	3.1
Iron	NTV	NTV	NTV	NTV	NTV	NTV	0
Lead	0.36	81	0.086	19	0.00050	0	0.45
Manganese	0.49	97	0.015	3	0.00078	0	0.51
Mercury	0.038	98	0.00089	2	NA	NA	0.039
Nickel	0.048	74	0.016	26	0.00011	0	0.064
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.66	99	0.0092	1	NA	NA	0.67
Silver	0.29	100	0.00031	0	NA	NA	0.29
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.0040	39	0.0064	61	NA	NA	0.010
Zinc	0.21	97	0.0070	3	0.000033	0	0.22

Shading indicates HQ >1.0.

Note: Results rounded to two significant digits.

NA = Not available, COPEC not detected in medium.

Table 2-36
Hazard Quotients - Mink - LOAEL-based - Three Mile Run
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Acenaphthylene	0.0000046	92	0.00000037	7	0.000000012	0	0.0000050
Anthracene	0.0000043	69	0.0000020	31	NA	NA	0.0000062
Benzo(a)anthracene	NA	NA	0.000049	100	NA	NA	0.000049
Chrysene	NA	NA	0.000059	100	NA	NA	0.000059
Fluorene	0.0000012	23	0.0000040	76	0.000000027	1	0.0000052
Naphthalene	0.0000026	47	0.0000028	51	0.000000079	1	0.0000055
Phenanthrene	0.0000034	46	0.0000040	54	0.0000000091	0	0.0000073
SVOCs							
Benzaldehyde	0.0063	100	NA	NA	NA	NA	0.0063
Metals							
Aluminum	0.26	28	0.67	72	0.0049	1	0.94
Barium	0.046	99	0.00042	1	0.000036	0	0.047
Cadmium	0.0048	94	0.00030	6	NA	NA	0.0051
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0
Chromium	0.00087	73	0.00032	27	0	0	0.0012
Cobalt	0.0147	86	0.0024	14	0	0	0.017
Copper	0.50	95	0.0250	5	0.00025	0	0.53
Iron	5.7	71	2.3	28	0.051	1	8.1
Lead	0.018	82	0.0038	17	0	0	0.022
Manganese	0.093	97	0.0027	3	0.00050	1	0.096
Mercury	0.00091	98	0.000020	2	NA	NA	0.00093
Nickel	0.026	75	0.0085	25	0.00020	1	0.035
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.62	99	0.0083	1	NA	NA	0.63
Silver	0.0020	100	0.0000020	0	NA	NA	0.0020
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.0014	40	0.0022	60	NA	NA	0.0036
Zinc	0.0082	97	0.00027	3	0.0000044	0	0.0085

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.

Table 2-37
Hazard Quotients - Belted Kingfisher - LOAEL-based - Three Mile Run
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Acenaphthylene	0.0000052	92	0.00000044	8	0.0000000042	0	0.0000057
Anthracene	0.0000049	68	0.0000024	32	NA	NA	0.0000073
Benzo(a)anthracene	NA	NA	0.00000056	100	NA	NA	0.00000056
Chrysene	NA	NA	0.00000065	100	NA	NA	0.00000065
Fluorene	0.0000014	23	0.0000047	77	0.0000000094	0	0.00000617
Naphthalene	0.0000029	46	0.0000034	53	0.000000027	0	0.0000064
Phenanthrene	0.0000040	44	0.0000050	56	0.0000000031	0	0.0000090
SVOCs							
Benzaldehyde	NTV	NTV	NA	NA	NA	NA	0
Metals							
Aluminum	0.033	25	0.096	75	0.00018	0	0.13
Barium	1.1	99	0.010	1	0.00024	0	1.1
Cadmium	0.059	94	0.0038	6	NA	NA	0.063
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0.0
Chromium	0.047	72	0.018	28	0.000079	0	0.065
Cobalt	0.015	85	0.0026	15	0.000017	0	0.018
Copper	0.99	95	0.055	5	0.00016	0	1.05
Iron	NTV	NTV	NTV	NTV	NTV	NTV	0
Lead	0.18	81	0.043	19	0.00025	0	0.22
Manganese	0.098	97	0.0030	3	0.00016	0	0.10
Mercury	0.019	98	0.00044	2	NA	NA	0.019
Nickel	0.0095	74	0.0033	26	0.000022	0	0.013
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.33	99	0.0046	1	NA	NA	0.33
Silver	0.029	100	0.000031	0	NA	NA	0.029
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.00081	39	0.0013	61	NA	NA	0.0021
Zinc	0.042	97	0.0014	3	0.0000067	0	0.044

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.

Table 2-38. Summary of Significant Endpoints. Surface Water Evaluation. USEPA Region III DAS No. 35440. November 2018.

USEPA Sample Number	ESI Code	Finding of Significant Difference(s) between Project Sites and																			
		Laboratory Control					Meade Run Reference (COAL6)					Kinzua Creek Reference (COAL3)					Three Mile Run Reference (COAK3)				
		Survival		Growth		Repro	Survival		Growth		Repro	Survival		Growth		Repro	Survival		Growth		Repro
		Cd	Pp	dry wt.	dry bio.		Cd	Pp	dry wt.	dry bio.		Cd	Pp	dry wt.	dry bio.		Cd	Pp	dry wt.	dry bio.	
COAL6	31183-001		Y		Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COAL3	31183-003						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COAK3	31183-009			Y	Y		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COAK6	31183-007			Y	Y	Y			Y					Y	Y		-	-	-	-	-
COAK7	31183-005				Y	Y											-	-	-	-	-
COAJ6	31183-011			Y	Y				Y			-	-	-	-	-					
COAJ7	31183-013			Y	Y				Y			-	-	-	-	-					

Note: Data were analyzed to determine significant differences between test surface water, reference surface water, and the laboratory control.
Statistical difference was evaluated at a=0.05.
Y Indicates that a statistically significant difference was found.
“ ” Indicates that a statistically significant difference was not found. “-“ Indicates that statistical analysis was not conducted.

Table 2-39. Summary of Significant Endpoints. Sediment Evaluation. USEPA Region III DAS No. 35440. November 2018.

Finding of Significant Difference(s) between Project Sites and

Laboratory Control (000)

USEPA Sample Number	ESI Code	survival day 28	survival day 35	survival day 42	growth dry wt. day 28	growth dry bio. day 28	growth dry wt. day 42	growth dry bio. day	reproduction day 35	reproduction day 35+42	reproduction day 42	reproduction day 35+42
COAL7	31183-002				Y							
COAL4	31183-004							Y				
COAK4	31183-010				Y	Y	Y	Y				
COAK8	31183-008					Y						
COAK9	31183-006						Y	Y		Y		
COAJ9	31183-012							Y		Y		Y
COAK0	31183-014			Y				Y				

Meade Run Reference COAL7 (002)

USEPA Sample Number	ESI Code	survival day 28	survival day 35	survival day 42	growth dry wt. day 28	growth dry bio. day 28	growth dry wt. day 42	growth dry bio. day 42	reproduction day 35	reproduction day 35+42	reproduction day 42	reproduction day 35+42
COAL7	31183-002	-	-	-	-	-	-	-	-	-	-	-
COAL4	31183-004		Y									
COAK4	31183-010	Y[a]						Y				
COAK8	31183-008	Y[a]										
COAK9	31183-006						Y			Y	Y	
COAJ9	31183-012	Y[a]								Y	Y	Y
COAK0	31183-014	Y	Y	Y				Y			Y[a]	

Kinzua Creek Reference COAL4 (004)

USEPA Sample Number	ESI Code	survival day 28	survival day 35	survival day 42	growth dry wt. day 28	growth dry bio. day 28	growth dry wt. day 42	growth dry bio. day 42	reproduction day 35	reproduction day 35+42	reproduction day 42	reproduction day 35+42
COAL7	31183-002	-	-	-	-	-	-	-	-	-	-	-
COAL4	31183-004	-	-	-	-	-	-	-	-	-	-	-
COAK4	31183-010	-	-	-	-	-	-	-	-	-	-	-
COAK8	31183-008											
COAK9	31183-006									Y		
COAJ9	31183-012	-	-	-	-	-	-	-	-	-	-	-
COAK0	31183-014	-	-	-	-	-	-	-	-	-	-	-

Three Mile Run Reference COAK4 (010)

USEPA Sample Number	ESI Code	survival day 28	survival day 35	survival day 42	growth dry wt. day 28	growth dry bio. day 28	growth dry wt. day 42	growth dry bio. day 42	reproduction day 35	reproduction day 35+42	reproduction day 42	reproduction day 35+42
COAL7	31183-002	-	-	-	-	-	-	-	-	-	-	-
COAL4	31183-004	-	-	-	-	-	-	-	-	-	-	-
COAK4	31183-010	-	-	-	-	-	-	-	-	-	-	-
COAK8	31183-008	-	-	-	-	-	-	-	-	-	-	-
COAK9	31183-006	-	-	-	-	-	-	-	-	-	-	-
COAJ9	31183-012								Y	Y		Y
COAK0	31183-014											

Note: Data were analyzed to determine significant differences between test sediments, reference sediments, and the laboratory control. Statistical difference was evaluated at a=0.05.

Y Indicates that a statistically significant difference was found.

“ ” Indicates that a statistically significant difference was not found.

- Indicates that statistical analysis was not conducted.

“a” Indicates that the analysis was conducted both with and without a statistical outlier and the findings of significance were split (Yes and No).

TABLE 2-40
Comparisons of prevalence of parasites and/or parasite-induced abnormalities in fish between Threemile Run locations and Meade Run watershed (reference) using Fisher's Exact Test (https://www.graphpad.com/quickcalcs/contingency2/).

	ABNORMAL	NORMAL	Total
MEADE RUN MOTTLED SCULPIN	**0**	**23**	**23**
THREEMILE RUN 1 ALL SPECIES	**18**	**14**	**32**
Total	**18**	**37**	**55**
One-tailed P value is less than 0.0001 Extremely statistically significant.			

	ABNORMAL	NORMAL	Total
MEADE RUN MOTTLED SCULPIN	**0**	**23**	**23**
THREEMILE RUN 2 COMMON SHINER	**20**	**15**	**35**
Total	**20**	**38**	**58**
One-tailed P value is less than 0.0001 Extremely statistically significant.			

	ABNORMAL	NORMAL	Total
MEADE RUN MOTTLED SCULPIN	**0**	**23**	**23**
THREEMILE RUN 2 W BLACKNOSE DACE	**12**	**18**	**30**
Total	**12**	**41**	**53**
One-tailed P value is less than 0.0003 Extremely statistically significant.			

Table 2-41
Waste Characterization Samples- Three Mile Run
Kinzua Creek Watershed Tar Site
McKean County, PA

CLP Number		C0AP3	C0AP4	C0AP5
Sample Number		KCW-MA-TAR-001	KCW-MA-TAR-002	KCW-MA-TAR-003
Date Collected		5/20/2020	5/20/2020	5/20/2020
Sample Matrix		Tar	Tar	Tar
Sample Type		Field Sample	Field Sample	Field Sample
Analytes	Units			
TCLP VOA				
Vinyl chloride	µg/L	0.17 U	0.17 U	0.17 U
1,1-Dichloroethene	µg/L	0.27 U	0.27 U	0.27 U
2-Butanone	µg/L	54.8	160	16.4 J
Carbon tetrachloride	µg/L	0.26 U	0.26 U	0.26 U
Chloroform	µg/L	0.19 U	0.19 U	0.19 U
Benzene	µg/L	11	31.3	0.13 U
1,2-Dichloroethane	µg/L	0.27 U	0.27 U	0.27 U
Trichloroethene	µg/L	0.13 U	0.13 U	0.13 U
Tetrachloroethene	µg/L	0.13 U	0.13 U	0.13 U
Chlorobenzene	µg/L	0.13 U	0.12 U	0.12 U
TCLP BNA				
Pyridine	µg/L	680 UD	340 UD	34 U
1,4-Dichlorobenzene	µg/L	340 UD	170 UD	16.8 U
2-Methylphenol	µg/L	9,400 D	4,400 D	260
3+4-Methylphenols	µg/L	14,900 D	7,000 D	610
Hexachloroethane	µg/L	440 UD	220 UD	22.2 U
Nitrobenzene	µg/L	280 UD	140 UD	14.2 U
Hexachlorobutadiene	µg/L	430 UD	210 UD	21.4 U
2,4,6-Trichlorophenol	µg/L	320 UD	160 UD	16.2 U
2,4,5-Trichlorophenol	µg/L	210 UD	110 UD	10.7 U
2,4-Dinitrotoluene	µg/L	560 UD	280 UD	28.1 U
Hexachlorobenzene	µg/L	380 UD	190 UD	18.9 U
Pentachlorophenol	µg/L	590 UD	300 UD	29.5 U
TCLP Pesticides				
gamma-BHC (Lindane)	µg/L	0.39 U	0.39 U	0.16 U
Heptachlor	µg/L	0.12 U	0.12 U	0.048 U
Heptachlor epoxide	µg/L	0.30 U	0.30 U	0.12 U
Endrin	µg/L	0.14 U	0.14 U	0.056 U
Methoxychlor	µg/L	0.47 U	0.47 U	0.19 U
Toxaphene	µg/L	5.50 U	5.50 U	2.20 U
Chlordane	µg/L	3.90 U	3.90 U	1.60 U

Table 2-41
Waste Characterization Samples- Three Mile Run
Kinzua Creek Watershed Tar Site
McKean County, PA

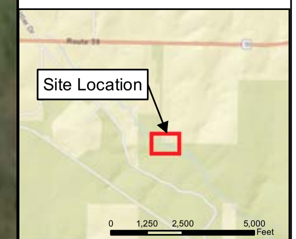
TCLP Herbicide				
2,4-D	µg/L	6.0 U	6.0 U	6.0 U
2,4,5-TP (Silvex)	µg/L	2.60 U	2.60 U	2.60 U
Corrosivity/Ignitability				
Corrosivity	pH	5.32 H	5.07 H	5.30 H
Ignitability	oC	NO	NO	NO
Cyanide/Sulfide				
Reactive Cyanide	mg/Kg	0.050 U	0.050 U	0.050 U
Reactive Sulfide	mg/Kg	25.5	33.2	20.7
Total Sulfide	mg/Kg	82.9	182	47.7
TCLP Metals				
Aluminum	mg/L	2.0 U	2.0 U	2.0 U
Antimony	mg/L	0.60 U	0.60 U	0.60 U
Arsenic	mg/L	50.0 U	50.0 U	50.0 U
Barium	mg/L	1000 U	1000 U	1000 U
Beryllium	mg/L	50.0 U	50.0 U	50.0 U
Cadmium	mg/L	10.0 U	10.0 U	10.0 U
Calcium	mg/L	50.0 U	50.0 U	50.0 U
Chromium	mg/L	50.0 U	50.0 U	50.0 U
Cobalt	mg/L	0.50 U	0.50 U	0.50 U
Copper	mg/L	0.25 U	0.25 U	0.25 U
Iron	mg/L	2.6	1.1	1.0 U
Lead	mg/L	50.0 U	50.0 U	50.0 U
Magnesium	mg/L	0.98 J	1.1 J	50.0 U
Manganese	mg/L	1.5	0.36	0.15 U
Nickel	mg/L	0.40 U	0.40 U	0.40 U
Potassium	mg/L	50.0 U	50.0 U	50.0 U
Selenium	mg/L	10.0 U	10.0 U	10.0 U
Silver	mg/L	50.0 U	50.0 U	50.0 U
Sodium	mg/L	1300	1370	1390
Thallium	mg/L	0.25 UJ	0.25 UJ	0.25 UJ
Vanadium	mg/L	0.50 U	0.50 U	0.50 U
Zinc	mg/L	0.60 U	0.60 U	0.60 U
Mercury	mg/L	0.20 U	0.20 U	0.20 U
Total Cyanide	mg/Kg	0.46	0.46 U	0.50 U

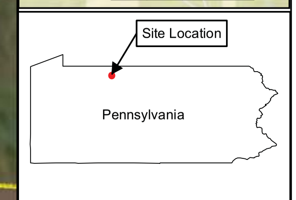
CLP - Contract Laboratory Program
U - Analyte not detected
D - Dilution
H - Sample analysis out of hold time
J - Estimated value
UJ - Analyte not detected but the quantitation limit is estimated

SECTION 2
FIGURES

Legend

- Tar
- No Tar
- Parcel Boundary
- Wood Tar Seeps
- Three Mile Run
- Pond
- Island
- Charcoal Pile
- Road





Background: ESRI, USGS Mapping Service
The source of this map image is Esri,
used by the EPA with Esri's permission

Coordinate System:
WGS84 UTM Zone 18N Feet

N

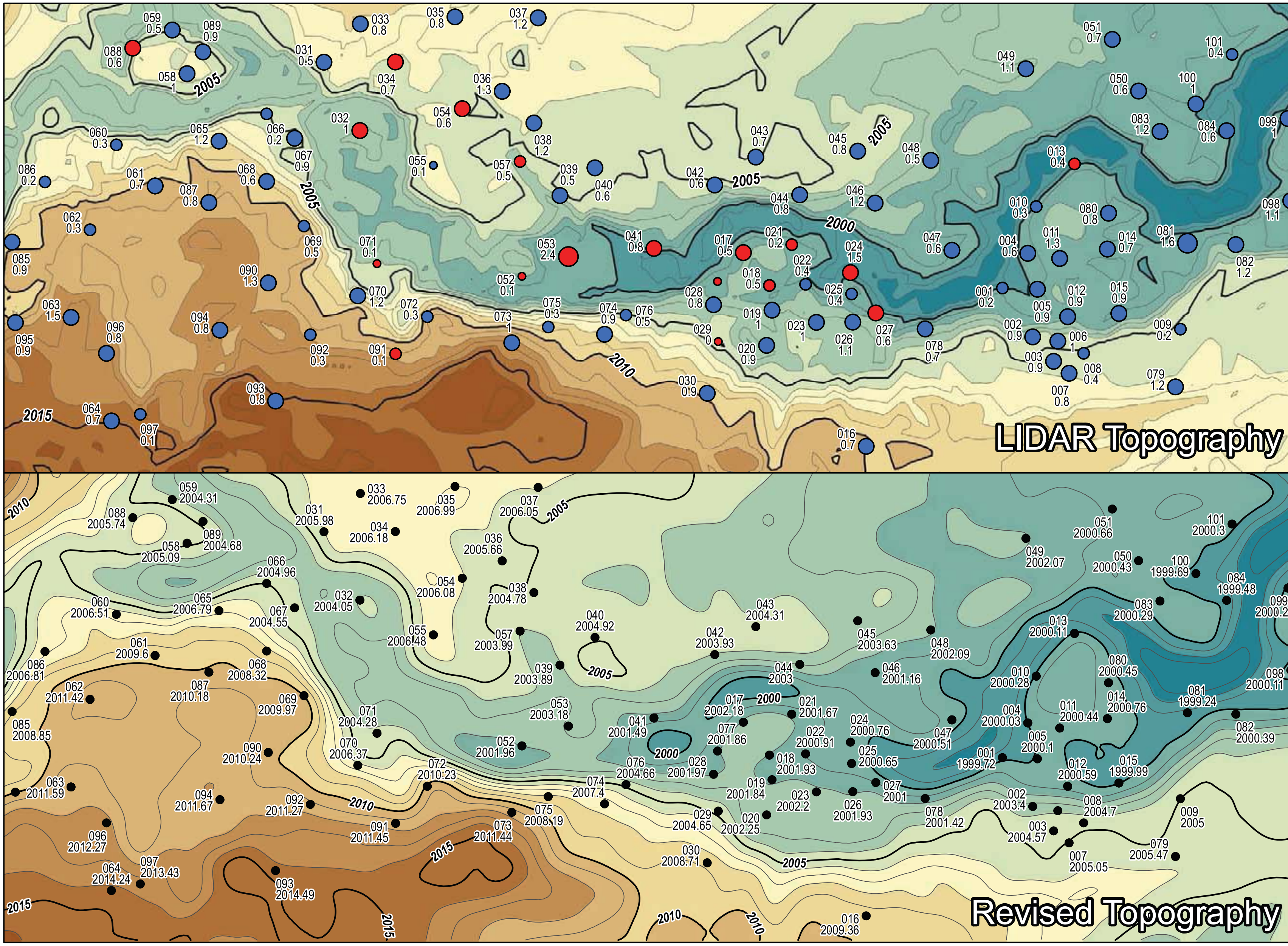
0 15 30 60
Feet

Kinzua Creek Watershed Tar Sites
McKean County, PA

Figure 2-1
Soil Boring Locations
Former Mount Alton Facility

TDD#: W501-17-03-001
Contract: S3-15-02
Prepared: 6/19/2020

File: Y:\EPA_Region_III\KinzuaCreek\MXD\Mount_Alton_Grid_Status_06192020.mxd, 6/19/2020 2:48:36 PM, johna



Legend

- ● Surveyed ground elevation (famsl)

LIDAR bias (feet)

Survey is over-predicted
- < 0.1
- 0.2 - 0.5
- 0.6 - 1.5
- > 1.6

Survey is under-predicted
- < 0.1
- 0.2 - 0.5
- 0.6 - 1.5
- > 1.6

Topographic contour (famsl)

Topographic model elevation (famsl)
High : 2018
Low : 1996

Notes:
1. Location prefixes were removed to reduce figure clutter.
2. 1-meter 2007 LIDAR obtained from Pennsylvania Spatial Data Access.
3. famsl = feet above mean sea level

Imagery: Pennsylvania Emergency Management Agency, 2018
Coordinate System: PA State Plane North, Feet

0 25 50
Feet

Kinzua Creek Watershed Tar Sites
McKean County, PA

Figure 2-2

Topographic Correction
Former Mount Alton Facility

TDD#: W501-17-03-001
Contract: S3-15-02
Prepared: 6/23/2020

WESTON SOLUTIONS

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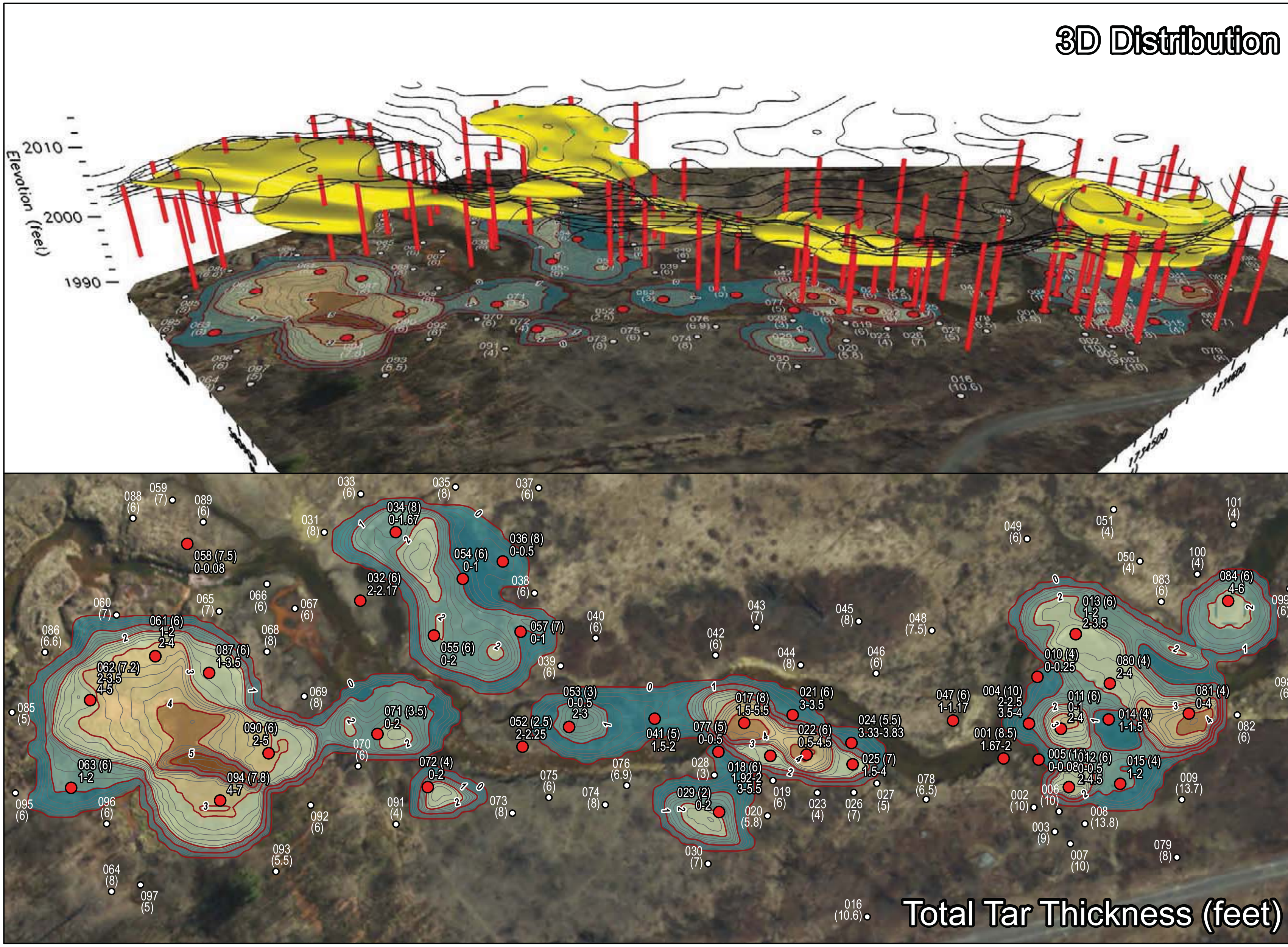


Legend

- Observed tar interval
- Tar not encountered
- Total tar thickness (feet)

Tar thickness (feet)

- 0.1 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- 5.1 - 6

Data posting forma:
Location ID (boring depth in feet)
Observed tar interval in feet

Note that location prefixes were removed to reduce figure clutter.

Imagery: Pennsylvania Emergency Management Agency, 2018
Coordinate System: PA State Plane North, Feet

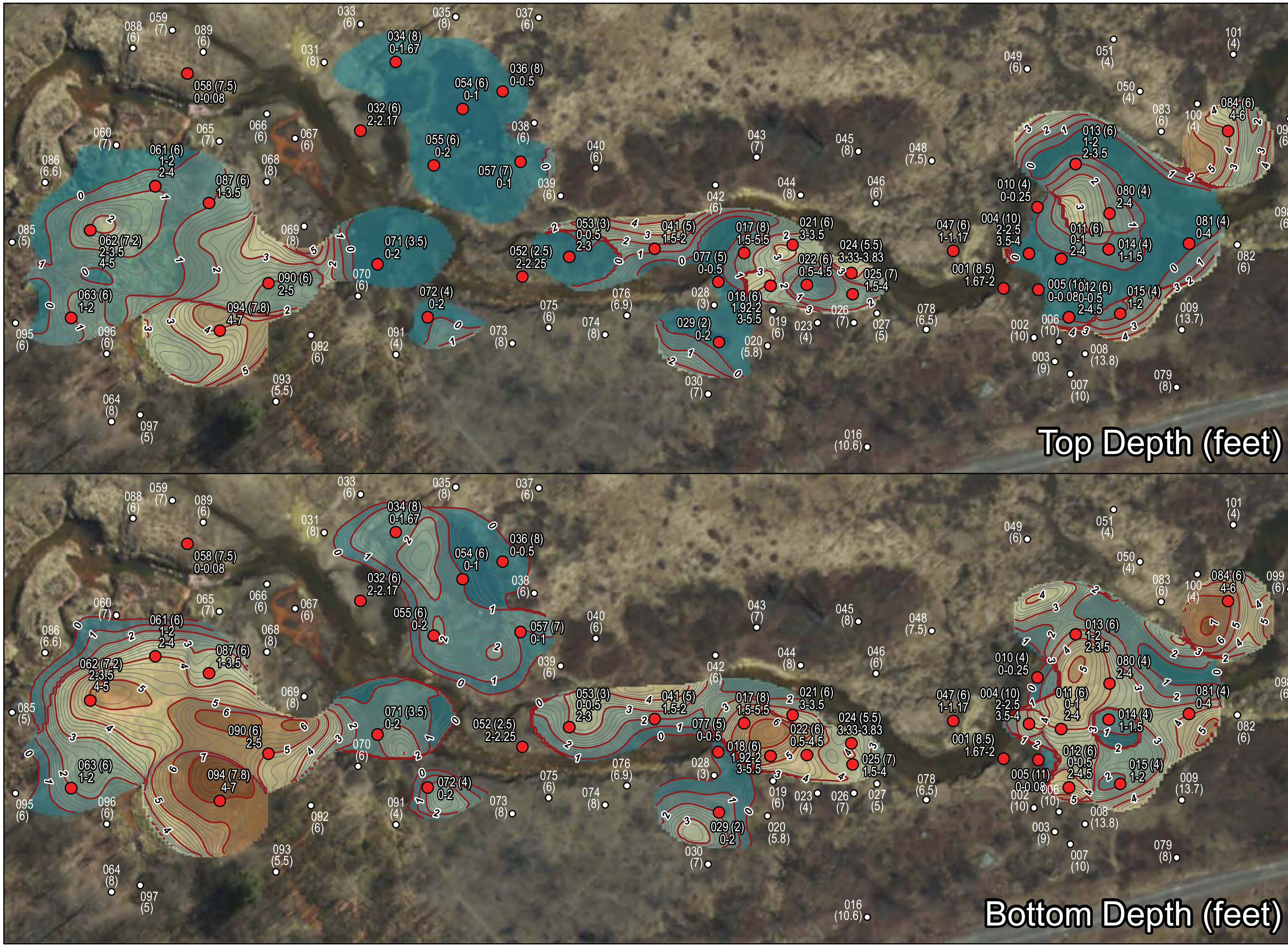
0 25 50
Feet

Kinzua Creek Watershed Tar Sites
McKean County, PA

Figure 2-3
3D Interpolated
Tar Distribution
with Total Thickness
Former Mount Alton Facility

TDD#: W501-17-03-001
Contract: S3-15-02
Prepared: 6/23/2020

C:\Projects\EPA_STARTIII\KinzuaCr\GIS\mxd\KinzCr_MtAlton_Thk3D.mxd 6/23/2020 4:09:41 PM BY: STROBRID



Legend

- Observed tar interval
- Tar not encountered
- Tar interval depth contour (feet)

Tar depth (feet)

- 0 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 5
- 5.1 - 6
- 6.1 - 7
- 7.1 - 8

Data posting forma:
Location ID (boring depth in feet)
Observed tar interval in feet

Note that location prefixes were removed to reduce figure clutter.

Imagery: Pennsylvania Emergency Management Agency, 2018
Coordinate System: PA State Plane North, Feet

0 25 50
Feet

Kinzua Creek Watershed Tar Sites
McKean County, PA

Figure 2-4

Interpolated Tar Zone Interval Top and Bottom Depth below Ground Surface Former Mount Alton Facility

TDD#: W501-17-03-001
Contract: S3-15-02
Prepared: 6/23/2020

WESTON SOLUTIONS

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3. STREAMLINED RISK EVALUATION

The assessment of potential risk to ecological receptors associated with exposure to contaminants in waste tar deposits used a variety of approaches over several phases as described in Section 2. Initially, chemical characterization data on sediment and surface water media at the Threemile Run wood tar site was screened against human health and ecological benchmarks. While the initial screening indicated that the Site was unlikely to pose significant risk to human health, sediment concentration data exceeded numerous ecological benchmarks, principally those associated with PAH compounds. As a consequence, subsequent data collection and evaluations focused on the potential risks to ecological receptors. Additional data development included performing chronic toxicity tests of tar site and reference site surface water samples on the test organisms *Ceriodaphnia dubia* and fathead minnow, and chronic toxicity tests of co-located sediment samples on *Hyalella azteca* as a surrogate test organism for effects on resident macrobenthic invertebrate receptors. Additionally, surveys of the macrobenthic invertebrate and fish communities at tar sites and reference sites, characterization of PAH concentrations in resident crayfish, and collection of fish specimens for histopathology analyses of multiple organ and tissue types and evaluation of microscopic anomalies associated with parasitic infections were completed.

Chronic toxicity testing of surface water and sediment samples from the Threemile Run wood tar site indicated toxic effects relative to the reference location samples. The fathead minnow growth endpoint of dry weight was significantly lower in Threemile Run tar site surface water samples relative to the Meade Run reference samples. In sediment toxicity tests, amphipod survival was significantly lower in Threemile Run sediment relative to Meade Run sediment and statistically significant differences in reproduction endpoints were observed between the Threemile Run sediment samples and the tar site samples relative to the sediment collected at the upstream reference site. Based on the chronic toxicity testing results, the macrobenthic invertebrate and fish communities, especially more sensitive species than the surrogate organisms tested, may be adversely impacted by exposure to contaminated media at the Threemile Run wood tar site.

Additional evidence for adverse effects to aquatic receptors at the Threemile Run wood tar site was provided by the benthic macroinvertebrate community survey results that showed markedly lower IBI values than those obtained at the Meade Run reference site; a scarcity of sensitive taxa;

and the observation of ingested tar in chironomid specimens and tar deposits on external structures of mayfly, caddisfly, and isopod specimens collected from the impacted area. In addition, the evaluation of microscopic anomalies associated with parasitic infections indicated high parasite prevalence and abundance in Threemile Run fish specimens that were statistically significantly different than the incidence of parasite abnormalities observed in Meade Run fish specimens. The combined stressors of nematode parasitism and direct toxic effects from PAH exposure may result in higher oxidative stress to fish.

While dietary exposure modeling using crayfish tissue PAH concentrations did not indicate risk to the upper trophic level receptors of belted kingfisher and mink, the weight of evidence indicates that the presence of wood tar deposits in and adjacent to Threemile Run is adversely affecting the macrobenthic invertebrate and fish communities.

4. IDENTIFICATION OF REMOVAL ACTION GOAL, OBJECTIVES, AND SCHEDULES

Prior to identifying the removal action objectives, it is necessary to consider other relevant information leading to the removal action objectives. The Applicable or Relevant and Appropriate Requirements (ARARs) are discussed in Section 4.1, the preliminary removal action goal is discussed in Section 4.2, the extent of contamination is discussed in Section 4.3, the removal action objectives are presented in Section 4.4, and the removal action schedule is discussed in Section 4.5.

4.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Pursuant to Section 300.400(g)(3) and 300.415(j) of the NCP, a list of ARARs and other advisories, criteria, and guidance to be considered (TBC) is developed for a site or sites to identify requirements that may apply to Site Inspections (SIs), remedial response actions, and risk assessments. EPA policy, as reflected in CERCLA (as amended by the Superfund Amendments and Reauthorization Act of 1986 [SARA]) and the NCP, provides that the development and evaluation of removal actions under CERCLA must include removal alternatives (for EE/CAs) or remedial alternatives (for Feasibility Studies [FSs]) to meet ARARs and to ensure protection of public health and the environment.

ARARs are defined as follows:

- Applicable requirements—Those cleanup standards, standards of control, and other substantive environmental protection requirements promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

- Relevant and appropriate requirements—Those cleanup standards, standards of control, and other substantive environmental protection requirements promulgated under federal or state law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at a CERCLA site.

Applicable requirements and relevant and appropriate requirements are considered to have the same weight with respect to requiring compliance at CERCLA site cleanups.

SARA also identifies the TBC category, which includes non-promulgated federal and state criteria, strategies, advisories, and guidance documents. TBCs do not have the same status as ARARs; however, if no ARAR exists for a substance or particular situation, TBCs may be used to ensure that a remedy is protective.

ARARs and TBCs are divided into three general categories: chemical-specific, location-specific, and action-specific. Definitions of each of these categories and specific ARARs/TBCs are presented in the following sections.

4.1.1 Chemical-Specific ARARs

Chemical-specific requirements are health or risk-based concentration limits or ranges in various environmental media for specific hazardous substances, pollutants, or contaminants. These limits may take the form of cleanup levels or discharge levels.

The 2018 Final Site Inspection (SI) Report (WESTON, 2018a) found that concentrations of PAH compounds and metals in surface water and sediment samples collected from the Site in 2017 exceeded BTAG screening criteria. There are no chemical specific ARARs for sediment for human health or ecological protection. There are chemical specify ARARs for surface water under PA Code Chapter 93 Water Quality Standards. All detected PAH compounds in surface water samples from 2016 through 2019 were below their respective PA Code Chapter 93 Water Quality Standards for the protection of aquatic life.

4.1.2 Location-Specific ARARs

Location-specific requirements are restrictions on activities that are based on the characteristics of a site or its immediate environment. Location of threated species will need to be coordinated with PA DCNR as per the Endangered Species Act and/or the Migratory Bird Treaty Act. As mentioned in an earlier section of the EE/CA a Pennsylvania Natural Diversity Inventory (PNDI) screening was performed for the Threemile Run site (Project Search ID: PNDI-712468). The screening indicates the project site could contain habitat for the Long Dash (*Polites mystic*) which is listed as a species of special concern. PA DCNR will perform a desktop survey and indicate whether further studies are necessary. Further studies could include a field survey to exclude the species from the project area, which would be required to be conducted from late May through early August.

ARARs related to floodplains and wetlands are provided in Section 4.1.3.

4.1.3 Action-Specific ARARs and TBCs

Action-specific requirements are controls or restrictions on particular types of activities in related areas such as hazardous waste management or wastewater treatment. No federal or state solid waste handling regulations, other than hazardous waste regulations, were identified that would be applicable or relevant and appropriate for the removal action at Threemile Run. Wood tar is not classified as a RCRA hazardous waste and is regulated under 25 PA 271 Municipal Waste Regulations.

The Pennsylvania National Pollutant Discharge Elimination System (NPDES) Stormwater Program, codified in 25 PA Code Chapter 102, requires operators of construction sites that disturb one (1) acre or greater, including smaller sites that are part of a larger common plan of development, to obtain authorization to discharge stormwater under an NPDES Construction Stormwater General Permit. The limit of disturbance at the Threemile Run site involves an area greater than 1 acre; therefore, the project is required to comply with the substantive requirements of Chapter 102 and substantive requirements of an NPDES construction permit, including preparing a stormwater control plan, implementation of sediment and erosion controls during the project and site stabilization and Post Construction stormwater management after the project is complete. The NPDES permitting program is administered by the McKean County Soil Conservation Service. Projects within the Threemile Run floodway are under 25 PA Chapter 105 – Stream Encroachment and under the jurisdiction of the US Army Corps of Engineers. Working in wetlands also requires meeting the substantive requirements of Section 404 of the Clean Water Act.

4.2 PRELIMINARY REMOVAL ACTION GOAL

The preliminary removal action goal for this project is to reduce the imminent and substantial endangerment to the public health, or welfare, or the environment by removing the potential for an actual or threatened release of pollutants and contaminants from the Site. Removal of the identified wood tar deposits is considered the permanent removal action.

4.3 EXTENT OF CONTAMINATION

A plan view of the Threemile Run site showing the extent of identified wood tar deposits is depicted in Figure 1-2.

4.4 REMOVAL ACTION SCOPE AND OBJECTIVES

The scope of the removal action is to remove and dispose the identified wood tar deposits (referred to hereafter as the removal action goal) from the Threemile Run site. Although the action is being performed as a "removal action" as defined by CERCLA (i.e., NTCRA), the EPA intends for it to be a final action (i.e., remedial action). The goal of the removal action at the Threemile Run site is to prevent further exposure of aquatic ecological receptors to the historical industrial waste deposits and to allow for recovery of the macrobenthic invertebrate and fish communities to conditions typical of un-impacted headwater stream habitats. Specific components of the removal action objectives for the Threemile Run site are summarized as follows:

- Remove and dispose identified wood tar deposits.
- Conduct removal action in compliance with ARARs.
- Properly dispose of any waste streams generated from the removal action.
- Stabilize stream banks.
- Stabilize land disturbance by restoring natural grades and establishing vegetative cover using native species upon completion of removal action.
- Complete removal action by the year 2022.

4.5 REMOVAL ACTION SCHEDULE

EPA intends to have the Threemile Run site administratively closed out by 2022, based on a signed Action Memorandum by the end of fiscal year 2020. A proposed schedule for the implementation of the recommended removal action alternative is provided in Section 7. This schedule is based on the assumed agency approval periods/dates for the EE/CA and other supporting documentation as shown on the schedule. A public review and comment period of 30 days is also included.

5. IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

5.1 IDENTIFICATION OF REMOVAL ACTION ALTERNATIVES

The objective of this section is to identify and analyze a range of removal action alternatives for implementing an NTCRA at the Threemile Run project site. These alternatives are designed to provide various degrees of protection to the environment in achieving removal action objectives. The removal action objectives for the Threemile Run project site are presented in Section 4. In accordance with CERCLA, the identified removal action alternatives are evaluated in sufficient detail to allow an administrative decision to be made based on the relevant criteria.

Based on the results of the SI and the October 2018 soil characterization reported in the EE/CA, PAHs are the COCs in the Threemile Run project site area. The removal action goal for the Threemile Run project site is to physically remove all identified wood tar to a degree that is protective of the environment. Approximately 4,360 cubic yards (yd^3) of wood tar have been determined to be present at the Site.

Based on the removal action objectives and the nature and extent of the wood tar identified at the Threemile Run project site area, a limited number of alternatives have been identified for evaluation of applicability to the Site. Because the action is being performed as an NTCRA, the screening included only alternatives based on physical removal of the wood tar.

The following factors were considered when developing the removal action alternatives:

- The alternatives often include an alternative that is used as a baseline. For the Threemile Run project site area EE/CA, other alternatives were compared against the no action alternative (Alternative 1) during the analysis.
- The alternatives must provide a range of protectiveness to the environment in achieving removal action objectives.
- The alternatives must be able to be implemented in a timely manner. The Threemile Run project site final remedial action, including the removal action, is being performed as an NTCRA.
- The alternatives must include removal of identified wood tar, or sequestration to protect the Threemile Run stream channel.

The following removal action alternatives were identified for the Threemile Run project site:

- Alternative 1: No Action.
- Alternative 2: Excavation and Off-Site Disposal of Identified Wood Tar within 25 Feet of Threemile Run.
- Alternative 3: Excavation and Off-Site Disposal of All Identified Wood Tar in the Threemile Run Site Project Area.

As mentioned earlier, the no action alternative was included as a baseline alternative against which other alternatives are compared. The second alternative consists of the removal and off-site disposal of wood tar deposits located within 25 feet of the top of bank of Threemile Run and the installation of a slurry wall which will protect the receiving water from future wood tar migration or from exposure from future stream meander. The third alternative consists of the excavation and off-site disposal of all identified wood tar deposits, includes standard channel and stream bank stabilization in areas where exposed tar is removed from Threemile Run and the adjacent riparian zone, and does not require sequestration measures to protect the receiving water.

The NCP (40 CFR 300.415) requires that alternatives be developed in sufficient detail to support the technical decision in the administrative record. The information presented herein meets these criteria. The nature of the wood tar deposits exposed along both banks of Threemile Run does not present an option to treat and reuse the material by available technologies; therefore, partial removal to protect the receiving water or complete removal were evaluated as feasible removal action alternatives. Each of the alternatives was evaluated using the following three main criteria, in consideration of the likelihood that the use of the alternative will enable the removal action objectives to be met:

- **Effectiveness**—The effectiveness of the removal relative to other alternatives within the same technology type. The effectiveness evaluation focuses on performance and the reliability of the technology considering its stage of development (i.e., well-established, proven technologies are considered more reliable than those still in the experimental stages). This evaluation also includes protectiveness (public health, community, residents, and workers during implementation); short- and long-term effectiveness; level of treatment expected (reduction of toxicity, mobility, and volume [TMV]); compliance with ARARs; and residual effect concerns.

- **Implementability**—Implementability includes both the technical and administrative feasibility of implementing a process option. The implementability evaluation primarily considers the level of difficulty in overcoming technical and institutional concerns associated with a given technology. This evaluation includes construction/operational considerations; time for implementation; availability of equipment, personnel, and services; state and community acceptance; and permits/approvals required.

- **Cost—**Cost is a limited factor in the evaluation process. In lieu of detailed cost estimates, relative costs for capital purchases and operations and maintenance (O&M) are used to compare alternatives. Cost estimates developed for the Threemile Run Site project area EE/CA are order-of-magnitude costs based on available information. As required under CERCLA guidance, the accuracy of the estimated costs should be between +50% and –30%. General categories of costs (high, medium, or low) are used to compare alternatives against one another.

A detailed evaluation of the three alternatives against each of these evaluation criteria is presented in Sections 5.2 through 5.4.

5.2 ALTERNATIVE 1 – NO ACTION

Alternative 1 was evaluated as a baseline scenario against which other alternatives may be compared. Under the no action alternative, no remedial measures would be implemented. Potential risks due to wood tar contamination would continue to exist.

5.2.1 Effectiveness—Protectiveness and Ability to Achieve Removal Action Objectives

Alternative 1 would not be effective in achieving the removal action objectives, and it would not be protective of aquatic receptors. The risks to the macrobenthic invertebrate and fish communities inhabiting the Threemile Run stream corridor in the vicinity of the Site would continue to exist as a result of the presence of wood tar deposits along the stream banks, wood tar fragments in the stream sediments, and leaching of PAHs directly to surface water and to shallow groundwater that may be intercepted by the stream, where wood tar deposits are in direct contact with Threemile Run. In the absence of remedial action, the Threemile Run site area would be left undisturbed and untreated; therefore, there would be a continued risk to the aquatic community. If no action were taken, the removal action objective would not be met. There are no location-specific or action-specific ARARs associated with Alternative 1.

5.2.2 Implementability—Technical Feasibility, Availability, and Administrative Feasibility

Alternative 1 can be easily implemented. There are no technical or administrative difficulties involved with the implementation because there would be no activities or permitting associated with this alternative. Alternative 1 could be implemented within the time period desired for an NTCRA.

5.2.3 Cost

There are no costs associated with Alternative 1.

5.3 ALTERNATIVE 2 – EXCAVATION AND OFF-SITE DISPOSAL OF IDENTIFIED WOOD TAR WITHIN 50 FEET OF THREEMILE RUN

Alternative 2 would include the excavation and off-site disposal of identified wood tar in the Threemile Run channel and in the riparian zone within 25 feet of the top of the stream banks. Alternative 2 includes a project site extending on both sides of an approximate 1,000-foot segment of Threemile Run and access, laydown, and materials staging areas. Work within the stream channel will involve diverting stream flow around active work areas and implementation of erosion and sediment controls, including in-stream sediment curtains to prevent migration of wood tar and sediment beyond the work area.

Contiguous tar deposits existing within 25 feet of the top of stream bank will be removed. At the 25-foot project limit, a slurry wall or other impermeable barrier will be installed to prevent migration of any remaining wood tar toward the receiving stream. The excavated area will be backfilled with clean structural fill, overlain by a 6-inch layer of imported topsoil. The project area will be restored with native vegetation. Disturbed areas of the stream channel will be filled with imported cobble and boulders and be allowed to reestablish naturally. Stream banks will be protected with coir logs or other vegetated stream stabilization measures.

5.3.1 Effectiveness—Protectiveness and Ability to Achieve Removal Action Objectives

Upon completion, Alternative 2 would effectively remove sources of wood tar contamination within the Threemile Run stream corridor. The wood tar would be shipped to a landfill permitted to accept PA Residual Waste.

Alternative 2 would be protective of aquatic receptors but would leave identified wood tar deposits located farther than 25 feet from the stream banks in place. Exposure to contaminants during the implementation of Alternative 2 would be minimal because the material handling would be conducted using appropriate equipment and following the proper health and safety procedures. Dust suppression measures, if necessary, would minimize respiratory exposure to workers. To reduce the potential for runoff from the active excavation, erosion control measures would be used to protect the environment in the immediate vicinity of the removal action and downstream of the Site. Alternative 2 provides sustainable aspects consistent with EPA's *Superfund Green Remediation Strategy* (EPA, 2010), which outlines methods to reduce the demand placed on the environment during cleanup actions and to conserve natural resources. One of the green remediation methods in the EPA document states, "pursue ways to reduce the use of natural resources and energy during remedial actions and when developing cleanup alternatives." Alternative 2 supports this green method by minimizing the natural resources that would be used and by focusing on the stream channel and sequestering in-place remaining identified wood tar deposits.

All chemical-specific ARARs would be met under Alternative 2. Personal protective equipment (PPE) and other safety procedures required under Occupational Safety and Health Administration (OSHA) 29 CFR 1910 and 1926 would be necessary for protection of workers excavating and transporting soil to the disposal site. Proper runoff control measures would be used to prevent the off-site migration of contaminants. Alternative 2 will require coordination with PA DCNR regarding threated species.

Substantive requirements of a stormwater discharge permit and a stream encroachment permit would be required because the earthmoving activity would involve more than 1 acre and the project site encompasses regulated waters of the Commonwealth. Best management practices presented in the *PADEP Chapter 102 Program Manual (PADEP, 2012)* will be implemented as needed for erosion and sedimentation control measures to conform with the requirements for NPDES Construction Activity and Chapter 105 Stream Encroachment authorizations by PADEP.

5.3.2 Implementability—Technical Feasibility, Availability, and Administrative Feasibility

It is anticipated that Alternative 2 would be relatively easy to implement. The heavy earthmoving equipment, landfill capacity, clean fill material, and channel stabilization materials needed to complete the project are readily available.

PADEP, Pennsylvania Game Commission, and private landowner's acceptance of Alternative 2 would be anticipated because it is protective of the natural environment and protective measures will be undertaken during construction to mitigate temporary impacts from earth moving activities.

5.3.3 Cost

The costs associated with Alternative 2 include the following:

- Development of the work plans.
- Development of detailed design drawings and narratives to support authorizations from PADEP, EPA, Pennsylvania Game Commission, and McKean County Conservation District.
- Site preparation work.
- Work associated with wood tar removal, including excavating, dewatering, hauling and disposal of excavated wood tar deposits.
- Construction of slurry wall.
- Backfill and final grading, including stream channel stabilization.
- Site restoration.
- Preparation of the site closure report.

The approximate cost associated with Alternative 2 is $3,463,999. A summary of the estimated costs for this alternative is provided in Table 5-1.

Table 5-1

Cost Estimate for Alternative 2 - Excavation and Off-Site Disposal of Identified Wood Tar Within 25 Feet of Threemile Run

Alternative #2: Slurry Wall included, excavation to within 25' of stream

ITEM	TASK		TOTAL
Item 1	Mobilization	$	17,544.29
Item 2	Demobilization	$	8,072.70
Item 3	Slurry Wall, Interceptor Trench	$	2,583,761.61
Item 4	Alternative #2	$	835,501.63
Item 5	Completion Reports	$	19,118.46
	GRAND TOTAL	**$**	**3,463,998.70**

5.4 ALTERNATIVE 3 – EXCAVATION AND OFF-SITE DISPOSAL OF ALL IDENTIFIED WOOD TAR IN THE THREEMILE RUN SITE PROJECT AREA

Alternative 3 would include the excavation and off-site disposal of all identified wood tar deposits in the Threemile Run site project area. Alternative 3 includes the removal of approximately 3,774 yd^3 of wood tar deposits from the 4.3-acre area with additional access area. Laydown and materials staging areas would be included within the project site. Work within the stream channel will involve diverting stream flow around active work areas and implementation of erosion and sediment controls, including in-stream sediment curtains to prevent migration of wood tar and sediment beyond the work area.

The excavated area will be backfilled with clean structural fill, overlain by a 6-inch layer of imported topsoil and restored with native vegetation. Disturbed areas of the stream channel will be filled with imported cobble and boulders and be allowed to reestablish naturally. Stream banks will be protected with coir logs or other vegetated stream stabilization measures.

5.4.1 Effectiveness—Protectiveness and Ability to Achieve Removal Action Objectives

Upon completion, Alternative 3 would effectively remove sources of wood tar contamination within the Threemile Run project area. The wood tar would be shipped to a landfill permitted to accept PA Residual Waste.

Alternative 3 would be protective of users of the stream corridor and the entire Threemile Run project site. Worker exposure to contaminants during the implementation of Alternative 3 would be minimal because the material handling would be conducted using appropriate equipment and following the proper health and safety procedures. Dust suppression measures, if necessary, would minimize respiratory exposure. To reduce the potential for runoff from the active excavation, erosion control measures would be used to protect the environment and in the immediate vicinity of the removal action and downstream of the site.

Alternative 3 would not satisfy the preference for alternatives involving treatment under CERCLA. The removal action is anticipated to be the final remedial action to address the wood tar deposits at the Threemile Run site. Alternative 3 would result in a permanent long-term remediation because the wood tar deposits would be completely removed, thereby removing the source of risk and reducing the overall risk. After Alternative 3 has been implemented, the Threemile Run tar site would meet the removal action goal, and the resulting conditions would be protective of aquatic receptors.

All chemical-specific ARARs would be met under Alternative 3. PPE and other safety procedures required under OSHA 29 CFR 1910 and 1926 would be necessary for protection of workers excavating and transporting soil to the disposal site. Proper runoff control measures would be used to prevent the off-site migration of contaminants. Alternative 3 will require coordination with PA DCNR regarding threated species.

Substantive requirements of a stormwater discharge permit and a stream encroachment permit would be required because the earthmoving activity would involve more than 1 acre and the project site encompasses regulated waters of the Commonwealth. Best management practices presented in the *PADEP Chapter 102 Program Manual (2012)* will be implemented as needed for erosion and sedimentation control measures to conform to the requirements for NPDES Construction Activity and Chapter 105 Stream Encroachment authorizations by PADEP.

The proposed area of excavation is depicted in Figure 5-1. The rationale for selecting this area and the estimated quantities of excavation are discussed in Section 4.3. The estimated total area of excavation would cover 4.3 acres, but only identified wood tar deposits would be excavated. The estimated total volume of excavation would be approximately 5,136 yd^3. The total estimated volume of excavated material includes half of the native soils associated with the wood tar deposits. It is assumed that half of the native soils occurring above or between identified wood tar lenses could be segregated and stockpiled on-site for re-use.

5.4.2 Implementability—Technical Feasibility, Availability, and Administrative Feasibility

It is anticipated that Alternative 3 would be relatively easy to implement. Landfill capacity, heavy earthmoving equipment, clean fill material, and channel stabilization materials needed to complete the project are readily available. No administrative barriers are foreseen in the implementation of Alternative 3 because excavation and off-site disposal is an established technology accepted by EPA and other state agencies. The wood tar would be shipped to a landfill permitted to accept PA Residual Waste; therefore, state acceptance of this alternative would be anticipated.

PADEP, Pennsylvania Game Commission, and private landowner's acceptance of Alternative 3 would be anticipated because it is protective of the natural environment and protective measures will be undertaken during construction to mitigate temporary impacts from earth moving activities.

5.4.3 Cost

The costs associated with Alternative 3 include the following:

- Development of the work plans.
- Development of detailed design drawings and narratives to support authorizations from PADEP, EPA, Pennsylvania Game Commission, and McKean County Conservation District.
- Site preparation work.
- Work associated with wood tar removal, including excavating, dewatering, hauling and disposal of excavated wood tar deposits.
- Backfill and final grading, including stream channel stabilization.
- Site restoration.
- Preparation of the site closure report.

The approximate cost associated with Alternative 3 is $1,210,574. A summary of the estimated costs for this alternative is provided in Table 5-2.

Table 5-2

Cost Estimate for Alternative 3 – Excavation and Off-Site Disposal of All Identified Wood Tar in the Threemile Run Site Project Area

Alternative #3: Complete Removal

ITEM	TASK		TOTAL
Item 1	Mobilization	$	17,544.29
Item 2	Demobilization	$	8,072.70
Item 3	Alternative #3	$	1,165,838.63
Item 4	Completion Reports	$	19,118.46
	GRAND TOTAL	**$**	**1,210,574.08**

SECTION 5
FIGURES

File: Y:\EPA_Region_III\KinzuaCreek\MXD\Mount_Alton_Grid_Status_06192020.mxd, 6/19/2020 2:48:36 PM, johna

6. COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

Each alternative is evaluated using the following evaluation criteria: effectiveness, implementability, compliance with ARARs and other criteria, long-term effectiveness and permanence, reduction of TMV, and short-term effectiveness.

Alternative 1 (no action) can be easily implemented. There are no technical or administrative difficulties involved with the implementation because there would be no activities or permitting associated with this alternative. Alternative 1 could be implemented within the time period desired for an NTCRA. Alternative 1 would not be effective in reducing the risk of exposure to the wood tar deposits or prevent further migration into the surface water. For the no action alternative, there would be no activities to implement. Alternative 1 would not be in compliance with ARARs. Alternative 1 at the Threemile Run site would have no long-term effectiveness and permanence, no reduction of TMV, and no short-term effectiveness.

Alternative 2 (partial excavation and disposal of the wood tar deposits) has a potentially higher risk to the environment because of the earth disturbance associated with the removal action and potential releases of wood tar to the environment during transport to the off-site landfill. Alternative 2 would have long-term effectiveness in protecting Threemile Run from further migration of the wood tar deposits. Potential long-term O&M and/or corrective needs may be warranted in the event that the stream channel meanders from the existing course to the slurry wall(s) on either side of the remediated corridor. Periodic monitoring should be conducted of the slurry wall for integrity and, if necessary, adding additional protection to the slurry wall in the form of installing riprap to prevent undermining/erosion/failure of the slurry wall that could expose residual waste tar pits.

For Alternative 2, there is less potential of exposure to the general public that are along the transportation routes because there would be fewer truck trips than during implementation of the complete removal Alternative 3. Alternative 2 would use less fossil fuel than Alternative 3 with lower transportation-associated carbon emissions.

The comparative analysis shows that Alternative 3 (total excavation and disposal) presents the most favorable overall characteristics of the three alternatives evaluated in achieving the removal action objectives. Alternative 3 is technically and administratively feasible and can be easily implemented. Alternative 3 meets the removal action goal for the wood tar deposits, thereby reducing the potential risks for further migration or exposure. The excavation and disposal of all identified wood tar deposits is projected to take only a short time longer than Alternative 2 (partial removal) and involve the same mobilization, equipment, and permitting effort. Compared to Alternative 2, Alternative 3 is equally technically and administratively feasible, implementable, meets the removal action goal for the wood tar, and will not take significantly longer to complete. Both alternatives will require coordination with PA DCNR regarding threatened species.

The total cost of Alternative 2 (partial excavation and disposal) is $3,463,999, which is approximately 286% higher than the cost of Alternative 3 (complete excavation and off-site disposal).

7. RECOMMENDED ALTERNATIVE

Based on the detailed analysis of the removal action alternatives presented in Section 5, and the comparative analysis discussed in Section 6, Alternative 3 (complete removal of identified wood tar deposits) is recommended as the selected remedy. Specific components of Alternative 3 are as follows:

- Excavation and off-site disposal of all identified wood tar deposits.
- Establish natural grades with imported clean fill material.
- Stabilize Threemile Run channel banks.
- Site restoration by vegetated cover using native species.

The proposed excavation area totals 59,502 square feet (approximately 1.37 acres). The volume to be excavated is approximately 3,774 yd^3 of wood tar. For the purpose of the Threemile Run site EE/CA, it is assumed that the half of the excavated soil associated with the wood tar removal could be stockpiled and reused on-site, half would not be able to be separated from the wood tar and would need to be disposed at the landfill (an additional 1,362 yd^3 of material). Upon completion of the stream bank removals, the stream banks will be stabilized with coir logs or similar. Excavated areas outside of the stream banks will be filled to 6 inches below natural grade with clean fill material; covered with topsoil; and stabilized with a native species seed mix, plugs, trees, and shrubs.

Alternative 3 can be easily implemented. Technical or administrative difficulties are not expected. The equipment necessary for the implementation of this alternative is readily available. Administrative difficulties are not anticipated because Alternative 3 would meet the removal action objectives, permanently remove the wood tar deposits, and provide adequate protection to the environment.

The total estimated cost for Alternative 3 is $1,210,574 and could be completed within 12 to 18 months, which includes time necessary for site preparation and for restoration of the stream and associated wetlands to full function.

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APPENDIX A
SOIL BORING LOGS

Soil Boring Log

Job Name: Kinzua Mt Alton	Boring No.: MA-001		Logged By: Jana
Job No.:	Page ____ of ____		
Date Drilled: 5/18/20	Boring Method: Geoprobe		
Drilling Co.: Eichelbergers	Boring Depth: 0-10'ft		
Driller:			

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	2ft	0		light brown fine grain sand w/some clay + silt		
2		0		2ft → tar lense 6in" coarse grain gray sand		* tar lense 6" @ ~2ft
3		0		medium coarse grain orangeish tan sand		
4		0				
5		0		fine grain sand with clay (wet) + silt		
6	3.5ft	0				
7		0				
8		0				
8.5						→ refusal

Depth to Ground Water: ____________

Well Installed? YES NO

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

: ____________

? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt. Alton	Boring No.: MA-002	Logged By: Jana Pezarauski
Job No.:	Page ____ of ____	
Date Drilled: 5/18/20	Boring Method: Geoprobe	
Drilling Co.: Eichelbergers	Boring Depth: 0 - 10'	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1				fine to medium grain sand w/some gravel orangeish tan w/clay		no tar seen
2	4ft	0				
3						
4				gray clay		
5						
6				gray clay		
7	3ft					
8		0		medium coarse clayey sand tanish/orange in color (wet)		
9						
10						

Depth to Ground Water: ____________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID:

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt. Alton	Boring No.: MA-003	Logged By: Jana Pezanoski
Job No.:	Page _____ of _____	

Date Drilled: 5/18/20
Drilling Co.: Eichelbergers
Driller:

Boring Method: Geoprobe
Boring Depth: 0-10'

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
				very fine grain sandy clay brown in color 0-.5"		
1				very fine grain sandy clay orange/tan in color 1.5-2.5'		
2	4ft	0		light tan medium grain sand with gravel/large 2.5-3.5		
3				gray clay 3.5-5		
4						
5				gray/tan fine grain sandy clay 5-7*		@5ft ft switched to split spoon
6	1.5ft					
7		0		fine grain sand with larger gravel/sandstone throughout some clay present		*section 7-9ft smelt like gasoline no readings on the PID
8	1.5ft					
9						
~~10~~						

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinnug Mt. Alton
Boring No.: MA-004
Logged By: Jana Pezanoski
Job No.:
Page ____ of ____

Date Drilled: 5/18/20
Boring Method: Geoprobe - Split Spoon
Drilling Co.: Eichelbergers
Boring Depth: 10
Driller:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
0–2	0	0				0-2' no recovery
2–4	1.5	0		0-5" tar (2.0-2.5) 2'-3.5' sandy clay fine/medium gray saturated 3.5-4.0 tar mixed into sandy clay		* 2.0-2.5 tar seen * 3.5-4.0 - tar seen
4–6	1.5	0		4-4.5 saturated medium grain sand gray in color 4.5-5.5 soft sandstone 5.5-6.0 medium grain sand orangish/brown		
6–8	2.0	0		very saturated fine & coarse gray sand 6-7 7.0-7.5 fine grain sandy clay gray & silt fine sand orange/tan		*smells like tar no tar seen *smells like tar no tar seen
8–10	2.0	0		8.0-8.7 very fine sand with chunks of sandstone throughout tan 8.7-10 sandy clay fine grain tan/orange		

Depth to Ground Water: ____________
Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete
Monitoring Well Installed? YES NO
Monitoring Well ID: ____________
Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: himzuq mt. Alton	Boring No.: MA-006	Logged By: Jana Pezanowski
Job No.:	Page _____ of _____	
Date Drilled: 5/18/20	Boring Method: Geoprobe	
Drilling Co.: Eichelbergers	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	2'	0		0-2" sandy clay fine grain grayish/orange moist		*small tiny specs of tar were seen where they were noted
2				2"-2' gray clay tiny pieces of tar throughout moist		
3	1.5'	0		gray/orange clay tiny pieces of tar throughout +silt 2-4' moist small bands of sand throughout		
4-5	1.5' 2	0		~~Metrso~~ 1-4" clay with tar gray in color; Sandy clay gray/tan pieces of sandstone throughout		
6-7	1 2			6-8' light brown clay+silt ↓		
8-9	2	0		8-8.5 sandy clay tan/orange fine grain some tar can be seen (small pieces)		
10				8.5-10' gray ~~clayey sand~~ sandy clay fine→coarse some sand stone present		

Depth to Ground Water:

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Monitoring Well Installed? YES NO

Monitoring Well ID:

Location Surveyed? YES NO GPS Surveyor Other

Soil Boring Log

WESTON

Job Name: Kinzua Mt. Alton	Boring No.: MA-007	Logged By: Jana Pezanoski
Job No.:	Page ___ of ___	
Date Drilled: 5/18/20	Boring Method: Geoprobe	
Drilling Co.: Eichelbergers	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	1.5	0		0-1" vegetation 1-2" rock fragments 2"-0.5' sandy clay med. grain orange in color		
2				0.5'-2.0 gray sandy clay with pieces of gravel throughout moist		
3	1.0	0		fine gray sandy clay with small gravel pieces last 4" medium sand tan, moist		
4				4-5' sandy clay + silt tan/light brown small gravel present moist		
5	1.5			5-6' gray clay small specs of tar pieces throughout moist		
6				6-7' gray clay		
7	1.5			7-8 orange/tan sandy clay + silt rock fragments last 3" - moist		
8				8-8.5 sandy clay gray - moist		
9	1.5	0		8.5-10 sandy clay rock - moist fragments throughout fine to coarse grain light brown/orange in color. moist		
10						

Depth to Ground Water: ______ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Nimua Mt. Alter	Boring No.: MA-010	Logged By: J. Peranowski
Job No.:	Page ____ of ____	

Date Drilled: 5/19/20
Drilling Co.: Eichelbergers
Driller:

Boring Method: Geoprobe
Boring Depth:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
0–2	10"	0			tan sand w/ clay & silt tar seen ~3" from 0-.5' moist		* tar seen ~3" from 0-0.5'
2–4	15"	0			Saturated sandy w/ clay tan in color no tar		

Depth to Ground Water: ________

Monitoring Well Installed? YES NO

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Mt Alton Nimmys	Boring No.: MA-011	Logged By: J. Rezanowski
Job No.:	Page ____ of ____	
Date Drilled: 5/29/20 Drilling Co.: Eichelbergers Driller:	Boring Method: Geoprobe Boring Depth:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	18"	0			Tar seen 0-1ft 1-2ft gray sandy clay with silt fine grained		*Tar 0-1'
2							
3	12"	0			completely Tar Saturated		*Tar 2'-4'
4							
5	6"	0			Tar seen very wet can't tell how much ~~test~~ bottom 6" gray sandy clay		*Tar present can't tell how much due to water
6							

Depth to Ground Water: ______ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

Soil Boring Log

WESTON SOLUTIONS

Job Name: Kinzua Mt. Alton	Boring No.: MA-012	Logged By: J. Pezankuski
Job No.:	Page ____ of ____	

Date Drilled: 5/20/20	Boring Method: Geoprobe
Drilling Co.: Eichelbergers	Boring Depth:
Driller:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	18"	0			0-6" Tar 6"-2' gray sandy clay		* Tar 0-6"
2							
3	3"	0			24-29' Tar with clay & fine sand		Tar 24-30"
4							
5	18'	0			48-54" Wet/liquid tar		48-54" Tar liquid
6					54-~~60~~" Brown Sand with clay ~~60~~ 72" ~~brown~~, Pieces of Sandstone		

Depth to Ground Water: ____

Backfill Type: Cuttings / Cuttings/Bentonite / Bentonite / Asphalt/Concrete

Monitoring Well Installed? YES NO

Monitoring Well ID: ____

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kuzzuq MT Alton	Boring No.: MA-013	Logged By: M. Ewald
Job No.:	Page ____ of ____	

Date Drilled: 5/20/20

Drilling Co.:

Driller:

Boring Method: Geoprobe

Boring Depth:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	10"	0		0-12" Brown color, fine sand with little clay		
				12-24" Tar chunks		
2						
3	20"	0		2-3' Brown coarse sand, Wet, little clay		
				3-3.5 Tar		
				3.5-4 Coarse grey sand with some clay, Pieces of sandstone		
4				4-5 Wet coarse Brown sandy sediment		
5	24"	8		5-6' light Brown hard clay with sand		
6						

Depth to Ground Water:

Monitoring Well Installed? YES NO

Monitoring Well ID:

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua MT Allen	Boring No.: MH-014	Logged By: Matt Ewald
Job No.:	Page ____ of ____	

Date Drilled: 5/20/20	Boring Method: Geoprobe
Drilling Co.:	Boring Depth:
Driller:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	18"	0			0-1' Brown Top soil with organic material; 1-1.5 Top soil with tar mixed throughout; 1.5-2' ~~white~~ Orange/grey fine sand with little clay		1-1.5 Tar
2							
3	22"	0			2-3.5 grey Wet fine Sand Very little clay; 3.5-4, grey/brown coarse sand, Wet, little clay		
4							

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Soil Boring Log

WESTON SOLUTIONS

Job Name: Kinzua Mt Alton	Boring No.: MH-015	Logged By: J Pezanawski
Job No.:	Page ____ of ____	
Date Drilled: 5/20/20	Boring Method: Geoprobe	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	12"	0			0-1' Top soil, Brown clay & organics		1-2' Tar
2					1-2' Tar		
3	6"	0			2-3' grey wet clay with fine sand		
4					3-4' Coarse sand with clay		

Depth to Ground Water: ______

Monitoring Well Installed? YES NO

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON

Soil Boring Log

Job Name: Kinzua Mt. Alton	Boring No.: MA-017	Logged By: Jang Pez
Job No.:	Page ____ of ____	
Date Drilled: 5/20/20 Drilling Co.: Eichelbergers Driller:	Boring Method: Geoprobe Boring Depth:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	20"	0			0-1.5' gray sandy clay fine grain + silt 1.5-2' tar		*1.5-2.0 tar
2, 3	12"	0			2-4 Tar saturated		*2-4 Tar
4, 5	15"	0			4-5.5 Tar 5.5-6.0 Brown medium-coarse sand w/clay + gravel.		
6, 7					Brown medium-coarse sand w/clay gravel		*could not get down pass ~ 7.3'
8							

Depth to Ground Water: ____ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ____

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: hinuua Mt. Alton	Boring No.: MA-018	Logged By: J. Peganowski
Job No.:	Page ____ of ____	

Date Drilled: 5/20/20
Drilling Co.: Eichelberger
Driller:

Boring Method: Geoprobe
Boring Depth:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	22"	0			Brown fine grain sand w/ clay 0-1'		* tar seen bottom 1"
					1-2' gray clay Bottom 4" tar present		
2					2-3 gray clay		
3	22"	0			3-4 Tar		* 3-4' Tar
4					4-5.5 Tar		
5					5.5-5.8 gray clay		
6							5.8 could not get passed

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt. Alton	Boring No.: MA-019	Logged By: J. Perarowski
Job No.:	Page ____ of ____	
Date Drilled: 5/20/20 Drilling Co.: Eichelbergers Driller:	Boring Method: ~~Geoprobe~~ Hand Boring Depth:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	4"	0		very saturated gray sandy fine Clay 0-2'		
2						
3	18"	0		2-2.5 gray Clay saturated 2.5-3.0 fine sandy gray clay 3.0-3.5 medium-coarse tan sand 3.5-4.0 tan/orange fine sand w/clay moist		
4				4-4.5 gray fine-medium sand w/clay moist		
5	6"	0		4.5-5 tan/orange medium-coarse sand w/sandstone		refusal @ 5'
6						

Depth to Ground Water: ____________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Soil Boring Log

WESTON

Job Name: Kinzua Mt. Alton	Boring No.: MA-020	Logged By: J. Pezanowski
Job No.:	Page _____ of _____	

Date Drilled: 5/20/20
Drilling Co.: Eichelbergers
Driller:

Boring Method: Geoprobe
Boring Depth:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	6"	0			very saturated gray sandy clay 0-2'		
2							
3	12'	0			fine-coarse sand with clay and gravel, tan in color		
4							
5		0			4-4.5' fine-medium sand w/ clay 4.5-5.8' medium-coarse sand with sandstone tan		
6							*5.8 refusal

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Soil Boring Log

WESTON SOLUTIONS

Job Name: Kimura Mt. Allen	Boring No.: MA-021	Logged By: J. Pezanowski
Job No.:	Page ____ of _____	
Date Drilled: 5/22/20 Drilling Co.: Eichelbergers Driller:	Boring Method: Geoprobe Boring Depth:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	8"	0			Brown fine grain sand with clay 0-2'		
2							
3	18"	0			2-3 Brown sand fine-coarse grain w/gravel 3-3.5 Tar 3.5-4 fine gray sand w/ clay		* 3-3.5 Tar
4					1" Tar gray sand 4-5 medium grain gray/tan sand with gravel		
5	18"	0			5-6 fine grain gray sand with gravel with some clay		
6							

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt Allan	Boring No.: MA-022	Logged By: Ewald
Job No.:	Page ____ of ____	

Date Drilled: 5/22/20	Boring Method: Geoprobe
Drilling Co.:	Boring Depth:
Driller:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	12"	0			0-6" ~~Top Soil~~ Sandy Top Soil 6-24" TAR		Tar 6"-24"
2							
3	12"	0			2-3.5' Tar 3.5-4 Coarse grey sand with chunks of sandstone		Tar 2-3.5'
4							
5	24"	0			~~4-5 Tar~~ 4-4.5 Tar 4.5-5 Dark grey coarse sand stained with tar 5-5.5 Coarse light brown sand 5.5-6 light Brown fine sand with little clay		4-4.5' Tar
6							

Depth to Ground Water: ________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua M.T Alton	Boring No.: MA-023	Logged By: Ewald
Job No.:	Page ____ of ____	

Date Drilled: 6/22/17

Drilling Co.:

Driller:

Boring Method: Geoprobe

Boring Depth:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	24"	0			0-2" Top soil/organics 2"-22" light brown clay with fine sand 22"-24" Brown Coarse sand with clay		
2					2-2.5 Brown Coarse sand with clay		
3	14"	0			2.5-4 Grey clay with fine sand		
4							

Depth to Ground Water: ________

Monitoring Well Installed? YES NO

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt Alton	Boring No.: MA-024	Logged By: Ewald
Job No.:	Page ____ of ____	

Date Drilled: 5/22/20
Drilling Co.:
Driller:

Boring Method: Geoprobe
Boring Depth:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	6"	0			0-1" topsoil /organics 1-24" Brown fine Sand, NO clay		
2							
3	20"	0			2-3' Brown/grey fine sand with little clay 36-40" Coarse grey sand		
4					40-46" Tar 46-48" Sandstone		40-46" Tar
5	14"	0			4-4.5 Wet fine sand with little clay 4.5-5.5 Coarse grey Sand with chunks of Sandstone		
5.5							Refusal 5.5'

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: MH Alton Kinzua	Boring No.: MA-025	Logged By: S Pezanoski
Job No.:	Page ____ of ____	
Date Drilled: 5/26/20	Boring Method: ~~Geoprobe~~ hand	
Drilling Co.: Eichelbergers	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	18"	0		1-1.5' Brown sand fine (moist) with some clay 1.5-2.0 - Tar		* 1.5-2.0 Tar
2–3	15"	9.5 ppb		~~3" fine Brown sand~~ 2-2.5 fine Brown sand ~~3"-13" Tar~~ SP ~~13"~~ 2.5-4.0 Tar ~ last 2 inch Sandstone		* 2.5-4.0 Tar (sticky)
4–5	22"	0		4-4.5 Tar 4.5-5 wet Brown Sand with fine grains + gravel 5.0-6.0 medium & fine grain sand with gravel		* 4-4.5 - Tar (sticky)
6–7	12"	0		Sand fine grayish color with gravel		- 7.0' refusal
8						

Depth to Ground Water: ______

Monitoring Well Installed? YES NO

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kimua Mt. Alton	Boring No.: MA-026	Logged By: J. Pezarowski
Job No.:	Page _____ of _____	

Date Drilled: 5/26/20	Boring Method: ~~Geoprobe~~ Hand
Drilling Co.: Eichelbergers	Boring Depth:
Driller:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	0					0-2 No recovery
2						
3	12'	0		gray fine grain sand with clay 2-4 (moist) 4-5 medium/fine sand tanish/Brown with gravel (moist) 5-6 gray fine sand (wet)		
4						
5	18'					
6						
7	24'	0		fine gray fine w/ clay (6.0-6.5) 6.5-7 fine-medium tanish/brown sand w/ sandstone		hit refusal @ 7'
8						

Depth to Ground Water: | Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Monitoring Well Installed? YES NO

Monitoring Well ID:

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kimzia Mt. Alton	Boring No.: MA-027	Logged By:
Job No.:	Page _____ of ______	

Date Drilled:
Drilling Co.:
Driller:

Boring Method: Geoprobe
Boring Depth:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	3"	0			fine brown sand 0-2'		
2							
3	12"	0			Dark brown fine sand (moist) 2-2.5; 2.5-3.0 wet tan fine sand w/ clay 3.0-3.5 gray clay 3.5-4.0 medium-coarse tan sand		
4							
5	12"	0			4-5 fine-coarse tan/gray sand w/ gravel & sandstone		Refusal @ 5'
6							

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Soil Boring Log

WESTON SOLUTIONS

Job Name: Ain2UA Mt. Alton	Boring No.: MA-028	Logged By: Erik Armistead
Job No.:	Page ____ of ____	
Date Drilled: 5/26/20	Boring Method: ~~Geoprobe~~ Hand probe	
Drilling Co.: Eichelbergers	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	13"	0 ↓		Topsoil 0-6" Wet light brown sand		
2				wet grey clayey sand		
3				sandstone		*Refusal @ 3ft (went to 3 different location all hit refusal @ 3 ft in this grid)
4						
5						
6						

Depth to Ground Water: ____________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt. Alton	Boring No.: MA-029	Logged By: J Prazanowski
Job No.:	Page ___ of ___ 1	
Date Drilled: 5/26/20	Boring Method: ~~Geoprobe~~ hand	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1						
2						*complete far could only get down 2ft got stuck will walk whole area w/ GPS

Depth to Ground Water: ______

Monitoring Well Installed? YES NO

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kimura Mt. Allen	Boring No.: MA-130	Logged By: J. Przanowski
Job No.:	Page ____ of ____	
Date Drilled: 5/26/20	Boring Method: Geoprobe	
Drilling Co.: Eichelbergers	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	18"	0			0-0.5 Top soil brown; 0.5-2.0 fine grain sand orange tan w/ clay		
2–3	24"	0			light Brown fine sand w/ small gravel 2-3'; 3-4' fine-medium ~~coarse~~ sand tan/orange with gravel		
4–5	18"	0			4-5 fine-medium grain tan/orange sand with gravel; 5.0-5.5 fine grain sand gray with gravel 5.5-6 gray ~~sand~~ sandy clay fine		
6–7	12"	0			orange/tan sand w/ gravel fine-medium grain		hit refusal @ 7'
8							

Depth to Ground Water: ____________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt. Alton | Boring No.: MA-031 F3 | Logged By: J. Pezanowski
Job No.: | Page ____ of ____ |
Date Drilled: 5/27/20 | Boring Method: ~~Geoprobe~~ Hand
Drilling Co.: Eichelbergers | Boring Depth:
Driller:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1–2	18"	0		Brown/orange sand fine-coarse 0-2'		
2–4	18"	0		gray sandy clay w/ small pieces of gravel + silt 2-4'		
4–6	8"	0		gray sandy clay w/ small pieces of gravel + silt 4-6'		
6–8	24"	0		gray sandy clay w/ gravel (wet) + silt		

Depth to Ground Water:

Well Installed? YES NO

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log F4 (Red)

Job Name: Kinzua Mt. Alton	Boring No.: MA-032	Logged By: J. Pezanauski
Job No.:	Page ____ of ____	

Date Drilled: 5/27/20
Drilling Co.: Eichelbergers
Driller:

Boring Method: ~~Geoprobe~~ Hand
Boring Depth:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	2"	0		Brown fine sand 0-2'		
2						
3	8"	0		Top 2" Tar 2"-2.5 sand medium-coarse 2.5-3.5 fine sandy clay (gray) + silt 3.5-4.0 gray sand medium-coarse		* Tar Top 2 inches from 2-4
4				4-5 gray sand medium-coarse		
5	24"	0		5-6 Brown sand medium coarse with gravel		
6						

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Mining Mt. Alton	Boring No.: MA-033 Co3	Logged By: J. Rezanowski
Job No.:	Page ____ of ____	
Date Drilled: 5/27/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.: Eichelbergers	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	18"	0			0-0.5 Brown sand fine 0.5-1.0 Brown sand fine-medium 1.0-1.5 gray clay 1.5-2.0 fine sandy gray clay w/ small gravel + silt		
2							
3	22"	0			2-4 Gray sandy clay with silt with gravel throughout		
4							
5	12"	0			gray sand with clay fine-coarse small pieces of gravel		
6							

Depth to Ground Water: ________

Monitoring Well Installed? YES NO

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kimzug Mt. Allen	Boring No.: MA-034 C04	Logged By: J. Pczanowski
Job No.:	Page ____ of ____	
Date Drilled: 5/27/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	20"	0		0-20" Tar 20"-24" gray sandy clay with gravel		* Tar 0-20"
2						
3	10"	0		2-4' gray sandy clay fine with gravel		
4						
5	2"	0		gray sand fine-coarse w/ gravel & clay		
6						
7	20"	0		gray sand fine-coarse w/ gravel & clay 6-8' last inch pieces of sandstone		
8						

Depth to Ground Water: ______ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

Soil Boring Log

WESTON SOLUTIONS

Job Name: Mt Alton Kinzua	Boring No.: MA-033 A-4	Logged By: J Peranoski
Job No.:	Page ____ of ____	
Date Drilled: 5/27/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
					Brown sand w/ clay & gravel 0-1		
1	18"	0			1-2 gray clay		
2					2-4' gray sandy clay w/ small pieces of gravel		
3	24"	0					
4					gray clay 4-6		
5	12"	0					
6					fine sand gray w/ clay		
7	12"	0					
8							

Depth to Ground Water: ____ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ____

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Rinzua Mt Attar	Boring No.: MA-036 #5	Logged By: J Pezanowski
Job No.:	Page ____ of ____	
Date Drilled: 5/27/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	18"	0			Tar 0-0.5 0.5-2.0 Brown sand w/ clay and gravel		*Tar 0-0.5'
2							
3	18"	0			gray sandy clay w/ small gravel 2-4'		
4							
5	16"	0			gray sandy clay w/ gravel 4-6		
6							
7	8"	0			gray sandy clay w/ gravel 6-8		
8							

Depth to Ground Water: ____________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt. Alton	Boring No.: MA-037 I-5	Logged By: J. Pezanowski
Job No.:	Page ____ of ____	

Date Drilled: 5/27/20	Boring Method: ~~Geoprobe~~ Hand
Drilling Co.: Eichelbergers	Boring Depth:
Driller:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	22"	0		0-0.5 Brown, fine sand 0.5-1.5 gray sandy clay (fine) moist		
2				1.5-2 gray clay moist		
3	20"	0		2-3.5 wet gray clay ish silt 3.5-4.0 gray sandy clay w/ gravel		
4						
5	12"	0		gray sand clay wet 4-5.5 5.5-6.0 gray sand with medium-coarse		
6						

Depth to Ground Water: ________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

Soil Boring Log

WESTON SOLUTIONS

Job Name: Kinmunda Mt. Alton	Boring No.: MA-038 H-6	Logged By: J. Pezanowski
Job No.:	Page ____ of ____	
Date Drilled: 5/27/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	18'	0			0-0.5 topsoil 0.5-1.5 Brown/orange sandy clay w/ silt 1.5-2.0 gray clay w/ gravel		
2							
3	18'	0			2-4' gray clay w/ gravel		
4							
5	4"				gray sand with clay and gravel		
6							

Depth to Ground Water: ______ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kimura Mt Alton	Boring No.: MA-039	Logged By: J. Pezonawski	
Job No.:	Page ____ of ____		
Date Drilled: 5/27/20	Boring Method: ~~Geoprobe~~ Hand		
Drilling Co.: Eichelbergers	Boring Depth:		
Driller:			

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	20"	0		0-2" Topsoil 2"–24" Tan/orange Sandy clay		
2						
3	18"	0		gray Sandy Clay w/ small pieces of gravel 2-4'		
4						
5	18"	6		Sand gray medium-coarse w/ some clay 4-5.6'		~~5~~ 5.6 refusal
6						

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Nimzia Mt. Alton	Boring No.: MA-040 H-8	Logged By: J. Pezanowski
Job No.:	Page ___ of ___	

Date Drilled: 5/28/20

Drilling Co.:

Driller:

Boring Method: ~~Geoprobe~~ Hand

Boring Depth:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	22"	0			Fine sandy clay Tan/orange in color 0-2'		
2					↓		
3	24"	0			Fine sandy clay Tan/orange in color 2-3.5		
					3.5-4.0 gray clay w/ small pieces of gravel		
4					gray sand fine-medium w/ gravel 4-6'		
5	18"	0					
6							

Depth to Ground Water: ______

Monitoring Well Installed? YES NO

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kimzua Mt. Alton	Boring No.: MA-041 T-18	Logged By: J. Pezanowski
Job No.:	Page ____ of ____	
Date Drilled: 5/28/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	20'	0		0-1.5 Brown sand fine w/ some clay 1.5-2.0 Tar		*Tar 1.5-2.0
2				2.0-3.0 Tar		
3	16"	0		3.0-4.0 Tan sand medium-fine		
4	6"	0		Tan sand 4-5		
5						Hit refusal

Depth to Ground Water: ____ Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Monitoring Well Installed? YES NO

Monitoring Well ID: ____

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Lintua Mt. Alton	Boring No.: MA-042 I8	Logged By: J. Peranowski
Job No.:	Page _____ of _____	

Date Drilled: 5/28/20

Drilling Co.:

Driller:

Boring Method: ~~Geoprobe~~ Hand

Boring Depth:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	24"	0			0-0.5 Orange Sand w/ clay 0.5-1.5 Tan sandy clay 1.5-2.0 Brown Sand fine		
2							
3	12'	0			Tan/orange sand medium-coarse 2-4		
4							Refusal @ 5.5'
5	16"	0			gray sand w/ clay 4-5.5		
6							

Depth to Ground Water: ______________

Monitoring Well Installed? YES NO

Monitoring Well ID: ______________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Soil Boring Log

...e: Kinzua Mt. Alton	Boring No.: MA-043.18	Logged By: J. Pezanowski
. No.:	Page ___ of ___	
Date Drilled: 5/28/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.: Eichelbergers	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	24"	0		Brown sand fine w/ clay 0-0.5 0.5-1.5 tan fine sandy clay 1.5-2.0 orange sand medium w/gravel		
2				2.0-2.5 orange sand medium w/gravel		
3	24"	0		2.5-3.5 light Brown sand fine w/clay and gravel		
4				3.5-4.0 light brown sandy clay w/ gravel 4-5 wet light brown sandy clay w/gravel		
5	16"	0		5-6 wet gray sand w/gravel & clay		
6				6-7 wet gray sand w/ gravel and clay		
7	12"					hit refusal @ 7'
8						

Depth to Ground Water: ______ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ______

...on Surveyed? YES NO GPS Surveyor Other

WESTON

Soil Boring Log

Job Name: Kinzua Mt Alton	Boring No.: MA-044	Logged By: J. Pezanowski
Job No.:	Page ____ of ____	
Date Drilled: 5/28/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.: Eichelbergers	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	24"	0		0-0.5 Topsoil 0.5-2.0 orange sand fine-medium w/ gravel and clay		
2						
3	24"	0		light brown sand fine-medium w/ clay and gravel 2-4'		
4						
5	20"	0		light brown sand fine-medium w/ clay & gravel (pieces of sandstone throughout)		
6						
7	20"	0		light brown sand fine-medium w/ gravel & clay 6-8' wet @ first 4"		
8						*hit refusal @ 8'

Depth to Ground Water:

Monitoring Well Installed? YES NO

Monitoring Well ID:

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Soil Boring Log

WESTON SOLUTIONS

Job Name: ~~AIA~~ Kinzua Mt. Alton	Boring No.: MA-045 K-9	Logged By: J. Pezanowski
Job No.:	Page ____ of ____	
Date Drilled: 5/28/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.: Eichelbergers	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	24"	0		0-1.5 orange fine sand w/ clay 1.5-2.0' Brown sand fine-medium w/ clay + gravel		
2						
3	24"	0		2-4 Brown sand fine-medium w/ clay + gravel		
4						
5	24"	0		4-6 Brown sand fine-medium w/ clay + gravel		
6						
7	20"	0		6-6.5 Brown sand fine-medium w/ clay + gravel 6.5-8' brown clay w/ gravel		
8						

Depth to Ground Water: ______

Backfill Type: Cuttings / Cuttings/Bentonite / Bentonite / Asphalt/Concrete

Monitoring Well Installed? YES NO

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kirzua Mt. Afton	Boring No.: MA-04 K10	Logged By: J. Perzanowski
Job No.:	Page ____ of ____	

Date Drilled: 5/28/20	Boring Method: Geoprobe
Drilling Co.: Eichelbergers	Boring Depth:
Driller:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	10"	0			0-1 Top Soil		
2					1-2 Brown sand fine w/ clay		
3	24"	0			2-2.5 Brown sand fine w/ clay		
4					2.5-3.0 Tan clay 3.0-4.0 gray fine sand w/ clay		
5	24"	0			4.0-5.0 gray fine sand w/ clay		
6					5.0-6.0 Tan sand fine-medium w/ sandstone		*6" refusal

Depth to Ground Water: ________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID:

Location Surveyed? YES NO GPS Surveyor Other

[redacted]

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt Alton	Boring No.: MA-C417 B11	Logged By: J. Perzanowski
Job No.:	Page ____ of ____	
Date Drilled: 5/28/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1–2	12"	0		0-2 Brown sand medium-Coarse wet from 1-2 Small tar lense @ 1ft		small tar lense ~"2in right @ 1ft
2–4	22"	0		fine brown sand 2-2.5 ft wet / 2.5-4 gray sand fine-medium some gravel + clay		
4–6	18"	0		gray sand fine-coarse w/ gravel 4-5		- Refusal @ 5'

Depth to Ground Water:		Backfill Type:	Cuttings / Cuttings/Bentonite
Monitoring Well Installed?	YES NO		Bentonite / Asphalt/Concrete
Monitoring Well ID:			
Location Surveyed?	YES NO	GPS Surveyor Other	

Soil Boring Log

WESTON SOLUTIONS

Job Name: Kinzua MC. Alton	Boring No.: MA-048	Logged By: J. Peranawski
Job No.:	Page ____ of ____	
Date Drilled: 5/28/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	22"	0		0-0.5' Top soil 0.5-2.0' Tan sandy clay fine grains		
2–3	18"	0		2-3 sand tan fine-medium grain w/ gravel 3-4 gray sand fine-medium grain		*should be switched
4–5	20"	0		Tan sandy clay fine grain 4-5'		4-5' should be 2-3'
6–7	24"	0		gray sand fine-medium w/ gravel		refusal @ 7.5'
8						

Depth to Ground Water: ____

Monitoring Well Installed? YES NO

Monitoring Well ID: ____

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt. Alton	Boring No.: MA-049	Logged By: J. Pezanoski
Job No.:	Page ____ of ____	
Date Drilled: 5/28/20	Boring Method: Geoprobe	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	24"	0			0-2' orange/tan clay fine w/ small gravel & silt		
2							
3	20"	0			Brown sand fine-medium coarse w/ gravel & clay & silt 2-4'		
4							
5	20"	0			gray sandy clay w/ gravel & silt		
6							

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinder Mt. Alton	Boring No.: MA-050	Logged By: J. Pezancwski
Job No.:	Page ____ of ____	

Date Drilled: 5/28/26

Drilling Co.:

Driller:

Boring Method: ~~Geoprobe~~ Hand

Boring Depth:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	18"	0		0-2 Brown fine sand w/ clay & silt		
2				sandy		
3	20"	0		2-3 gray clay fine		
4				3-4 gray sand fine-medium grain w/ gravel		

Depth to Ground Water:

Monitoring Well Installed? YES NO

Monitoring Well ID:

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt Alton	Boring No.: MA-051	Logged By: J. Pezanowski
Job No.:	Page ____ of ____	
Date Drilled: 5/28/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
0–2	14"	6		0-0.5 Topsoil 0.5-2.0 gray sandy clay (fine)		
2–4	14"	0		2-3.0 gray clay. 3.0-4.0 gray sandy clay w/ gravel		

Depth to Ground Water: ______

Monitoring Well Installed? YES NO

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Soil Boring Log

Job Name: Kinzua Mt Alton	Boring No.: MA-052 F1	Logged By: J. Pezanuski
Job No.:	Page ____ of ____	
Date Drilled: 5/29/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.: Eichelbergers	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
				0-0.5 brown fine sand		
1	12"	0		0.5-1.0 medium-coarse light brown sand 1.0-1.5 Tar		
2		0		1.5-2.0 gray sand 2-2.5 Tar top 3" then hits clay bottom 3"		-*hit refusal @ 2.5 stepping back because of tar
3						

Depth to Ground Water: ____________

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Soil Boring Log

WESTON SOLUTIONS

Job Name: Kinzua Mt. Alton	Boring No.: MA-053 C08	Logged By: J. Pezanowski
Job No.:	Page ____ of ____	

Date Drilled: 5/29/20	Boring Method: ~~Geoprobe~~ Hand
Drilling Co.: Eichelbergers	Boring Depth:
Driller:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	12"			0-0.5 Tar 0.5-2.0 Brown sand medium-fine grain		*0-0.5 Tar
2				2-3' Tar		*2-3' Tar
3						*hit refusal @ 3
4						

Depth to Ground Water: ______

Monitoring Well Installed? YES NO

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinnug Mt. Allen	Boring No.: MA-054 Gb	Logged By: J. Pezanowski
Job No.:	Page ____ of ____	
Date Drilled: 5/29/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
0–2	18"	0			0-1 Tar 1-2 Clay gray		#0-1 Tar
2–4	24"	0			2-3 gray fine sandy clay w/ gravel small 3-4 gray clay		
4–6	18"	0			gray sand fine-medium w/ clay 5-6 clay gray		

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

[redacted]

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt. Alton | Boring No.: MA-055 | Logged By: J. Pezanowski

Job No.: | Page ____ of ____

Date Drilled: 5/29/20 | Boring Method: ~~Geoprobe~~ Hand

Drilling Co.: | Boring Depth:

Driller:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1					0-2' Tar		0-2' Tar changes from weather hard to sticky
2							*Refusal @ 2ft
3							Moved the hole and still
4							had refusal @
5							the same depth
6							

Depth to Ground Water: | Backfill Type: Cuttings / Cuttings/Bentonite

Monitoring Well Installed? YES NO | Bentonite / Asphalt/Concrete

Monitoring Well ID:

Location Surveyed? YES NO | GPS Surveyor Other

Soil Boring Log

Job Name: Kinzua Mt. Alton	Boring No.: MA-056	Logged By: J. Pezanowski
Job No.:	Page ____ of ____	

Date Drilled:	Boring Method: Geoprobe
Drilling Co.:	Boring Depth:
Driller:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	3"	0		0-8" Tar		~~#~~ could not get passed 8" completely tar but rod got stuck in the tar moved over prior to this spot and could not get passed a ~~foot~~ 1'
2						

Depth to Ground Water: ________ Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Monitoring Well Installed? YES NO

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt. Alton	Boring No.: MA-57	Logged By: J. Przinkowski
Job No.:	Page ____ of ____	
Date Drilled: 6/1/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
					0-1' Tar		*Tar 0-1'
1	6"	0			1-2 gray sand w/ gravel + clay		
2					2-4' gray sand fine-coarse w/ gravel		
3	12"						
4					4-6' gray sand fine-coarse pieces of sandstone		
5	12"						
6					Brown (light) sand fine-medium w/ clay		
7							* hit refusal @ 7

Depth to Ground Water: ____________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Soil Boring Log

WESTON SOLUTIONS

Job Name: Kinzua Mt. Alton	Boring No.: MA-058	Logged By: J. Pezarcwski
Job No.:	Page ____ of ____	

Date Drilled: 6/1/20
Drilling Co.:
Driller:

Boring Method: ~~Geoprobe~~ Hand
Boring Depth:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	14"	0			First 1" Tar, Brown fine sand w/ clay 1"–1.5		*Tar @ 1"
					1.5–2.0 Brown sand fine		
2	18"	0			2–3.0 fine gray sand (moist)		
3					3.0–4.0 fine gray sand (wet)		
4					4–6 wet gray sand fine–coarse grain w/ gravel		
5							
6							
7							*hit refusal @ 7.5'

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt Alton | Boring No.: MA-059 | Logged By: J. Peranowski
Job No.: | Page ___ of ___

Date Drilled: 6/1/20 | Boring Method: ~~Geoprobe~~ Hand
Drilling Co.: | Boring Depth:
Driller:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
				0-2': Brown fine sand w/ clay		
				0-0.5 medium gray sand (saturated)		
1	14"	0		0.5-1' light brown sand fine-medium moist)		
				1.0-1.5 Dark gray sand w/ gravel (moist)		
2				1.5-2.0 fine gray sand (saturated)		
3		0				
4				4-5 gray clay w/ small gravel		
5	16"	0		5-6 fine gray sand saturated w/ small gravel		
6				6-7 medium brown sand w/ small gravel		
7						*hit refusal @ 7'
8						

Depth to Ground Water: ________
Monitoring Well Installed? YES NO
Monitoring Well ID: ________
Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Soil Boring Log

Job Name: Einzua	Boring No.: MA 060	Logged By: Chuck Rapone
Job No.: Mount Alto	Page ____ of ____	
Date Drilled: 6/1/2020	Boring Method: Geoprobe	MA.060
Drilling Co.: [illegible]		
Driller:	Completion Depth 8 ft	Gnd C2

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	8"	0.0			0-2" organic dark 2"-8" silty clay		no tar observed
	8"	0.0			fine sandy clay		no tar
	8"	0.0			coarse sandy clay		no tar Refusal at 7 ft

Depth to Ground Water: ______

Monitoring Well Installed? YES NO

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON

Soil Boring Log

Job Name: Rizzo	Boring No.:	Logged By: Chuck Rapan
Job No.:	Page ____ of ____	
Date Drilled: 6/1/2020 Drilling Co.: Eastly Driller:	Boring Method: Geoprobe MA 061 C3 Completion Depth 7	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
	6"			Tar gravel mix dark w/ orange		Tar observed odor
	6"			Sandy cly orange to brown		Tar observed
	~~18~~			~~Sandy~~ Clay n sand gravel fine to coarse		
	2ft					No Tar

Depth to Ground Water: ________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt Alton | Boring No.: MA-062 | Logged By: J. Przemyski
Job No.: | Page ____ of ____

Date Drilled: 6/1/20 | Boring Method: Geoprobe
Drilling Co.: | Boring Depth:
Driller:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1				No recovery		
2				~~2-3.5 tar~~ 2-3.5' Tar		2-3.5 Tar
3		0		~~3-4~~ 3.5-4 Brown fine sand w/silt		
4				4-5 Tar		4-5 Tar
5				5-6 gray clay		
6				6-7.2 gray clay		
7						Hit Refusal @ 7.2'

Depth ... nd Water: | Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

...nstalled? YES NO

YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Mt. Alton Kinzua
Boring No.: MA-003
Logged By: J. Pezanoski
Job No.:
Page ____ of ____
Date Drilled: 6/1/20
Boring Method: Geoprobe
Drilling Co.:
Boring Depth:
Driller:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	12"	0			vegetation 0-0.5 Top Soil 0.5-1.0 Brown fine sand w/ clay 1.0-2.0 Tar		*1.0-2.0 Tar
2							
3	6"	0			First 2" Tar 2"-4 Wood		
4							
5	12"	0			Brown fine sand w/ clay, wet		
6							

Depth to Ground Water: ____
Backfill Type: Cuttings Cuttings/Bentonite
Monitoring Well Installed? YES NO
Bentonite Asphalt/Concrete
Monitoring Well ID: ____
Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Mt Alton Kinzua	Boring No.: MA-064	Logged By: E Armstead
Job No.:	Page ____ of ____	
Date Drilled: 6/1/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.: Eichelbergers	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
				topsoil ~~Hav~~ 0"		~~Hav~~ 0-1'
1	12"	0		brown dry sand/clay		
2						
3	12"	0				
4						
5	24"					
6						
7	8"			wet brown sand/clay		
				↓		end of boring 8'
8						

Depth to Ground Water: ____________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID:

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Em2on	Boring No.: MA 065	Logged By: Chuck Rapane
Job No.: Mt Alta	Page ____ of ____	

Date Drilled: 6/1/2020

Drilling Co.: Enviroserv

Driller:

Boring Method: Geoprobe

Completion Depth ____________

MA 065

grid 03

0

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	12"				Coarse sand mix gravel dark brown to orange		No Tar
	14"				dark sandy silty clay dark black to grey		No tar / slight Tar odor
	16"				Coarse sandy silt brown to grey		No Tar
	12"				Sand Coarse		no tar Refusal @ 7 ft

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Rinzon	Boring No.: MA 064	Logged By: Chuck Rapp
Job No.: Mt Airy	Page _____ of _____	

Date Drilled: 6/1/20
Drilling Co.: Bruderson
Driller:

Boring Method: Geoprobe

Completion Depth ___________

MA 066 gnd E3

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
	12"			0-2 organic 2-12 Sand fine to coarse		No tar
	24"			coarse sand light brown to grey		Very slight tar odor No Tar observed
	24"			Coarse sand black to grey		No Tar observed

Depth to Ground Water: ___________

Monitoring Well Installed? YES NO

Monitoring Well ID: ___________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kazoo	Boring No.: MA 007	Logged By: Chuck Rapp
Job No.: Mt Alta	Page ___ of ___	
Date Drilled: 6/1/20	Boring Method: Geoprobe	
Drilling Co.: Eichelberger		
Driller:	Completion Depth 6 ft	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	6"				Silty Sand gray to brown		No Tar
	6"				~~Sand~~ clayey Sand dark black to grey		No Tar
	6"				clayey Sand		No Tar

Depth to Ground Water: ______

Monitoring Well Installed? YES NO

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua	Boring No.: MA 068	Logged By: Chuck Rapone
Job No.: Mt Alta	Page ___ of ___	
Date Drilled: 6/1/2020	Boring Method: Geoprobe	
Drilling Co.:		
Driller:	Completion Depth ___	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
	12"			0-2 organic 2-12 sandy Clay orange to gray		No Tag
	24"			Sandy course grey to black		No Tag
	14"			Sa Clayey Sand		No Tag
	18"			sand		No Tag

Depth to Ground Water: ___

Backfill Type: Cuttings / Cuttings/Bentonite / Bentonite / Asphalt/Concrete

Monitoring Well Installed? YES NO

Monitoring Well ID: ___

Location Surveyed? YES NO GPS Surveyor Other

WESTON

Soil Boring Log

Job Name: Kinzua	Boring No.: MA 069	Logged By: [illegible signature]
Job No.: Mt Alta	Page ____ of ____	

Date Drilled: 6/1/2020

Drilling Co.: Eichelberger

Driller:

Boring Method: Geoprobe

Completion Depth ________

soil DS 069

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
0	8"			0-6" silty sand w/ slag grey to orange		NO Tar odor
2	10"			woody dark grey to black		No Tar odor
	12"			woody debris decomposed black to sandy silt		no odor
				silty sand grey to brown		No Tar
5						

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kazwa	Boring No.: MA 070	Logged By: Chuck Roper
Job No.: Mt Atta	Page ____ of ____	
Date Drilled: 6/1/2020	Boring Method: Geoprobe	
Drilling Co.: E. cam Serys	MA070	DS no Tar
Driller:	Completion Depth ____	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	18"	0.0			0-2" wood/ w/soil dark gray to black		No Tar observed
	6"	0.0			silty Clay		No Tar

Depth to Ground Water: ____________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua	Boring No.: MA ~~070~~ 071		Logged By: Chris Ryan
Job No.: MtAlto	Page ____ of ____		
Date Drilled: 6/1/2020	Boring Method: Geoprobe		
Drilling Co.: Eichelberger		MAØ71	
Driller:	Completion Depth ________		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
0	18"			Tar w/in the entire sleeve		Tar / black / odor strong
2						
	10"			Sand cly orange to brown		
5						Refusal @ 3.5'

Depth to Ground Water: ________

Monitoring Well Installed? YES NO

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Rizzuto	Boring No.: MA072	Logged By: Chuck Rapone
Job No.: Mt Alta	Page ____ of ____	
Date Drilled: 6/1/2020 Drilling Co.: Envirotech Driller:	Boring Method: Geoprobe Completion Depth ________	MAØ72

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	12"	0.0			0-2" sandy clay ~~some~~ grey to brown ~~san~~		Slight tar present w/odor
	18"	0.0			Sandy Clay dark orange to grey		No tar observed

Depth to Ground Water: ________

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Monitoring Well Installed? YES NO

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinza

Job No.: Mt Alts

Boring No.: MA073

Page ____ of ____

Logged By: Chuck Ragan

Date Drilled: 6/1/202

Drilling Co.: Eichenberger

Driller:

Boring Method: Geoprobe

MA073

Completion Depth ________

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
	0			No Recovery		
	24"			0-12 gravelly w/ coarse sand black to grey		No Tar observed
				12-24 silty clay w/ fine sand		no tar
	18"			silty clay, sand grey to brown		no tar
	3"			Coarse sand brown		no tar

Depth to Ground Water: ________

Monitoring Well Installed? YES NO

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Soil Boring Log

WESTON SOLUTIONS

Job Name: Kinzua Mt. Alton	Boring No.: MA-074	Logged By: J. Pezanowski
Job No.:	Page ____ of ____	
Date Drilled: 6/2/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	8"	0		Brown sand w/ clay and small gravel		
2						
3	12"	0		gray sand w/ orange fine-medium clay & silt		
4						
5	14"	0		gray fine sand some clay saturated		
6						
7	6"	0		gray clay 6–6.5 6.5 to 6.8 sandstone		*Hit refusal @ 6.8'
8						

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: K.2 Zo?
Job No.: M1 Alta
Boring No.: MA 075
Page ____ of ____
Logged By: Chuck Rapp

Date Drilled: 6/1/2020
Drilling Co.: Fr LaSargen
Driller:
Boring Method: Geoprobe
Completion Depth ________
MA075

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
	20"	0.0		Clayey Silt dark brown to grey		No Tar
	24"	0.0		Sand / Clayey Silty ~~clay~~ grey to brown		No Tar
	20"	0.0		coarse sand grey		no tar

Depth to Ground Water: ________
Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete
Monitoring Well Installed? YES NO
Monitoring Well ID: ________
Location Surveyed? YES NO GPS Surveyor Other

Soil Boring Log

WESTON SOLUTIONS

Job Name: MA Kinzua	Boring No.: MA-076	Logged By: J. Poranawski
Job No.:	Page ____ of ____	
Date Drilled: 6/2/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.: Eichelbergers	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1				fine sandy clay gray / orange in color		
2						
3				Tan sand w/ gravel Clay & silt (wet		
4						
5				Tan sand w/ gravel clay & silt (wet)		
6						
7				Orange-Tan sand medium grain 6-6.6' → then Sandstone		* Refusal @ 6.9'
8						

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Soil Boring Log

WESTON SOLUTIONS

Job Name: Kinzua Mt. Alton	Boring No.: MA-077	Logged By: J. Pezanawski
Job No.:	Page ____ of ____	
Date Drilled: 6/2/20	Boring Method: ~~Geoprobe~~ Hand	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	24"	0			Tar 0-6" Brown fine sand with clay 0.5-2.0 (SP)		*Tar 0-6"
2							
3	16"	0			gray ~~clay~~ sand fine-medium w/ small gravel		
4							
5	12"	0			4-5 gray sand fine-medium w/ small gravel		-Hit refusal @ 5'
6							

Depth to Ground Water:

Monitoring Well Installed? YES NO

Monitoring Well ID:

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kunzua	Boring No.: MAØ78	Logged By: Chuck Rapone
Job No.: Mt. Alta	Page ____ of ____	
Date Drilled: 6/2/2020	Boring Method: Geoprobe	
Drilling Co.: Eichelberger		
Driller:	Completion Depth ________	MAØ78 (Grid J12) NO TAR

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
0	12"			Clayey Sand wet Coarse Brown to grey No Tar observable		Two attempts @ refusal w/i 8" due to rock Third attempt moved location closer to Stream
2	24"			Sandy clay moist med fine to coarse brown to grey		No Tar observed
4	18"			Sandy clay med fine to coarse moist		No Tar observe
				Coarse sand brown Refusal @ 6.5 ft wet		refusal at 6.5 ft

Depth to Ground Water: ________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua	Boring No.:	Logged By: Chuck Lupon[?]
Job No.: Mt Alto	Page ___ of ___	

Date Drilled: 6/2/2020

Drilling Co.: Eichelbergers[?]

Driller:

Boring Method: Geoprobe

Completion Depth ___________

MA079 grid ~~MT2~~ L15

No Tar

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
0	24"	0.0			Sandy Clay orange to grey med coarse sand (moist)		No Tar
2	24"				Sandy clay moist dark brown		No Tar
					Sandy clay brown to grey wet		
4	18"				dark grey Clay w/ Sand wet		No Tar
6	24"						No Tar
8							

Depth to Ground Water: ___________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ___________

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Lintz	Boring No.: MA080	Logged By: Chuck Ryan
Job No.: Mt Alta	Page ____ of ____	
Date Drilled: 6/2/2020 Drilling Co.: Entact Driller:	Boring Method: Geoprobe Completion Depth ____	MA 080

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
	12"	0.0		Sandy Clay w/ woody material		Strong odor Tar @ 18" bgs
2	12"	0.0		Sandy clay black Tar		Tar observed throughout core sleeve
1						

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Soil Boring Log

Job Name: Kinzua	Boring No.: MAØ81	Logged By: Chris Rogers
Job No.: Mt Alta	Page ____ of ____	
Date Drilled: 6/2/2020	Boring Method: Geoprobe	
Drilling Co.: Enviro Sciences		
Driller:	Completion Depth ______	MAØ81 Tar observed

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	18"	0.0			Sandy clay brown to black		Tar @ 16" bgs
	18"	0.0			Sand coarse black		Tar throughout sleeve

Depth to Ground Water: ______

Monitoring Well Installed? YES NO

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Soil Boring Log

WESTON SOLUTIONS

Job Name: Kinzua	Boring No.:	Logged By: Chuck Roper
Job No.: Mt Alta	Page ____ of ____	
Date Drilled: 6/2/2020	Boring Method: Geoprobe	MAØ82
Drilling Co.: B[illegible]		
Driller:	Completion Depth ________	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	18"	00			Sandy clay [illegible] brown to grey		odor Tar odor upper 2 No tar observed
	14"				Clayey sand wet brown to dark grey		No Tar no odor
	24"				Sandy clay grey		No Tar no odor

Depth to Ground Water: ________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua	Boring No.: MA083	Logged By: Chuck Rapan
Job No.: Mt Alto	Page ____ of ____	
Date Drilled: 6/2/2020 Drilling Co.: Bischel Berger Driller:	Boring Method: Geoprobe Completion Depth ____	MA083 cross stream NO Tar

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	12"	0.6 ↓			Sandy silt moist to wet dark brown to black		NO Tar observed
	12" 24"				Sandy silt grey to dark grey wet		
	24"				sandy clay black to brown		NO Tar

Depth to Ground Water: ____ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ____

Location Surveyed? YES NO GPS Surveyor Other

Soil Boring Log

WESTON

Job Name: Kinzua	Boring No.: MAφ84	Logged By: Chuck Rapone
Job No.: Mt Alta	Page ____ of ____	

Date Drilled: 6/02/2020
Drilling Co.: Bichel Sayn
Driller:

Boring Method: Geoprobe
Completion Depth ______

cross Street
MAφ84

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	6				sandy silt brown wet		no tar slight odor
	14				Sandy silt wet brown to black		Tar observed ~4 ft bgs
	12				sand coarse sand grey		Tar 6 ft bgs

Depth to Ground Water: ______
Monitoring Well Installed? YES NO
Monitoring Well ID: ______
Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Soil Boring Log

WESTON SOLUTIONS

Job Name: Kimzey Mt Alton	Boring No.: MA-085	Logged By: J. Pezankowski
Job No.:	Page _____ of _____	

Date Drilled: 6/2/20
Drilling Co.:
Driller:

Boring Method: Geoprobe
Boring Depth:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	12"	0		0-1' gray fine sand w/ clay + silt		
2				1-2 Tanish brown fine sand w/ clay + silt		
3	16"	0		2-4 fine medium sand w/ clay & silt + gravel		
4				↓		
5	16"	0		4-5 coarse-fine sand		*hit refusal @ 5'
6						

Depth to Ground Water: ______________
Monitoring Well Installed? YES NO
Monitoring Well ID: ______________
Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Soil Boring Log

WESTON SOLUTIONS

Job Name: Kinzua Mt. Alton	Boring No.: MA-086	Logged By: J. Brzanowski
Job No.:	Page ____ of ____	
Date Drilled: 6/2/20	Boring Method: Geoprobe	
Drilling Co.:	Boring Depth:	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
				0-1" Burned material Not Tar		
1	3"			Brown fine sand (organics)		
2				gray fine sand w/ clay and silt, 2-4'		
3	20"					
4				light brown/gray clay 4-5		
5				5-6 Brown sand medium-coarse		
6				6-6.6 gray sand fine-coarse grain		*hit refusal @ 6.6'
7						

Depth to Ground Water: ____________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Soil Boring Log

WESTON SOLUTIONS

Job Name: Kimzua Mt. Alton	Boring No.: MA-087	Logged By: J. Pezanuski
Job No.:	Page ____ of ____	

Date Drilled: 6/2/20
Drilling Co.:
Driller:

Boring Method: Geoprobe
Boring Depth:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1–2	12"	0		0-2 Mixture of Tar and brick		#Tar 0-1
2–4	14"	0		Tar 2-3.5 3.5-4.0 gray medium-coarse sand		#Tar 2-3.5
4–6	18"	0		4-5 Brown medium Sand 5-6 fine sand w/ clay & silt Brown		

Depth to Ground Water:
Monitoring Well Installed? YES NO
Monitoring Well ID:
Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua	Boring No.: MAØ88	Logged By: Chuck Rapone
Job No.: Mt Alta	Page ____ of ____	
Date Drilled: 6/2/2020 Drilling Co.: Bichel Surge Driller:	Boring Method: Geoprobe Completion Depth ________	MAØ88 No tar observed

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	12"				sand med fine tan to brown dry to moist		no tar
	8"				fine sand some gravel dark brown to black wet		no tar observed
	18"				fine sand tan to brown wet		no tar no odor

Depth to Ground Water: ______________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ______________

Location Surveyed? YES NO GPS Surveyor Other

Soil Boring Log

WESTON SOLUTIONS

Job Name: Kinzua	Boring No.: MAØ89	Logged By: Chuck Rogoon
Job No.: not alt	Page ____ of ____	
Date Drilled: 6/2/2020	Boring Method: Geoprobe	MAØ89
Drilling Co.:		
Driller:	Completion Depth ________	no tar

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	" 12				Sand Coarse tan to grd		no tar
2	" 18				Sand coarse dark grey to tan		no tar
	" 18				Sand coarse		refusal

Depth to Ground Water: ________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt. Alton	Boring No.: MA-C9U	Logged By: J. Pezanowski
Job No.:	Page ____ of ____	

Date Drilled: 6/2/20	Boring Method: ~~Geoprobe~~ Hand
Drilling Co.:	Boring Depth:
Driller:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	12"	0		0-2 Orange fine sand w/ clay & silt		
2						
3	12"	0		2-4 Tar		
4						
5	14"	0		4-5 Tar		
6				5-6 gray sand medium grain & silt		

Depth to Ground Water: ________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua	Boring No.: MAØ91	Logged By: Chuck Rapson
Job No.: Mt Alta	Page ____ of ____	
Date Drilled: 6/2/2020 Drilling Co.: Eichelberger Driller:	Boring Method: Geoprobe Completion Depth ________	MAØ91

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	2"				moss some clay soil Brown		no tar
	10"				Clay brown to grey		slight tar odor but no tar observed
					Sand grey coarse		
					refusal at five (5) ft		Refusal 5" ft

Depth to Ground Water: ________

Monitoring Well Installed? YES NO

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Rin 2Ua	Boring No.: MAφ92	Logged By: Chuck Rapan
Job No.: M+ Alta	Page ____ of ____	
Date Drilled: 6/2/2020 Drilling Co.: Richelieu Driller:	Boring Method: Geoprobe Completion Depth ______	MAφ92 No tar grid B6

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	4"	0.0			Sandy Clay brown to black Coarse Sand wet		No tar
	8"				Sandy clay Coarse wet black		No tar
	8"				Sandy Clay brown to black wet		No tar

Depth to Ground Water:	______	Backfill Type:	Cuttings / Cuttings/Bentonite
Monitoring Well Installed?	YES NO		Bentonite / Asphalt/Concrete
Monitoring Well ID:	______		
Location Surveyed?	YES NO	GPS Surveyor Other	

WESTON SOLUTIONS

Soil Boring Log

Job Name: Rinzua	Boring No.: MAØ93	Logged By: Chuck Rapone
Job No.: Mt. Alto	Page ____ of ____	
Date Drilled: 6/2/2020 Drilling Co.: Eichelberger Driller:	Boring Method: Geoprobe Completion Depth ____	MAØ93

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	14"	0.0			~~Clay~~ ~~stone~~ Sand/gravel mix Brown wet some clay		No tar
	14"				dark brown to grey sand ~~Clay~~ Coarse some clay		no tar
	14"				Sand some clay brown ~~SE~~ mix fine to very coarse wet		no tar
							Moist at 5.5 ft
					Refusal		

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt. Alton	Boring No.: MA-C94	Logged By: J. Pezanowski
Job No.:	Page ____ of ____	

Date Drilled: 6/2/20

Drilling Co.:

Driller:

Boring Method: Geoprobe

Boring Depth:

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1–2	0"	0			No Recovery		
2–4	4"	0			orange sand fine w/ silt		
4–6	6"	0			4-6 Tar		* 4-6 Tar
6–8	6"	0			6-7 Tar 7-8 gray sand		* 6-7 Tar

Depth to Ground Water: ____________

Monitoring Well Installed? YES NO

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua Mt Alton	Boring No.: MA-095	Logged By: J. Pezanawski
Job No.:	Page ____ of ____	

Date Drilled: 6/2/20	Boring Method: ~~Geoprobe~~ Hand
Drilling Co.:	Boring Depth:
Driller:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	4"				vegetation orange sand medium-coarse		
2							
3	12"				2-3 Brown fine sand w/ silt & clay 3-4 Brown sand fine-coarse w/ gravel		
4					4-6 gray sand (medium)		
5	12"						
6							*6 ft refusal

Depth to Ground Water: ______

Monitoring Well Installed? YES NO

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Virmya Mt. Alton	Boring No.: MA-C46	Logged By: J. Pezanawski
Job No.:	Page ____ of ____	

Date Drilled: 6/2/20	Boring Method: ~~Geoprobe~~ Hand
Drilling Co.:	Boring Depth:
Driller:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
1	12"				0-0.5 fine brown sand w/ clay + silt		
					0.5-2.0 fine gray sand w/ clay		
2					2-3' fine gray sand w/ clay + silt (wet)		
3	12"				3-4' fine-medium sand w/ silt (wet)		
4					4-5' fine-medium sand w/ silt wet		
5	12"						*Refusal @ 5'
6							

Depth to Ground Water: ________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ________

Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kimua Mt Alton	Boring No.: MA097	Logged By: J Pezanowski
Job No.:	Page _____ of _____	
Date Drilled: 6/2/20 Drilling Co.: Driller:	Boring Method: ~~Geoprobe~~ Hand Boring Depth:	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
1	12"	0		0-0.5 fine brown sand 0.5-1.0 Burn material Black char gray/brown sand w/ clay + Silt		
2	16"	0		2-3.5 Brown sand fine w/ clay		
3				3.5-4.0 gray clay		
4		0		4-5 sand orange w/ pieces of sandstone		
5						Refusal @ 5'
6						

Depth to Ground Water: ____________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: [illegible]	Boring No.: MA-Ø98	Logged By: Chuck Rogers
Job No.: M + Attc	Page ____ of ____	
Date Drilled: 6/2/20	Boring Method: Geoprobe	MAØ98 No Tar
Drilling Co.: Fichel [illegible]		
Driller:	Completion Depth ________	

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
	18			Sand fine grain to med dark brown to grey		Total depth 6 ft No Tar
2						
	18			Sand med grain brown some clay		No Tar
4						
	20			clay @ 5.3 ft		No Tar
6						

Depth to Ground Water: ________

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

Monitoring Well Installed? YES NO

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

Soil Boring Log

WESTON SOLUTIONS

Job Name: Kinzua	Boring No.:	Logged By: Chuck Ropa
Job No.: Mt Alts	Page ____ of ____	
Date Drilled: 6/2/20 Drilling Co.: Eichelberger Driller:	Boring Method: Geoprobe Completion Depth ______	MAØ99

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	12"	0.0			Sandy silt, organic brown to tan		no tar
	12"				Sand silty clay brown to grey wet		no tar
	14"				Sandy clay brown to grey wet		no tar

Depth to Ground Water: ______ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ______

Location Surveyed? YES NO GPS Surveyor Other

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua	Boring No.:	Logged By: Chuck Rupp
Job No.: Mt Alton	Page ___ of ___	

Date Drilled: 6/02/2020
Drilling Co.: Eichelberger
Driller:

Boring Method: Geoprobe
Boring Depth:

MA100

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
	8"				0-8" Sand some Silt Brown to tan		No Tar, no odor
2	20"				Silty Sand some clay Sand med to fine grain		No Tar
4							

Depth to Ground Water: ______
Monitoring Well Installed? YES NO
Monitoring Well ID: ______
Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

WESTON SOLUTIONS

Soil Boring Log

Job Name: Kinzua	Boring No.: MA101	Logged By: Ryan
Job No.: Mt Alton	Page ___ of ___	
Date Drilled: 6/2/2020	Boring Method: Geoprobe	
Drilling Co.: Eichelberger	Boring Depth: MA101	
Driller:		

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
	18"			Sandy silt brown to grey		No Tm
2						
	24"			fine grain Sandy silt - gray to brown		No Tm
4						

WESTON SOLUTIONS

SPLIT SPOON Soil Boring Log

Job Name: Kinzua ME Alton	Boring No.: MA-005-GT	Logged By: J. Rezanowski
Job No.:	Page ____ of ____	

Date Drilled: 5/18/20
Drilling Co.: Eichelbergers
Driller:

Boring Method: Mud Rotary Air Rotary ODEX Hollow-stem Auger
Sample Method ________ Spoon Diameter: 2" 3" other____
Completion Depth: Bedrock Boring Depth ________

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
0–2	1"	0		1" tar		* 0-2 only 1" of recovery tar present
2–4	0					* No recovery 2-4
4–6	1.5ft	0		4.5-5.0 medium → coarse gray sand gray saturated with gravel angular / 5.0-5.5 grayish orange medium grain gravel angular moist 5.5-6.0 weathered sandstone light gray		
6–8	1.5	0		6.0-6.75 saturated gray sand with medium → coarse grains / 6.75-7.50' fine to coarse sand gray with orange lenses a pieces of sandstone 7.50-8.0' medium-coarse sand with Tar		
8–10	1.0	0		8.0-9.5 gray clay moist / 9.5-10 medium sand gray/orange in color rocks last 2" moist		
10–11	1.0	8		10-10.5 medium coarse gray sand moist / 10.5-11 fine coarse sand w/ sandstone orange		gray clay present saturated 50 Blows ~~Refusal~~ Bedrock @ 11' JR

Depth to Ground Water: ________
Monitoring Well Installed? YES NO
Monitoring Well ID: ________
Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

EICHELBERGERS, INC.
Geotechnical Boring Log

Project KINZUA CREEK WATERSHED TAR SITES Project No. DK20050 Page 1 of 1

Boring No. 5-GT Date Started 5/18/2020 Date Completed 5/18/2020

Driller CHRONISTER Logged By WATTS

Client WESTON SOLUTIONS Field Rep. JANA PEZANOWSKI

From	To	Soil Description	Sample No.	From	To	1st Interval	2nd Interval	3rd Interval	4th Interval	Rec.
0.0'	2.0'	SEE JANA LOG	1			WH	WH	WH	2	.3'
2.0'	4.0'	↓	2			WH	WH	WH	1	.1'
4.0'	6.0'		3			8	12	20	17	1.1'
6.0'	8.0'		4			16	19	14	14	1.2'
8.0	10.0		5			3	4	8	15	1.0'
10.0	11.1'		6			28	41	50/1	–	1.0'
	EOB									

Drill Rig GEO PROBE 7822 DT

Weather CLOUDY 69°

Auger Size 3½" RODS

Water Encountered .5'

Hammer Auto X Manual ______

Cave-In Depth N/A

WESTON SOLUTIONS

SPLIT SPOON Soil Boring Log

Job Name: Kinzua Mt. Allen	Boring No.: MA-C08-[illegible]T	Logged By: Jana Pezarcwski
Job No.:	Page ____ of ____	

Date Drilled: 5/19/20

Drilling Co.: Eichelbergers

Driller:

Boring Method: Mud Rotary Air Rotary ODEX Hollow-stem Auger

Sample Method ______ Spoon Diameter: 2" 3" other____

Completion Depth Bedrock

Boring Depth ________

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"	Visual Description	Sample No.	Comments
0–2	1.5	0		0-0.5' light brown clayey sand fine grains 0.5-2.0 light brown/orange moist fine grain sand with clay moist		*small specs of "charcoal" looking tar pieces
2–4	1.0	0		tan/orange fine grain sand with subangular gravel moist (2-4)		
4–6	2.0'	0		gray sandy clay with subangular gravel moist 4'-6'		*small specs of charcoal looking tar pieces
6–8	2.0'	0		6-6.5 gray clay moist 6.5-7.5 tanish/gray sandy clay with subangular gravel moist 7.5-8.0 sand stone mixed with medium grain sand tan/orange can see quartz some clay present		
8–10	2.0'	0		light gray/brown fine-coarse sand with clay can see quartz pieces of sandstone/conglomerate throughout moist, orangish color also 8-10'		
10–12	1.0'	0		10-11.5 medium-coarse sand tan in color with pieces of sandstone throughout 11.5-12.0 sandy clay gray in color fine-medium coarse		*sample is saturated in clay layer small lense ~2" of charcoal
12–14	1.0'	0		12-13.8 fine-coarse sand with clay tan/gray in color pieces of sandstone throughout		Bedrock ~~refusal~~ 13.8' JP

Depth to Ground Water: ________

Monitoring Well Installed? YES NO

Monitoring Well ID: ________

Location Surveyed? YES NO GPS Surveyor Other

Backfill Type: Cuttings Cuttings/Bentonite Bentonite Asphalt/Concrete

EICHELBERGERS, INC.
Geotechnical Boring Log

Project KINZUA CREEK WATERSHED TAR SITES Project No. DK20050 Page 1 of 1

Boring No. 08-GT Date Started 5/19/2020 Date Completed 5/19/2020

Driller CHRONISTER Logged By CHRONISTER

Client WESTON SOLUTIONS Field Rep. JANA PEZANOWSKI

From	To	Soil Description	Sample No.	From	To	1st Interval	2nd Interval	3rd Interval	4th Interval	Rec.
0.0'	2.0'	SEE JANA LOG	1			WH	2	5	5	1.1'
2.0'	4.0'		2			5	5	9	7	1.2'
4.0'	6.0'		3			2	3	3	4	1.4'
6.0'	8.0'		4			5	10	10	14	1.7'
8.0'	10.0'		5			10	17	24	22	1.9'
10.0'	12.0'		6			14	18	12	12	1.1'
12.0'	13.9'		7			13	23	49	50/3	1.2'
	EOB									

Drill Rig GEO PROBE 7822 DT Weather SUNNY 76°

Auger Size 3 1/2" RODS Water Encountered 7

Hammer Auto X Manual ______ Cave-In Depth N/A

SPLIT SPOON Soil Boring Log

WESTON SOLUTIONS

Job Name: Kinzua Mt. Alton	Boring No.: MA-009-ST	Logged By: Jana Pezanowski
Job No.:	Page ____ of ____	

Date Drilled: 5/19/20	Boring Method	Mud Rotary Air Rotary ODEX Hollow-stem Auger
Drilling Co.: Eichelbergers	Sample Method ____	Spoon Diameter: 2" 3" other____
Driller:	Completion Depth Bedrock	Boring Depth ________

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
0–2	15"	0			0-1.5 gray clay moist 1.5-2 sand ~~w/~~ clay ~~gravel~~ Brown/orange with gravel ~~Black~~ charcoal moist		
2–4	15"	0			~~Sand~~ Sand w/ clay Brown/orange with gravel (subangular) 2-4' moist		
4–6	24"	0			4.0-4.5 medium - coarse sand with large gravel subangular [illegible] moist 4.5-6.0 gray clay w/ small pieces of gravel moist		
6–8	20"	0			6-8 gray clay w/small gravel 6-6.5 saturated remaining moist		
8–10	20"	0			8-10 gray clay w/ small gravel moist ↓		
10–12	18"	0			10-10.5 gray clay w/small gravel moist 10.5-12 Brown sand fine-coarse grain fractured rock pieces throughout		
12–14	18"	0			12-13.0 sand with clay gray/brown in color fine to coarse grain with rock fragments throughout 13.0-13.7 Broken up rock (Sandstone)		Bedrock ~~Refusal~~ 13.7'

Depth to Ground Water:		Backfill Type:	Cuttings Cuttings/Bentonite
Monitoring Well Installed?	YES NO		Bentonite Asphalt/Concrete
Monitoring Well ID:			
Location Surveyed?	YES NO	GPS Surveyor Other	

EICHELBERGERS, INC.
Geotechnical Boring Log

Project KINZUA CREEK WATERSHED TAR SITES Project No. DK20050 Page 1 of 1

Boring No. 09-GT Date Started 5/19/2020 Date Completed 5/19/2020

Driller CHRONISTER Logged By CHRONISTER

Client WESTON SOLUTIONS Field Rep. JANA PEZANOWSKI

From	To	Soil Description	Sample No.	From	To	1st Interval	2nd Interval	3rd Interval	4th Interval	Rec.
0.0'	2.0'	SEE JANA LOG	1			WH	2	5	8	1.8'
2.0'	4.0'		2			9	10	8	8	1.3'
4.0'	6.0'		3			9	5	3	5	1.7'
6.0'	8.0'		4			4	5	5	7	1.8'
8.0'	10.0'		5			4	6	9	10	2.0'
10.0	12.0'		6			10	24	27	40	1.5'
12.0'	13.7		7			30	37	40	50/2	1.7
	EOB									

Drill Rig GEO PROBE 7822 DT

Auger Size 3½" RODS

Hammer Auto X Manual ______

Weather SUNNY 76°

Water Encountered 7

Cave-In Depth N/A

WESTON SOLUTIONS

SPLIT SPOON Soil Boring Log

Job Name: Kinzua Mt. Alton	Boring No.: MA-016 (6)T	Logged By: Jana Pezanoski
Job No.:	Page ____ of ____	

Date Drilled: 5/20/20	Boring Method	Mud Rotary Air Rotary ODEX Hollow-stem Auger
Drilling Co.: Eichelbergers	Sample Method ________	Spoon Diameter: 2" 3" other____
Driller:	Completion Depth ________	Boring Depth ________

Depth (Feet)	Recovery	PID every 6"	Blow Counts for each 6"		Visual Description	Sample No.	Comments
0–2	16"	0			0-4" clay gray 4"-2' Brown/orange sand fine grain with small gravel some clay subangular charcoal pieces throughout		
2–4	22"	0			0-3" clay gray 3"-4' Brown/orange fine grain sand with clay small subangular gravel throughout		
4–6	14"	0			0-4" tan medium grain sand with sandstone can identify quartz 4"-6 gray clay with small pieces of gravel moist		
6–8	12"	0			~~6-6.5~~ 0-7' orange/tan sand medium-coarse pieces of sandstone throughout 7-8' gray clay with small pieces of gravel		
8–10	24"				0-.5' gray clay 8.5-10 gray sandy clay fine grain		
10–11	19"				10-10.5 gray sandy clay fine grain 10.5-10.6 sandstone		10.6' Bedrock

Depth to Ground Water: ____________ Backfill Type: Cuttings Cuttings/Bentonite

Monitoring Well Installed? YES NO Bentonite Asphalt/Concrete

Monitoring Well ID: ____________

Location Surveyed? YES NO GPS Surveyor Other

EICHELBERGERS, INC.
Geotechnical Boring Log

Project KINZUA CREEK WATERSHED TAR SITES Project No. DK20050 Page 1 of 1

Boring No. 016-GT Date Started 5/20/2020 Date Completed 5/20/2020

Driller CHRONISTER Logged By WATTS

Client WESTON SOLUTIONS Field Rep. JANA PEZANOWSKI

From	To	Soil Description	Sample No.	From	To	1st Interval	2nd Interval	3rd Interval	4th Interval	Rec.
0.0'	2.0'	SEE JANA LOG	1			WH	WH	4	4	1.0'
2.0'	4.0'		2			4	4	4	4	1.2'
4.0'	6.0'		3			WH	3	6	17	1.6'
6.0'	8.0'		4			16	35	22	12	1.2'
8.0'	10.0'		5			4	6	7	6	1.8'
10.0'	10.6'		6			6	50/1	—	—	.5'
	EOB									

Drill Rig GEO PROBE 7822 DT Weather SUNNY 76°

Auger Size 3 1/2" RODS Water Encountered 6'

Hammer Auto X Manual ____ Cave-In Depth N/A

APPENDIX B
KINZUA CREEK WATERSHED TAR SITES AQUATIC SLERA REFINEMENT

Bluestone ENVIRONMENTAL GROUP
301 Lindenwood Drive | Suite 102 | Malvern, PA 19355
610.647.9500 | www.bluestoneenviro.com

FINAL TECHNICAL MEMORANDUM

TO: ANN DIDONATO (USEPA)

FROM: BLUESTONE ENVIRONMENTAL GROUP

DATE: 30 JUNE 2020

SUBJECT: KINZUA CREEK WATERSHED TAR SITES AQUATIC SLERA REFINEMENT

INTRODUCTION

Bluestone Environmental Group (Bluestone), an 8(a), Economically Disadvantaged Women-Owned Small Business, is pleased to provide this Technical Memorandum to refine the aquatic Screening Level Ecological Risk Assessment (SLERA) for the Kinzua Creek Watershed Tar Sites. This Technical Memorandum provides a description of potential ecological risks based on exposure to contaminated crayfish, surface water and sediments at the sites. Specifically, surface water and sediment data collected at five separate sites (Kinzua Creek 1, Kinzua Creek 2, Meade Run, Threemile Run 1 and Threemile Run 2) from 2017 through 2019 were compared to appropriate ecological benchmarks for the protection of aquatic life, and crayfish tissue contaminant concentrations, in conjunction with surface water and sediment data, were used to estimate exposure and potential risks to the belted kingfisher (*Megaceryle alcyon*) and mink (*Neovison vison*) using receptor-specific exposure and effects modeling.

The following text presents a discussion of the approach used and subsequent results of the surface water and sediment benchmark comparisons, kingfisher and mink exposure and effects modeling and a summary of conclusions regarding the ecological risk potential at each location sampled. The findings of this assessment are presented primarily as a table-based technical memo. In addition to the aforementioned screening assessment, the conclusions include a brief summary of surface water and sediment toxicity testing that was conducted in 2018. A more complete discussion of the toxicity testing approach and findings can be found in Weston (2019).

DATA

Validated data used in this evaluation include the following:

- Surface water and sediment data collected for (two sites) in 2017,
- Surface water, sediment and whole-body crayfish data collected in 2018, and
- Surface water and sediment data collected in 2019.

Figures 1 through 5 are sample location maps. Tables 1 through 17 present the raw data used in this assessment.

SURFACE WATER AND SEDIMENT BENCHMARK COMPARISONS

Surface water and sediment data were compared on a sample-by-sample basis with appropriate ecological benchmarks. The following sources were used to obtain surface water and sediment benchmarks.

<u>Surface Water Benchmarks</u>

1) Federal National Recommended WQC for the Protection of Aquatic Life (EPA, 2020) — This document provides a compilation of the water quality criteria (WQC) for a wide variety of pollutants, predominantly metals and pesticides, in freshwater and marine. Two sets of criteria for each environment are provided in this guidance, i.e., criteria maximum concentrations (CMCs), and criteria continuous concentrations (CCCs). CMCs represent acute criteria applied as 1-hour average concentrations not to be exceeded more than once in any 3-year period. CCCs represent chronic criteria applied as 4-day average concentrations not to be exceeded more than once in any 3-year period. As the CCC accurately reflects long term exposure to ecological exposure in the stream, it was used in this SLERA.

2) EPA Region 4 Surface Water Screening Values (EPA, 2018) – EPA Region 4 surface water (freshwater) screening values are based on the following hierarchy and were used when a Federal WQC benchmark was not available. These benchmarks were generally not derived by EPA, but are based on a compilation of the following sources:
   - National Recommended Surface Water Criteria
   - Tier 2 values or equivalent
     - Great Lakes Initiative Tier 2 Values (freshwater)
     - State Surface Water Standards for freshwater
     - Suter and Tsao (1996) Tier 2 Values
   - Canadian Water Quality Values
   - Minimum value from either the Target Lipid Model or Ecological Structure Activity Relationships (ECOSAR) model.
   - Office of Pesticide Programs Aquatic Life Benchmarks.
   - Minimum of chronic toxicity observed as recorded in the Ecotoxicological database (ECOTOX).

<u>Sediment Benchmarks</u>

1) EPA Region 4 Sediment Screening values (2018)— Many of the Region 4 sediment ESVs are derived from statistical interpretation of effects databases obtained from the literature (e.g., from states such as Florida and Washington). Benchmarks are generally based on observations of direct toxicity to benthic organisms. In general, the hierarchy used was as follows: Threshold effect levels (TELs) or threshold effect concentrations (TECs) such as those provided in MacDonald et al., (2000) for other than polyaromatic hydrocarbons (PAHs); modeled equilibrium partitioning values for organic chemicals from surface water benchmarks; other effect ranges such as effects range-low (ER-L) values and Washington State sediment quality objectives.

2) Equilibrium Sediment Benchmarks (EPA, 2003a) — EPA developed equilibrium partitioning-based sediment benchmarks (ESBs) following guidance as in EPA guidance *Procedures for the Derivation of Equilibrium Partitioning Benchmarks (ESBs) for the Protection of Benthic Organisms: PAHs Mixtures* (EPA, 2003a). This approach incorporates the equilibrium partitioning

theory (EqP) that holds that nonionic chemicals in sediment partition between sediment total organic carbon (TOC), interstitial (pore) water and benthic organisms. The combination of EqP, narcosis toxicity theory and additivity provide the technical foundation for the development PAH benchmarks.

EPA Region 4 screening values were released in 2018 compared with EPA Region 3 screening values which are dated 2006, many of the same sources (or updates of the sources) were used by Region 4 that were used by Region 3, and the value derivations were similar. Therefore, it was deemed appropriate to use the more up-to-date Region 4 values.

BIOASSAY RESULTS

Chronic toxicity tests on tar site surface water samples (Weston, 2019) did not demonstrate statistically significant differences in the survival of *Ceriodaphnia dubia* or fathead minnows relative to reference locations, the fathead minnow growth endpoints of dry weight at both sites were significantly lower than Meade Run The fathead minnow growth endpoint of dry biomass associated with a Kinzua Creek 2 sample was significantly lower than in the upgradient Kinzua Creek 1 sample.

Chronic sediment toxicity tests (Weston, 2019) on survival and growth with gammarid amphipod, *Hyalella azteca*, indicated significantly lower survival associated with exposures to Threemile Run and Kinzua Creek site sediment samples relative to the Meade Run reference sediment. Differences in growth endpoints were observed in Day 42 dry biomass in sediment samples from both tar sites relative to the Meade Run reference location sediment. Differences in reproduction endpoints between tar site samples and their respective upstream reference sample locations included total reproduction (total juvenile production per Day 42 surviving amphipod) in a Kinzua Creek 2 sample relative to the upstream Kinzua Creek reference sample.

KINGFISHER AND MINK EXPOSURE AND EFFECTS MODELING

One avian and one mammalian species (kingfisher and mink, respectively) were selected as surrogate species with which to evaluate the ecological risk from dietary exposure to aquatic organisms. Because of the small size of the existing datasets, the exposure point concentration is the maximum detected concentration (see Tables 18 through 20). Exposure modeling was performed only for analytes detected in crayfish. Exposure models used in this assessment take the following general form:

$$TDI = FT \times \left[\left(FIR \times \sum_{i=1}^{n} C_i \times P_i \right) + SIR \times C_{sed} + WIR \times C_{sw} \right]$$

Where:

TDI	=	Total daily intake (mg/kg body weight [BW]-day)
FT	=	Foraging time in the exposure area (unitless)
FIR	=	Body weight normalized food intake rate (kg WW/kg BW-day)
C_i	=	Concentration in the i^{th} prey item (mg/kg WW)
P_i	=	Proportion of the i^{th} prey item in the diet (unitless)
SIR	=	Sediment ingestion rate (kg dry weight [DW]/kg BW-day)

C_{sed}	=	Concentration in sediment (mg/kg DW)
WIR	=	Water ingestion rate (L/kg BW-day)
C_{sw}	=	Concentration in unfiltered surface water (mg/L)

Receptor-specific life history exposure parameters are presented in Table 21. Using food ingestion rates (FIRs) based on captive animals potentially underestimates the intake rates because these animals do not expend as much energy as their wild counterparts do because activities for captive animals do not include behaviors such as foraging and avoiding predators. Therefore, allometric equations using free metabolic rates (FMRs) were used to determine FIRs. The equations and parameters used to determine food ingestion rates are presented in Tables 22, 23 and 24.

In this screening assessment, risks were estimated by comparing single-point estimates of exposure (i.e., a dose) with effects levels.

Hazard quotients (HQs) were developed to determine potential effects to target receptors from exposure to COPECs in sediment, surface water, and prey items (crayfish). The HQ approach used for this evaluation simplifies the comparison process and allows for a more standardized interpretation of the results i.e., the HQ reflects the magnitude by which the dose exceeds or is less than the toxicity reference value (TRV). Although the HQ method does not measure risk in terms of likelihood or probability of effects at the individual or population level, it does provide a functional benchmark for judging potential risk (EPA, 1994).

HQs were calculated specific to measurement receptor and exposure scenario location (e.g., habitat) evaluated in this SLERA as follows:

$$HQ \quad = \quad EEL/TRV$$

Where:

HQ	=	Hazard quotient (unitless)
EEL	=	estimated exposure level (estimated dose in units of mg COPEC/kg BW-day)
TRV	=	toxicity reference value (dose in mg COPEC/kg BW-day)

Note that although PAHs are evaluated as LMW and HMW PAHs, HQs for each individual PAH are presented for transparency in the calculations. In addition, HQs for each pathway are provided for transparency in calculations and to give a better understanding of the uncertainties associated with any potential risk drivers.

UNCERTAINTY ANALYSIS

The goal of an uncertainty analysis is to provide the appropriate decision makers (i.e., risk managers) information about the key assumptions, their inherent uncertainty and variability, and the impact of this uncertainty and variability on the estimates of risk.

Media Sampling

Sediment, surface water and crayfish tissue collected from the study area reflect the conditions at that exact point in space and time. Spatial and temporal variations in medium conditions (both physical and chemical conditions) are often observed on very small scales. Given the heterogeneity of the environment, sample size and location greatly affect the certainty associated with the estimation of exposure and the consequent effects.

Bioavailability of Detected Concentrations

Detected concentrations of contaminants may not be indicative of bioavailable concentrations. Organic chemicals may bind to other substances in the soil and sediments, e.g., humic acids, making them less available for uptake. Metals in sediments may be associated with various mineral complexes that regulate potential variability. These interactions, along with the interactions of the contaminant with other chemicals in the environment, may make the contaminant either more or less toxic to organisms than expected.

Benchmark Limitations

In general benchmarks do not address possible synergistic, antagonistic, or additive effects of contaminant mixtures (note: this concern is addressed for the narcosis endpoint when assessing PAHs in sediment using the ESB approach); the test conditions used in the toxicological studies used to develop chemical-specific benchmarks may not match the conditions at the study area; and the form in which a chemical was added to the medium in deriving the benchmark may not be representative of the form the chemical is found in at the study area. The lattermost is particularly true where the metallic salts added for toxicity testing purposes enhance the bioavailability of the metal relative to the metal species present under equilibrium conditions (i.e., complexed or strongly bound forms present). These variables mean risk may be over- or underestimated, depending on the site-specific differences from test conditions.

Target Receptor Selection

Target receptors were selected to represent organisms with similar feeding and behavioral strategies to those expected to occur on the study area. However, species-specific exposure within similar feeding groups may vary and may result in differing risk potential. Target receptors were selected with the intent of optimizing exposure and assuming that a significant portion of their life cycles was restricted to that area of contamination.

Exposure Assumption Selections

Conservative exposure assumptions were selected to result in a conservative estimate of risk. It is assumed that 100% of the target receptor's diet derives from the affected study area. Given the size of the foraging range for kingfisher and mink, and the suitable habitat nearby, this likely overestimates risk.

TRV Uncertainties

Appropriate toxicity data specific to target receptors were not always available; therefore, application of literature-derived toxicity data to the species of concern was sometimes necessary. When selecting toxicological data to compare with site-specific conditions, avian TRVs were selected from the lowest-available bird NOAELs and LOAELs. However, species sensitivity may vary even among closely related species. Variations in species sensitivity may be due to differences in some of the following factors: toxicity, tolerance thresholds, toxic symptoms exhibited, time period until toxic effects are observed, and metabolism of the ingested chemical.

Background Data Comparisons

Site soil, sediment, and surface water concentrations were compared with site-specific background levels. In many cases, the site maxima were less than the background levels indicating that the site levels of metals are consistent with regional background levels.

RESULTS AND CONCLUSIONS

Surface Water Benchmarks Comparison Results

Surface water benchmarks comparison results were consistent among all three years (see Tables 1, 2, 3, 7, 8, 12, and 13). With the exception of one anthracene benchmark exceedance at Kinzua Creek 2 in 2018, no organic compound exceedances were observed. There were numerous benchmark exceedances for aluminum, iron, manganese and lead at both Threemile Run 2 and Kinzua Creek 2; however, background concentrations from Kinzua Creek for these same metals were very similar with site-related concentrations typically less than 2X background levels.

Sediment Benchmarks Comparison Results

Sediment concentrations for PAHs at both Threemile Run 2 and Kinzua Creek 2 exceeded Region 4 sediment benchmarks for numerous individual compounds, in many cases individual site-related PAH concentrations exceeded Region 4 benchmarks and associated background levels by more than an order of magnitude (see Tables 4, 5, 6, 9, 10, 11, 14, 15, and 16). When the same PAH levels were compared to equilibrium partitioning sediment benchmarks (EPA 2003), the resulting equilibrium partitioning benchmark toxic units (ESBTUs) exceeded 100 for most Threemile Run 2 and Kinzua Creek 2 samples and were frequently more than an order of magnitude higher than their corresponding background ESBTUs.

Sediment metal concentrations exceeded EPA Region 4 benchmarks for several analytes; however, site-related metals concentrations were similar to (often less than) associated background levels.

Exposure Modeling Results

Kingfisher and mink risks were assessed at two potentially impacted sites (Threemile Run 2 and Kinzua Creek 2) and their corresponding background locations (Meade Run and Kinzua Creek 1). As previously discussed, risks were estimated for the exposure to contaminants identified site-specific surface water, sediment and crayfish. Exposure concentrations used to estimate potential risk were the maximum concentration identified in each medium for a given location. Estimated daily intakes for each receptor by location are provided in Tables 25 through 32. Risks were calculated using both No-Observed-Adverse-Effects-Level (NOAEL)- and Lowest-Observed-Adverse-Effects-Levels (LOAEL)-based TRVs (see Tables 33 and 34). The following discussion summarizes risk to each target receptor by location. Whenever HQs ≥1 were observed at one of the potentially impacted sites, the risk for that contaminant at the corresponding background location was also reviewed to help distinguish potential site-related risk as opposed to background risk. Hazard quotients for each receptor by location are presented in Tables 35 through 50 The total HQs for mink and kingfisher are summarized in Tables 51 and 52, respectively.

Belted Kingfisher

NOAEL-based hazard quotients ≥1 were observed for two contaminants, barium and copper. At Threemile Run 2 location, the HQs for barium (HQ = 2.2) and copper (HQ = 3.1) were less than or slightly above the corresponding background HQs, 4.2 and 1.9, respectively. Potential kingfisher risks using a LOAEL-based benchmarks were HQ = 1.1 and HQ = 1.05 for barium and copper, respectively, corresponding background risk levels were HQ=2.1 and HQ=0.64.

At Kinzua Creek 2, NOAEL-based HQs≥1 were observed for barium (HQ=3.4), copper (HQ=3.7) and selenium (HQ=1.0) and the corresponding background HQs were 4.5, 2.5 and 0.77, respectively. Potential kingfisher risks using a LOAEL-based benchmarks were HQ =1.7 and HQ= 1.25 for barium and copper respectively, and corresponding background risk levels were HQ = 2.3 and HQ = 0.83.

Mink

NOAEL-based hazard quotients ≥1 were observed for four contaminants: aluminum, copper, iron and selenium. At Threemile Run 2 location, the mink HQs were as follows: aluminum (HQ = 4.7), copper (HQ=1.1), iron (HQ 81) and selenium (HQ 1.3), the corresponding background HQs were 1.8, 0.62, 7.1 and 1.3 respectively. Potential mink risks (i.e., HQ ≥1) using a LOAEL-based benchmarks were only identified for iron (HQ=8.1) with an associated background risk of HQ=0.71.

At Kinzua Creek 2, NOAEL-based HQs≥1 were observed for aluminum (HQ=3.0), copper (HQ=1.25), iron (HQ=34) and selenium (HQ=2.8) and the corresponding background HQs were 4.9, 0.8, 20 and 0.77, respectively. Potential mink risks using a LOAEL-based benchmarks were identified for iron (HQ=3.4) and selenium (HQ =1.4) with associated background risks of HQ=2.0 and HQ=0. 70.

Conclusions

Surface water concentrations observed at Threemile Run 2 and Kinzua Creek 2 were similar to Kinzua Creek background levels and were not at levels typically associated with adverse ecological effects (see Tables 1, 2, 3, 7, 8, 12, and 13). However, the developmental effects identified in the bioassays with surrogate species exposed to site surface water indicate potential risk to the fish community.

Sediment concentrations for PAHs at both Threemile Run 2 and Kinzua Creek 2 substantially exceeded background levels and benchmarks developed for the protection of benthic organisms. Based on the magnitude of exceedances observed, the concentrations of PAHs at both Threemile Run 2 and Kinzua Creek 2 are likely toxic to aquatic organisms (see Tables 4, 5, 6, 9, 10, 11, 14, 15, and 16). In addition, the survival, growth, and reproduction effects identified in the bioassays with surrogate species exposed to site sediment indicate potential risk to the benthic community.

Exposure and effects modeling for the belted kingfisher and mink at Threemile Run 2 and Kinzua Creek 2 indicate there is little to no risk potential for these receptors based on conservative modeling and effects assumptions. No potential risks from organic contaminants were identified and potential inorganics risks were limited to a few metals (i.e., aluminum, barium, copper, iron and selenium); none of which are expected to be site-related contaminants. With the exception of potential iron risk to the mink, HQs resulting from site exposure were all < 10 and typically comparable to background levels.

It should be noted that the mammalian iron TRV used was based on a study in which rats were exposed sub-chronically to iron (Whittaker et al., 1994). The NOAEL and LOAEL were 31.5 mg/kg-day and 315 mg/kg-day, respectively based on liver, heart, and pancreatic effects. An uncertainty factor of 10 was added to each to estimate chronic values. Risks are likely overestimated as the ecological significance of the measured effects are not known.

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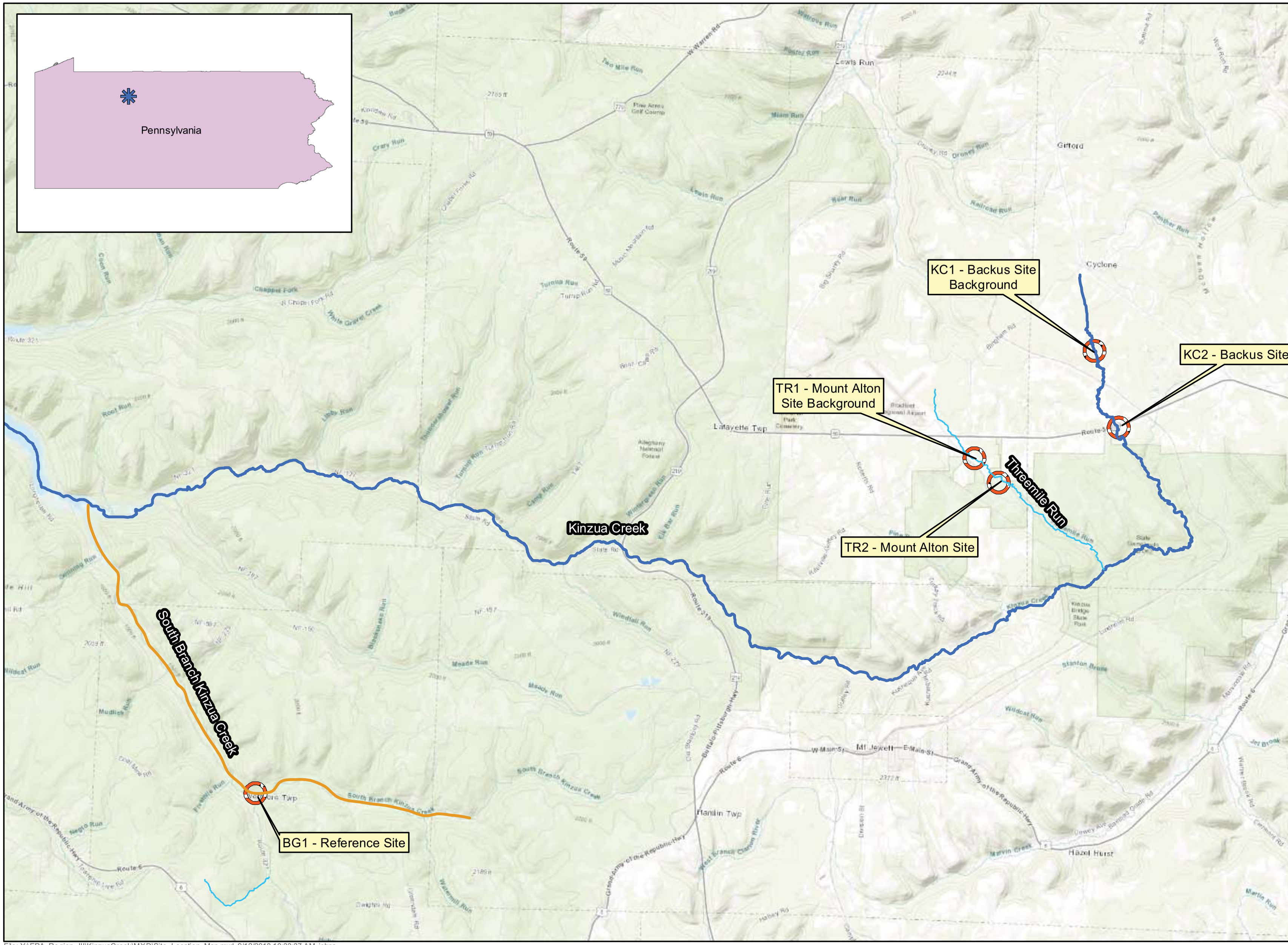
FIGURES



Legend
Kinzua Creek
Threemile Run
Sampling Locations

Background: ESRI, USGS Mapping Service
The source of this map image is Esri, used by the EPA with Esri's permission

Coordinate System: WGS84 UTM Zone 18N Feet

N
0 0.375 0.75 1.5 Miles

Kinzua Creek Watershed Tar Sites
McKean County, PA

Figure 1
Site Location Map

TDD#: W501-17-03-001
Contract: S3-15-02
Prepared: 9/12/2018

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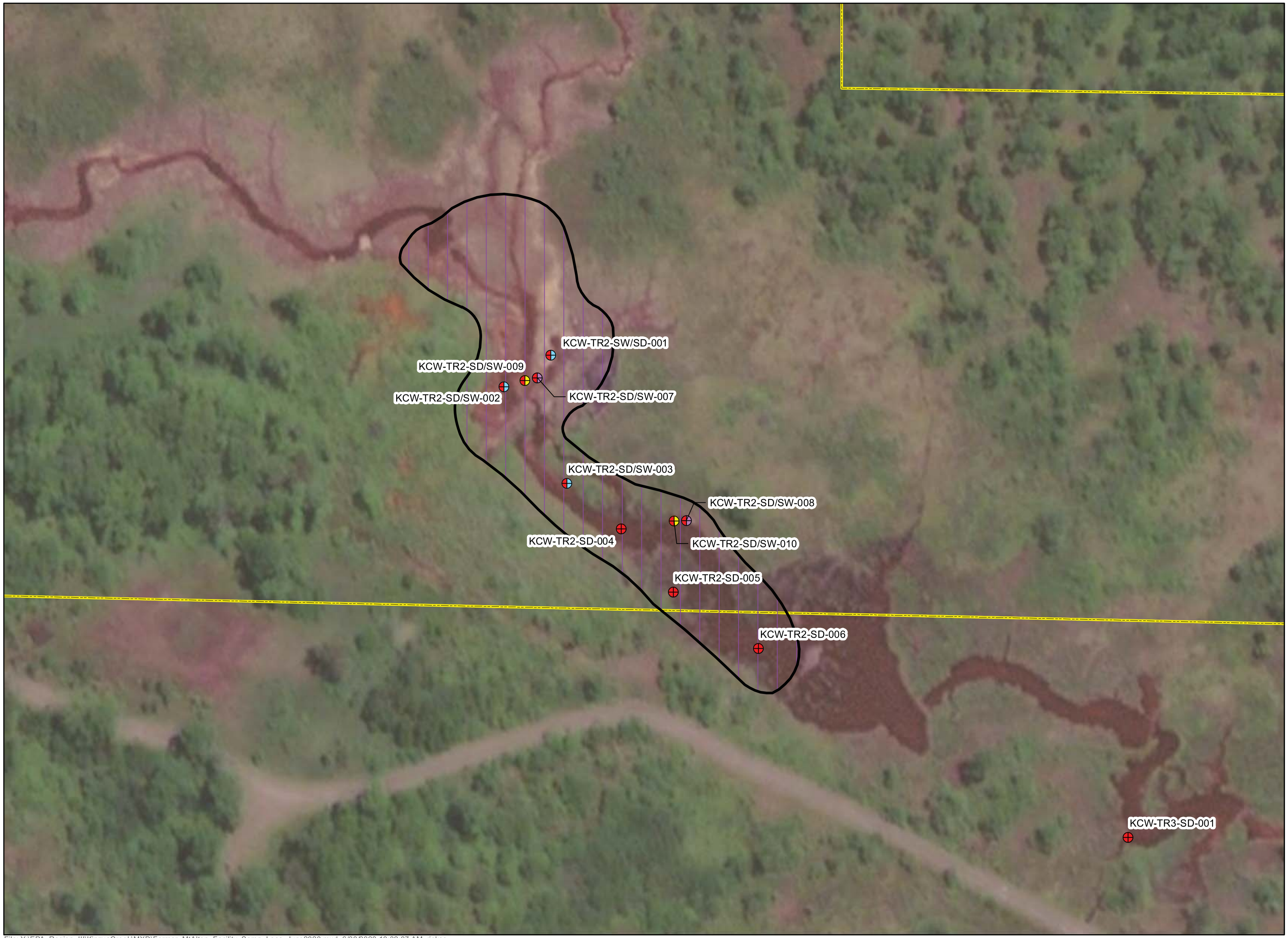

Legend
- 2017 Sediment Sample Location
- 2017 Sediment/Surface Water Sample Location
- 2018 Sediment/Surface Water Sample Location
- 2019 Sediment/Surface Water Sample Location
- Parcel Boundary
- Biological Sampling Reach

Notes:

Background: ESRI Imagery Mapping Service, 2017 used by the EPA with Esri's permission

N

PA State Plane, NAD83

0 25 50 100 Feet

Kinzua Creek Watershed Tar Sites
McKean County, PA

Figure 2
Threemile Run
Sample Location Map

TDD#: W501-17-03-001
Contract: S3-15-02
Prepared: 6/30/2020

WESTON SOLUTIONS

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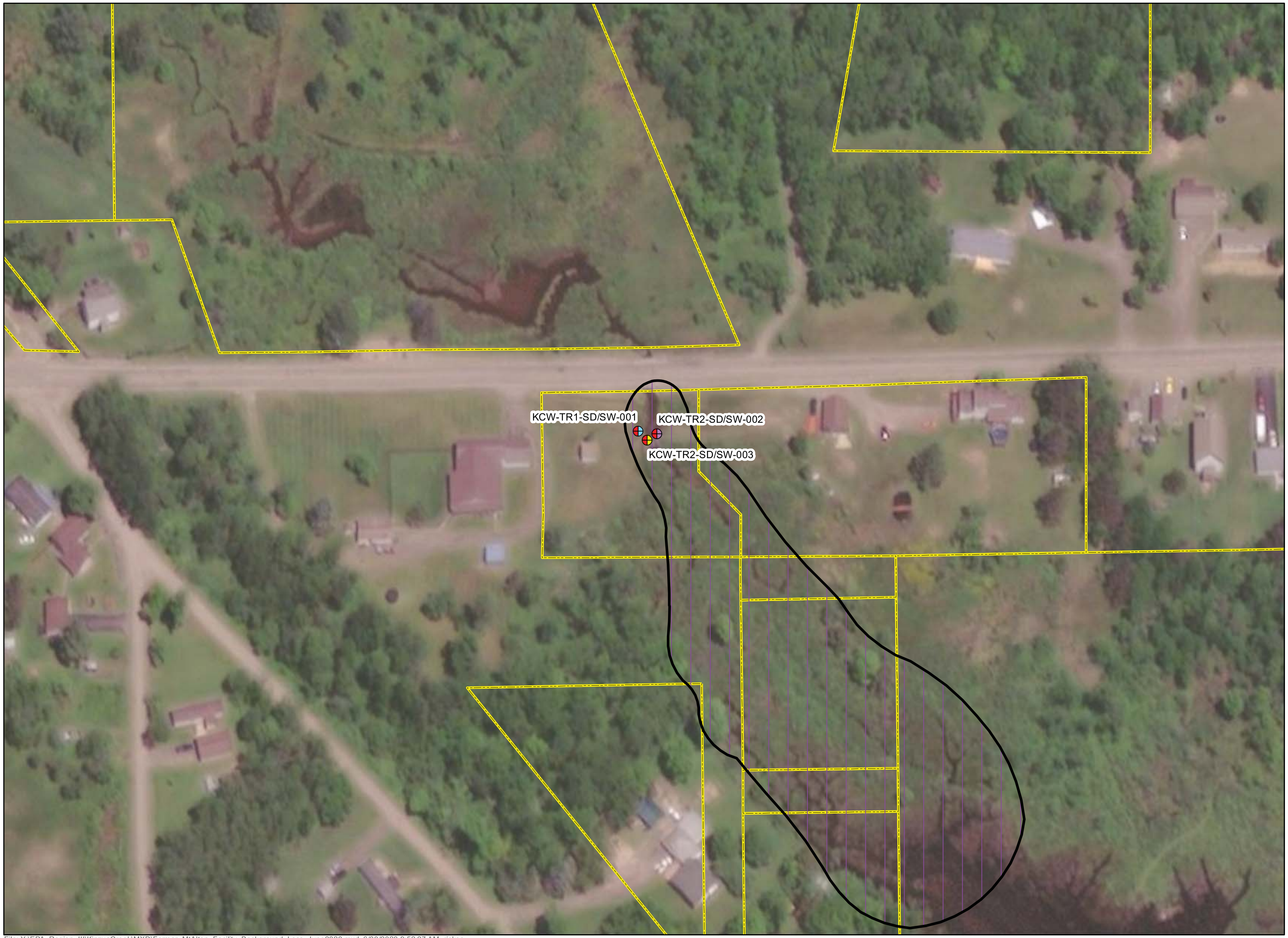

Legend

- 2017 Sediment/Surface Water Sample Location
- 2018 Sediment/Surface Water Sample Location
- 2019 Sediment/Surface Water Sample Location
- Parcel Boundary
- Biological Sampling Reach

Notes:

Background: ESRI Imagery Mapping Service, 2017 used by the EPA with Esri's permission

N

PA State Plane, NAD83

0 25 50 100 Feet

Kinzua Creek Watershed Tar Sites
McKean County, PA

Figure 3
Threemile Run Background
Sample Location Map

TDD#: W501-17-03-001
Contract: S3-15-02
Prepared: 6/30/2020

WESTON SOLUTIONS

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Legend
- 2017 Sediment Sample Location
- 2017 Sediment/Surface Water Sample Location
- 2018 Sediment/Surface Water Sample Location
- 2019 Sediment/Surface Water Sample Location
- Parcel Boundary
- Biological Sampling Reach

Notes:

Background: ESRI Imagery Mapping Service, 2017 used by the EPA with Esri's permission

N

PA State Plane, NAD83

0 25 50 100
Feet

Kinzua Creek Watershed Tar Sites
McKean County, PA

Figure 4
Kinzua Creek - Backus
Sample Location Map

TDD#: W501-17-03-001
Contract: S3-15-02
Prepared: 6/30/2020

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Legend

- 2017 Sediment/Surface Water Sample Location
- 2018 Sediment/Surface Water Sample Location
- 2019 Sediment/Surface Water Sample Location
- Parcel Boundary
- Biological Sampling Reach

Notes:

Background: ESRI Imagery Mapping Service, 2017 used by the EPA with Esri's permission

N

PA State Plane, NAD83

0 20 40 80 Feet

Kinzua Creek Watershed Tar Sites
McKean County, PA

Figure 5
Kinzua Creek - Backus Background Sample Location Map

TDD#: W501-17-03-001
Contract: S3-15-02
Prepared: 6/30/2020

File: Y:\EPA_Region_III\KinzuaCreek\MXD\Former_Backus_Facility_Background_Locs_June2020.mxd, 6/30/2020 11:07:27 AM, ricksc

TABLES

Table 1
2017 Surface Water - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**BG1**-SW-001		KCW-**TR1**-SW-001		KCW-**TR2**-SW-001		KCW-**TR2**-SW-002		KCW-**TR2**-SW-003	
CLP Sample Number:		C0AG5		C0AA2		C0AB0		C0AB1		C0AB2	
Units:		µg/L		µg/L		µg/L		µg/L		µg/L	
Sample Date:		7/27/2017		7/30/2017		7/30/2017		7/30/2017		7/30/2017	
Sample Type:		Background		Background		Field		Field		Field	
VOCs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Benzene	160	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U
Ethylbenzene	61	0.5	U	0.5	U	0.5	U	0.42	J	0.59	
m,p-Xylene	27 (T)	0.5	U	0.5	U	0.5	U	0.67		0.48	J
o-xylene	27 (T)	0.5	U	0.5	U	0.5	U	0.61		0.4	J
Toluene	62	0.5	U	0.5	U	0.5	U	0.23	J	0.55	
SVOCs - SIM											
2-Methylnaphthalene	4.7	0.1	U	0.1	U	0.1	U	0.13		0.1	U
Acenaphthylene	13	0.1	U	0.1	U	0.1	U	0.03	J	0.04	J
Acenaphthene	15	0.1	U	0.1	U	0.1	U	0.03	J	0.1	U
Fluorene	19	0.1	U	0.1	U	0.1	U	0.09	J	0.06	J
Naphthalene	21	0.1	U	0.1	U	0.1	U	0.26		0.1	U
Phenanthrene	2.3	0.1	U	0.1	U	0.1	U	0.03	J	0.1	U
Pentachlorophenol	15	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
SVOCs											
2,4-Dimethylphenol	15	5.1	U	5	U	5	U	1.2	J	5	U
4-Chloro-3-methylphenol	NL	5.1	U	5	U	5	U	5.1	U	5	U
Dimethyl phthalate	NL	5.1	U	5	U	5	U	5.1	U	5	U

Notes:
BG1 = Reference Site; **TR1** = Threemile Run Background; **TR2** = Threemile Run Site; **KC1** = Kinzua Creek Background; **KC2** = Kinzua Creek Site
Data compared to EPA National AWQC (2020) for pentachlorophenol and EPA Region 4 Freshwater Chronic Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
µg/L= Micrograms per liter
J = Reported value is estimated; actual value may be higher or lower
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
NL = No listed value
Q = Qualifier
SIM = Selected Ion Monitoring
SVOC = Semi-volatile organic compound
(T) = Total Xylenes
UJ= The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise
VOC = Volatile organic compound

Table 1
2017 Surface Water - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC1**-SW-001		KCW-**KC2**-SW-001		KCW-**KC2**-SW-002		KCW-**KC2**-SW-005	
CLP Sample Number:		C0AC0		C0AC7		C0AC8		C0AC9	
Units:		µg/L		µg/L		µg/L		µg/L	
Sample Date:		7/31/2017		7/31/2017		7/31/2017		7/31/2017	
Sample Type:		Background		Field		Field		Field	
VOCs		Result	Q	Result	Q	Result	Q	Result	Q
Benzene	160	0.5	U	0.5	U	0.5	U	0.32	J
Ethylbenzene	61	0.5	U	0.5	U	0.5	U	0.5	U
m,p-Xylene	27 (T)	0.5	U	0.5	U	0.5	U	0.75	
o-xylene	27 (T)	0.5	U	0.5	U	0.5	U	0.64	
Toluene	62	0.5	U	0.5	U	0.5	U	1.5	
SVOCs - SIM									
2-Methylnaphthalene	4.7	0.1	U	0.1	U	0.1	U	0.07	J
Acenaphthylene	13	0.1	U	0.1	U	0.1	U	0.1	U
Acenaphthene	15	0.1	U	0.1	U	0.1	U	0.1	U
Fluorene	19	0.1	U	0.1	U	0.1	U	0.1	U
Naphthalene	21	0.1	U	0.1	U	0.1	U	0.18	
Phenanthrene	2.3	0.1	U	0.1	U	0.1	U	0.1	U
Pentachlorophenol	15	0.2	U	0.03	J	0.2	U	0.2	U
SVOCs									
2,4-Dimethylphenol	15	5	U	5	U	5	U	5	U
4-Chloro-3-methylphenol	NL	5	U	5	U	5	U	6.1	
Dimethyl phthalate	NL	5	U	2.5	J	1.4	J	5.1	U

Notes:
BG1 = Reference Site; **TR1** = Threemile Run Background; **TR2** = Threemile Run Site; **KC1** = Kinzua Creek Background; **KC2** = Kinzua Creek
Data compared to EPA National AWQC (2020) for pentachlorophenol and EPA Region 4 Freshwater Chronic Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value.
µg/L= Micrograms per liter
J = Reported value is estimated; actual value may be higher or lower
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
NL = No listed value
Q = Qualifier
SIM = Selected Ion Monitoring
SVOC = Semi-volatile organic compound
(T) = Total Xylenes
UJ= The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise
VOC = Volatile organic compound

Table 2
2017 Surface Water - Benchmark Comparisons - Total Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**BG1**-SW-001		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR1**-SW-001		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-001		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-002		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-003	
CLP Sample Number:		MC0AG5			MC0AA2			MC0AB0			MC0AB1			MC0AB2	
Units:		µg/L			µg/L			µg/L			µg/L			µg/L	
Sample Date:		7/27/2017			7/30/2017			7/30/2017			7/30/2017			7/30/2017	
Sample Type:		Background			Background			Field			Field			Field	
Metals		Result	Q		Result	Q		Result	Q		Result	Q		Result	Q
Aluminum	87	92.5		87	118		87	106		87	943		87	157	
Antimony	190	2.0	U	190	0.1	J	190	0.10	J	190	0.14	J	190	0.093	J
Arsenic	150	1.0	U	150	1.0	U	150	1.4		150	2.2		150	1.1	
Barium	220	39.7		220	25.5		220	54.3		220	93.3		220	54.6	
Beryllium	11	1.0	U	11	1.0	U	11	1.0	U	11	1.0	U	11	1.0	U
Cadmium	0.18	1.0	U	0.22	1.0	U	0.34	1.0	U	0.603	1.0	U	0.47	1.0	U
Calcium	116,000	4300		116,000	6420		116,000	8580		116,000	21500		116,000	16600	
Chromium	11	2.0	UJ	11	2.0	U	11.0	2.0	U	11	2.0	U	11	2.0	U
Cobalt	19	1.0	U	19	1.0	U	19	2.7		19	5.9		19	3.5	
Copper	1.847	0.54	J	2.3	2.0	U	3.8	2.0	U	7.3	17.2		5	2.0	U
Iron	1,000	443		1,000	1880	J	1,000	6690	J	1,000	15500	J	1,000	5130	J
Lead	0.321	1.0	U	0.4339	1.0	U	0.84	1.0	U	2.0	7.4		1.3	1.0	U
Magnesium	82,000	1220		82,000	1100		82,000	3750		82,000	6200		82,000	3590	
Manganese	93	48.5		93	274		93	1340		93	963		93	1280	
Mercury	0.77	0.2	U	0.77	0.2	U	0.77	0.2	U	0.77	0.2	U	0.77	0.2	U
Nickel	11	1.7		14	2.2	J+	22.4	3.6	J+	43	6.8		32	4.3	J+
Potassium	53,000	867		53,000	559		53,000	1210		53,000	2240		53,000	1350	
Selenium	5	5.0	U	5.0	5.0	U	5	5.0	U	5	5.0	U	5	5.0	U
Silver	0.06	1.0	U	0.06	1.0	U	0.06	1.0	U	0.06	1.0	U	0.06	1.0	U
Sodium	680,000	3710		680,000	7340		680,000	2590		680,000	4600		680,000	5290	
Thallium	6	1.0	UJ	6	1.0	U	6	1.0	U	6	1.0	U	6	1.0	U
Vanadium	27	5.0	U	27	5.0	U	27	5.0	U	27	5.0	U	27	5.0	U
Zinc	25	3.7	J	31	6.9	J+	51	4.2	U	97	19.6		73	6.2	J+

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA National AWQC (2020) for Al,As,Cd,Cr,Cu,Fe,Pb,Ni,Se,Ag and Zn, and EPA Region 4 Freshwater Chronic Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
µg/L = micrograms per liter
Q = Data qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 2
2017 Surface Water - Benchmark Comparisons - Total Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC1**-SW-001		**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC2**-SW-001		**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC2**-SW-002		**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC2**-SW-005	
CLP Sample Number:		MC0AC0			MC0AC7			MC0AC8			MC0AC9	
Units:		µg/L			µg/L			µg/L			µg/L	
Sample Date:		7/31/2017			7/31/2017			7/31/2017			7/31/2017	
Sample Type:		Background			Field			Field			Field	
Metals		Result	Q		Result	Q		Result	Q		Result	Q
Aluminum	87	851		87	255		87	266		87	281	
Antimony	190	0.18	J	190	0.16	J	190	0.12	J	190	0.12	J
Arsenic	150	2.3		150	2.1		150	1.9		150	1.9	
Barium	220	74.7		220	30.5		220	31.0		220	35.4	
Beryllium	11	1.0	U	11	1.0	U	11	1.0	U	11	1.0	U
Cadmium	0.27	1.0	U	0.17	1.0	U	0.17	1.0	U	0.202	1.0	U
Calcium	116,000	7630		116,000	3850		116,000	3860		116,000	5310	
Chromium	11	2.0	U	11	2.1		11	2.0	U	11	2.0	U
Cobalt	19	2.6		19	1.9		19	1.8		19	2.0	
Copper	2.94	2.8		1.725	2.0	U	1.7	2.0	U	2.1	13.9	
Iron	1,000	5370	J	1,000	7840	J	1,000	7920	J	1,000	8400	J
Lead	0.59	3.4		0.29	1.4		0.29	1.5		0.39	1.9	
Magnesium	82,000	1980		82,000	1200		82,000	1210		82,000	1290	
Manganese	93	402		93	413		93	398		93	459	
Mercury	0.77	0.2	U	0.77	0.2	U	0.77	0.2	U	0.77	0.2	U
Nickel	17	3.5		10	2.8		10	2.7		13	2.9	
Potassium	53,000	3930		53,000	940		53,000	780		53,000	883	
Selenium	5	5.0	U	5	5.0	U	5	5.0	U	5	5.0	U
Silver	0.06	1.0	U	0.06	1.0	U	0.06	1.0	U	0.06	1.0	U
Sodium	680,000	47800		680,000	9210		680,000	9610		680,000	10300	
Thallium	6	1.0	U	6	1.0	U	6	1.0	U	6	1.0	U
Vanadium	27	5.0	U	27	5.0	U	27	5.0	U	27	5.0	U
Zinc	39	13.0		23	5.4		23	5.1		28	7.7	

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA National AWQC (2020) for Al,As,Cd,Cr,Cu,Fe,Pb,Ni,Se,Ag and Zn, and EPA Region 4 Freshwater Chronic Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
µg/L = micrograms per liter
Q = Data qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 3
2017 Surface Water - Benchmark Comparisons - Dissolved Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**BG1**-SW-001		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR1**-SW-001		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-001		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-002		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-003		**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC1**-SW-001	
CLP Sample Number:		MC0AG5			MC0AA2			MC0AB0			MC0AB1			MC0AB2			MC0AC0	
Units:		µg/L			µg/L			µg/L			µg/L			µg/L			µg/L	
Sample Date:		7/27/2017			7/30/2017			7/30/2017			7/30/2017			7/30/2017			7/31/2017	
Sample Type:		Background			Background			Field			Field			Field			Background	
Metals		Result	Q		Result	Q		Result	Q		Result	Q		Result	Q		Result	Q
Aluminum	87	31.1		87	38.8		87	21.3		87	20.0	U	87	20.0	U	87	112	
Antimony	190	2.0	U	190	2.0	U	190	2.0	U	190	2.0	U	190	2.0	U	190	2.0	U
Arsenic	150	0.48	J	150	1.0	U	150	1.0	U	150	1.0	U	150	1.0	U	150	1.3	
Barium	220	41.3		220	24.6		220	33.1		220	70.3		220	53.9		220	56.8	
Beryllium	11	1.0	U	11	1.0	U	11	1.0	U	11	1.0	U	11	1.0	U	11	1.0	U
Cadmium	0.18	1.0	U	0.22	1.0	U	0.33	1.0	U	0.6	1.0	U	0.46	1.0	U	0.26	1.0	U
Calcium	116,000	4350		116,000	6380		116,000	8520		116,000	21300		116,000	16300		116,000	7330	
Chromium	11	2.0	UJ	11	2.0	U	11	2.0	U	11	2.0	U	11	2.0	U	11	2.0	U
Cobalt	19	1.0	U	19	1.0	U	19	1.7		19	1.6		19	2.9		19	1.5	
Copper	1.9	1.2	J	2.3	2.0	U	3.7	2.4		7.2	2.0	U	5.4	2.1		2.8	2.7	
Iron	1,000	200	U	1,000	790		1,000	1680		1,000	200	UJ	1,000	350		1,000	1950	
Lead	0.32	1.0	U	0.43	1.0	U	0.82	1.0	U	1.9	1.0	U	1.3	1.0	U	0.57	1.0	U
Magnesium	82,000	1220		82,000	1100		82,000	3590		82,000	6010		82,000	3480		82,000	1880	
Manganese	93	34.9		93	265		93	1200		93	732		93	1220		93	343	
Mercury	0.77	0.2	U	0.77	0.2	U	0.77	0.2	U	0.77	0.2	U	0.77	0.2	U	0.77	0.2	U
Nickel	11	1.6		14	2.0		22	2.9		42	2.3		31	3.6		17	2.5	
Potassium	53,000	872		53,000	550		53,000	1070		53,000	2110		53,000	1290		53,000	3810	
Selenium	5	5.0	U	5	5.0	U	5	5.0	U	5	5.0	U	5	5.0	U	5	5.0	U
Silver	0.06	1.0	U	0.06	1.0	U	0.06	1.0	U	0.06	1.0	U	0.06	1.0	U	0.06	1.0	U
Sodium	680,000	3660		680,000	7410		680,000	2530		680,000	4630		680,000	5350		680,000	47400	
Thallium	6	1.0	U	6	1.0	U	6	1.0	U	6	1.0	U	6	1.0	U	6	1.0	U
Vanadium	27	1.1	J	27	5.0	U	27	5.0	U	27	5.0	U	27	5.0	U	27	5.0	U
Zinc	25	3.1		31	5.8		50	2.0	U	96	2.0	U	71	2.5		38	5.3	

Notes:
BG1 = Reference Site; **TR1** = Mount Alton Background; **TR2** = Mount Alton Site; **KC1** = Backus Background; **KC2** = Backus Site
Data compared to EPA Region 4 Freshwater Chronic Screening Values (2018)
Yellow highlighted values indicate exceedance of EPA Region 4 Screening Value
µg/L = micrograms per liter
Q = Data qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
J = Reported value is estimated; actual value may be higher or lower
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 3
2017 Surface Water - Benchmark Comparisons - Dissolved Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC2**-SW-001		**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC2**-SW-002		**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC2**-SW-005	
CLP Sample Number:		MC0AC7			MC0AC8			MC0AC9	
Units:		µg/L			µg/L			µg/L	
Sample Date:		7/31/2017			7/31/2017			7/31/2017	
Sample Type:		Field			Field			Field	
Metals		Result	Q		Result	Q		Result	Q
Aluminum	87	112		87	88.8		87	90.6	
Antimony	190	2.0	U	190	2.0	U	190	2.0	U
Arsenic	150	1.2		150	1.1		150	1.2	
Barium	220	25.7		220	24.1		220	26.8	
Beryllium	11	1.0	U	11	1.0	U	11	1.0	U
Cadmium	0.17	1.0	U	0.16	1.0	U	0.18	1.0	U
Calcium	116,000	3810		116,000	3690		116,000	4300	
Chromium	11	2.0	U	11	2.0	U	11	2.0	U
Cobalt	19	1.5		19	1.4		19	1.5	
Copper	1.7	2.0	U	1.7	2.0	U	1.9	2.0	U
Iron	1,000	3310		1,000	2520		1,000	2910	
Lead	0.29	1.0	U	0.28	1.0	U	0.33	1.0	U
Magnesium	82,000	1200		82,000	1170		82,000	1300	
Manganese	93	373		93	363		93	409	
Mercury	0.77	0.2	U	0.77	0.2	U	0.77	0.2	U
Nickel	10	2.3		10	2.4		11	2.4	
Potassium	53,000	779		53,000	718		53,000	811	
Selenium	5	5.0	U	5	5.0	U	5	5.0	U
Silver	0.06	1.0	U	0.06	1.0	U	0.06	1.0	U
Sodium	680,000	9190		680,000	9190		680,000	10300	
Thallium	6	1.0	U	6	1.0	U	6	1.0	U
Vanadium	27	5.0	U	27	5.0	U	27	5.0	U
Zinc	23	3.9		22	3.7		25	4.4	

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Cree
Data compared to EPA National AWQC (2020) for Al,As,Cd,Cr,Cu,Fe,Pb,Ni,Se,Ag and Zn, and EPA Region 4 Freshwater Chronic Screening Values (2018
Yellow highlighted values indicate exceedance of benchmark value
µg/L = micrograms per liter
Q = Data qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
J = Reported value is estimated; actual value may be higher or lower
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 4
2017 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**BG1**-SD-001		KCW-**TR1**-SD-001		KCW-**TR2**-SD-001		KCW-**TR2**-SD-001D		KCW-**TR2**-SD-002		KCW-**TR2**-SD-003	
CLP Sample Number:		C0AG4		C0AA1		C0AA3		C0AA4		C0AA5		C0AA6	
Units:		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg	
Sample Date:		7/27/2017		7/30/2017		7/30/2017		7/30/2017		7/30/2017		7/30/2017	
Sample Type:		Background		Background		Field		Dup of C0AA3		Field		Field	
VOCs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
2-Butanone	7,604	12	U	14	U	30	U	35	U	18	U	21	UJ
Acetone	NL	65	U	28	U	30	U	47	U	18	U	21	UJ
Ethylbenzene	290	6.1	U	7.1	U	15	U	18	U	9.1	U	11	UJ
m,p-Xylene	130 (T)	6.1	U	7.1	U	15	U	18	U	9.1	U	11	UJ
o-xylene	130 (T)	6.1	U	7.1	U	15	U	18	U	9.1	U	11	UJ
Toluene	10	6.1	U	7.1	U	15	U	18	U	9.1	U	11	UJ
SVOCs-SIM													
2-Methylnaphthalene	20.2	5.0	U	6.4	U	10		13		490		7.9	U
Acenaphthene	6.7	3.4	J	5.9	J	10	U	9.9	U	66		7.9	U
Acenaphthylene	5.9	5.0	U	6.5		10	U	9.9	U	37		7.9	U
Anthracene	57	19		16		6.1	J	9.9	U	190		7.9	U
Benzo(a)anthracene	108	37		79		4.5	J	6.3	J	98		2.5	J
Benzo(a)pyrene	150	29		92		3.9	J	5.0	J	81		2.2	J
Benzo(b)fluoranthene	190	32		94		3.1	J	9.9	U	84		7.9	U
Benzo(g,h,i)perylene	170	11		47		10	U	9.9	U	31		7.9	U
Benzo(k)fluoranthene	240	12		41		3.2	J	9.9	U	32		7.9	U
Chrysene	166	35		86		4.3	J	6.2	J	110		2.5	J
Dibenzo(a,h)anthracene	33	7.3		15		10	U	9.9	U	11		7.9	U
Fluoranthene	423	67		170		6.8	J	9.5	J	310		4.5	J
Fluorene	77	8.0		8.1		7.4	J	9.8	J	400		4.8	J
Indeno(1,2,3-cd)pyrene	200	13		50		10	U	9.9	U	34		7.9	U
Naphthalene	176	5.0	U	6.4	U	10	U	9.9	U	280		7.9	U
Pentachlorophenol	10	10	U	13	U	21	U	20	U	14	U	16	U
Phenanthrene	204	70		88		17		22		740	J	9.6	
Pyrene	195	70		170		17	J+	21		410		8.9	

Table 4
2017 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**BG1**-SD-001		KCW-**TR1**-SD-001		KCW-**TR2**-SD-001		KCW-**TR2**-SD-001D		KCW-**TR2**-SD-002		KCW-**TR2**-SD-003	
CLP Sample Number:		C0AG4		C0AA1		C0AA3		C0AA4		C0AA5		C0AA6	
Units:		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg	
Sample Date:		7/27/2017		7/30/2017		7/30/2017		7/30/2017		7/30/2017		7/30/2017	
Sample Type:		Background		Background		Field		Dup of C0AA3		Field		Field	
VOCs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
SVOCs													
1,1-Biphenyl	198	260	U	330	U	520	U	510	U	110	J	410	U
2-Methylnaphthalene	20.2	260	U	330	U	520	U	510	U	430		410	U
2-Methylphenol	119	500	U	640	U	1000	U	990	U	100	J	790	U
2,4-Dimethylphenol	39	260	U	330	U	520	U	510	U	340	J	410	U
4-Methylphenol	93	500	U	640	U	1000	U	990	U	190	J	690	U
Acenaphthene	6.7	260	U	330	U	520	U	510	U	110	J	410	U
Acetophone	NL	500	U	640	U	1000	U	990	U	680	U	790	U
Anthracene	57	260	U	330	U	520	U	510	U	350	U	410	U
Benzo(a)anthracene	108	260	U	91	J	520	U	510	U	130	J	410	U
Benzo(a)pyrene	150	260	U	85	J	520	U	510	U	89	J	410	U
Bis(2-ethylhexyl)phthalate	180	260	U	330	U	520	U	510	U	350	U	410	U
Chrysene	166	260	U	97	J	520	U	510	U	130	J	410	U
Dibenzofuran	510	260	U	330	U	520	U	510	U	230	J	410	U
Dimethyl phthalate	NL	300		440		470	J	570		430		340	J
Fluoranthene	423	83	J	210	J	1000	U	990	U	310	J	790	U
Fluorene	77.4	260	U	330	U	520	U	510	U	390		410	U
Naphthalene	176	260	U	330	U	520	U	510	U	250	J	410	U
Phenanthrene	204	72	J	100	J	520	U	510	U	680		410	U
Phenol	175	500	U	180	J	210	J	230	J	210	J	130	J
Pyrene	195	63	J	170	J	520	U	510	U	320	J	410	U
TOC (mg/kg)	NL	11,100	R	19,100	R	16,000	R	18,800	R	20,100	R	15,700	R

Notes:
BG1 = Reference Site; **TR1** = Mount Alton Background; **TR2** = Mount Alton Site; **KC1** = Backus Background; **KC2** = Backus Site
Data compared to EPA Region 4 Freshwater Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
Biphenyl is a synonym for 1,1-Biphenyl; mp-Cresol is a synonym for 2-Methylphenol; and o-Cresol is a synonym for 4-Methylphenol
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
µg/kg = micrograms per kilogram
NL = No listed value
Q = Qualifier
R = The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.
SIM = Selected Ion Monitoring
SVOC = Semi-volatile organic compound
(T) = Total Xylenes
TOC = Total organic carbon
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
VOC = Volatile organic compound

Table 4
2017 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SD-004		KCW-**TR2**-SD-005		KCW-**TR2**-SD-006		KCW-**KC1**-SD-001		KCW-**KC2**-SD-001	
CLP Sample Number:		C0AA7		C0AA8		C0AA9		C0AB9		C0AC1	
Units:		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg	
Sample Date:		7/28/2017		7/28/2017		7/28/2017		7/31/2017		7/31/2017	
Sample Type:		Field		Field		Field		Background		Field	
VOCs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
2-Butanone	7,604	12	U	33		16	U	31	UJ	10	U
Acetone	NL	12	U	210		21		18	U	10	U
Ethylbenzene	290	6	U	12	U	8.2	U	15	UJ	14	
m,p-Xylene	130 (T)	6	U	12	U	8.2	U	15	UJ	43	
o-xylene	130 (T)	6	U	12	U	8.2	U	15	UJ	22	
Toluene	10	11		12	U	8.2	U	15	UJ	13	
SVOC-SIM											
2-Methylnaphthalene	20.2	42		140		590	J	10	U	310	
Acenaphthene	6.7	6.3		31		62		10	U	22	
Acenaphthylene	5.9	2.7	J	17		26		10	U	16	
Anthracene	57	18		120		190		10	U	21	
Benzo(a)anthracene	108	15		140		76		10	U	13	
Benzo(a)pyrene	150	6.4		82		34		10	U	9.0	
Benzo(b)fluoranthene	190	7.1		80		27		10	U	9.9	
Benzo(g,h,i)perylene	170	4.5	U	28		11		10	U	3.9	J
Benzo(k)fluoranthene	240	1.7	J	20		8.6		10	U	3.9	J
Chrysene	166	15		140		74		10	U	13	
Dibenzo(a,h)anthracene	33	4.5	U	8.9		3.0	J	10	U	4.5	U
Fluoranthene	423	24		190		140		10	U	29	
Fluorene	77	26		110		330		10	U	94	
Indeno(1,2,3-cd)pyrene	200	2.3	J	35		11		10	U	3.9	J
Naphthalene	176	17		53		180		10	U	220	
Pentachlorophenol	10	9.2	U	15	U	12	U	21	U	9.2	U
Phenanthrene	204	51		450		490	J	10	U	66	
Pyrene	195	42		350		250		10	U	40	

Table 4
2017 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	Chronic Freshwater Benchmark (µg/L)	KCW-**TR2**-SD-004		KCW-**TR2**-SD-005		KCW-**TR2**-SD-006		KCW-**KC1**-SD-001		KCW-**KC2**-SD-001	
CLP Sample Number:		C0AA7		C0AA8		C0AA9		C0AB9		C0AC1	
Units:		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg	
Sample Date:		7/28/2017		7/28/2017		7/28/2017		7/31/2017		7/31/2017	
Sample Type:		Field		Field		Field		Background		Field	
VOCs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
SVOCs											
1,1-Biphenyl	198	230	U	380	U	100	J	520	U	230	U
2-Methylnaphthalene	20.2	49	J	170	J	590		520	U	290	
2-Methylphenol	119	450	U	740	U	580	U	1000	U	460	
2,4-Dimethylphenol	39	230	U	260	J	300	U	520	U	230	U
4-Methylphenol	93	450	U	140	J	580	U	1000	U	2100	
Acenaphthene	6.7	230	U	120	J	300	U	520	U	230	U
Acetophone	NL	450	U	740	U	580	U	1000	U	450	U
Anthracene	57	230	U	380	U	300	U	520	U	230	U
Benzo(a)anthracene	108	230	U	180	J	84	J	520	U	239	U
Benzo(a)pyrene	150	230	U	120	J	300	U	520	U	230	U
Bis(2-ethylhexyl)phthalate	180	230	U	380	U	300	U	520	U	230	U
Chrysene	166	230	U	200	J	81	J	520	U	230	U
Dibenzofuran	510	230	U	120	J	210	J	520	U	54	J
Dimethyl phthalate	NL	190	J	360	J	300		520		230	
Fluoranthene	423	450	U	270	J	580	U	1000	U	450	U
Fluorene	77.4	230	U	160	J	390		520	U	98	J
Naphthalene	176	230	U	380	U	190	J	520	U	210	J
Phenanthrene	204	60	J	560		520		520	U	82	J
Phenol	175	450	U	120	J	83	J	270	J	300	
Pyrene	195	230	U	440		240	J	520	U	230	U
TOC (mg/kg)	NL	8,770	R	20,600	R	20,200	R	17,300	R	8,970	R

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA Region 4 Freshwater Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
Biphenyl is a synonym for 1,1-Biphenyl; mp-Cresol is a synonym for 2-Methylphenol; and o-Cresol is a synonym for 4-Methylphenol
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
µg/kg = micrograms per kilogram
NL = No listed value
Q = Qualifier
R = The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.
SIM = Selected Ion Monitoring
SVOC = Semi-volatile organic compound
(T) = Total Xylenes
TOC = Total organic carbon
U = The analyte was analyzed for, but was not detected above the level of the reported sar
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
VOC = Volatile organic compound

Table 4
2017 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC2**-SD-002		KCW-**KC2**-SD-003		KCW-**KC2**-SD-004		KCW-**KC2**-SD-005		KCW-**KC2**-SD-006	
CLP Sample Number:		C0AC2		C0AC3		C0AC4		C0AC5		C0AC6	
Units:		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg	
Sample Date:		7/31/2017		7/31/2017		7/31/2017		7/31/2017		7/31/2017	
Sample Type:		Field		Field		Field		Field		Field	
VOCs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
2-Butanone	NL	11	U	11	U	8.9	U	19	R	11	U
Acetone	NL	11	U	11	U	14	U	30	R	11	U
Ethylbenzene	1,099	5.6	U	5.7	U	5.4		37	J+	5.7	U
m,p-Xylene	25.2 (M)	5.6	U	5.7	U	19		150	J+	5.7	U
o-xylene	NL	5.6	U	5.7	U	6.3		65	J+	5.7	U
Toluene	NL	5.6	U	5.7	U	4	J	150	J+	5.7	U
SVOC-SIM											
2-Methylnaphthalene	20.2	18		440	J	650	J	170		43	
Acenaphthene	6.7	2.4	J	50		36		18		14	
Acenaphthylene	5.9	4.7	U	19		13		7.6	U	7.5	
Anthracene	57.2	4.7	U	100	J+	59		32		32	
Benzo(a)anthracene	108	3.3	J	47		16		22		60	
Benzo(a)pyrene	150	2.4	J	30		7.7		19		51	
Benzo(b)fluoranthene	190 (H)	4.7	U	25		6.2		20		62	
Benzo(g,h,i)perylene	170	4.7	U	12		2.7	J	8.7		24	
Benzo(k)fluoranthene	240	4.7	U	9.2		1.7	J	6.4	J	22	
Chrysene	166	3.7	J	50		14		22		58	
Dibenzo(a,h)anthracene	33	4.7	U	4.4	U	4.5	U	7.6	U	8.4	
Fluoranthene	423	6.7		87	J+	34		45		130	
Fluorene	77.4	9.9		250	J+	250		71		42	
Indeno(1,2,3-cd)pyrene	17	4.7	U	12		2.5	J	8.3		25	
Naphthalene	176	7.8		160	J+	250		66		18	
Pentachlorophenol	504	9.6	U	8.9	U	9.2	U	15	U	8.9	U
Phenanthrene	204	16		300	J+	190		99		130	
Pyrene	195	13		150	J+	59		67		180	

Table 4
2017 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC2**-SD-002		KCW-**KC2**-SD-003		KCW-**KC2**-SD-004		KCW-**KC2**-SD-005		KCW-**KC2**-SD-006	
CLP Sample Number:		C0AC2		C0AC3		C0AC4		C0AC5		C0AC6	
Units:		µg/Kg		µg/Kg		µg/Kg		µg/Kg		µg/Kg	
Sample Date:		7/31/2017		7/31/2017		7/31/2017		7/31/2017		7/31/2017	
Sample Type:		Field		Field		Field		Field		Field	
VOCs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
SVOC											
1,1-Biphenyl	1,225	240	U	84	J	98	J	390	U	230	U
2-Methylnaphthalene	20.2	240	U	520		660		170	J	45	J
2-Methylphenol	NL	470	U	110	J	450	U	760	U	440	U
2,4-Dimethylphenol	29	240	U	310		160	J	390	U	230	U
4-Methylphenol	670	470	U	200	J	450	U	180	J	440	U
Acenaphthene	6.7	240	U	79	J	63	J	390	U	230	U
Acetophone	NL	470	U	440	U	450	U	760	U	440	U
Anthracene	57.2	240	U	110	J	65	J	390	U	230	U
Benzo(a)anthracene	108	240	U	58	J	230	U	390	U	71	J
Benzo(a)pyrene	150	240	U	230	U	230	U	390	U	56	J
Bis(2-ethylhexyl)phthalate	180	240	U	230	U	230	U	390	U	230	U
Chrysene	166	240	U	59	J	230	U	390	U	76	J
Dibenzofuran	415	240	U	160	J	150	J	390	U	230	U
Dimethyl phthalate	NL	280		230	U	390		950		480	
Fluoranthene	423	470	U	120	J	55	J	760	U	130	J
Fluorene	77.4	240	U	330		270		98	J	51	J
Naphthalene	176	240	U	190	J	260		390	U	230	U
Phenanthrene	204	240	U	330		210	J	110	J	120	J
Phenol	420	95	U	130	J	100	J	280	J	120	J
Pyrene	195	240	U	170	J	66	J	390	U	150	J
TOC (mg/kg)		4,800	R	9,850	R	11,600	R	17,400	R	3.41	R

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA Region 4 Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of EPA Region 4 Screening Value
Biphenyl is a synonym for 1,1-Biphenyl; mp-Cresol is a synonym for 2-Methylphenol; and o-Cresol is a synonym for 4-Methylphenol
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
µg/kg = micrograms per kilogram
NL = No listed value
Q = Qualifier

R = The data are unusable. The sample results are rejected due to serious deficiencies in meeting QC criteria. The analyte may or may not be present in the sample.
SIM = Selected Ion Monitoring

(T) = Total Xylenes

U = The analyte was analyzed for, but was not detected above the level of the reported sam
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

Table 5
2017 Sediment - Equilibrium Partitioning Sediment Benchmark Comparisons
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:		KCW-**BG1**-SD-001				KCW-**TR1**-SD-001				KCW-**TR2**-SD-001				KCW-**TR2**-SD-001D			
Sample Date:		7/27/2017				7/30/2017				7/30/2017				7/30/2017			
Units:	$C_{OC,PAHi,FCVi}$	µg/kg		(µg/g_{oc})	µg/kg	µg/kg		(µg/g_{oc})	µg/kg	µg/kg		(µg/g_{oc})	µg/kg	µg/kg		(µg/g_{oc})	µg/kg
Analyte (PAH by SIM)	(µg/g_{oc})	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$
2-Methylnaphthalene	447	5.0	U			6.4	U			10		532	1.2	13		691	1.5
Acenaphthene	491	3.4	J	178	0.36	5.9	J	369	0.75	10	U			9.9	U		
Acenaphthylene	452	5.0	U			6.5		406	0.90	10	U			9.9	U		
Anthracene	594	19		995	1.7	16		1000	1.7	6.1	J	324	0.55	9.9	U		
Benzo(a)anthracene	841	37		1937	2.3	79		4938	5.9	4.5	J	239	0.28	6.3	J	335	0.40
Benzo(a)pyrene	965	29		1518	1.6	92		5750	6.0	3.9	J	207	0.21	5.0	J	266	0.28
Benzo(b)fluoranthene	979	32		1675	1.7	94		5875	6.0	3.1	J	165	0.17	9.9	U		
Benzo(g,h,i)perylene	1095	11		576	0.53	47		2938	2.7	10	U			9.9	U		
Benzo(k)fluoranthene	981	12		628	0.64	41		2563	2.6	3.2	J	170	0.17	9.9	U		
Chrysene	844	35		1832	2.2	86		5375	6.4	4.3	J	229	0.27	6.2	J	330	0.39
Dibenz(a,h)anthracene	1123	7.3		382	0.34	15		938	0.83	10	U			9.9	U		
Fluoranthene	707	67		3508	5.0	170		10625	15	6.8	J	362	0.51	9.5	J	505	0.71
Fluorene	538	8		419	0.78	8.1		506	0.94	7.4	J	394	0.73	9.8	J	521	0.97
Indeno(1,2,3-cd)pyrene	1115	13		681	0.61	50		3125	2.8	10	U			9.9	U		
Naphthalene	385	5.0	U			6.4	U			10	U			9.9	U		
Phenanthrene	596	70		3665	6.1	88		5500	9.2	17		904	1.5	22		1170	2.0
Pyrene	697	70		3665	5.3	170		10625	15	17	J+	904	1.3	21		1117	1.6
Total $\sum ESBTU_{FCV}$					30				83				6.9				7.9
Total Organic Carbon (TOC; mg/kg)		19100	R			16000	R			18800	R			18800	R		

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
2017 SIM PAH data represents concentrations of only 17 compounds and may underestimate toxic effects.
$C_{OC,PAHi,FCVi}$ = Final Chronic Value concentration normalized to organic carbon
C_{OC} = Concentration normalized to organic carbon
ESB = equilibrium partitioning sediment benchmark
$ESBTU_{FCVi}$ = Equilibrium partitioning benchmark toxic units (dimensionless)
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
PAH = polyaromatic hydrocarbon
Q = Data qualifier
SD = sediment
SIM = Selected Ion Monitoring
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 5
2017 Sediment - Equilibrium Partitioning Sediment Benchmark Comparisons
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:		KCW-**TR2**-SD-002				KCW-**TR2**-SD-003				KCW-**TR2**-SD-004				KCW-**TR2**-SD-005			
Sample Date:		7/30/2017				7/30/2017				7/28/2017				7/28/2017			
Units:	**$C_{OC,PAHi,FCVi}$**	µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg
Analyte (PAH by SIM)	**($\mu g/g_{oc}$)**	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$
2-Methylnaphthalene	447	490		24378	55	7.9	U			42		4789	11	140		6796	15
Acenaphthene	491	66		3284	6.7	7.9	U			6.3		718	1.5	31		1505	3.1
Acenaphthylene	452	37		1841	4.1	7.9	U			2.7	J	308	0.68	17		825	1.8
Anthracene	594	190		9453	16	7.9	U			18		2052	3.5	120		5825	9.8
Benzo(a)anthracene	841	98		4876	5.8	2.5	J	159	0.19	15		1710	2.0	140		6796	8.1
Benzo(a)pyrene	965	81		4030	4.2	2.2	J	140	0.15	6.4		730	0.76	82		3981	4.1
Benzo(b)fluoranthene	979	84		4179	4.3	7.9	U			7.1		810	0.83	80		3883	4.0
Benzo(g,h,i)perylene	1095	31		1542	1.4	7.9	U			4.5	U			28		1359	1.2
Benzo(k)fluoranthene	981	32		1592	1.6	7.9	U			1.7	J	194	0.20	20		971	1.0
Chrysene	844	110		5473	6.5	2.5	J	159	0.19	15		1710	2.0	140		6796	8.1
Dibenz(a,h)anthracene	1123	11		547	0.49	7.9	U			4.5	U			8.9		432	0.38
Fluoranthene	707	310		15423	22	4.5	J	287	0.41	24		2737	3.9	190		9223	13
Fluorene	538	400		19900	37	4.8	J	306	0.57	26		2965	5.5	110		5340	9.9
Indeno(1,2,3-cd)pyrene	1115	34		1692	1.5	7.9	U			2.3	J	262	0.24	35		1699	1.5
Naphthalene	385	280		13930	36	7.9	U			17		1938	5.0	53		2573	6.7
Phenanthrene	596	740	J	36816	62	9.6		611	1.0	51		5815	9.8	450		21845	37
Pyrene	697	410		20398	29	8.9		567	0.81	42		4789	6.9	350		16990	24
Total $\sum ESBTU_{FCV}$					301				3.3				55				196
Total Organic Carbon (TOC; mg/kg)		20100	R			15700	R			8770	R			20600	R		

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
2017 SIM PAH data represents concentrations of only 17 compounds and may underestimate toxic effects.
$C_{OC,PAHi,FCVi}$ = Final Chronic Value concentration normalized to organic carbon
C_{OC} = Concentration normalized to organic carbon
ESB = equilibrium partitioning sediment benchmark
$ESBTU_{FCVi}$ = Equilibrium partitioning benchmark toxic units (dimensionless)
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
PAH = polyaromatic hydrocarbon
Q = Data qualifier
SD = sediment
SIM = Selected Ion Monitoring
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 5
2017 Sediment - Equilibrium Partitioning Sediment Benchmark Comparisons
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:		KCW-**TR2**-SD-006				KCW-**KC1**-SD-001				KCW-**KC2**-SD-001				KCW-**KC2**-SD-002			
Sample Date:		7/28/2017				7/31/2017				7/31/2017				7/31/2017			
Units:	$C_{OC,PAHi,FCVi}$	µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg
Analyte (PAH by SIM)	**($\mu g/g_{oc}$)**	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$
2-Methylnaphthalene	447	590	J	29208	65	10	U			310		34560	77	18		3750	8.4
Acenaphthene	491	62		3069	6.3	10	U			22		2453	5.0	2.4	J	500	1.0
Acenaphthylene	452	26		1287	2.8	10	U			16		1784	3.9	4.7	U		
Anthracene	594	190		9406	16	10	U			21		2341	3.9	4.7	U		
Benzo(a)anthracene	841	76		3762	4.5	10	U			13		1449	1.7	3.3	J	688	0.82
Benzo(a)pyrene	965	34		1683	1.7	10	U			9.0		1003	1.0	2.4	J	500	0.52
Benzo(b)fluoranthene	979	27		1337	1.4	10	U			9.9		1104	1.1	4.7	U		
Benzo(g,h,i)perylene	1095	11		545	0.50	10	U			3.9	J	435	0.40	4.7	U		
Benzo(k)fluoranthene	981	8.6		426	0.43	10	U			3.9	J	435	0.44	4.7	U		
Chrysene	844	74		3663	4.3	10	U			13		1449	1.7	3.7	J	771	0.91
Dibenz(a,h)anthracene	1123	3.0	J	149	0.13	10	U			4.5	U			4.7	U		
Fluoranthene	707	140		6931	9.8	10	U			29		3233	4.6	6.7		1396	2.0
Fluorene	538	330		16337	30	10	U			94		10479	19	9.9		2063	3.8
Indeno(1,2,3-cd)pyrene	1115	11		545	0.49	10	U			3.9	J	435	0.39	4.7	U		
Naphthalene	385	180		8911	23	10	U			220		24526	64	7.8		1625	4.2
Phenanthrene	596	490	J	24257	41	10	U			66		7358	12	16		3333	5.6
Pyrene	697	250		12376	18	10	U			40		4459	6.4	13		2708	3.9
Total ∑ESBTUFCV					236								207				31
Total Organic Carbon (TOC; mg/kg)		20200	R			17300	R			8970	R			4800	R		

Notes:
BG1 = Reference Site; **TR1** = Mount Alton Background; **TR2** = Mount Alton Site; **KC1** = Backus Background; **KC2** = Backus Site
2017 SIM PAH data represents concentrations of only 17 compounds and may underestimate toxic effects.
$C_{OC,PAHi,FCVi}$ = Final Chronic Value concentration normalized to organic carbon
C_{OC} = Concentration normalized to organic carbon
ESB = equilibrium partitioning sediment benchmark
$ESBTU_{FCVi}$ = Equilibrium partitioning benchmark toxic units (dimensionless)
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
PAH = polyaromatic hydrocarbon
Q = Data qualifier
SD = sediment
SIM = Selected Ion Monitoring
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 5
2017 Sediment - Equilibrium Partitioning Sediment Benchmark Comparisons
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:		KCW-**KC2**-SD-003				KCW-**KC2**-SD-004				KCW-**KC2**-SD-005				KCW-**KC2**-SD-006			
Sample Date:		7/31/2017				7/31/2017				7/31/2017				7/31/2017			
Units:	$C_{OC,PAHi,FCVi}$	µg/kg		($µg/g_{oc}$)	µg/kg	µg/kg		($µg/g_{oc}$)	µg/kg	µg/kg		($µg/g_{oc}$)	µg/kg	µg/kg		($µg/g_{oc}$)	µg/kg
Analyte (PAH by SIM)	($µg/g_{oc}$)	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$
2-Methylnaphthalene	447	440	J	44670	100	650	J	56034	125	170		9770	22	43		12609971	28210
Acenaphthene	491	50		5076	10	36		3103	6.3	18		1034	2.1	14		4105572	8362
Acenaphthylene	452	19		1929	4.3	13		1121	2.5	7.6	U			7.5		2199413	4866
Anthracene	594	100	J+	10152	17	59		5086	8.6	32		1839	3.1	32		9384164	15798
Benzo(a)anthracene	841	47		4772	5.7	16		1379	1.6	22		1264	1.5	60		17595308	20922
Benzo(a)pyrene	965	30		3046	3.2	7.7		664	0.69	19		1092	1.1	51		14956012	15498
Benzo(b)fluoranthene	979	25		2538	2.6	6.2		534	0.55	20		1149	1.2	62		18181818	18572
Benzo(g,h,i)perylene	1095	12		1218	1.1	2.7	J	233	0.21	8.7		500	0.46	24		7038123	6428
Benzo(k)fluoranthene	981	9.2		934	1.0	1.7	J	147	0.15	6.4	J	368	0.37	22		6451613	6577
Chrysene	844	50		5076	6.0	14		1207	1.4	22		1264	1.5	58		17008798	20153
Dibenz(a,h)anthracene	1123	4.4	U			4.5	U			7.6	U			8.4		2463343	2194
Fluoranthene	707	87	J+	8832	12	34		2931	4.1	45		2586	3.7	130		38123167	53922
Fluorene	538	250	J+	25381	47	250		21552	40	71		4080	7.6	42		12316716	22894
Indeno(1,2,3-cd)pyrene	1115	12		1218	1.1	2.5	J	216	0.19	8.3		477	0.43	25		7331378	6575
Naphthalene	385	160	J+	16244	42	250		21552	56	66		3793	9.9	18		5278592	13711
Phenanthrene	596	300	J+	30457	51	190		16379	27	99		5690	9.5	130		38123167	63965
Pyrene	697	150	J+	15228	22	59		5086	7.3	67		3851	5.5	180		52785924	75733
Total ∑ESBTUFCV					355				283				74				398370
Total Organic Carbon (TOC; mg/kg)		9850	R			11600	R			17400	R			3.41	R		

Notes:
BG1 = Reference Site; **TR1** = Mount Alton Background; **TR2** = Mount Alton Site; **KC1** = Backus Background; **KC2** = Backus Site
2017 SIM PAH data represents concentrations of only 17 compounds and may underestimate toxic effects.
$C_{OC,PAHi,FCVi}$ = Final Chronic Value concentration normalized to organic carbon
C_{OC} = Concentration normalized to organic carbon
ESB = equilibrium partitioning sediment benchmark
$ESBTU_{FCVi}$ = Equilibrium partitioning benchmark toxic units (dimensionless)
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
PAH = polyaromatic hydrocarbon
Q = Data qualifier
SD = sediment
SIM = Selected Ion Monitoring
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 6
2017 Sediment - Benchmark Comparisons - Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (mg/kg)**	KCW-**BG1**-SD-001		KCW-**TR1**-SD-001		KCW-**TR2**-SD-001		KCW-**TR2**-SD-001D		KCW-**TR2**-SD-002		KCW-**TR2**-SD-003		KCW-**TR2**-SD-004		KCW-**TR2**-SD-005	
CLP Sample Number:		MC0AG4		MC0AA1		MC0AA3		MC0AA4		MC0AA5		MC0AA6		MC0AA7		MC0AA8	
Units:		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg	
Sample Date:		7/27/2017		7/30/2017		7/30/2017		7/30/2017		7/30/2017		7/30/2017		7/28/2017		7/28/2017	
Sample Type:		Background		Background		Field		Dup of MC0AA3		Field		Field		Field		Field	
Metals		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Aluminum	25,000	4020		8210		12100		12000		5980		9470		6300		15900	
Antimony	2	9.2	UJ	0.97	J	15.7	UJ	15.5	UJ	11.3	UJ	13.2	UJ	8.1	UJ	13.9	UJ
Arsenic	9.8	5.8		20.7	J	6.8	J	7.3	J	12.3	J	6.4	J	3.7		8.7	
Barium	20	66.0		67.1		132		142		112		100		99.1		89.2	
Beryllium	NL	0.85		0.97		1.4		1.5		1.4		1.1	UJ	0.78		2.3	
Cadmium	1	0.41	J	2.2		2.3		2.3		3.0		2.0		0.85		2.3	
Calcium	NL	768	UJ	1930		1310	U	1290	U	2250		1110		676	U	1150	U
Chromium	43.4	6.1	J	13.6	J	14.8	J	14.6	J	8.3	J	12.2	J	10.1		15.1	
Cobalt	50	7.5	J	13.7		21.0		20.2		31.4		17.3		11.0		21.8	
Copper	31.6	6.1		35.9	J	25.1	J	24.9	J	203	J	17.8	J	23.4		42.9	
Iron	20,000	15700		43100	J	45000	J	45500	J	86200	J	43100	J	24100		46200	
Lead	35.8	14.6		125	J	30.5	J	30.2	J	43.1	J	22.9	J	10.6		41.1	
Magnesium	NL	335	J	1080		1010	J	995	J	791	J	866	J	631	J	943	J
Manganese	460	446	J	319	J	624	J	687	J	832	J	716	J	342		304	
Mercury	0.18	0.035	J	0.24		0.081	J	0.089	J	0.057	J	0.071	J	0.028	J	0.12	J
Nickel	22.7	15.0		25.1		24.4		22.3		33.7		17.2		8.8		20.8	
Potassium	NL	768	U	997		1310	U	1290	U	943	U	1100	U	971		1150	U
Selenium	0.72	5.4	U	4.2	J	1.3	J	1.4	J	0.68	J	0.90	J	0.49	J	1.1	J
Silver	1	0.10	J	0.39	J	0.12	J	0.18	J	1.9	U	0.17	J	0.14	J	0.19	J
Sodium	NL	768	U	876	U	1310	U	1290	U	943	U	1100	U	676	U	1150	U
Thallium	NL	3.8	UJ	4.4	U	6.5	U	6.4	U	4.7	U	5.5	U	3.4	U	5.8	U
Vanadium	NL	9.1		18.1		21.3		20.9		13.2		17.2		11.4		21.7	
Zinc	121	92.3		155		141		136		110		120		70.4		162	

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA Region 4 Freshwater Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of EPA Region 4 Screening Value
J = Reported value is estimated; actual value may be higher or lower
mg/kg = milligrams per kilogram
NL = No listed value
Q = Qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limi
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 6
2017 Sediment - Benchmark Comparisons - Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Sediment (mg/kg)**	KCW-**TR2**-SD-006		KCW-**KC1**-SD-001		KCW-**KC2**-SD-001		KCW-**KC2**-SD-002		KCW-**KC2**-SD-003		KCW-**KC2**-SD-004		KCW-**KC2**-SD-005		KCW-**KC2**-SD-006	
CLP Sample Number:		MC0AA9		MC0AB9		MC0AC1		MC0AC2		MC0AC3		MC0AC4		MC0AC5		MC0AC6	
Units:		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg		mg/Kg	
Sample Date:		7/28/2017		7/31/2017		7/31/2017		7/31/2017		7/31/2017		7/31/2017		7/31/2017		7/31/2017	
Sample Type:		Field		Background		Field		Field		Field		Field		Field		Field	
Metals		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Aluminum	25,000	10800		15400		4390		3350		5020		5420		7810		6330	
Antimony	2	10.7	UJ	17.0	UJ	8.3	UJ	7.9	UJ	7.9	UJ	8.1	UJ	11.4	UJ	7.7	UJ
Arsenic	9.8	5.6		7.5	J	2.5	J	2.2	J	3.1	J	6.5	J	5.5	J	9.7	J
Barium	20	52.3		113		34.3		26.2	UJ	51.5		37.2		68.6		35.7	
Beryllium	NL	0.56	J	1.4	UJ	0.69	U	0.66	U	0.66	UJ	0.67	UJ	0.95	UJ	0.94	
Cadmium	1	0.89	UJ	1.8		0.69	UJ	0.66	UJ	0.86		2.4		1.2		1.4	
Calcium	NL	891	U	1420	U	693	U	656	U	661	U	672	U	2400		644	U
Chromium	43.4	12.4		20.9	J	7.8	J	6.3	J	8.5	J	14.9	J	11.0	J	17.9	J
Cobalt	50	8.9	UJ	17.1		7.0		6.6	UJ	12.4		13.1		9.5	UJ	12.1	
Copper	31.6	13.5		19.7	J	7.4	J	3.6	J	17.6	J	21.8	J	48.2	J	22.3	J
Iron	20,000	21600		33600	J	16100	J	13400	J	21500	J	71100	J	23900	J	37100	J
Lead	35.8	18.9		27.2	J	7.0	J	5.1	J	16.5	J	20.1	J	21.2	J	15.6	J
Magnesium	NL	908		1500		435	J	361	J	650	J	454	J	990		837	
Manganese	460	133		313	J	283	J	90.7	J	219	J	96.2	J	258	J	270	J
Mercury	0.18	0.073	J	0.098	J	0.14	U	0.13	U	0.13	U	0.13	U	0.057	J	0.049	J
Nickel	22.7	7.8		13.7		7.3		5.9		15.8		24.8		9.7		15.7	
Potassium	NL	891	U	1430		693	U	656	U	661	U	672	U	951	U	790	
Selenium	1	0.53	J	1.2	J	0.66	J	0.23	J	0.38	J	0.71	J	0.60	J	0.49	J
Silver	1	0.15	J	2.8	U	1.4	U	1.3	U	0.062	J	1.3	U	0.097	J	0.082	J
Sodium	NL	891	U	1420	U	693	U	656	U	661	U	672	U	951	U	644	U
Thallium	NL	4.5	U	7.1	U	3.5	U	3.3	U	3.3	U	3.4	U	4.8	U	3.2	U
Vanadium	NL	18.1		29.5		9.3		7.3		11.0		11.4		15.2		18.2	
Zinc	121	41.7		121		52.1		41.6		69.7		39.7		78.9		103	

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA Region 4 Freshwater Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of EPA Region 4 Screening Value
J = Reported value is estimated; actual value may be higher or lower
mg/kg = milligrams per kilogram
NL = No listed value
Q = Qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limi
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 7
2018 Surface Water - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	Chronic Freshwater Benchmark (µg/L)	KCW-**BG1**-SW-002		KCW-**TR1**-SW-002		KCW-**TR1**-SW-002D		KCW-**TR2**-SW-007		KCW-**TR2**-SW-008		KCW-**TR2**-SW-008D		KCW-**KC1**-SW-002		KCW-**KC2**-SW-007		KCW-**KC2**-SW-008	
CLP Sample Number:		MC0AL6		MC0AK3		MC0AK3D		MC0AJ6		MC0AJ7		MC0AJ8		MC0AL3		MC0AK6		MC0AK7	
Units:		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L	
Sample Date:		10/1/2018		10/3/2018		10/03/218		10/2/2018		10/2/2018		10/3/2018		10/3/2018		10/3/2018		10/3/2018	
Sample Type:		Background		Background		Background		Field		Field		Dup of MC0AJ7		Background		Field		Field	
PAHs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
2-Methylnaphthalene	4.7	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.21		0.1	
Acenaphthene	15	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Acenaphthylene	13	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Anthracene	0.02	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.04	J	0.02	J
Benzo(a)anthracene	4.7	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Benzo(a)pyrene	0.006	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Benzo(b)fluoranthene	2.6	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Benzo(g,h,i)perylene	0.012	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Benzo(k)fluoranthene	0.06	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Chrysene	4.7	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Dibenzo(a,h)anthracene	0.012	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Fluoranthene	0.8	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.04	J	0.02	J
Fluorene	19	0.1	U	0.1	U			0.1	U	0.03	J	0.03	J	0.1	U	0.12		0.04	J
Indeno(1,2,3-cd)pyrene	0.012	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Naphthalene	21	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.1		0.1	U
Pentachlorophenol	15	0.2	U	0.2	U			0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Phenanthrene	2.3	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.1		0.04	J
Pyrene	4.6	0.1	U	0.1	U			0.1	U	0.1	U	0.1	U	0.1	U	0.06	J	0.1	U
SVOCs																			
Dimethyl phthalate	NL	8.7		2.2	J			5	U	2.3	J	1.9	J	7.9		5	U	5	U
Di-n-butyl phthalate	19	5	U	5	U			5	U	5	U	5	U	5	U	5	U	5	U
Di-n-octyl phthalate	250	10	U	10	U			10	U	10	U	10	U	10	U	10	U	10	U
Fluoranthene	0.8	10	U	10	U			10	U	10	U	10	U	10	U	10	U	10	U
Fluorene	19	5	U	5	U			5	U	5	U	5	U	5	U	5	U	5	U
Hexachlorobenzene	0.15	5	U	5	U			5	U	5	U	5	U	5	U	5	U	5	U
Hexachlorobutadiene	1	5	U	5	U			5	U	5	U	5	U	5	U	5	U	5	U
Hexachlorocyclopentadiene	0.45	10	U	10	U			10	U	10	U	10	U	10	U	10	U	10	U
Hexachloroethane	12	5	U	5	U			5	U	5	U	5	U	5	U	5	U	5	U
Isophorone	920	5	U	5	U			5	U	5	U	5	U	5	U	5	U	5	U
Nitrobenzene	230	5	U	5	U			5	U	5	U	5	U	5	U	5	U	5	U
N-Nitroso-di-n-propylamine	NL	5	U	5	U			5	U	5	U	5	U	5	U	5	U	5	U
N-Nitrosodiphenylamine	25	5	U	5	U			5	U	5	U	5	U	5	U	5	U	5	U
Phenol	160	10	U	2.2	J			10	U	10	U	2.1	J	10	U	1.4	J	1.5	J
Total Alkanes	NL			7.1												5.2			

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA National AWQC (2020) for pentachlorophenol and EPA Region 4 Freshwater Chronic Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
J = Reported value is estimated; actual value may be higher or lower
NL = No listed value
PAH = Polyaromatic hydrocarbon
Q = Qualifier
SVOC = Semi-volatile organic compound
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
µg/L = micrograms per liter

Table 8
2018 Surface Water - Benchmark Comparisons - Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**BG1**-SW-002		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR1**-SW-002		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR1**-SW-002D		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-007		**Chronic Freshwater Benchmark (µg/L)**
CLP Sample Number:		MC0AL6			MC0AK3			MC0AK3D			MC0AJ6		
Units:		µg/L			µg/L			µg/L			µg/L		
Sample Date:		10/1/2018			10/3/2018			10/03/218			10/2/2018		
Sample Type:		Background			Background			Background			Field		
Metals		Result	Q		Result	Q		Result	Q		Result	Q	
Aluminum	87	242		87	135		87	113		87	39.1		87
Antimony	190	2	U	190	2	U	190	0.34	J	190	2	U	190
Arsenic	150	0.58	J	150	0.34	J	150	0.31	J	150	0.27	J	150
Barium	220	50.5		220	18.9		220	17.5		220	20.2		220
Beryllium	11	1	U	11	1	U	11	1	U	11	1	U	11
Cadmium	0.17	1	U	0.19	1	U	0.17	0.043	J	0.15	1	U	0.15
Calcium	116,000	4530		116,000	5500		116,000	4910		116,000	3710		116,000
Chromium	11	2	U	11	2	U	11	0.26	J	11	2	U	11
Cobalt	19	1	U	19	1	U	19	0.43	J	19	1	U	19
Copper	1.8	2	U	1.96	2	U	1.8	0.96	J	1.5	2	U	1.6
Iron	1,000	966		1,000	652		1,000	581		1,000	446		1,000
Lead	0	1	U	0.35	1	U	0.305	0.42	J	0.24	1	U	0.26
Magnesium	82,000	918		82,000	760		82,000	676		82,000	766		82,000
Manganese	93	114		93	82.2		93	73.2		93	93.5		93
Mercury	0.77	0.2	UJ	0.77	0.2	UJ	0.77	0.2	U	0.77	0.2	UJ	0.77
Nickel	11	1.5		12	1.3		10	1.2		8.9	1.6		9.3
Potassium	53,000	1410		53,000	874		53,000	824		53,000	898		53,000
Selenium	5	5	U	5	5	U	5	5	U	5	5	U	5
Silver	0.06	1	U	0.06	1	U	0.06	0.01	J	0.06	1	U	0.06
Sodium	680,000	16300		680,000	6790		680,000	6250		680,000	5940		680,000
Thallium	6	1	U	6	1	U	6	1	U	6	1	U	6
Vanadium	27	5	U	27	5	U	27	5	U	27	5	U	27
Zinc	24	6.9		26	5.3	J+	24	5.1		20	4.3	J+	21

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA National AWQC (2020) for Al,As,Cd,Cr,Cu,Fe,Pb,Ni,Se,Ag and Zn, and EPA Region 4 Freshwater Chronic Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
NL = No listed value
Q = Qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise
µg/L = micrograms per liter

Table 8
2018 Surface Water - Benchmark Comparisons - Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	KCW-**TR2**-SW-008		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-008D		**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC1**-SW-002		**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC2**-SW-007		**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC2**-SW-008	
CLP Sample Number:	MC0AJ7			MC0AJ8			MC0AL3			MC0AK6			MC0AK7	
Units:	µg/L			µg/L			µg/L			µg/L			µg/L	
Sample Date:	10/2/2018			10/3/2018			10/3/2018			10/3/2018			10/3/2018	
Sample Type:	Field			Dup of MC0AJ7			Background			Field			Field	
Metals	Result	Q		Result	Q		Result	Q		Result	Q		Result	Q
Aluminum	241		87	181		87	179		87	1060		87	341	
Antimony	2	U	190	2	U	190	2.0	U	190	2	U	190	2	U
Arsenic	0.53	J	150	0.44	J	150	0.28	J	150	0.92	J	150	0.55	J
Barium	23.6		220	22.6		220	29.4		220	31.7		220	25.9	
Beryllium	0.09	J	11	1	U	11	0.077	J	11	0.13	J	11	1	U
Cadmium	1	U	0.15	1	U	0.097	1	U	0.13	1	U	0.11	1	U
Calcium	3880		116,000	3820		116,000	1780		116,000	2850		116,000	2390	
Chromium	2	U	11	2	U	8.5	2	U	11	2	U	10	2	U
Cobalt	1	U	19	1	U	19	1	U	19	1.8		19	1	U
Copper	2	U	1.5	2	U	0.93	2	U	1.3	6		1.1	2	U
Iron	1800		1,000	1370		1,000	741		1,000	3330		1,000	1530	
Lead	1	U	0.25	1	U	0.13	1	U	0.19	2.8		0.15	1	U
Magnesium	807		82,000	791		82,000	638		82,000	729		82,000	564	
Manganese	121		93	112		93	52.1		93	148		93	91.8	
Mercury	0.2	UJ	0.77	0.2	UJ	0.77	0.2	UJ	0.77	0.2	UJ	0.77	0.2	UJ
Nickel	1.9		9.1	2.1		5.5	2.1		7.5	2.7		6.3	1.9	
Potassium	932		53,000	925		53,000	524		53,000	834		53,000	785	
Selenium	5	U	5	5	U	5	5	U	5	5	U	5	5	U
Silver	1	U	0.06	1	U	0.06	1	U	0.06	1	U	0.06	1	U
Sodium	6080		680,000	6030		680,000	500	U	680,000	4410		680,000	4480	
Thallium	1	U	6	1	U	6	1	U	6	1	U	6	1	U
Vanadium	5	U	27	5	U	27	5	U	27	5	U	27	5	U
Zinc	8.7		21	7.8		13	8.7		17	15.4		14	9	

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA National AWQC (2020) for Al,As,Cd,Cr,Cu,Fe,Pb,Ni,Se,Ag and Zn, and EPA Region 4 Freshwater Chronic Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
NL = No listed value
Q = Qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise
µg/L = micrograms per liter

Table 9
2018 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (µg/kg)**	KCW-**BG1**-SD-002		KCW-**TR1**-SD-002		KCW-**TR2**-SD-007		KCW-**TR2**-SD-008		KCW-**KC1**-SD-002		KCW-**KC2**-SD-007		KCW-**KC2**-SD-008		KCW-**KC2**-SD-008D	
CLP Sample Number:		MC0AL7		MC0AK4		MCOAJ9		MC0AK0		MC0AL4		MC0AK8		MC0AK9		MC0AL0	
Units:		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg	
Sample Date:		10/1/2018		10/3/2018		10/3/2018		10/03/218		10/2/2018		10/2/2018		10/3/2018		10/3/2018	
Sample Type:		Background		Background		Field		Field		Background		Field		Field		Dup of MC0AK9	
PAHs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
2-Methylnaphthalene	20	4.1	U	7.4	U	410	J	190		4.4	U	110		110		40	
Acenaphthene	6.7	4.1	U	7.4	U	32		22		4.4	U	14		21		8.5	
Acenaphthylene	5.9	4.1	U	13		16		9.2		4.4	U	6.2		8.8		3.8	J
Anthracene	57	4.1	U	24		110		55		4.4	U	31		50		16	
Benzo(a)anthracene	108	4.1	U	100		41		26		4.4	U	13		48		17	
Benzo(a)pyrene	150	4.1	U	98		25		15		4.4	U	13		39		13	
Benzo(b)fluoranthene	190	4.1	U	110		20		13		4.4	U	18		43		17	
Benzo(g,h,i)perylene	170	4.1	U	60		10		6.6		4.4	U	7.9		23		8.2	
Benzo(k)fluoranthene	240	4.1	U	38		5.1		2.9	J	4.4	U	5.1		15		4.8	
Chrysene	166	4.1	U	110		34		25		8.4		20		47		18	
Dibenzo(a,h)anthracene	33	4.1	U	18		2.9	J	1.8	J	4.4	U	4.5	U	6.8		2.4	J
Fluoranthene	423	4.1	U	230		87		47		4.4	U	50		110		29	
Fluorene	77	4.1	U	18		190		120		4.4	U	66		110		35	
Indeno(1,2,3-cd)pyrene	200	4.1	U	55		9.1		6.3		4.4	U	7.0		21		7.6	
Naphthalene	176	4.1	U	7.4	U	150		66		4.4	U	31		20		9.6	
Pentachlorophenol	10	8.4	U	15	U	8.6	U	9.0	U	9.0	U	9.0	U	8.1	U	8.5	U
Phenanthrene	204	4.1	U	160		290		180		4.4	U	110		170		53	
Pyrene	195	4.1	U	240		120		71		4.4	U	56		120		45	
SVOCs																	
.alpha.-Methyl stilbene	NL											120	J				
[1,1-Biphenyl]-4-carboxaldehyde	NL							140	J					150	J		
1,1-Biphenyl	198	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
1,2,3-Trimethylindene	NL											94	J				
1,2,4,5-Tetrachlorobenzene	187	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
1,4-Dioxane	NL	84	U	150	U	86	U	90	U	90	U	90	U	81	U	85	U
1,7-Dimethyl-3-phenyltricyclo[4.1.	NL							330	J								
1H-Benzimidazole, 2-ethyl-	NL					140	J	130	J								
1H-Cyclopropa[l]phenanthrene,1a,9b	NL							100	J								
1-Heptadecanol	NL							360	J								
1H-Indazole, 3,6-dimethyl-	NL					220	J										
1H-Indene, 1,3-dimethyl-	NL					130	J										
2,2-oxybis(1-Chloropropane)	NL	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
2,3,4,6-Tetrachlorophenol	30	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
2,4,5-Trichlorophenol	34	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
2,4,6-Cycloheptatrien-1-one, 2-phe	NL					210	J										
2,4,6-Trichlorophenol	89	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
2,4-Dichlorophenol	57	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
2,4-Dimethylphenol	39	210	U	380	U	74	J	230	U	230	U	230	U	200	U	220	U
2,4-Dinitrophenol	223	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
2,4-Dinitrotoluene	290	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
2,5,6-Trimethylbenzimidazole	NL					120	J							160	J		
2,6-Dinitrotoluene	296	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
2-Chloronaphthalene	NL	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U

Table 9
2018 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (µg/kg)**	KCW-**BG1**-SD-002		KCW-**TR1**-SD-002		KCW-**TR2**-SD-007		KCW-**TR2**-SD-008		KCW-**KC1**-SD-002		KCW-**KC2**-SD-007		KCW-**KC2**-SD-008		KCW-**KC2**-SD-008D	
CLP Sample Number:		MC0AL7		MC0AK4		MCOAJ9		MC0AK0		MC0AL4		MC0AK8		MC0AK9		MC0AL0	
Units:		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg	
Sample Date:		10/1/2018		10/3/2018		10/3/2018		10/03/218		10/2/2018		10/2/2018		10/3/2018		10/3/2018	
Sample Type:		Background		Background		Field		Field		Background		Field		Field		Dup of MC0AK9	
PAHs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
SVOCs																	
2-Chlorophenol	55	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
2-Methylphenol	119	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
2-Nitroaniline	NL	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
2-Nitrophenol	168	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
2-Propenal, 2-methyl-3-phenyl-	NL													110	J		
3-Nitroaniline	NL	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
3-Penten-2-one, 4-phenyl-	NL							120	J								
3,3-Dichlorobenzidine	NL	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
4,6-Dinitro-2-methylphenol	NL	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
4-Bromophenyl-phenylether	47	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
4-Chloro-3-methylphenol	NL	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
4-Chloroaniline	0.9	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
4-Chlorophenyl-phenyl ether	NL	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
4-Methoxy-2-methyl-1-(methylthio)b	NL							450	J								
4-Methylphenol	93	410	U	740	U	56	J	440	U	440	U	450	U	400	U	420	U
4-Nitroaniline	NL	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
4-Nitrophenol	153	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
5-tert-Butylpyrogallol	NL							550	J								
6H-Dibenzo[b,d]-pyran	NL							130	J			160	J	94	J		
9H-Fluoren-9-ol	NL					230	J							150	J		
9H-Fluorene, 2-methyl-	NL													240	J		
9H-Fluorene, 2,3-dimethyl-	NL					190	J	100	J								
9H-Fluorene, 9-methyl-	NL					130	J										
9H-Fluorene, 9,9-dimethyl-	NL													140	J		
Acetophenone	NL	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
A-Norcholestan-3-one, 5-ethenyl-,	NL											410	J				
Atrazine	0.3	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
Benzaldehyde	59	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
Benzenamine, 4-chloro-N-(2-pyridin	NL															250	J
Benzene, 4-ethyl-1,2-dimethyl-	NL					200	J										
PAHs by SIM																	
Benzocycloheptatriene	NL													110	J		
Bis(2-Chloroethoxy)methane	NL	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
Bis(2-Chloroethyl)ether	NL	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
Bis(2-ethylhexyl)phthalate	180	210	U	380	U	220	U	230	U	230	U	230	U	46	J	220	U
Butylbenzyl phthalate	0.59	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
Caprolactam	NL	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
Carbazole	69	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
Dibenzofuran	510	210	U	380	U	110	J	64	J	230	U	230	U	58	J	220	U
Dibenzofuran, 4-methyl-	NL					270	J							210	J		
Diethyl phthalate	NL	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
PAHs by SIM																	

Table 9
2018 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	EPA Region 4 Freshwater Sediment (µg/kg)	KCW-**BG1**-SD-002		KCW-**TR1**-SD-002		KCW-**TR2**-SD-007		KCW-**TR2**-SD-008		KCW-**KC1**-SD-002		KCW-**KC2**-SD-007		KCW-**KC2**-SD-008		KCW-**KC2**-SD-008D	
CLP Sample Number:		MC0AL7		MC0AK4		MCOAJ9		MC0AK0		MC0AL4		MC0AK8		MC0AK9		MC0AL0	
Units:		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg	
Sample Date:		10/1/2018		10/3/2018		10/3/2018		10/03/218		10/2/2018		10/2/2018		10/3/2018		10/3/2018	
Sample Type:		Background		Background		Field		Field		Background		Field		Field		Dup of MC0AK9	
PAHs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Dimethyl phthalate	NL	390		620		270		290		250		320		290		350	
Di-n-butyl phthalate	11	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
Di-n-octyl phthalate	39	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
Ethanone, 1-(2,6-dihydroxy-4-metho	NL					700	J										
Ethanone, 1-(4-hydroxy-3,5-dimetho	NL					470	J										
Hexachlorobenzene	20	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
Hexachlorobutadiene	NL	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
Hexachlorocyclopentadiene	7	410	U	740	U	420	U	440	U	440	U	450	U	400	U	420	U
Hexachloroethane	27	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
Hydroquinone mono-trimethylsilyl e	NL													110	J		
Isophorone	876	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
Naphthalene, 1-methyl-	141					240	J	150	J								
Naphthalene, 1,3-dimethyl-	NL													98	J		
Naphthalene, 1,4-dimethyl-	NL													190	J		
Naphthalene, 1,4,6-trimethyl-	NL					120	J					93	J				
Naphthalene, 1,6-dimethyl-	NL					150	J							200	J		
Naphthalene, 1,6,7-trimethyl-	NL					98	J							84	J		
Naphthalene, 2,3-dimethyl-	NL					360	J										
Naphthalene, 2,3,6-trimethyl-	NL							110	J					130	J		
Naphthalene, 2,6-dimethyl-	NL							180	J			120	J				
Naphthalene, 2,7-dimethyl-	NL													83	J		
Naphtho[2,1-b]furan, 1,2-dimethyl-	NL					270	J	170	J			110	J	210	J		
Naphtho[2,3-b]norbornadiene	NL													100	J		
N-Hexadecanoic acid	NL	94	J	160	J	710	J	430	J			320	J	510	J	170	J
Nitrobenzene	407	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
N-Nitroso-di-n-propylamine	NL	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
N-Nitrosodiphenylamine	110	210	U	380	U	220	U	230	U	230	U	230	U	200	U	220	U
Octadecanoic acid	NL							100	J								
Phenanthrene, 4-methyl-	NL					90	J										
Phenol	175	240	J	180	J	100	J	100	J	150	J	120	J	89	J	100	J
Phenol, 2-ethyl-4-methyl-	NL							100	J								
Phenol, 2-methoxy-4-propyl-	NL					120	J										
Phenol, 2,6-dimethoxy-	NL					170	J	150	J								
Phenol, 2,6-dimethoxy-4-(2-propeny	NL					120	J										
Phenol, 4-ethyl-2-methoxy-	NL					150	J	110	J								
Tetradecanethiol	NL													81	J		
Squalene	NL											140	J				
Total Alkanes	NL	140		950		6300		2600				3300		4200		490	

Table 9
2018 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (µg/kg)**	KCW-**BG1**-SD-002		KCW-**TR1**-SD-002		KCW-**TR2**-SD-007		KCW-**TR2**-SD-008		KCW-**KC1**-SD-002		KCW-**KC2**-SD-007		KCW-**KC2**-SD-008		KCW-**KC2**-SD-008D	
CLP Sample Number:		MC0AL7		MC0AK4		MCOAJ9		MC0AK0		MC0AL4		MC0AK8		MC0AK9		MC0AL0	
Units:		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg	
Sample Date:		10/1/2018		10/3/2018		10/3/2018		10/03/218		10/2/2018		10/2/2018		10/3/2018		10/3/2018	
Sample Type:		Background		Background		Field		Field		Background		Field		Field		Dup of MC0AK9	
PAHs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Trichloroacetic acid, hexadecyl es	NL															310	J

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA Region 4 Freshwater Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
J = Reported value is estimated; actual value may be higher or lower
NL = No listed value
PAH = Polyaromatic hydrocarbon
Q = Qualifier
SIM = Selective Ion Monitoring
SVOC = Semi-volatile organic compound
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
µg/kg = micrograms per kilogram

Table 10
2018 Sediment - Equilibrium Partitioning Sediment Benchmark Comparisons
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:		KCW-**BG1**-SD-002				KCW-**TR1**-SD-002				KCW-**TR2**-SD-007				KCW-**TR2**-SD-008			
Sample Date:		10/1/2018				10/3/2018				10/3/2018				10/3/2018			
Units:	**$C_{OC,PAHi,FCVi}$ ($\mu g/g_{oc}$)**	µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg
Analyte (PAH by SIM)		Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$
2-Methylnaphthalene	447	4.1	U			160		2985	6.7	290		18831	42	180		7143	16
Acenaphthene	491	4.1	U			7.4	U			32		2078	4.2	22		873	1.8
Acenaphthylene	452	4.1	U			13		243	0.54	16		1039	2.3	9.2		365	0.81
Anthracene	594	4.1	U			24		448	0.75	110		7143	12	55		2183	3.7
Benzo(a)anthracene	841	4.1	U			100		1866	2.2	41		2662	3.2	26		1032	1.2
Benzo(a)pyrene	965	4.1	U			98		1828	1.9	25		1623	1.7	15		595	0.62
Benzo(b)fluoranthene	979	4.1	U			110		2052	2.1	20		1299	1.3	13		516	0.53
Benzo(g,h,i)perylene	1095	4.1	U			60		1119	1.0	10		649	0.59	6.6		262	0.24
Benzo(k)fluoranthene	981	4.1	U			38		709	0.72	5.1		331	0.34	2.9	J	115	0.12
Chrysene	844	4.1	U			110		2052	2.4	34		2208	2.6	25		992	1.2
Dibenz(a,h)anthracene	1123	4.1	U			18		336	0.30	2.9	J	188	0.17	1.8	J	71	0.064
Fluoranthene	707	4.1	U			230		4291	6.1	87		5649	8.0	47		1865	2.6
Fluorene	538	4.1	U			18		336	0.62	190		12338	23	120		4762	8.9
Indeno(1,2,3-cd)pyrene	1115	4.1	U			55		1026	0.92	9.1		591	0.53	6.3		250	0.22
Naphthalene	385	4.1	U			7.4	U			150		9740	25	66		2619	6.8
Phenanthrene	596	4.1	U			160		2985	5.0	290		18831	32	180		7143	12
Pyrene	697	4.1	U			240		4478	6.4	120		7792	11	71		2817	4.0
Total $\sum ESBTU_{FCV}$									30				177				63
Total Organic Carbon (TOC; mg/kg)		5980				53600				15400				25200			

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
2017 SIM PAH data represents concentrations of only 17 compounds and may underestimate toxic effects.
$C_{OC,PAHi,FCVi}$ = Final Chronic Value concentration normalized to organic carbon
C_{OC} = Concentration normalized to organic carbon
$ESBTU_{FCVi}$ = Equilibrium partitioning benchmark toxic units (dimensionless)
ESB = equilibrium partitioning sediment benchmark
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
PAH = polyaromatic hydrocarbon
Q = Data qualifier
SIM = selective ion monitoring
SD = sediment
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 10
2018 Sediment - Equilibrium Partitioning Sediment Benchmark Comparisons
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:		KCW-**KC1**-SD-002				KCW-**KC2**-SD-007				KCW-**KC2**-SD-008				KCW-**KC2**-SD-008D			
Sample Date:		10/2/2018				10/2/2018				10/3/2018				10/3/2018			
Units:	**$C_{OC,PAHi,FCVi}$**	µg/kg		(µg/g_{oc})	µg/kg	µg/kg		(µg/g_{oc})	µg/kg	µg/kg		(µg/g_{oc})	µg/kg	µg/kg		(µg/g_{oc})	µg/kg
Analyte (PAH by SIM)	**(µg/g_{oc})**	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$
2-Methylnaphthalene	447	4.4	U			110		6627	15	170		6464	14	53		1262	2.8
Acenaphthene	491	4.4	U			14		843	1.7	21		798	1.6	8.5		202	0.41
Acenaphthylene	452	4.4	U			6.2		373	0.83	8.8		335	0.74	3.8	J	90	0.20
Anthracene	594	4.4	U			31		1867	3.1	50		1901	3.2	16		381	0.64
Benzo(a)anthracene	841	4.4	U			13		783	0.93	48		1825	2.2	17		405	0.48
Benzo(a)pyrene	965	4.4	U			13		783	0.81	39		1483	1.5	13		310	0.32
Benzo(b)fluoranthene	979	4.4	U			18		1084	1.1	43		1635	1.7	17		405	0.41
Benzo(g,h,i)perylene	1095	4.4	U			7.9		476	0.43	23		875	0.80	8.2		195	0.18
Benzo(k)fluoranthene	981	4.4	U			5.1		307	0.31	15		570	0.58	4.8		114	0.12
Chrysene	844	8.4		459	0.54	20		1205	1.4	47		1787	2.1	18		429	0.51
Dibenz(a,h)anthracene	1123	4.4	U			4.5	U			6.8		259	0.23	2.4	J	57	0.05
Fluoranthene	707	4.4	U			50		3012	4.3	110		4183	5.9	29		690	0.98
Fluorene	538	4.4	U			66		3976	7.4	110		4183	7.8	35		833	1.5
Indeno(1,2,3-cd)pyrene	1115	4.4	U			7		422	0.38	21		798	0.72	7.6		181	0.16
Naphthalene	385	4.4	U			31		1867	4.9	20		760	2.0	9.6		229	0.59
Phenanthrene	596	4.4	U			110		6627	11	170		6464	11	53		1262	2.1
Pyrene	697	4.4	U			56		3373	4.8	120		4563	6.5	45		1071	1.5
Total ∑ESBTUFCV					0.54				61				67				14
Total Organic Carbon (TOC; mg/kg)		18300				16600				26300				42000	J		

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
2017 SIM PAH data represents concentrations of only 17 compounds and may underestimate toxic effects.
$C_{OC,PAHi,FCVi}$ = Final Chronic Value concentration normalized to organic carbon
C_{OC} = Concentration normalized to organic carbon
$ESBTU_{FCVi}$ = Equilibrium partitioning benchmark toxic units (dimensionless)
ESB = equilibrium partitioning sediment benchmark
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J+ = Reported value is estimated; actual value expected to be higher
PAH = polyaromatic hydrocarbon
Q = Data qualifier
SIM = selective ion monitoring
SD = sediment
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 11
2018 Sediment - Benchmark Comparisons - Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (mg/kg)**	KCW-**BG1**-SD-002		KCW-**TR1**-SD-002		KCW-**TR1**-SD-002D		KCW-**TR2**-SD-007		KCW-**TR2**-SD-008		KCW-**KC1**-SD-002	
CLP Sample Number:		MC0AL7		MC0AK4		MC0AK4D		MCOAJ9		MC0AK0		MC0AL4	
Units:		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg	
Sample Date:		10/1/2018		10/3/2018		10/3/2018		10/3/2018		10/03/218		10/2/2018	
Sample Type:		Background		Background		Background		Field		Field		Background	
Metals		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Aluminum	25,000	3160	J	18000	J	13700		4900	J	4460	J	4070	J
Antimony	2	0.51	J	1.8	J	1.6	J	0.67	J	1	J	0.51	J
Arsenic	9.8	4		12.1		10.1		5.2		7.1		3.5	
Barium	20	23	UJ	143	J	92.2		34.7	J	32.3	J	38.3	J
Beryllium	NL	0.58	UJ	1.9		1.4		0.63	UJ	0.98		0.67	UJ
Cadmium	1	0.68	J	2.1	J	2.9		1.3	J	2.7	J	0.7	J
Calcium	NL	340	J	35800	J	2170		307	J	682	J	283	J
Chromium	43.4	4.4	J	15.1	J	17.4		9.5	J	7	J	5.7	J
Cobalt	50	6.4	J	18.2	J	19.6		10	J	8.2	J	6.7	UJ
Copper	31.6	3.6	J	21.6	J	30.4		9.5	J	17.8	J	3.7	J
Iron	20,000	11800	J	21100	J	26100		25500	J	52900	J	12300	J
Lead	35.8	4.9	J	66.2	J	85		9.3	J	10.5	J	6.3	J
Magnesium	NL	359	J	7450	J	1290		603	J	346	J	310	J
Manganese	460	218	J	1140	J	294		312	J	359	J	144	J
Mercury	0.18	0.12	U	0.2	J	0.37		0.13	U	0.12	U	0.022	J
Nickel	22.7	5.2		21.4		24.2		10.5		7.8		4.4	J
Potassium	NL	465	J	2070	J	1550		748	J	485	J	516	J
Selenium	0.72	4	U	8	U	8	U	4.4	U	4.4	U	4.7	U
Silver	1	1.2	UJ	2.3	UJ	2.3	U	1.3	UJ	1.3	UJ	1.3	UJ
Sodium	NL	3	J	567	J	182	J	32.5	J	12.5	J	20.7	J
Thallium	NL	2.9	UJ	5.7	UJ	5.7	U	3.1	UJ	3.1	UJ	3.3	UJ
Vanadium	NL	6.6	J	23	J	26.6		10.4	J	9.2	J	9	J
Zinc	121	43.1	J	164	J	225		74.4	J	101	J	47.2	J

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA Region 4 Freshwater Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of EPA Region 4 Screening Value
J = Reported value is estimated; actual value may be higher or lower
mg/kg = milligrams per kilogram
NL = No listed value
Q = Qualifier

U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 11
2018 Sediment - Benchmark Comparisons - Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Sediment (mg/kg)**	KCW-**KC2**-SD-007		KCW-**KC2**-SD-008		KCW-**KC2**-SD-008D	
CLP Sample Number:		MC0AK8		MC0AK9		MC0AL0	
Units:		mg/kg		mg/kg		mg/kg	
Sample Date:		10/2/2018		10/3/2018		10/3/2018	
Sample Type:		Field		Field		Dup of MC0AK9	
Metals		Result	Q	Result	Q	Result	Q
Aluminum	25,000	4650	J	6790	J	7440	J
Antimony	2	0.59	J	0.92	J	1.1	J
Arsenic	9.8	2.6		8		9.1	
Barium	20	46.1	J	46.3	J	37.1	J
Beryllium	NL	0.58	UJ	0.84		0.89	
Cadmium	1	0.67	J	1.6	J	2	J
Calcium	NL	1090	J	319	J	262	J
Chromium	43.4	6.1	J	16.3	J	16.5	J
Cobalt	50	5.8	UJ	12.6	J	14.5	J
Copper	31.6	9.4	J	19	J	21.6	J
Iron	20,000	11500	J	31100	J	42300	J
Lead	35.8	6.7	J	17	J	15.3	J
Magnesium	NL	320	J	1220	J	1330	J
Manganese	460	84.1	J	237	J	294	J
Mercury	0.18	0.12	U	0.12	U	0.12	U
Nickel	22.7	6.4		15.9		20.4	
Potassium	NL	499	J	910	J	914	J
Selenium	0.72	4	U	3.7	U	4	U
Silver	1	1.2	UJ	1.1	UJ	1.1	UJ
Sodium	NL	92.4	J	34.7	J	26.7	J
Thallium	NL	2.9	UJ	2.7	UJ	2.8	UJ
Vanadium	NL	8.3	J	17.6	J	21.9	J
Zinc	121	41.7	J	80.5	J	97.6	J

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA Region 4 Freshwater Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of EPA Region 4 Screening Value
J = Reported value is estimated; actual value may be higher or lower
mg/kg = milligrams per kilogram
NL = No listed value
Q = Qualifier

U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 12
2019 Surface Water - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR1**-SW-003		KCW-**TR2**-SW-010		KCW-**TR2**-SW-010D		KCW-**TR2**-SW-009		KCW-**KC1**-SW-003		KCW-**KC2**-SW-009		KCW-**KC2**-SW-010	
CLP Sample Number:		MC0AN9		MC0AN6		MC0AP0		MC0AN7		MC0AN8		MC0AN4		MC0AN5	
Units:		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L	
Sample Date:		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019	
Sample Type:		Background		Field		Dup of MC0AN6		Field		Background		Field		Field	
PAHs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
1-Methylnaphthalene	6.1	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
1-Methylphenanthrene	NL	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.0023	J
2,3,5-Trimethylnaphthalene	NL	0.019	U	0.0032	J	0.0028	J	0.003	J	0.019	U	0.018	J	0.018	J
2,6-Dimethylnaphthalene	26	0.0027	J	0.0052	J	0.0044	J	0.0035	J	0.019	U	0.029		0.035	
2-Methylnaphthalene	4.7	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
Acenaphthene	15	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
Acenaphthylene	13	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
Anthracene	0.02	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
Benzo(a)anthracene	4.7	0.003	J	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
Benzo(a)pyrene	0.006	0.0031	J	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
Benzo(k)fluoranthene	0.06	0.003	J	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
Benzo[e]pyrene	0.9	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
Chrysene	4.7	0.0037	J	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
Fluoranthene	0.8	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
Fluorene	19	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
Indeno(1,2,3-cd)pyrene	0.012	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
Naphthalene	21	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
Perylene	0.9	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
Phenanthrene	2.3	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
Pyrene	4.6	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U	0.019	U
SVOCs															
1,1,Biphenyl	6.5	5	U	5	U	5	U	5	U	5	U	5	U	5	U
1,2,4,5-Tetrachlorobenzene	8.3	5	U	5	U	5	U	5	U	5	U	5	U	5	U
1,4-Dioxane (P-Dioxane)	22,000	2	U	2	U	2	U	2	U	2	U	2	U	2	U
2-Chloronaphthalene	NL	5	U	5	U	5	U	5	U	5	U	5	U	5	U
2-Chlorophenol	18	5	U	5	U	5	U	5	U	5	U	5	U	5	U
2-Nitroaniline	17	5	U	5	U	5	U	5	U	5	U	5	U	5	U
2-Nitrophenol	73	5	U	5	U	5	U	5	U	5	U	5	U	5	U
2,2-oxybis (1-Chloropropane)	NL	10	U	10	U	10	U	10	U	10	U	10	U	10	U
2,3,4,6-Tetrachlorophenol	1	5	U	5	U	5	U	5	U	5	U	5	U	5	U
2,4-Dichlorophenol	11	5	U	5	U	5	U	5	U	5	U	5	U	5	U
2,4-Dimethylphenol	15	5	U	5	U	5	U	5	U	5	U	2.7	J	2.2	J
2,4- Dinitrophenol	71	10	U	10	U	10	U	10	U	10	U	10	U	10	U
2,4-Dinitrotoluene	44	5	U	5	U	5	U	5	U	5	U	5	U	5	U
2,6-Dinitrotoluene	81	5	U	5	U	5	U	5	U	5	U	5	U	5	U
2,4,6-Trichlorophenol	4.9	5	U	5	U	5	U	5	U	5	U	5	U	5	U
2,4,5-Trichlorophenol	1.9	5	U	5	U	5	U	5	U	5	U	5	U	5	U
3-Nitroaniline	NL	10	U	10	U	10	U	10	U	10	U	10	U	10	U
3,3-Dichlorobenzidine	4.5	10	U	10	U	10	U	10	U	10	U	10	U	10	U
4-Nitrophenol	58	10	U	10	U	10	U	10	U	10	U	10	U	10	U
4,6-Dinitro-2-methylphenol	NL	10	U	10	U	10	U	10	U	10	U	10	U	10	U
4-Bromophenyl-phenyl ether	1.5	5	U	5	U	5	U	5	U	5	U	5	U	5	U

Table 12
2019 Surface Water - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR1**-SW-003		KCW-**TR2**-SW-010		KCW-**TR2**-SW-010D		KCW-**TR2**-SW-009		KCW-**KC1**-SW-003		KCW-**KC2**-SW-009		KCW-**KC2**-SW-010	
CLP Sample Number:		MC0AN9		MC0AN6		MC0AP0		MC0AN7		MC0AN8		MC0AN4		MC0AN5	
Units:		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L		µg/L	
Sample Date:		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019	
Sample Type:		Background		Field		Dup of MC0AN6		Field		Background		Field		Field	
PAHs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
SVOCs															
4-Chloro-3-methylphenol	NL	5	U	5	U	5	U	5	U	5	U	5	U	5	U
4- Chloroaniline	0.8	10	U	10	U	10	U	10	U	10	U	10	U	10	U
4-Chlorophenyl-phenylether	NL	5	U	5	U	5	U	5	U	5	U	5	U	5	U
4- Methylphenol	53	10	U	10	U	10	U	10	U	10	U	10	U	10	U
4-Nitroaniline	NL	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Acetophenone	NL	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Atrazine	0.03	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Benzaldehyde	143	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Bis(2-chloroethoxy)methane	NL	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Bis(2-chloroisopropyl)ether	NL	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Bis (2-ethylhexyl)phthalate	8	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Butylbenzyl phthalate	23	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Caprolactam	NL	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Carbazole	4	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Dibenzofuran	4	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Diethyl phthalate	220	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Dimethyl phthalate	1,100	4.6	J	5	U	5		1.1	J	5	U	5	U	5	U
Di-n-Butyl phthalate	19	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Di-n-octyl phthalate	215	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Fluorene	19	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Hexachlorobenzene	0.15	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Hexachlorobutadiene	1	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Hexachlorocyclopentadiene	0.45	10	U	10	U	10	U	10	U	10	U	10	U	10	U
Hexachloroethane	12	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Isophorone	920	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Nitrobenzene	230	5	U	5	U	5	U	5	U	5	U	5	U	5	U
N-nitroso-di-n-propylamine	NL	5	U	5	U	5	U	5	U	5	U	5	U	5	U
N-Nitrosodiphenylamine	25	5	U	5	U	5	U	5	U	5	U	5	U	5	U
Phenol	160	10	U	1.7	J	10	U	2.3	J	2.3	J	2.5	J	2.7	J
Total Alkanes	NL	2		54		0		22		4.6		14		6.9	

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA National AWQC (2020) for pentachlorophenol and EPA Region 4 Freshwater Chronic Screening Values (2018
Yellow highlighted values indicate exceedance of benchmark value
J = Reported value is estimated; actual value may be higher or lower
NL = No listed value
PAH = Polyaromatic hydrocarbon
Q = Qualifier
SVOC = Semi-volatile organic compound
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limi
µg/L = micrograms per liter

Table 13
2019 Surface Water - Benchmark Comparisons - Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR1**-SW-003		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-010		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-010D		**Chronic Freshwater Benchmark (µg/L)**	KCW-**TR2**-SW-009	
CLP Sample Number:		MC0AN9			MC0AN6			MC0AP0			MC0AN7	
Units:		µg/L			µg/L			µg/L			µg/L	
Sample Date:		7/31/2019			7/31/2019			7/31/2019			7/31/2019	
Sample Type:		Background			Field			Dup of MC0AN6			Field	
Metals		Result	Q		Result	Q		Result	Q		Result	Q
Aluminum	87	427		87	39.7		87	37.5		87	38.8	
Antimony	190	2	U	190	2	U	190	2	U	190	2	U
Arsenic	150	0.78	J	150	0.72	J	150	0.7	J	150	0.65	J
Barium	220	32.4		220	45.6		220	48.2		220	44.8	
Beryllium	11	1	U	11	1	U	11	1	U	11	1	U
Cadmium	0.28	1	U	0.29	1	U	0.304	1	U	0.28	1	U
Calcium	116,000	9020		116,000	7580		116,000	7890		116,000	7270	
Chromium	11	0.48	J	11	0.21	J	11	2	U	11	2	
Cobalt	19	1.4		19	1.9		19	2		19	1.7	
Copper	3.05	1	J	3.3	2	U	3.4	0.33	J	3.1	0.38	J
Iron	1,000	2930		1,000	4410		1,000	4700		1,000	4320	
Lead	0.62	1.2		0.68	0.43	J	0.71	0.43	J	0.64	0.43	J
Magnesium	82,000	1410		82,000	2830		82,000	2960		82,000	2650	
Manganese	93	597		93	623		93	619		93	590	
Nickel	18	2.9		19	3		20	3.2		18	3.1	
Potassium	53,000	723		53,000	1060		53,000	1110		53,000	1040	
Selenium	5	5	U	5	5	U	5	5	U	5	5	U
Silver	0.06	1	U	0.06	1	U	0.06	1	U	0.06	1	U
Sodium	680,000	10800		680,000	5650		680,000	5860		680,000	5340	
Thallium	6	1	U	6	1	U	6	1	U	6	1	U
Vanadium	27	5	U	27	5	U	27	5	U	27	5	U
Zinc	41	13.3		43	2.2		45	2	U	41	2	U

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA National AWQC (2020) for Al,As,Cd,Cr,Cu,Fe,Pb,Ni,Se,Ag and Zn, and EPA Region 4 Freshwater Chronic Screening Values (2018)
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NL = No listed value
Q = Qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
µg/L = micrograms per liter

Table 13
2019 Surface Water - Benchmark Comparisons - Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC1**-SW-003		**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC2**-SW-009		**Chronic Freshwater Benchmark (µg/L)**	KCW-**KC2**-SW-010	
CLP Sample Number:		MC0AN8			MC0AN4			MC0AN5	
Units:		µg/L			µg/L			µg/L	
Sample Date:		7/31/2019			7/31/2019			7/31/2019	
Sample Type:		Background			Field			Field	
Metals		Result	Q		Result	Q		Result	Q
Aluminum	87	144		87	204		87	154	
Antimony	190	2	U	190	2	U	190	2	U
Arsenic	150	0.98	J	150	1.5		150	1.6	
Barium	220	85		220	34.5		220	33.3	
Beryllium	11	1	U	11	1	U	11	1	U
Cadmium	0.39	1	U	0.21	1	U	0.197	1	U
Calcium	116,000	12200		116,000	5420		116,000	4970	
Chromium	11	0.38	J	11	0.63	J	11	0.59	
Cobalt	19	1.2		19	3.2		19	3.2	
Copper	4.5	1.2		2	0.99	J	2.1	0.79	J
Iron	1,000	1140		1,000	7670		1,000	7670	
Lead	1.03	0.64	J	0.41	1.4		0.37	1.4	
Magnesium	82,000	3360		82,000	1470		82,000	1360	
Manganese	93	142		93	1470		93	699	
Nickel	26	3.6		13	719		12	2.7	
Potassium	53,000	6880		53,000	2.7		53,000	718	
Selenium	5	5	U	5	776		5	5	U
Silver	0.06	1	U	0.06	5	U	0.06	1	U
Sodium	680,000	86600		680,000	1	U	680,000	8750	
Thallium	6	1	U	6	9640		6	1	U
Vanadium	27	5	U	27	1	U	27	5	U
Zinc	59	6		30	5	U	28	3.7	

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA National AWQC (2020) for Al,As,Cd,Cr,Cu,Fe,Pb,Ni,Se,Ag and Zn, and EPA Region 4 Freshwater Chronic Screening Values (2018)
Yellow highlighted values indicate exceedance of benchmark value
J = Reported value is estimated; actual value may be higher or lower
NL = No listed value
Q = Qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
µg/L = micrograms per liter

Table 14
2019 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (µg/kg)**	KCW-**TR1**-SD-003		KCW-**TR2**-SD-009		KCW-**TR2**-SD-010		KCW-**KC1**-SD-003		KCW-**KC2**-SD-009		KCW-**KC2**-SD-010		KCW-**KC2**-SD-010D	
CLP Sample Number:		MC0AM6		MC0AM4		MC0AM5		MC0AN1		MC0AM8		MC0AM9		MC0AN0	
Units:		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg	
Sample Date:		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019	
Sample Type:		Background		Field		Field		Background		Field		Field		Dup of MC0AM9	
PAHs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
1-Methylnaphthalene		20	U	200		2400		0.61	J	8100		360		330	
1-Methylphenanthrene		10	J	39		360		0.77	J	960		110		71	
2-Methylnaphthalene	20	20	U	180		3200		0.45	J	11000		440		400	
2,3,5-Trimethylnaphthalene		20	U	160		1600		0.23	J	5500		380		320	
2,6-Dimethylnaphthalene		20	U	170		2000		1.4		6200		350		320	
Acenaphthene	6.7	20	U	42		370		0.88	U	1300		65		58	
Acenaphthylene	5.9	8.3	J	15		140		0.54	J	380	J	23		21	
Anthracene	57	14	J	73		760		0.45	J	2400		180		130	
Benzo(a)anthracene	108	100		38		260		1.1		1500		68		60	
Benzo(a)pyrene	150	92		23		140		2.2		1100		40		37	
Benzo(b)fluoranthene	190	82		18		77	J	2.8		820		31		28	
Benzo(g,h,i)perylene	170	48		3.6	J	44	J	0.69	J	480		15		11	J
Benzo(k)fluoranthene	240	95		15		64	J	2		790		26		27	
Chrysene	166	100		32		210		8.1		1400		65		56	
Dibenzo(a,h)anthracene	33	16	J	6.5	U	99	U	0.88	U	130	J	4	J	3.6	J
Fluoranthene	423	210		66		360		3.5		2600		130		99	
Fluorene	77	8.4	J	150		1500		0.64	J	4600		290		230	
Indeno(1,2,3-cd)pyrene	200	49		4.2	J	45	J	0.67	J	460		12		12	
Naphthalene	176	20	U	65		1100		0.88	U	4000		110		110	
Perylene		620		17		47	J	13		270	J	19		12	
Phenanthrene	204	85		180		1600		1.5		5400		360		270	
Pyrene	195	160		100		590		2.4		3000		140		120	
C1- Benzo(a)anthracenes/Chrysenes	NL	34	J	42	J	390	J	6.8	J	1100	J	87	J	69	J
C2- Benzo(a)anthracenes/Chrysenes	NL	20	U	30	J	350	J	6.9	J	770	J	89	J	60	J
C3- Benzo(a)anthracenes/Chrysenes	NL	20	U	6.5	U	240	J	3.9	J	560	J	53	J	37	J
C4- Benzo(a)anthracenes/Chrysenes	NL	20	U	6.5	U	99	U	0.88	U	400	U	12	U	12	U
C1-Fluoranthenes/pyrene	NL	77	J	230	J	1700	J	2.5	J	4400	J	390	J	300	J
C1-Fluorenes	NL	20	U	250	J	2800	J	0.88	U	8500	J	670	J	540	J
C2-Fluorenes	NL	20	U	280	J	3100	J	3.8	J	8800	J	750	J	600	J
C3-Fluorenes	NL	20	U	250	J	2400	J	7.7	J	6800	J	600	J	420	J
C2-Naphthalenes	NL	20	U	790	J	9200	J	4.2	J	29000	J	1700	J	1500	J
C3-Naphthalenes	NL	20	U	800	J	8400	J	2.8	J	25000	J	1800	J	1500	J
C4-Naphthalenes	NL	20	U	620	J	6200	J	0.88	U	18000	J	1400	J	1100	J
C1-Phenanthrenes/Anthracenes	NL	41	J	310	J	2900	J	3.3	J	7400	J	790	J	540	J
C2-Phenanthrenes/Anthracenes	NL	25	J	270	J	2300	J	6	J	5400	J	630	J	450	J
C3-Phenanthrenes/Anthracenes	NL	20	U	130	J	1300	J	10	J	2700	J	420	J	220	J
C4-Phenanthrenes/Anthracenes	NL	20	U	160	J	1500	J	12	J	3700	J	450	J	290	J
SVOCs															
.alpha.-Methylstilbene	NL														
[1,1-Biphenyl]-4-carboxaldehyde	NL														
1,1-Biphenyl	198	250	U	240	U	300		220	U	410		300	U	270	U

Table 14
2019 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (µg/kg)**	KCW-**TR1**-SD-003		KCW-**TR2**-SD-009		KCW-**TR2**-SD-010		KCW-**KC1**-SD-003		KCW-**KC2**-SD-009		KCW-**KC2**-SD-010		KCW-**KC2**-SD-010D	
CLP Sample Number:		MC0AM6		MC0AM4		MC0AM5		MC0AN1		MC0AM8		MC0AM9		MC0AN0	
Units:		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg	
Sample Date:		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019	
Sample Type:		Background		Field		Field		Background		Field		Field		Dup of MC0AM9	
PAHs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
SVOCs															
1,2,3-Trimethylindene	NL									12000	JN				
1,2,4,5-Tetrachlorobenzene	187	250	U	240	U	220	U	220	U	250	U	300	U	270	U
1,4-Dioxane	NL	98	U	93	U	88	U	86	U	100	U	120	U		
1,7-Dimethyl-3-phenyltricyclo[4.1.	NL														
1H-Benzimidazole, 2-ethyl-	NL														
1H-Cyclopropa[l]phenanthrene,1a,9b	NL														
1-Heptadecanol	NL														
1H-Indazole, 3,6-dimethyl-	NL														
1H-Indene, 1,3-dimethyl-	NL					440	JN			1000	JN				
2,2-oxybis(1-Chloropropane)	NL	480	U	460	U	430	U	420	U	490	U	590	U		
2,3,4,6-Tetrachlorophenol	30	250	U	240	U	220	U	220	U	2T0	U	300	U	270	U
2,4,5-Trichlorophenol	34	250	U	240	U	220	U	220	U	250	U	300	U	270	U
2,4,6-Cycloheptatrien-1-one, 2-phe	NL														
2,4,6-Trichlorophenol	89	250	U	240	U	220	U	220	U	250	U	300	U		
2,4-Dichlorophenol	57	250	U	240	U	220	U	220	U	250	U	300	U		
2,4-Dimethylphenol	39	250	U	240	U	450		220	U	2300		300	U		
2,4-Dinitrophenol	223	480	U	460	U	430	U	420	U			590	U	530	U
2,4-Dinitrotoluene	290	250	U	240	U	220	U	220	U	250	U	300	U	270	U
2,5,6-Trimethylbenzimidazole	NL									960	JN				
2,6-Dinitrotoluene	296	250	U	240	U	220	U	220	U	250	U	300	U	270	U
2-Chloronaphthalene	NL	250	U	240	U	220	U	220	U	250	U	300	U	270	U
2-Chlorophenol	55	250	U	240	U	220	U	220	U	250	U	300	U		
2-Methylphenol	119	480	U	460	U	76	U	420	U	690		590	U		
2-Nitroaniline	NL	250	U	240	U	220	U	220	U	250	U	300	U	270	U
2-Nitrophenol	NL	250	U	240	U	220	U	220	U	250	U	300	U		
2-Propenal, 2-methyl-3-phenyl-	NL														
3-Nitroaniline	NL					430	U	420	U	490	U	590	U	530	U
3,3-Dichlorobenzidine	NL	480	U	460	U	430	U	420	U	490	U	590	U	530	U
3-Penten-2-one, 4-phenyl-	NL														
4,6-Dinitro-2-methylphenol	NL	480	U	460	U	430	U	420	U	490	U	590	U	530	U
4-Bromophenyl-phenylether	47	250	U	240	U	220	U	220	U	250	U	300	U	270	U
4-Chloro-3-methylphenol	NL			240	U	220	U	220	U	250	U	300	U		
4-Chloroaniline	0.9	480	U	460	U	430	U	420	U	490	U	590	U		
4-Chlorophenyl-phenylether	NL	250	U	240	U	220	U	220	U	250	U	300	U	270	U
4-Methoxy-2-methyl-1-(methylthio)b	NL														
4-Methylphenol	93	480	U	460	U	120	J	420	U	1700		590	U		
4-Nitroaniline	NL	480	U	460	U	430	U	420	U	490	U	590	U	530	U
4-Nitrophenol	153	480	U	460	U	430	U	420	U					530	U
5-tert-Butylpyrogallol	NL														
6H-Dibenzo[b,d]-pyran	NL														

Table 14
2019 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	EPA Region 4 Freshwater Sediment (µg/kg)	KCW-**TR1**-SD-003		KCW-**TR2**-SD-009		KCW-**TR2**-SD-010		KCW-**KC1**-SD-003		KCW-**KC2**-SD-009		KCW-**KC2**-SD-010		KCW-**KC2**-SD-010D	
CLP Sample Number:		MC0AM6		MC0AM4		MC0AM5		MC0AN1		MC0AM8		MC0AM9		MC0AN0	
Units:		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg	
Sample Date:		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019	
Sample Type:		Background		Field		Field		Background		Field		Field		Dup of MC0AM9	
PAHs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
SVOCs															
9H-Fluoren-9-ol	NL														
9H-Fluorene, 2-methyl-	NL														
9H-Fluorene, 2,3-dimethyl-	NL														
9H-Fluorene, 9-methyl-	NL											210	JN		
9H-Fluorene, 9,9-dimethyl-	NL														
Acetophenone	NL	480	U	460	U	430	U	420	U	490	U	590	U		
A-Norcholestan-3-one, 5-ethenyl-,	NL														
Atrazine	0.3	480	U	460	U	430	U	420	U	490	U	590	U	530	U
Benzaldehyde	59	480	U	460	U	430	U	420	U	490	U	590	U		
Benzenamine, 4-chloro-N-(2-pyridin	NL														
Benzene, 4-ethyl-1,2-dimethyl-	NL														
PAHs by SIM															
Benzocycloheptatriene	NL														
Bis(2-Chloroethoxy)methane	NL	250	U	240	U	220	U	220	U	250	U	300	U		
Bis(2-Chloroethyl)ether	NL	480	U	460	U	430	U	420	U	490	J	590	U		
Bis(2-ethylhexyl)phthalate	180	250	U	240	U	220	U	220	U	250	U	300	U	270	U
Butylbenzylphthalate	NL	250	U	240	U	220	U	220	U	250	U	300	U	270	J
Caprolactam	NL			460	U	430	U	420	U	490	U	590	U		
Carbazole	69	480	U	460	U	74	J	420	U	170	J	590	U	530	U
Dibenzofuran	510	250	U	240	U	440		220	U	700		300	U	270	U
Dibenzofuran, 4-methyl-	NL											140	JN		
Diethyl phthalate	NL	250	U	240	U	230	U	220	U	250	U	300	U	270	U
Dimethyl phthalate	NL	280		120	J	230		89	J	400		320		360	
Di-n-butylphthalate	11	250	U	240	U	220	U	220	U	250	U	300	U	270	U
Di-n-octyl phthalate	39	480	U	460	U	430	U	420	U	490	U	590	U	530	U
Ethanone, 1-(2,6-dihydroxy-4-metho	NL			110	JN										
Ethanone, 1-(4-hydroxy-3,5-dimetho	NL														
Hexachlorobenzene	20	250	U	240	U	220	U	220	U	250	U	300	U	270	U
Hexachlorobutadiene	NL			240	U	220	U	220	U	250	U	300	U		
Hexachlorocyclopentadiene	7	480	U	460	U	430	U	420	U	490	U	590	U		
Hexachloroethane	27	250	U	240	U	220	U	220	U	250	U	300	U		
Hydroquinone mono-trimethylsilyl e	NL														
Isophorone	876	250	U	240	U	220	U	220	U	250	U	300	U		
Naphthalene, 1-methyl-	141											130	JN		
Naphthalene, 1,3-dimethyl-	NL									990	JN	120	JN		
Naphthalene, 1,4-dimethyl-	NL					480	JN								
Naphthalene, 1,4,6-trimethyl-	NL											140	JN		
Naphthalene, 1,6-dimethyl-	NL					260	JN								
Naphthalene, 1,6,7-trimethyl-	NL					320	JN								
Naphthalene, 2,3-dimethyl-	NL					920	JN					130	JN		

Table 14
2019 Sediment - Benchmark Comparisons - Organics
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	**EPA Region 4 Freshwater Sediment (µg/kg)**	KCW-**TR1**-SD-003		KCW-**TR2**-SD-009		KCW-**TR2**-SD-010		KCW-**KC1**-SD-003		KCW-**KC2**-SD-009		KCW-**KC2**-SD-010		KCW-**KC2**-SD-010D	
CLP Sample Number:		MC0AM6		MC0AM4		MC0AM5		MC0AN1		MC0AM8		MC0AM9		MC0AN0	
Units:		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg		µg/kg	
Sample Date:		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019	
Sample Type:		Background		Field		Field		Background		Field		Field		Dup of MC0AM9	
PAHs		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
PAHs by SIM															
Naphthalene, 2,3,6-trimethyl-	NL					380	JN					200	JN		
Naphthalene, 2,6-dimethyl-	NL														
Naphthalene, 2,7-dimethyl-	NL														
Naphtho[2,1-b]furan, 1,2-dimethyl-	NL											130	JN		
Naphtho[2,3-b]norbornadiene	NL														
n-Hexadecanoic acid	NL	98	JN	160	JN			110	JN			260	JN	140	JN
Nitrobenzene	407	250	U	240	U	220	U	220	U	250	U	300	U		
N-Nitroso-di-n-propylamine	NL	250	U	240	U	220	U	220	U	250	U	300	U		
N-Nitrosodiphenylamine	110	250	U	240	U	220	U	220	U	250	U	300	U	270	U
Octadecanoic acid	NL														
Phenanthrene, 4-methyl-	NL														
Phenol	175	59	J	460	U	74	J	420	U	330	J	75	J		
Phenol, 2-ethyl-4-methyl-	NL														
Phenol, 2-methoxy-4-propyl-	NL									630	JN				
Phenol, 2,6-dimethoxy-	NL					290	JN								
Phenol, 2,6-dimethoxy-4-(2-propeny	NL														
Phenol, 4-ethyl-2-methoxy-	NL									1200	JN				
Tetradecanethiol	NL														
Squalene	NL														
Total Alkanes	NL			2200		10000		200		14000		680		370	
Total Alkanes	NL														
Trichloroacetic acid, hexadecyl es	NL														
unknown-01	NL			230	J	680	J			1000	J				
unknown-02	NL					360	J			400	J				
unknown-03	NL									450	J				

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA Region 4 Freshwater Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of EPA Region 4 Screening Value
J = Reported value is estimated; actual value may be higher or lower
JN = The analyte has been "tentatively identified" at the reported value
NL = No listed value
PAH = Polyaromatic hydrocarbon
Q = Qualifier
SIM = Selective Ion Monitoring
SVOC = Semi-volatile organic compound
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
µg/kg = micrograms per kilogram

Table 15
2019 Sediment - Equilibrium Partitioning Sediment Benchmark Comparisons
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:		KCW-**TR1**-SD-003				KCW-**TR2**-SD-009				KCW-**TR2**-SD-010			
Sample Date:		7/31/2019				7/31/2019				7/31/2019			
Units:	**$C_{OC,PAHi,FCVi}$**	µg/kg		$(\mu g/g_{oc})$	µg/kg	µg/kg		$(\mu g/g_{oc})$	µg/kg	µg/kg		$(\mu g/g_{oc})$	µg/kg
Analyte (PAH by SIM)	**$(\mu g/g_{oc})$**	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$
1-Methylnaphthalene	446	20	U			200		24907	56	2400		104348	234
1-Methylphenanthrene	670	10	J	1502	2.2	39		4857	7.2	360		15652	23
2-Methylnaphthalene	447	20	U			180		22416	50	3200		139130	311
2,3,5-Trimethylnaphthalene	584	20	U			160		19925	34	1600		69565	119
2,6-Dimethylnaphthalene	513	20	U			170		21171	41	2000		86957	170
Acenaphthene	491	20	U			42		5230	11	370		16087	33
Acenaphthylene	452	8.3	J	1246	2.8	15		1868	4.1	140		6087	13
Anthracene	594	14	J	2102	3.5	73		9091	15	760		33043	56
Benzo(a)anthracene	841	100		15015	18	38		4732	5.6	260		11304	13
Benzo(a)pyrene	965	92		13814	14	23		2864	3.0	140		6087	6.3
Benzo(b)fluoranthene	979	82		12312	13	18		2242	2.3	77	J	3348	3.4
Benzo(e)pyrene	967	57		8559	8.9	13		1619	1.7	72	J	3130	3.2
Benzo(g,h,i)perylene	1095	48		7207	6.6	3.6	J	448	0.41	44	J	1913	1.7
Benzo(k)fluoranthene	981	95		14264	15	15		1868	1.9	64	J	2783	2.8
Chrysene	844	100		15015	18	32		3985	4.7	210		9130	11
Dibenz(a,h)anthracene	1123	16	J	2402	2.1	6.5	U			99	U		
Fluoranthene	707	210		31532	45	66		8219	12	360		15652	22
Fluorene	538	8.4	J	1261	2.3	150		18680	35	1500		65217	121
Indeno(1,2,3-cd)pyrene	1115	49		7357	6.6	4.2	j	523	0.47	45	J	1957	1.8
Naphthalene	385	20	U			65		8095	21	1100		47826	124
Perylene	967	620		93093	96	17		2117	2	47	J	2043	2.1
Phenanthrene	596	85		12763	21	180		22416	38	1600		69565	117
Pyrene	697	160		24024	34	100		12453	18	590		25652	37
C1- Benzo(a)anthracenes/Chrysenes	929	34	J	5105	5.5	42	J	5230	5.6	390	J	16957	18
C2- Benzo(a)anthracenes/Chrysenes	1008	20	U			30	J	3736	3.7	350	J	15217	15
C3- Benzo(a)anthracenes/Chrysenes	1112	20	U			6.5	U			240	J	10435	9.4
C4- Benzo(a)anthracenes/Chrysenes	1214	20	U			6.5	U			99	U		
C1-Fluoranthenes/pyrene	770	77	J	11562	15	230	J	28643	37	1700	J	73913	96
C1-Fluorenes	611	20	U			250	J	31133	51	2800	J	121739	199
C2-Fluorenes	686	20	U			280	J	34869	51	3100	J	134783	196
C3-Fluorenes	769	20	U			250	J	31133	40	2400	J	104348	136
C2-Naphthalenes	510	20	U			790	J	98381	193	9200	J	400000	784
C3-Naphthalenes	581	20	U			800	J	99626	171	8400	J	365217	629
C4-Naphthalenes	657	20	U			620	J	77210	118	6200	J	269565	410
C1-Phenanthrenes/Anthracenes	670	41	J	6156	9.2	310	J	38605	58	2900	J	126087	188
C2-Phenanthrenes/Anthracenes	746	25	J	3754	5.0	270	J	33624	45	2300	J	100000	134
C3-Phenanthrenes/Anthracenes	829	20	U			130	J	16189	20	1300	J	56522	68
C4-Phenanthrenes/Anthracenes	913	20	U			160	J	19925	22	1500	J	65217	71
Total $\sum ESBTU_{FCV}$					344				1179				4381
Total Organic Carbon (TOC; mg/kg)		6660				8030				23000			

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
2017 SIM PAH data represents concentrations of only 17 compounds and may underestimate toxic effects.
$C_{OC,PAHi,FCVi}$ = Final Chronic Value concentration normalized to organic carbon
C_{OC} = Concentration normalized to organic carbon
$ESBTU_{FCVi}$ = Equilibrium partitioning benchmark toxic units (dimensionless)
ESB = equilibrium partitioning sediment benchmark
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
PAH = polyaromatic hydrocarbon
Q = Data qualifier
SD = sediment
SIM = selective ion monitoring
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 15
2019 Sediment - Equilibrium Partitioning Sediment Benchmark Comparisons
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:		KCW-**KC1**-SD-003				KCW-**KC2**-SD-009			
Sample Date:		7/31/2019				7/31/2019			
Units:	$C_{OC,PAHi,FCVi}$	µg/kg		$(\mu g/g_{oc})$	µg/kg	µg/kg		$(\mu g/g_{oc})$	µg/kg
Analyte (PAH by SIM)	$(\mu g/g_{oc})$	Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$
1-Methylnaphthalene	446	0.61	J	31	0.070	8100		310345	696
1-Methylphenanthrene	670	0.77	J	39	0.059	960		36782	55
2-Methylnaphthalene	447	0.45	J	23	0.052	11000		421456	943
2,3,5-Trimethylnaphthalene	584	0.23	J	12	0.020	5500		210728	361
2,6-Dimethylnaphthalene	513	1.4		72	0.14	6200		237548	463
Acenaphthene	491	0.88	U			1300		49808	101
Acenaphthylene	452	0.54	J	28	0.061	380	J	14559	32
Anthracene	594	0.45	J	23	0.039	2400		91954	155
Benzo(a)anthracene	841	1.1		56	0.067	1500		57471	68
Benzo(a)pyrene	965	2.2		113	0.12	1100		42146	44
Benzo(b)fluoranthene	979	2.8		144	0.15	820		31418	32
Benzo(e)pyrene	967	3.1		159	0.16	620		23755	25
Benzo(g,h,i)perylene	1095	0.69	J	35	0.032	480		18391	17
Benzo(k)fluoranthene	981	2.0		103	0.10	790		30268	31
Chrysene	844	8.1		415	0.49	1400		53640	64
Dibenz(a,h)anthracene	1123	0.88	U			130	J	4981	4.4
Fluoranthene	707	3.5		179	0.25	2600		99617	141
Fluorene	538	0.64	J	33	0.061	4600		176245	328
Indeno(1,2,3-cd)pyrene	1115	0.67	J	34	0.031	460		17625	16
Naphthalene	385	0.88	U			4000		153257	398
Perylene	967	13		667	0.69	270	J	10345	11
Phenanthrene	596	1.5		77	0.13	5400		206897	347
Pyrene	697	2.4		123	0.18	3000		114943	165
C1- Benzo(a)anthracenes/Chrysenes	929	6.8	J	349	0.38	1100	J	42146	45
C2- Benzo(a)anthracenes/Chrysenes	1008	6.9	J	354	0.35	770	J	29502	29
C3- Benzo(a)anthracenes/Chrysenes	1112	3.9	J	200	0.18	560	J	21456	19
C4- Benzo(a)anthracenes/Chrysenes	1214	0.88	U			400	U		
C1-Fluoranthenes/pyrene	770	2.5	J	128	0.17	4400	J	168582	219
C1-Fluorenes	611	0.88	U			8500	J	325670	533
C2-Fluorenes	686	3.8	J	195	0.28	8800	J	337165	491
C3-Fluorenes	769	7.7	J	395	0.51	6800	J	260536	339
C2-Naphthalenes	510	4.2	J	215	0.42	29000	J	1111111	2179
C3-Naphthalenes	581	2.8	J	144	0.25	25000	J	957854	1649
C4-Naphthalenes	657	0.88	U			18000	J	689655	1050
C1-Phenanthrenes/Anthracenes	670	3.3	J	169	0.25	7400	J	283525	423
C2-Phenanthrenes/Anthracenes	746	6	J	308	0.41	5400	J	206897	277
C3-Phenanthrenes/Anthracenes	829	10	J	513	0.62	2700	J	103448	125
C4-Phenanthrenes/Anthracenes	913	12	J	615	0.67	3700	J	141762	155
Total ∑ESBTUFCV					7.4				12029
Total Organic Carbon (TOC; mg/kg)		19500				26100			

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kin:
2017 SIM PAH data represents concentrations of only 17 compounds and may underestimate toxic effects.
$C_{OC,PAHi,FCVi}$ = Final Chronic Value concentration normalized to organic carbon
C_{OC} = Concentration normalized to organic carbon
$ESBTU_{FCVi}$ = Equilibrium partitioning benchmark toxic units (dimensionless)
ESB = equilibrium partitioning sediment benchmark
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
PAH = polyaromatic hydrocarbon
Q = Data qualifier
SD = sediment
SIM = selective ion monitoring
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 15
2019 Sediment - Equilibrium Partitioning Sediment Benchmark Comparisons
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	$C_{OC,PAHi,FCVi}$ ($\mu g/g_{oc}$)	KCW-**KC2**-SD-010				KCW-**KC2**-SD-010D			
Sample Date:		7/31/2019				7/31/2019			
Units:		µg/kg		($\mu g/g_{oc}$)	µg/kg	µg/kg		($\mu g/g_{oc}$)	µg/kg
Analyte (PAH by SIM)		Result	Q	C_{OC}	$ESBTU_{FCVi}$	Result	Q	C_{OC}	$ESBTU_{FCVi}$
1-Methylnaphthalene	446	360		14343	32	330		8483	19
1-Methylphenanthrene	670	110		4382	6.5	71		1825	2.7
2-Methylnaphthalene	447	440		17530	39	400		10283	23
2,3,5-Trimethylnaphthalene	584	380		15139	26	320		8226	14
2,6-Dimethylnaphthalene	513	350		13944	27	320		8226	16
Acenaphthene	491	65		2590	5.3	58		1491	3.0
Acenaphthylene	452	23		916	2.0	21		540	1.2
Anthracene	594	180		7171	12	130		3342	5.6
Benzo(a)anthracene	841	68		2709	3.2	60		1542	1.8
Benzo(a)pyrene	965	40		1594	1.7	37		951	1.0
Benzo(b)fluoranthene	979	31		1235	1.3	28		720	0.74
Benzo(e)pyrene	967	27		1076	1.1	25		643	0.66
Benzo(g,h,i)perylene	1095	15		598	0.55	11	J	283	0.26
Benzo(k)fluoranthene	981	26		1036	1.1	27		694	0.71
Chrysene	844	65		2590	3.1	56		1440	1.7
Dibenz(a,h)anthracene	1123	4	J	159	0.14	3.6	J	93	0.082
Fluoranthene	707	130		5179	7.3	99		2545	3.6
Fluorene	538	290		11554	21	230		5913	11
Indeno(1,2,3-cd)pyrene	1115	12		478	0.43	12		308	0.28
Naphthalene	385	110		4382	11	110		2828	7.3
Perylene	967	19		757	0.78	12		308	0.32
Phenanthrene	596	360		14343	24	270		6941	12
Pyrene	697	140		5578	8.0	120		3085	4.4
C1- Benzo(a)anthracenes/Chrysenes	929	87	J	3466	3.7	69	J	1774	1.9
C2- Benzo(a)anthracenes/Chrysenes	1008	89	J	3546	3.5	60	J	1542	1.5
C3- Benzo(a)anthracenes/Chrysenes	1112	53	J	2112	1.9	37	J	951	0.86
C4- Benzo(a)anthracenes/Chrysenes	1214	12	U			12	U		
C1-Fluoranthenes/pyrene	770	390	J	15538	20	300	J	7712	10
C1-Fluorenes	611	670	J	26693	44	540	J	13882	23
C2-Fluorenes	686	750	J	29880	44	600	J	15424	22
C3-Fluorenes	769	600	J	23904	31	420	J	10797	14
C2-Naphthalenes	510	1700	J	67729	133	1500	J	38560	76
C3-Naphthalenes	581	1800	J	71713	123	1500	J	38560	66
C4-Naphthalenes	657	1400	J	55777	85	1100	J	28278	43
C1-Phenanthrenes/Anthracenes	670	790	J	31474	47	540	J	13882	21
C2-Phenanthrenes/Anthracenes	746	630	J	25100	34	450	J	11568	16
C3-Phenanthrenes/Anthracenes	829	420	J	16733	20	220	J	5656	6.8
C4-Phenanthrenes/Anthracenes	913	450	J	17928	20	290	J	7455	8.2
Total ∑ESBTUFCV					845				440
Total Organic Carbon (TOC; mg/kg)		25100				38900			

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2
2017 SIM PAH data represents concentrations of only 17 compounds and may underestimate toxic effects.
$C_{OC,PAHi,FCVi}$ = Final Chronic Value concentration normalized to organic carbon
C_{OC} = Concentration normalized to organic carbon
$ESBTU_{FCVi}$ = Equilibrium partitioning benchmark toxic units (dimensionless)
ESB = equilibrium partitioning sediment benchmark
J = Reported value is estimated; actual value may be higher or lower
J+ = Reported value is estimated; actual value expected to be higher
PAH = polyaromatic hydrocarbon
Q = Data qualifier
SD = sediment
SIM = selective ion monitoring
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 16
2019 Sediment - Benchmark Comparisons - Metals
Kinzua Creek Watershed Tar Sites
McKean County, PA

Sample ID:	EPA Region 4 Freshwater Sediment (mg/kg)	KCW-**TR1**-SD-003		KCW-**TR2**-SD-009		KCW-**TR2**-SD-010		KCW-**KC1**-SD-003		KCW-**KC2**-SD-009		KCW-**KC2**-SD-010		KCW-**KC2**-SD-010D	
CLP Sample Number:		MC0AM6		MC0AM4		MC0AM5		MC0AN1		MC0AM8		MC0AM9		MC0AN0	
Units:		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg	
Sample Date:		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019		7/31/2019	
Sample Type:		Background		Field		Field		Background		Field		Field		Dup of MC0AM9	
Metals		Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Aluminum	25,000	3430	J	2870	J	2300	J	2530	J	3360	J	5090	J	3350	J
Antimony	2	6.7	U	7	U	7.9	U	7.3	U	8.3	U	9	U	10.4	U
Arsenic	9.8	2.4		6.4		4.1		3.1		6.4		7.6		5	
Barium	20	30.3		31.4		57.4	J	41.1		40.2		67.8		39.7	
Beryllium	NL	0.28	J	0.47	J	0.62	J	0.41	J	0.63	J	0.59	J	0.35	J
Cadmium	1	0.27	J	0.42	J	0.47	J	0.32	J	0.5	J	0.91		0.53	J
Calcium	NL	296	J	340	J	885		385	J	565	J	908		552	J
Chromium	43.4	4.9		5.5		3.8		4.4		7.1		11.5		7	
Cobalt	50	4.3	J	8.1		7.5		6.5		9.6		13.7		7.7	J
Copper	31.6	4.8		5.7		6.7		2.7	J	53.6		18.5		10.1	
Iron	20,000	14400	J	22400	J	19900	J	11800	J	23800	J	31800	J	21100	J
Lead	35.8	6.6		9		7.3	J	5.9		17.8		19.6		13.5	
Magnesium	NL	576		504	J	298	J	250	J	484	J	510	J	349	J
Manganese	460	125		360		406	J	332		216		630		346	
Nickel	22.7	5.7		8.4		6.5		3.9	J	10		9.9		5.2	J
Potassium	NL	309	J	338	J	311	J	290	J	370	J	393	J	290	J
Selenium	0.72	3.9	U	4.1	U	4.6	U	4.3	U	4.9	U	1.6	J	6	U
Silver	1	1.1	U	1.2	UJ	1.3	UJ	1.2	U	1.4	U	1.5	U	1.7	U
Sodium	NL	559	U	586		659	U	609	U	694	U	754	U	863	U
Thallium	NL	2.8	U	2.9	U	3.3	U	3	U	3.5	U	3.8	U	4.3	U
Vanadium	NL	6.4		5.4	J	1.9	J	6	J	7.8		15		10.7	
Zinc	121	33.8		53		46		41.3		71.8		72.2		39.5	

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek Site
Data compared to EPA Region 4 Freshwater Sediment Screening Values (2018)
Yellow highlighted values indicate exceedance of EPA Region 4 Screening Value
J = Reported value is estimated; actual value may be higher or lower
mg/kg = milligrams per kilogram
NL = No listed value
Q = Qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Table 17
Crayfish Analytical Results Summary
Kinzua Creek Watershed Tar Sites
McKean County, PA

CLP Sample Numer: Sample ID: Sample Date: Sample Type:	Units	C0AM3 KCW-**BG1**-CF-001 10/1/2018 Background	C0AM6 KCW-**TR2**-CF-001 10/3/2018 Field	COAM4 KCW-**KC1**-CF-001 10/2/2018 Background	C0AM5 KCW-**KC2**-CF-001 10/3/2018 Field
PAHS					
Acenaphthylene	ug/kg	0.24 U	9.3	1.31 J	67.2
Anthracene	ug/kg	10.3	8.83	13.2	37.8
Benzaldehyde	ug/kg	745 JV	2820 V	844 JV	2090 V
Benzo(a)anthracene	ug/kg	0.966 J	0.32 U	0.32 U	2.58
Chrysene	ug/kg	1.12 J	0.35 U	0.35 U	2.45
Fluorene	ug/kg	0.35 U	2.52	0.35 U	21.8
Naphthalene	ug/kg	0.26 U	5.33	2.76	16.4
Phenanthrene	ug/kg	0.44 U	7.12	4.42	0.44 U
Metals					
Aluminum	mg/kg	22.9 J	30.9 J	36.7 J	31 J
Antimony	mg/kg	6 U	6 U	6 U	6 U
Arsenic	mg/kg	1 UJ	1 UJ	1 UJ	1 UJ
Barium	mg/kg	151	75.9	161	116
Beryllium	mg/kg	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ
Cadmium	mg/kg	0.49 J	0.23 J	0.3 J	0.29 J
Calcium	mg/kg	41400	26700	45100	32800
Chromium	mg/kg	0.19 J	0.22 J	0.26 J	0.24 J
Cobalt	mg/kg	0.26 J	0.97 J	0.59 J	1.1 J
Copper	mg/kg	13	21.1	17.1	26.4
Iron	mg/kg	59	1060	201	276
Lead	mg/kg	1 U	1 U	0.5 J	1 U
Magnesium	mg/kg	500 U	500 U	500 U	500 U
Manganese	mg/kg	73.7 J	152 J	143 J	211 J
Mercury	mg/kg	0.019 J	0.029 J	0.043 J	0.028 J
Nickel	mg/kg	0.39 J	0.55 J	0.21 J	0.33 J
Potassium	mg/kg	1590	1660	1690	1710
Selenium	mg/kg	0.59 J	0.56 J	0.65 J	0.72 J
Silver	mg/kg	1 U	1 U	0.063 J	1 U
Sodium	mg/kg	1930	1850	1920	1900
Thallium	mg/kg	2.5 U	2.5 U	2.5 U	2.5 U
Vanadium	mg/kg	5 U	0.078 J	0.051 J	0.071 J
Zinc	mg/kg	32.6	23.1	25.2	22.2

Notes:
BG1 = Reference Site; TR1 = Threemile Run Background; TR2 = Threemile Run Site; KC1 = Kinzua Creek Background; KC2 = Kinzua Creek
J = Reported value is estimated; actual value may be higher or lower
mg/kg = milligrams per kilogram
NL = No listed value
Q = Qualifier
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise
μg/kg = micrograms per kilogram

Table 18
Exposure Point Concentrations - Aquatic Food Chain Modeling - Surface Water
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Concentration mg/L			
	Meade Run	**Threemile Run 2**	**Kinzua Creek 2**	**Kinzua Creek 2**
PAHs				
Acenaphthylene	ND	4.00E-05	ND	ND
Anthracene	ND	ND	ND	4.00E-05
Benzo(a)anthracene	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND
Fluorene	ND	9.00E-05	ND	1.20E-04
Naphthalene	ND	2.60E-04	ND	1.80E-04
Phenanthrene	ND	3.00E-05	ND	1.00E-04
SVOCs				
Benzaldehyde	ND	ND	ND	ND
Metals				
Aluminum	0.24	0.94	0.85	1.1
Barium	0.050	0.093	0.085	0.035
Cadmium	ND	ND	ND	ND
Calcium	4.5	22	12	5.4
Chromium	ND	0.002	0.00038	0.0021
Cobalt	ND	0.0059	0.0026	0.0032
Copper	0.0012	0.017	0.0028	0.014
Iron	0.97	16	5.4	7.9
Lead	ND	0.0074	0.0034	0.0028
Manganese	0.11	1.3	0.40	1.5
Mercury	ND	ND	ND	ND
Nickel	0.0017	0.0068	0.0036	0.72
Potassium	1.40	2.2	6.9	0.94
Selenium	ND	ND	ND	0.78
Silver	ND	ND	ND	ND
Sodium	16	6	87	10
Vanadium	0.0011	ND	ND	ND
Zinc	0.0069	0.020	0.013	0.015

mg/L = Milligrams per liter

Table 19
Exposure Point Concentrations - Aquatic Food Chain Modeling - Sediment
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Concentration mg/kg dw			
	Meade Run	**Threemile Run 2**	**Kinzua Creek 2**	**Kinzua Creek 2**
PAHs				
Acenaphthylene	ND	1.40E-01	5.40E-04	3.80E-01
Anthracene	1.90E-02	7.60E-01	4.50E-04	2.40E+00
Benzo(a)anthracene	3.70E-02	1.80E-01	ND	2.10E-01
Chrysene	3.50E-02	2.10E-01	8.40E-03	1.40E+00
Fluorene	8.00E-03	1.50E+00	6.40E-04	4.60E+00
Naphthalene	ND	1.10E+00	ND	4.00E+00
Phenanthrene	7.20E-02	1.60E+00	1.90E-03	5.40E+00
SVOCs				
Benzaldehyde	ND	ND	ND	ND
Metals				
Aluminum	4000	16000	15000	7800
Barium	66	130	110	69
Cadmium	0.68	2.7	1.8	1.6
Calcium	340	2200	380	1100
Chromium	6.1	15	21	16.00
Cobalt	7.5	31	17	14
Copper	6.1	200	20	54
Iron	16000	86000	34000	71000
Lead	15	41	27	21
Manganese	450	830	330	630
Mercury	0.035	0.12	0.098	0.057
Nickel	15	34	17	25
Potassium	460	970	1400	910
Selenium	ND	1.4	1.2	0.86
Silver	0.1	0.19	0.12	0.097
Sodium	3	590	21	92
Vanadium	9.1	22	30	22
Zinc	92	140	120	100

mg/kg dw = Milligrams per kilogram dry weight

Table 20
Exposure Point Concentrations - Aquatic Food Chain Modeling - Crayfish
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Concentration mg/kg ww			
	Meade Run	Threemile Run 2	Kinzua Creek 2	Kinzua Creek 2
PAHs				
Acenaphthylene	ND	9.30E-03	1.30E-03	6.70E-02
Anthracene	1.00E-02	8.80E-03	1.30E-02	3.80E-02
Benzaldehyde	7.40E-01	2.80E+00	8.40E-01	2.10E+00
Benzo(a)anthracene	9.70E-04	ND	ND	2.60E-03
Chrysene	1.10E-03	ND	ND	2.40E-03
Fluorene	ND	2.50E-03	ND	2.20E-02
Naphthalene	ND	5.30E-03	2.80E-03	1.60E-02
Phenanthrene	ND	7.10E-03	4.40E-03	ND
SVOCs				
Benzaldehyde	7.40E-01	2.80E+00	8.40E-01	2.10E+00
Metals				
Aluminum	23	31	37	31
Barium	150	76	160	120
Cadmium	0.49	0.23	0.30	0.29
Calcium	41000	27000	45000	33000
Chromium	0.19	0.22	0.26	0.24
Cobalt	0.26	0.97	0.59	1.1
Copper	13	21	17	26
Iron	59	1100	200	280
Lead	1.0	1.0	0.5	1.0
Manganese	74	150	140	210
Mercury	0.019	0.029	0.043	0.028
Nickel	0.39	0.55	0.21	0.33
Potassium	1600	1700	1700	1700
Selenium	1	1	1	1
Silver	1	1	0.063	1
Sodium	1900	1800	1900	1900
Vanadium	5	0	0	0
Zinc	33	23	25	22

mg/kg ww = Milligrams per kilogram wet weight

Table 21
Receptor-specific Life History Exposure Parameters
Kinzua Creek Watershed Tar Sites

	Parameter							
Receptor	**FIR[a] (kg WW/kg BW-day)**	**Fraction Moisture in Diet[b]**	**FIR[c] (kg DW/kg BW-day)**	**SIR (fraction of FIR DW)**	**SIR Source**	**SIR[d] (kg DW/kg BW-day)**	**WIR[e] (L/kg BW-day)**	**FT[f] (unitless)**
Belted kingfisher	0.59	0.833	0.100	0.033	Mallard value; Beyer et al. 1994	0.0033	0.11	1
Mink	0.16	0.833	0.030	0.028	Fox value; Beyer et al. 1994	0.0008	0.10	1

Definitions:
FIR = Food Ingestion Rate.
FT = Fraction of Foraging Time at the Site.
NA = Not applicable
SIR = Sediment Ingestion Rate.
WIR = Water Ingestion Rate.

[a]Table 22.
[b]Moisture in diet as follows:

Dietary Item	Fraction Moisture	Source
Crayfish	0.833	EPA, 1999; benthic invertebrate value

[c]FIR DW calculated as FIR WW * (1-Fraction Moisture in Diet)
[d]SIR on body weight basis calculated as FIR DW times fraction SIR.
[e]EPA, 1993a. Birds = Equation 3-15 and Mammals = Equation 3-17.
[f]Conservative default value.

Table 22
Food Ingestion Rates
Kinzua Creek Watershed Tar Sites

$$\text{FIR (kg ww/kg BW - day)} = \frac{\text{FMR}}{\sum_{i=1}^{n}\left(AE_i \times GE_i \times P_i\right)}$$

Parameter	Definition	Value		Reference
FIR	Body weight normalized field ingestion rate (kg WW/kg BW-day equals g WW/g BW-day)	Belted kingfisher	0.59	Calculated
		Mink	0.16	
FMR	Field metabolic rate (kcal/g BW-day)	Species-specific		Table 23
AE_i	Assimilation efficiency of the i^{th} food item (unitless)	Species- and food item-specific		Table 24
GE_i	Gross energy of the i^{th} food item (kcal/g)	Food item-specific		Table 24
P_i	Proportion of diet comprised of the ith food item (unitless)	1		Professional judgment

Table 23
Calculation of Field Metabolic Rates*
Kinzua Creek Watershed Tar Sites

$$\text{FMR (kcal/g BW - day)} = a \times BW^{b} \times \frac{1\,\text{kcal}}{4.1876\,\text{kJ}} \div BW$$

Target Receptor	Allometric Equation Basis	a	b	Body Weight (g)	Body Weight Reference	FMR (kcal/g BW-day)
Belted Kingfisher	Birds - All Birds	10.5	0.681	150	Mean body weight based on means from Dunning, 1993; Alexander, 1977; Salyer and Lagler, 1946; Brooks and Davis, 1987; and Hamas, 1994	0.51
Mink	Mammals - Carnivora	1.67	0.869	946	Mean adult body weight based on male and female means in spring; Mitchell, 1961 as in EPA, 1995	0.16

*From Nagy et al., 1999.

Table 24
Assimilation Efficiency (AE) and Gross Energy (GE) of Anticipated Prey Items
Kinzua Creek Watershed Tar Sites

Predator/Prey Item	Assimilation Efficiency (unitless)	Basis of Value	Gross Energy (kcal/g WW)	Basis of Value
Birds/Crayfish	0.79	Eagles/seabirds - fish	1.1	Shrimp
Mammals/Crayfish	0.91	Mammals - fish	1.1	Shrimp

*Source: EPA, 1993a.

Table 25
Estimated Daily Intake - Mink - Meade Run
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Intake (mg/kg bw-day)			
	Crayfish	**Sediment**	**Surface Water**	**Total**
PAHs				
Acenaphthylene	NA	NA	NA	NA
Anthracene	1.60E-03	1.60E-05	NA	1.60E-03
Benzo(a)anthracene	1.60E-04	3.10E-05	NA	1.90E-04
Chrysene	1.80E-04	2.90E-05	NA	2.10E-04
Fluorene	NA	6.70E-06	NA	6.70E-06
Naphthalene	NA	NA	NA	NA
Phenanthrene	NA	6.00E-05	NA	6.00E-05
SVOCs				
Benzaldehyde	1.20E-01	NA	NA	1.20E-01
Metals				
Aluminum	3.70E+00	3.40E+00	2.40E-02	7.10E+00
Barium	2.40E+01	5.50E-02	5.00E-03	2.40E+01
Cadmium	7.80E-02	5.70E-04	NA	7.90E-02
Calcium	6.60E+03	2.90E-01	4.50E-01	6.60E+03
Chromium	3.00E-02	5.10E-03	NA	3.50E-02
Cobalt	4.20E-02	6.30E-03	NA	4.80E-02
Copper	2.10E+00	5.10E-03	1.20E-04	2.10E+00
Iron	9.40E+00	1.30E+01	9.70E-02	2.20E+01
Lead	1.60E-01	1.30E-02	NA	1.70E-01
Manganese	1.20E+01	3.80E-01	1.10E-02	1.20E+01
Mercury	3.00E-03	2.90E-05	NA	3.00E-03
Nickel	6.20E-02	1.30E-02	1.70E-04	7.50E-02
Potassium	2.60E+02	3.90E-01	1.40E-01	2.60E+02
Selenium	9.40E-02	NA	NA	9.40E-02
Silver	1.60E-01	8.40E-05	NA	1.60E-01
Sodium	3.00E+02	2.50E-03	1.60E+00	3.00E+02
Vanadium	8.00E-01	7.60E-03	1.10E-04	8.10E-01
Zinc	5.30E+00	7.70E-02	6.90E-04	5.40E+00

Note: Results rounded to two significant digits.
mg/kg bw-day = Milligrams per kilogram body weight/day.
NA = Not applicable.

Table 26
Estimated Daily Intake - Belted Kingfisher - Meade Run
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Intake (mg/kg bw-day)			
	Crayfish	Sediment	Surface Water	Total
PAHs				
Acenaphthylene	NA	NA	NA	NA
Anthracene	5.90E-03	6.30E-05	NA	6.00E-03
Benzo(a)anthracene	5.70E-04	1.20E-04	NA	6.90E-04
Chrysene	6.50E-04	1.20E-04	NA	7.70E-04
Fluorene	NA	2.60E-05	NA	2.60E-05
Naphthalene	NA	NA	NA	NA
Phenanthrene	NA	2.40E-04	NA	2.40E-04
SVOCs				
Benzaldehyde	4.40E-01	NA	NA	4.40E-01
Metals				
Aluminum	1.40E+01	1.30E+01	2.60E-02	2.70E+01
Barium	8.80E+01	2.20E-01	5.50E-03	8.80E+01
Cadmium	2.90E-01	2.20E-03	NA	2.90E-01
Calcium	2.40E+04	1.10E+00	5.00E-01	2.40E+04
Chromium	1.10E-01	2.00E-02	NA	1.30E-01
Cobalt	1.50E-01	2.50E-02	NA	1.80E-01
Copper	7.70E+00	2.00E-02	1.30E-04	7.70E+00
Iron	3.50E+01	5.30E+01	1.10E-01	8.80E+01
Lead	5.90E-01	5.00E-02	NA	6.40E-01
Manganese	4.40E+01	1.50E+00	1.20E-02	4.60E+01
Mercury	1.10E-02	1.20E-04	NA	1.10E-02
Nickel	2.30E-01	5.00E-02	1.90E-04	2.80E-01
Potassium	9.40E+02	1.50E+00	1.50E-01	9.40E+02
Selenium	3.50E-01	NA	NA	3.50E-01
Silver	5.90E-01	3.30E-04	NA	5.90E-01
Sodium	1.10E+03	9.90E-03	1.80E+00	1.10E+03
Vanadium	3.00E+00	3.00E-02	1.20E-04	3.00E+00
Zinc	1.90E+01	3.00E-01	7.60E-04	1.90E+01

Note: Results rounded to two significant digits.
mg/kg bw-day = Milligrams per kilogram body weight/day.
NA = Not applicable.

Table 27
Estimated Daily Intake - Mink - Threemile Run 2
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Intake (mg/kg bw-day)			
	Crayfish	Sediment	Surface Water	Total
PAHs				
Acenaphthylene	1.50E-03	1.20E-04	4.00E-06	1.60E-03
Anthracene	1.40E-03	6.40E-04	NA	2.00E-03
Benzo(a)anthracene	NA	1.50E-04	NA	1.50E-04
Chrysene	NA	1.80E-04	NA	1.80E-04
Fluorene	4.00E-04	1.30E-03	9.00E-06	1.70E-03
Naphthalene	8.50E-04	9.20E-04	2.60E-05	1.80E-03
Phenanthrene	1.10E-03	1.30E-03	3.00E-06	2.40E-03
SVOCs				
Benzaldehyde	4.50E-01	NA	NA	4.50E-01
Metals				
Aluminum	5.00E+00	1.30E+01	9.40E-02	1.80E+01
Barium	1.20E+01	1.10E-01	9.30E-03	1.20E+01
Cadmium	3.70E-02	2.30E-03	NA	3.90E-02
Calcium	4.30E+03	1.80E+00	2.20E+00	4.30E+03
Chromium	3.50E-02	1.30E-02	2.00E-04	4.80E-02
Cobalt	1.60E-01	2.60E-02	5.90E-04	1.90E-01
Copper	3.40E+00	1.70E-01	1.70E-03	3.60E+00
Iron	1.80E+02	7.20E+01	1.60E+00	2.50E+02
Lead	1.60E-01	3.40E-02	7.40E-04	1.90E-01
Manganese	2.40E+01	7.00E-01	1.30E-01	2.50E+01
Mercury	4.60E-03	1.00E-04	NA	4.70E-03
Nickel	8.80E-02	2.90E-02	6.80E-04	1.20E-01
Potassium	2.70E+02	8.10E-01	2.20E-01	2.70E+02
Selenium	9.00E-02	1.20E-03	NA	9.10E-02
Silver	1.60E-01	1.60E-04	NA	1.60E-01
Sodium	2.90E+02	5.00E-01	6.10E-01	2.90E+02
Vanadium	1.20E-02	1.80E-02	NA	3.00E-02
Zinc	3.70E+00	1.20E-01	2.00E-03	3.80E+00

Note: Results rounded to two significant digits.
mg/kg bw-day = Milligrams per kilogram body weight/day.
NA = Not applicable.

Table 28
Estimated Daily Intake - Belted Kingfisher - Threemile Run 2
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Intake (mg/kg bw-day)			
	Crayfish	**Sediment**	**Surface Water**	**Total**
PAHs				
Acenaphthylene	5.50E-03	4.60E-04	4.40E-06	6.00E-03
Anthracene	5.20E-03	2.50E-03	NA	7.70E-03
Benzo(a)anthracene	NA	5.90E-04	NA	5.90E-04
Chrysene	NA	6.90E-04	NA	6.90E-04
Fluorene	1.50E-03	5.00E-03	9.90E-06	6.50E-03
Naphthalene	3.10E-03	3.60E-03	2.90E-05	6.70E-03
Phenanthrene	4.20E-03	5.30E-03	3.30E-06	9.50E-03
SVOCs				
Benzaldehyde	1.70E+00	NA	NA	1.70E+00
Metals				
Aluminum	1.80E+01	5.30E+01	1.00E-01	7.10E+01
Barium	4.50E+01	4.30E-01	1.00E-02	4.50E+01
Cadmium	1.40E-01	8.90E-03	NA	1.50E-01
Calcium	1.60E+04	7.30E+00	2.40E+00	1.60E+04
Chromium	1.30E-01	5.00E-02	2.20E-04	1.80E-01
Cobalt	5.70E-01	1.00E-01	6.50E-04	6.70E-01
Copper	1.20E+01	6.60E-01	1.90E-03	1.30E+01
Iron	6.50E+02	2.80E+02	1.80E+00	9.30E+02
Lead	5.90E-01	1.40E-01	8.20E-04	7.30E-01
Manganese	8.80E+01	2.70E+00	1.40E-01	9.10E+01
Mercury	1.70E-02	4.00E-04	NA	1.70E-02
Nickel	3.20E-01	1.10E-01	7.50E-04	4.30E-01
Potassium	1.00E+03	3.20E+00	2.40E-01	1.00E+03
Selenium	3.30E-01	4.60E-03	NA	3.30E-01
Silver	5.90E-01	6.30E-04	NA	5.90E-01
Sodium	1.10E+03	1.90E+00	6.70E-01	1.10E+03
Vanadium	4.60E-02	7.30E-02	NA	1.20E-01
Zinc	1.40E+01	4.60E-01	2.20E-03	1.40E+01

Note: Results rounded to two significant digits.
mg/kg bw-day = Milligrams per kilogram body weight/day.
NA = Not applicable.

Table 29
Estimated Daily Intake - Mink - Kinzua Creek 1
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Intake (mg/kg bw-day)			
	Crayfish	Sediment	Surface Water	Total
PAHs				
Acenaphthylene	2.10E-04	4.50E-07	NA	2.10E-04
Anthracene	2.10E-03	3.80E-07	NA	2.10E-03
Benzo(a)anthracene	NA	NA	NA	NA
Chrysene	NA	7.10E-06	NA	7.10E-06
Fluorene	NA	5.40E-07	NA	5.40E-07
Naphthalene	4.50E-04	NA	NA	4.50E-04
Phenanthrene	7.00E-04	1.60E-06	NA	7.00E-04
SVOCs				
Benzaldehyde	1.30E-01	NA	NA	1.30E-01
Metals				
Aluminum	5.90E+00	1.30E+01	8.50E-02	1.90E+01
Barium	2.60E+01	9.20E-02	8.50E-03	2.60E+01
Cadmium	4.80E-02	1.50E-03	NA	5.00E-02
Calcium	7.20E+03	3.20E-01	1.20E+00	7.20E+03
Chromium	4.20E-02	1.80E-02	3.80E-05	6.00E-02
Cobalt	9.40E-02	1.40E-02	2.60E-04	1.10E-01
Copper	2.70E+00	1.70E-02	2.80E-04	2.70E+00
Iron	3.20E+01	2.90E+01	5.40E-01	6.20E+01
Lead	8.00E-02	2.30E-02	3.40E-04	1.00E-01
Manganese	2.20E+01	2.80E-01	4.00E-02	2.20E+01
Mercury	6.90E-03	8.20E-05	NA	7.00E-03
Nickel	3.40E-02	1.40E-02	3.60E-04	4.80E-02
Potassium	2.70E+02	1.20E+00	6.90E-01	2.70E+02
Selenium	1.00E-01	1.00E-03	NA	1.00E-01
Silver	1.00E-02	1.00E-04	NA	1.00E-02
Sodium	3.00E+02	1.80E-02	8.70E+00	3.10E+02
Vanadium	8.20E-03	2.50E-02	NA	3.30E-02
Zinc	4.00E+00	1.00E-01	1.30E-03	4.10E+00

Note: Results rounded to two significant digits.
mg/kg bw-day = Milligrams per kilogram body weight/day.
NA = Not applicable.

Table 30
Estimated Daily Intake - Belted Kingfisher - Kinzua Creek 1
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Intake (mg/kg bw-day)			
	Crayfish	Sediment	Surface Water	Total
PAHs				
Acenaphthylene	7.70E-04	1.80E-06	NA	7.70E-04
Anthracene	7.70E-03	1.50E-06	NA	7.70E-03
Benzo(a)anthracene	NA	NA	NA	NA
Chrysene	NA	2.80E-05	NA	2.80E-05
Fluorene	NA	2.10E-06	NA	2.10E-06
Naphthalene	1.70E-03	NA	NA	1.70E-03
Phenanthrene	2.60E-03	6.30E-06	NA	2.60E-03
SVOCs				
Benzaldehyde	5.00E-01	NA	NA	5.00E-01
Metals				
Aluminum	2.20E+01	5.00E+01	9.40E-02	7.20E+01
Barium	9.40E+01	3.60E-01	9.40E-03	9.40E+01
Cadmium	1.80E-01	5.90E-03	NA	1.90E-01
Calcium	2.70E+04	1.30E+00	1.30E+00	2.70E+04
Chromium	1.50E-01	6.90E-02	4.20E-05	2.20E-01
Cobalt	3.50E-01	5.60E-02	2.90E-04	4.10E-01
Copper	1.00E+01	6.60E-02	3.10E-04	1.00E+01
Iron	1.20E+02	1.10E+02	6.00E-01	2.30E+02
Lead	3.00E-01	8.90E-02	3.80E-04	3.90E-01
Manganese	8.30E+01	1.10E+00	4.40E-02	8.40E+01
Mercury	2.50E-02	3.20E-04	NA	2.50E-02
Nickel	1.20E-01	5.60E-02	4.00E-04	1.80E-01
Potassium	1.00E+03	4.60E+00	7.60E-01	1.00E+03
Selenium	3.80E-01	4.00E-03	NA	3.80E-01
Silver	3.70E-02	4.00E-04	NA	3.70E-02
Sodium	1.10E+03	6.90E-02	9.60E+00	1.10E+03
Vanadium	3.00E-02	9.90E-02	NA	1.30E-01
Zinc	1.50E+01	4.00E-01	1.40E-03	1.50E+01

Note: Results rounded to two significant digits.
mg/kg bw-day = Milligrams per kilogram body weight/day.
NA = Not applicable.

Table 31
Estimated Daily Intake - Mink - Kinzua Creek 2
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Intake (mg/kg bw-day)			
	Crayfish	Sediment	Surface Water	Total
PAHs				
Acenaphthylene	1.10E-02	3.20E-04	NA	1.10E-02
Anthracene	6.10E-03	2.00E-03	4.00E-06	8.10E-03
Benzo(a)anthracene	4.20E-04	1.80E-04	NA	6.00E-04
Chrysene	3.80E-04	1.20E-03	NA	1.60E-03
Fluorene	3.50E-03	3.90E-03	1.20E-05	7.40E-03
Naphthalene	2.60E-03	3.40E-03	1.80E-05	6.00E-03
Phenanthrene	NA	4.50E-03	1.00E-05	4.50E-03
SVOCs				
Benzaldehyde	3.40E-01	NA	NA	3.40E-01
Metals				
Aluminum	5.00E+00	6.60E+00	1.10E-01	1.20E+01
Barium	1.90E+01	5.80E-02	3.50E-03	1.90E+01
Cadmium	4.60E-02	1.30E-03	NA	4.70E-02
Calcium	5.30E+03	9.20E-01	5.40E-01	5.30E+03
Chromium	3.80E-02	1.30E-02	2.10E-04	5.10E-02
Cobalt	1.80E-01	1.20E-02	3.20E-04	1.90E-01
Copper	4.20E+00	4.50E-02	1.40E-03	4.20E+00
Iron	4.50E+01	6.00E+01	7.90E-01	1.10E+02
Lead	1.60E-01	1.80E-02	2.80E-04	1.80E-01
Manganese	3.40E+01	5.30E-01	1.50E-01	3.50E+01
Mercury	4.50E-03	4.80E-05	NA	4.50E-03
Nickel	5.30E-02	2.10E-02	7.20E-02	1.50E-01
Potassium	2.70E+02	7.60E-01	9.40E-02	2.70E+02
Selenium	1.20E-01	7.20E-04	7.80E-02	2.00E-01
Silver	1.60E-01	8.10E-05	NA	1.60E-01
Sodium	3.00E+02	7.70E-02	1.00E+00	3.00E+02
Vanadium	1.10E-02	1.80E-02	NA	2.90E-02
Zinc	3.50E+00	8.40E-02	1.50E-03	3.60E+00

Note: Results rounded to two significant digits.
mg/kg bw-day = Milligrams per kilogram body weight/day.
NA = Not applicable.

Table 32
Estimated Daily Intake - Belted Kingfisher - Kinzua Creek 2
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Intake (mg/kg bw-day)			
	Crayfish	**Sediment**	**Surface Water**	**Total**
PAHs				
Acenaphthylene	4.00E-02	1.30E-03	NA	4.10E-02
Anthracene	2.20E-02	7.90E-03	4.40E-06	3.00E-02
Benzo(a)anthracene	1.50E-03	6.90E-04	NA	2.20E-03
Chrysene	1.40E-03	4.60E-03	NA	6.00E-03
Fluorene	1.30E-02	1.50E-02	1.30E-05	2.80E-02
Naphthalene	9.40E-03	1.30E-02	2.00E-05	2.20E-02
Phenanthrene	NA	1.80E-02	1.10E-05	1.80E-02
SVOCs				
Benzaldehyde	1.20E+00	NA	NA	1.20E+00
Metals				
Aluminum	1.80E+01	2.60E+01	1.20E-01	4.40E+01
Barium	7.10E+01	2.30E-01	3.90E-03	7.10E+01
Cadmium	1.70E-01	5.30E-03	NA	1.80E-01
Calcium	1.90E+04	3.60E+00	6.00E-01	1.90E+04
Chromium	1.40E-01	5.30E-02	2.30E-04	1.90E-01
Cobalt	6.50E-01	4.60E-02	3.50E-04	7.00E-01
Copper	1.50E+01	1.80E-01	1.50E-03	1.50E+01
Iron	1.70E+02	2.30E+02	8.70E-01	4.00E+02
Lead	5.90E-01	6.90E-02	3.10E-04	6.60E-01
Manganese	1.20E+02	2.10E+00	1.70E-01	1.20E+02
Mercury	1.70E-02	1.90E-04	NA	1.70E-02
Nickel	1.90E-01	8.20E-02	7.90E-02	3.50E-01
Potassium	1.00E+03	3.00E+00	1.00E-01	1.00E+03
Selenium	4.20E-01	2.80E-03	8.60E-02	5.10E-01
Silver	5.90E-01	3.20E-04	NA	5.90E-01
Sodium	1.10E+03	3.00E-01	1.10E+00	1.10E+03
Vanadium	4.20E-02	7.30E-02	NA	1.20E-01
Zinc	1.30E+01	3.30E-01	1.70E-03	1.30E+01

Note: Results rounded to two significant digits.
mg/kg bw-day = Milligrams per kilogram body weight/day.
NA = Not applicable.

Table 33
Mammalian Toxicity Reference Values (TRVs)
Kinzua Creek Watershed Tar Sites
McKean County, PA

Analyte	Test Species	Study Duration	Effect	Dose (mg/kg-day)		TRV (mg/kg-day)		Toxicity Value Comment	Initial Value Source
				NOAEL	LOAEL	NOAEL	LOAEL		
PAHs									
Low Molecular Weight PAHs	Rat	Subchronic	Growth	65.6	328	65.6	328		EPA, 2007d
High Molecular Weight PAHs	Mouse	Chronic	Survival	0.615	3.07	0.615	3.07		EPA, 2007d
SVOCs									
Benzaldehyde	Rat	Subchronic	Kidney Toxicity	143		14.3	71.5		IRIS, 2008
Metals									
Aluminum	Mouse	Chronic	Reproduction		19.3	3.86	19.3	Aluminum chloride	EPA, 1999 and Sample et al., 1996
Barium	Rat	Multiple	Reproduction and Growth	51.8		51.8	259	Geomean of NOAELs; Eco SSL TRV	EPA, 2005e
Cadmium	Rat	Chronic	Growth	0.77	7.7	0.77	7.7		EPA, 2005d
Calcium						NTV	NTV		
Chromium	Rat	Chronic	Growth	8.09		8.09	40.45	Chromium III	EPA, 2008
Cobalt	Rat	Chronic	Reproduction	5.45	10.9	5.45	10.9		EPA, 2005c
Copper	Mink	Chronic	Reproduction	3.4	6.79	3.4	6.79	Lowest bounded LOAEL - Aquatic	EPA, 2007a
Iron	Rat	Subchronic	Liver, Heart	31.5	315	3.15	31.5		Whittaker et al., 1994
Lead	Rat	Chronic	Growth	4.7	8.9	4.7	8.9		EPA, 2005b
Manganese	Multiple	Multiple	Reproduction and Growth	51.5		51.5	257.5	Geomean of NOAELs	EPA, 2007b
Mercury	Mink	Chronic	Reproduction	1.01		1.01	5.05	Mercuric chloride - Terrestrial	EPA, 1999 and Sample et al., 1996
Nickel	Mouse	Chronic	Reproduction	1.7	3.4	1.7	3.4		EPA, 2007c
Potassium						NTV	NTV		
Selenium	Mouse	Chronic	Reproduction	0.072	0.145	0.072	0.145		EPA, 2007e
Silver	Rat	Chronic	Growth		80.2	16.04	80.2	Lowest rodent LOAEL	EPA, 2006
Sodium						NTV	NTV		
Vanadium	Mouse	Chronic	Growth, Reproduction, and Survival	4.16	8.31	4.16	8.31		EPA, 2005a
Zinc	Rat	Chronic	Reproduction	181	452	181	452	Reproduction, growth, or survival study with lowest bounded LOAEL (non livestock)	EPA, 2007f

LOAEL = Lowest observed adverse effect level.
mg/kg-day = Milligrams per kilogram per day.
NOAEL = No observed adverse effect level.

Table 34
Avian Toxicity Reference Values (TRVs)
Kinzua Creek Watershed Tar Sites
McKean County, PA

Analyte	Test Species	Study Duration	Effect	Dose (mg/kg-day)		TRV (mg/kg-day)		Toxicity Value Form or Surrogate	Initial Value Source
				NOAEL	LOAEL	NOAEL	LOAEL		
PAHs									
Low Molcular Weight PAHs	Mallard	Chronic	Reproduction	211		211	1055	Weathered crude	Stubblefield et al., 1995
High Molecular Weight PAHs	Mallard	Chronic	Reproduction	211		211	1055	Weathered crude	Stubblefield et al., 1995
SVOCs									
Benzaldehyde						NTV	NTV		
Metals									
Aluminum	Ringed Dove	Chronic	Reproduction	110		110	550	Aluminum sulfate	EPA, 1999 and Sample et al., 1996
Barium	1-day old chick	Subchronic	Mortality	208.26	416.53	20.826	41.653		EPA, 1999 and Sample et al., 1996
Cadmium	Chicken	Chronic	Reproduction	0.593	2.37	0.593	2.37		EPA, 2005d
Calcium						NTV	NTV		
Chromium	Black Duck	Chronic	Reproduction and Growth	0.5	2.78	0.5	2.78	Chromium III	EPA, 2008
Cobalt	Multiple	Multiple	Growth And Mortality	7.61		7.61	38.05	Geomean of NOAELs	EPA, 2005c
Copper	Chicken	Chronic	Reproduction	4.05	12.1	4.05	12.1		EPA, 2007a
Iron						NTV	NTV		
Lead	Chicken	Chronic	Reproduction	1.63	3.26	1.63	3.26	Lead acetate	EPA, 2005b
Manganese	Multiple	Multiple	Reproduction, Growth, and Survival	179		179	895	Geomean of NOAELs	EPA, 2007b
Mercury	Japanese Quail	Chronic	Reproduction	0.45	0.9	0.45	0.9	Mercuric chloride - Ter	Sample et al., 1996
Nickel	Multiple	Multiple	Reproduction and Growth	6.71		6.71	33.55	Geomean of NOAELs	EPA, 2007c
Potassium						NTV	NTV		
Selenium	Mallard	Chronic	Reproduction	0.5	1	0.5	1	Sodium selinite	EPA, 1999 and Sample et al., 1996
Silver	Turkey	Subchronic	Growth	2.02	20.2	2.02	20.2		
Sodium						NTV	NTV		
Vanadium	Mallard	Chronic	Mortality, Body Weight, Blood Chemistry	11.38		11.38	56.9		Sample et al., 1996
Zinc	Multiple	Multiple	Reproduction and Growth	66.1		66.1	330.5	Geomean of NOAELs	EPA, 2007f

Note: Avian TRV not available for benzaldehyde.
LOAEL = Lowest observed adverse effect level.
mg/kg-day = Milligrams per kilogram per day.
NOAEL = No observed adverse effect level.

Table 35
Hazard Quotients - Mink - NOAEL-based - Meade Run
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	NA	NA	NA	NA	NA	NA	0
Anthracene	0.000024	99	0.00000024	1	NA	NA	0.000025
Fluorene	NA	NA	0.00000010	100	NA	NA	0.00000010
Naphthalene	NA	NA	NA	NA	NA	NA	0
Phenanthrene	NA	NA	0.00000091	100	NA	NA	0.00000091
Total Low Molecular Weight PAHs	0.000024	95	0.0000013	5	NA	NA	0.000026
High Molecular Weight PAHs							
Benzo(a)anthracene	0.00026	84	0.000050	16	NA	NA	0.00031
Chrysene	0.00029	86	0.000047	14	NA	NA	0.00034
Total High Molecular Weight PAHs	0.00055	85	0.000098	15	NA	NA	0.00065
SVOCs							
Benzaldehyde	0.0084	100	NA	NA	NA	NA	0.0084
Metals							
Aluminum	0.96	52	0.88	48	0.0062	0	1.8
Barium	0.46	100	0.0011	0	0.00010	0	0.46
Cadmium	0.10	99	0.00074	1	NA	NA	0.10
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0
Chromium	0.0037	85	0.00063	15	NA	NA	0.0043
Cobalt	0.0077	87	0.0012	13	NA	NA	0.0089
Copper	0.62	100	0.0015	0	0.000035	0	0.62
Iron	3.0	42	4.1	58	0.031	0	7.1
Lead	0.034	92	0.0028	8	NA	NA	0.037
Manganese	0.23	97	0.0074	3	0.00021	0	0.24
Mercury	0.0030	99	0.000029	1	NA	NA	0.0030
Nickel	0.036	82	0.0076	17	0.00010	0	0.044
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	1.3	100	NA	NA	NA	NA	1.3
Silver	0.010	100	0.0000052	0	NA	NA	0.010
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.19	99	0.0018	1	0.000026	0	0.19
Zinc	0.029	99	0.00043	1	0.0000038	0	0.030

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.
NTV = No toxicity value.

Table 36
Hazard Quotients - Belted Kingfisher - NOAEL-based - Meade Run
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	NA	NA	NA	NA	NA	NA	0
Anthracene	0.000028	99	0.00000030	1	NA	NA	0.000028
Fluorene	NA	NA	0.00000012	100	NA	NA	0.00000012
Naphthalene	NA	NA	NA	NA	NA	NA	0
Phenanthrene	NA	NA	0.0000011	100	NA	NA	0.0000011
Total Low Molecular Weight PAHs	0.000028	95	0.0000016	5	NA	NA	0.000030
High Molecular Weight PAHs							
Benzo(a)anthracene	0.0000027	83	0.00000057	17	NA	NA	0.0000033
Chrysene	0.0000031	84	0.00000057	16	NA	NA	0.0000036
Total High Molecular Weight PAHs	0.0000058	84	0.0000011	16	NA	NA	0.0000069
SVOCs							
Benzaldehyde	NTV	NTV	NA	NA	NA	NA	0
Metals							
Aluminum	0.13	52	0.12	48	0.00024	0	0.25
Barium	4.2	100	0.011	0	0.00026	0	4.2
Cadmium	0.49	99	0.0037	1	NA	NA	0.49
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0.0
Chromium	0.22	85	0.04	15	NA	NA	0.26
Cobalt	0.020	86	0.0033	14	NA	NA	0.023
Copper	1.9	100	0.0049	0	0.000032	0	1.9
Iron	NTV	NTV	NTV	NTV	NTV	NTV	0
Lead	0.36	92	0.031	8	NA	NA	0.39
Manganese	0.25	97	0.0084	3	0.000067	0	0.25
Mercury	0.024	99	0.00027	1	NA	NA	0.025
Nickel	0.034	82	0.0075	18	0.000028	0	0.042
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.7	100	NA	NA	NA	NA	0.70
Silver	0.29	100	0.00016	0	NA	NA	0.29
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.26	99	0.0026	1	0.000011	0	0.27
Zinc	0.29	98	0.0045	2	0.000011	0	0.29

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.
NTV = No toxicity value.

Table 37
Hazard Quotients - Mink - LOAEL-based - Meade Run
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	NA	NA	NA	NA	NA	NA	0
Anthracene	0.0000049	99	0.000000049	1	NA	NA	0.0000049
Fluorene	NA	NA	0.000000020	100	NA	NA	0.000000020
Naphthalene	NA	NA	NA	NA	NA	NA	0
Phenanthrene	NA	NA	0.00000018	100	NA	NA	0.00000018
Total Low Molecular Weight PAHs	0.00000488	95	0.00000025	5	NA	NA	0.00000513
High Molecular Weight PAHs							
Benzo(a)anthracene	0.000052	84	0.000010	16	NA	NA	0.000062
Chrysene	0.000059	86	0.0000094	14	NA	NA	0.000068
Total High Molecular Weight PAHs	0.00011075	85	0.00001954	15	NA	NA	0.00013029
SVOCs							
Benzaldehyde	0.0017	100	NA	NA	NA	NA	0.0017
Metals							
Aluminum	0.19	52	0.18	48	0.0012	0	0.37
Barium	0.093	100	0.00021	0	0.000019	0	0.093
Cadmium	0.010	99	0.000074	1	NA	NA	0.010
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0
Chromium	0.00074	85	0.00013	15	NA	NA	0.00087
Cobalt	0.0039	87	0.00058	13	NA	NA	0.0044
Copper	0.31	100	0.00075	0	0.000018	0	0.31
Iron	0.30	42	0.41	58	0.0031	0	0.71
Lead	0.018	92	0.0015	8	NA	NA	0.019
Manganese	0.047	97	0.0015	3	0.000043	0	0.048
Mercury	0.00059	99	0.0000057	1	NA	NA	0.00060
Nickel	0.018	82	0.0038	17	0.000050	0	0.022
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.65	100	NA	NA	NA	NA	0.65
Silver	0.0020	100	0.0000010	0	NA	NA	0.0020
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.096	99	0.00091	1	0.000013	0	0.10
Zinc	0.012	99	0.00017	1	0.0000015	0	0.012

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.
NTV = No toxicity value.

Table 38
Hazard Quotients - Belted Kingfisher - LOAEL-based - Meade Run
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	NA	NA	NA	NA	NA	NA	0
Anthracene	0.0000056	99	0.000000060	1	NA	NA	0.0000057
Fluorene	NA	NA	0.000000025	100	NA	NA	0.000000025
Naphthalene	NA	NA	NA	NA	NA	NA	0
Phenanthrene	NA	NA	0.00000023	100	NA	NA	0.00000023
Total Low Molecular Weight PAHs	0.0000056	95	0.00000031	5	NA	NA	0.0000059
High Molecular Weight PAHs							
Benzo(a)anthracene	0.00000054	83	0.00000011	17	NA	NA	0.00000065
Chrysene	0.00000062	84	0.00000011	16	NA	NA	0.00000073
Total High Molecular Weight PAHs	0.0000012	84	0.00000023	16	NA	NA	0.0000014
SVOCs							
Benzaldehyde	NTV	NTV	NA	NA	NA	NA	0
Metals							
Aluminum	0.025	52	0.024	48	0.000047	0	0.049
Barium	2.1	100	0.0053	0	0.00013	0	2.1
Cadmium	0.12	99	0.00093	1	NA	NA	0.12
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0.0
Chromium	0.040	85	0.0072	15	NA	NA	0.047
Cobalt	0.0039	86	0.00066	14	NA	NA	0.0046
Copper	0.64	100	0.0017	0	0.000011	0	0.64
Iron	NTV	NTV	NTV	NTV	NTV	NTV	0
Lead	0.18	92	0.015	8	NA	NA	0.20
Manganese	0.049	97	0.0017	3	0.000013	0	0.051
Mercury	0.012	99	0.00013	1	NA	NA	0.012
Nickel	0.0069	82	0.0015	18	0.0000057	0	0.0084
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.35	100	NA	NA	NA	NA	0.35
Silver	0.029	100	0.000016	0	NA	NA	0.029
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.053	99	0.00053	1	0.0000021	0	0.053
Zinc	0.057	98	0.00091	2	0.0000023	0	0.058

Shading indicates HQ >1.0.

Note: Results rounded to two significant digits.

NA = Not available, COPEC not detected in medium.

NTV = No toxicity value.

Table 39
Hazard Quotients - Mink - NOAEL-based - Threemile Run 2
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	0.000023	92	0.0000018	7	0.000000061	0	0.000025
Anthracene	0.000021	69	0.0000098	31	NA	NA	0.000031
Fluorene	0.0000061	23	0.000020	76	0.00000014	1	0.000026
Naphthalene	0.000013	47	0.000014	51	0.00000040	1	0.000027
Phenanthrene	0.000017	46	0.000020	54	0.000000046	0	0.000037
Total Low Molecular Weight PAHs	0.000080	55	0.000065	45	NA	NA	0.00015
High Molecular Weight PAHs							
Benzo(a)anthracene	NA	NA	0.00024	100	NA	NA	0.00024
Chrysene	NA	NA	0.00029	100	NA	NA	0.00029
Total High Molecular Weight PAHs	NA	NA	0.000537	100	NA	NA	0.00054
SVOCs							
Benzaldehyde	0.031	100	NA	NA	NA	NA	0.031
Metals							
Aluminum	1.3	28	3.4	72	0.024	1	4.7
Barium	0.23	99	0.0021	1	0.00018	0	0.23
Cadmium	0.048	94	0.0030	6	NA	NA	0.051
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0
Chromium	0.0043	73	0.0016	27	0.000025	0	0.0060
Cobalt	0.029	86	0.0048	14	0.00011	0	0.034
Copper	1.0	95	0.050	5	0.00050	0	1.1
Iron	57	71	23	28	0.51	1	81
Lead	0.034	82	0.0072	17	0.00016	0	0.041
Manganese	0.47	97	0.014	3	0.0025	1	0.48
Mercury	0.0046	98	0.000099	2	NA	NA	0.0047
Nickel	0.052	75	0.017	25	0.00040	1	0.069
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	1.3	99	0.017	1	NA	NA	1.3
Silver	0.010	100	0.000010	0	NA	NA	0.010
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.0029	40	0.0043	60	NA	NA	0.0072
Zinc	0.020	97	0.00066	3	0.000011	0	0.021

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.
NTV = No toxicity value.

Table 40
Hazard Quotients - Belted Kingfisher - NOAEL-based - Threemile Run 2
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	0.00002607	92	0.0000022	8	0.000000021	0	0.000028
Anthracene	0.000025	68	0.000012	32	NA	NA	0.000036
Fluorene	0.000007	23	0.000024	77	0.000000047	0	0.00003085
Naphthalene	0.000015	46	0.000017	53	0.00000014	0	0
Phenanthrene	0.000020	44	0.000025	56	0.000000016	0	0.000045
Total Low Molecular Weight PAHs	0.000092	54	0.000080	46	NA	NA	0.00017
High Molecular Weight PAHs							
Benzo(a)anthracene	NA	NA	0.0000028	100	NA	NA	0.0000028
Chrysene	NA	NA	0.0000033	100	NA	NA	0.0000033
Total High Molecular Weight PAHs	NA	NA	0.000006	100	NA	NA	0.000006
SVOCs							
Benzaldehyde	NTV	NTV	NA	NA	NA	NA	0
Metals							
Aluminum	0.16	25	0.48	75	0.00091	0	0.65
Barium	2.2	99	0.021	1	0.00048	0	2.2
Cadmium	0.24	94	0.015	6	NA	NA	0.25
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0.0
Chromium	0.26	72	0.10	28	0.00044	0	0.36
Cobalt	0.075	85	0.013	15	0.000085	0	0.088
Copper	3.0	95	0.16	5	0.00047	0	3.1
Iron	NTV	NTV	NTV	NTV	NTV	NTV	0
Lead	0.36	81	0.086	19	0.00050	0	0.45
Manganese	0.49	97	0.015	3	0.00078	0	0.51
Mercury	0.038	98	0.00089	2	NA	NA	0.039
Nickel	0.048	74	0.016	26	0.00011	0	0.064
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.66	99	0.0092	1	NA	NA	0.67
Silver	0.29	100	0.00031	0	NA	NA	0.29
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.0040	39	0.0064	61	NA	NA	0.010
Zinc	0.21	97	0.0070	3	0.000033	0	0.22

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.
NTV = No toxicity value.

Table 41
Hazard Quotients - Mink - LOAEL-based - Threemile Run 2
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	0.0000046	92	0.00000037	7	0.000000012	0	0.0000050
Anthracene	0.0000043	69	0.0000020	31	NA	NA	0.0000062
Fluorene	0.0000012	23	0.0000040	76	0.000000027	1	0.0000052
Naphthalene	0.0000026	47	0.0000028	51	0.000000079	1	0.0000055
Phenanthrene	0.0000034	46	0.0000040	54	0.0000000091	0	0.0000073
Total Low Molecular Weight PAHs	0.000016	55	0.000013	45	NA	NA	0.000029
High Molecular Weight PAHs							
Benzo(a)anthracene	NA	NA	0.000049	100	NA	NA	0.000049
Chrysene	NA	NA	0.000059	100	NA	NA	0.000059
Total High Molecular Weight PAHs	NA	NA	0.00011	100	NA	NA	0.00011
SVOCs							
Benzaldehyde	0.0063	100	NA	NA	NA	NA	0.0063
Metals							
Aluminum	0.26	28	0.67	72	0.0049	1	0.94
Barium	0.046	99	0.00042	1	0.000036	0	0.047
Cadmium	0.0048	94	0.00030	6	NA	NA	0.0051
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0
Chromium	0.00087	73	0.00032	27	0	0	0.0012
Cobalt	0.0147	86	0.0024	14	0	0	0.017
Copper	0.50	95	0.0250	5	0.00025	0	0.53
Iron	5.7	71	2.3	28	0.051	1	8.1
Lead	0.018	82	0.0038	17	0	0	0.022
Manganese	0.093	97	0.0027	3	0.00050	1	0.096
Mercury	0.00091	98	0.000020	2	NA	NA	0.00093
Nickel	0.026	75	0.0085	25	0.00020	1	0.035
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.62	99	0.0083	1	NA	NA	0.63
Silver	0.0020	100	0.0000020	0	NA	NA	0.0020
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.0014	40	0.0022	60	NA	NA	0.0036
Zinc	0.0082	97	0.00027	3	0.0000044	0	0.0085

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.
NTV = No toxicity value.

Table 42
Hazard Quotients - Belted Kingfisher - LOAEL-based - Threemile Run 2
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	0.0000052	92	0.00000044	8	0.0000000042	0	0.0000057
Anthracene	0.0000049	68	0.0000024	32	NA	NA	0.0000073
Fluorene	0.0000014	23	0.0000047	77	0.0000000094	0	0.00000617
Naphthalene	0.0000029	46	0.0000034	53	0.000000027	0	0.0000064
Phenanthrene	0.0000040	44	0.0000050	56	0.0000000031	0	0.0000090
Total Low Molecular Weight PAHs	0.000018	54	0.000016	46	NA	NA	0.000035
High Molecular Weight PAHs							
Benzo(a)anthracene	NA	NA	0.00000056	100	NA	NA	0.00000056
Chrysene	NA	NA	0.00000065	100	NA	NA	0.00000065
Total High Molecular Weight PAHs	NA	NA	0.0000012	100	NA	NA	0.0000012
SVOCs							
Benzaldehyde	NTV	NTV	NA	NA	NA	NA	0
Metals							
Aluminum	0.033	25	0.096	75	0.00018	0	0.13
Barium	1.1	99	0.010	1	0.00024	0	1.1
Cadmium	0.059	94	0.0038	6	NA	NA	0.063
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0.0
Chromium	0.047	72	0.018	28	0.000079	0	0.065
Cobalt	0.015	85	0.0026	15	0.000017	0	0.018
Copper	0.99	95	0.055	5	0.00016	0	1.05
Iron	NTV	NTV	NTV	NTV	NTV	NTV	0
Lead	0.18	81	0.043	19	0.00025	0	0.22
Manganese	0.098	97	0.0030	3	0.00016	0	0.10
Mercury	0.019	98	0.00044	2	NA	NA	0.019
Nickel	0.0095	74	0.0033	26	0.000022	0	0.013
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.33	99	0.0046	1	NA	NA	0.33
Silver	0.029	100	0.000031	0	NA	NA	0.029
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.00081	39	0.0013	61	NA	NA	0.0021
Zinc	0.042	97	0.0014	3	0.0000067	0	0.044

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.
NTV = No toxicity value.

Table 43
Hazard Quotients - Mink - NOAEL-based - Kinzua Creek 1
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	0.0000032	100	0.0000000069	0	NA	NA	0.0000032
Anthracene	0.000032	100	0.0000000058	0	NA	NA	0.000032
Fluorene	NA	NA	0.0000000082	100	NA	NA	0
Naphthalene	0.0000069	100	NA	NA	NA	NA	0.0000069
Phenanthrene	0.000011	100	0.000000024	0	NA	NA	0.000011
Total Low Molecular Weight PAHs	0.000053	100	0.000000045	0	NA	NA	0.000053
High Molecular Weight PAHs							
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	0
Chrysene	NA	NA	0.000012	100	NA	NA	0.000012
Total High Molecular Weight PAHs	NA	NA	0.000012	100	NA	NA	0.000012
SVOCs							
Benzaldehyde	0.0091	100	NA	NA	NA	NA	0.0091
Metals							
Aluminum	1.5	31	3.4	68	0.022	0	4.9
Barium	0.50	100	0.0018	0	0.00016	0	0.50
Cadmium	0.062	97	0.0019	3	NA	NA	0.064
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0
Chromium	0.0052	70	0.0022	30	0.0000047	0	0.0074
Cobalt	0.017	87	0.0026	13	0.000048	0	0.020
Copper	0.8	99	0.0050	1	0.000082	0	0.80
Iron	10	52	9.2	47	0.17	1	20
Lead	0.017	77	0.0049	22	0.000072	0	0.022
Manganese	0.43	99	0.0054	1	0.00078	0	0.43
Mercury	0.0068	99	0.000081	1	NA	NA	0.0069
Nickel	0.020	70	0.0082	29	0.00021	1	0.028
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	1.4	99	0.014	1	NA	NA	1.4
Silver	0.00062	99	0.0000062	1	NA	NA	0.00063
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.0020	25	0.0060	75	NA	NA	0.0080
Zinc	0.022	98	0.00055	2	0.0000072	0	0.023

Shading indicates HQ >1.0.

Note: Results rounded to two significant digits.

NA = Not available, COPEC not detected in medium.

NTV = No toxicity value.

Table 44
Hazard Quotients - Belted Kingfisher - NOAEL-based - Kinzua Creek 1
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	0.0000036	100	0.0000000085	0	NA	NA	0.0000037
Anthracene	0.000036	100	0.0000000071	0	NA	NA	0.000037
Fluorene	NA	NA	0.000000010	100	NA	NA	0.000000010
Naphthalene	0.0000081	100	NA	NA	NA	NA	0
Phenanthrene	0.000012	100	0.000000030	0	NA	NA	0.000012
Total Low Molecular Weight PAHs	0.000061	100	0.000000055	0	NA	NA	0.000061
High Molecular Weight PAHs							
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	0
Chrysene	NA	NA	0.00000013	100	NA	NA	0.00000013
Total High Molecular Weight PAHs	NA	NA	0.00000013	100	NA	NA	0.00000013
SVOCs							
Benzaldehyde	NTV	NTV	NA	NA	NA	NA	0
Metals							
Aluminum	0.20	31	0.45	69	0.00085	0.13	0.66
Barium	4.5	100	0.017	0	0.00045	0.010	4.5
Cadmium	0.30	97	0.010	3	NA	NA	0.31
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0.0
Chromium	0.30	68	0.14	32	0.000084	0.019	0.44
Cobalt	0.046	86	0.0074	14	0.000038	0.071	0.053
Copper	2.5	99	0.016	1	0.000077	0.0031	2.5
Iron	NTV	NTV	NTV	NTV	NTV	NTV	0
Lead	0.18	77	0.055	23	0.00023	0.10	0.24
Manganese	0.46	99	0.0061	1	0.00025	0.052	0.47
Mercury	0.056	99	0.00071	1	NA	NA	0.056
Nickel	0.018	68	0.0083	32	0.000060	0.23	0.026
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.76	99	0.0080	1	NA	NA	0.77
Silver	0.018	99	0.00020	1	NA	NA	0.019
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.0026	23	0.0087	77	NA	NA	0.011
Zinc	0.23	97	0.0061	3	0.000021	0.0091	0.23

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.
NTV = No toxicity value.

Table 45
Hazard Quotients - Mink - LOAEL-based - Kinzua Creek 1
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	0.00000064	100	0.0000000014	0	NA	NA	0.00000064
Anthracene	0.0000064	100	0.0000000012	0	NA	NA	0.0000064
Fluorene	NA	NA	0.0000000016	100	NA	NA	0.0000000016
Naphthalene	0.0000014	100	NA	NA	NA	NA	0.0000014
Phenanthrene	0.0000021	100	0.0000000049	0	NA	NA	0.0000021
Total Low Molecular Weight PAHs	0.000011	100	0.0000000091	0	NA	NA	0.000011
High Molecular Weight PAHs							
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	0
Chrysene	NA	NA	0.0000023	100	NA	NA	0.0000023
Total High Molecular Weight PAHs	NA	NA	0.0000023	100	NA	NA	0.0000023
SVOCs							
Benzaldehyde	0.0018	100	NA	NA	NA	NA	0.0018
Metals							
Aluminum	0.31	31	0.67	68	0.0044	0	0.98
Barium	0.10	100	0.00036	0	0.000033	0	0.10
Cadmium	0.0062	97	0.00019	3	NA	NA	0.0064
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0
Chromium	0.0010	70	0.00044	30	0.00000094	0	0.0015
Cobalt	0.0086	87	0.0013	13	0.000024	0	0.010
Copper	0.40	99	0.0025	1	0.000041	0	0.40
Iron	1.0	52	0.92	47	0.017	1	2.0
Lead	0.0090	77	0.0026	22	0.000038	0	0.012
Manganese	0.085	99	0.0011	1	0.00016	0	0.087
Mercury	0.0014	99	0.000016	1	NA	NA	0.0014
Nickel	0.010	70	0.0041	29	0.00011	1	0.014
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.69	99	0.0069	1	NA	NA	0.70
Silver	0.00012	99	0.0000012	1	NA	NA	0.00013
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.0010	25	0.0030	75	NA	NA	0.0040
Zinc	0.0088	98	0.00022	2	0.0000029	0	0.0091

Shading indicates HQ >1.0.

Note: Results rounded to two significant digits.

NA = Not available, COPEC not detected in medium.

NTV = No toxicity value.

Table 46
Hazard Quotients - Belted Kingfisher - LOAEL-based - Kinzua Creek 1
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	0.00000073	100	0.0000000017	0	NA	NA	0.00000073
Anthracene	0.0000073	100	0.0000000014	0	NA	NA	0.0000073
Fluorene	NA	NA	0.0000000020	100	NA	NA	0.0000000020
Naphthalene	0.0000016	100	NA	NA	NA	NA	0.0000016
Phenanthrene	0.0000025	100	0.0000000060	0	NA	NA	0.0000025
Total Low Molecular Weight PAHs	0.000012	100	0.000000011	0	NA	NA	0.000012
High Molecular Weight PAHs							
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	0
Chrysene	NA	NA	0.000000027	100	NA	NA	0.000000027
Total High Molecular Weight PAHs	NA	NA	0.000000027	100	NA	NA	0.000000027
SVOCs							
Benzaldehyde	NTV	NTV	NA	NA	NA	NA	0
Metals							
Aluminum	0.040	31	0.091	69	0.00017	0	0.13
Barium	2.3	100	0.0086	0	0.00023	0	2.3
Cadmium	0.076	97	0.0025	3	NA	NA	0.078
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0.0
Chromium	0.054	68	0.025	32	0.000015	0	0.079
Cobalt	0.0092	86	0.0015	14	0.0000076	0	0.011
Copper	0.83	99	0.0055	1	0.000026	0	0.83
Iron	NTV	NTV	NTV	NTV	NTV	NTV	0
Lead	0.092	77	0.027	23	0.00012	0	0.12
Manganese	0.093	99	0.0012	1	0.000049	0	0.094
Mercury	0.028	99	0.00036	1	NA	NA	0.028
Nickel	0.0036	68	0.0017	32	0.000012	0	0.0053
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.38	99	0.0040	1	NA	NA	0.38
Silver	0.0018	99	0.000020	1	NA	NA	0.0019
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.00053	23	0.0017	77	NA	NA	0.0023
Zinc	0.045	97	0.0012	3	0.0000042	0	0.047

Shading indicates HQ >1.0.

Note: Results rounded to two significant digits.

NA = Not available, COPEC not detected in medium.

NTV = No toxicity value.

Table 47
Hazard Quotients - Mink - NOAEL-based - Kinzua Creek 2
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	0.00017	97	0.0000049	3	NA	NA	0.00017
Anthracene	0.000093	75	0.00003049	25	0.000000061	0.05	0.00012
Fluorene	0.000053	47	0.000059	53	0.00000018	0.16	0
Naphthalene	0.000040	43	0.000052	56	0.00000027	0.3	0.000092
Phenanthrene	NA	NA	0.000069	100	0.00000015	0.22	0.000069
Total Low Molecular Weight PAHs	0.00035	62	0.00022	38	NA	NA	0.00057
High Molecular Weight PAHs							
Benzo(a)anthracene	0.00068	70	0.00029	30	NA	NA	0
Chrysene	0.00062	24	0.0020	76	NA	NA	0.0026
Total High Molecular Weight PAHs	0.0013	37	0.0022	63	NA	NA	0.0035
SVOCs							
Benzaldehyde	0.024	100	NA	NA	NA	NA	0.024
Metals							
Aluminum	1.3	43	1.7	56	0.028	1	3.0
Barium	0.37	100	0.0011	0	0.000068	0	0.37
Cadmium	0.060	97	0.0017	3	NA	NA	0.061
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0
Chromium	0.0047	74	0.0016	25	0.000026	0	0.0063
Cobalt	0.033	94	0.0022	6	0.000059	0	0.035
Copper	1.2	99	0.013	1	0.00041	0	1.25
Iron	14	43	19	57	0.25	1	34
Lead	0.034	90	0.0038	10	0.000060	0	0.038
Manganese	0.66	98	0.010	2	0.0029	0	0.67
Mercury	0.0045	99	0.000048	1	NA	NA	0.0045
Nickel	0.031	36	0.012	14	0.042	49	0.086
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	1.7	60	0.010	0	1.1	39.25	2.8
Silver	0.010	100	0.0000050	0	NA	NA	0.010
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.0026	38	0.0043	62	NA	NA	0.0070
Zinc	0.019	98	0.00046	2	0.0000083	0	0.020

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.
NTV = No toxicity value.

Table 48
Hazard Quotients - Belted Kingfisher - NOAEL-based - Kinzua Creek 2
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	0.00019	97	0.0000062	3	NA	NA	0.00020
Anthracene	0.00010	74	0.000037	26	0.000000021	0.015	0.00014
Fluorene	0.000062	46	0.000071	54	0.000000062	0.046	0.00013
Naphthalene	0.000045	42	0.000062	58	0.000000095	0.089	0
Phenanthrene	NA	NA	0.000085	100	0.000000052	0.061	0.000085
Total Low Molecular Weight PAHs	0.00040	60	0.00026	40	NA	NA	0.00066
High Molecular Weight PAHs							
Benzo(a)anthracene	0.0000071	68	0.0000033	32	NA	NA	0
Chrysene	0.0000066	23	0.000022	77	NA	NA	0.000028
Total High Molecular Weight PAHs	0.000014	35	0.000025	65	NA	NA	0.000039
SVOCs							
Benzaldehyde	NTV	NTV	NA	NA	NA	NA	0
Metals							
Aluminum	0.16	41	0.24	59	0.0011	0.27	0.40
Barium	3.4	100	0.011	0	0.00019	0.0055	3.4
Cadmium	0.29	97	0.0089	3	NA	NA	0.30
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0.0
Chromium	0.28	72	0.11	27	0.00046	0.12	0.39
Cobalt	0.085	93	0.0060	7	0.000046	0.050	0.092
Copper	3.7	99	0.044	1	0.00037	0.0099	3.7
Iron	NTV	NTV	NTV	NTV	NTV	NTV	0
Lead	0.36	89	0.042	10	0.00019	0.047	0.40
Manganese	0.67	98	0.0117	2	0.00095	0.14	0.68
Mercury	0.038	99	0.00042	1	NA	NA	0.038
Nickel	0.028	54	0.0122	23	0.012	23	0.052
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.84	83	0.0056	1	0.17	17	1.0
Silver	0.29	100	0.00016	0	NA	NA	0.29
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.0037	37	0.0064	63	NA	NA	0.010
Zinc	0.20	98	0.0050	2	0.000026	0.013	0.20

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.
NTV = No toxicity value.

Table 49
Hazard Quotients - Mink - LOAEL-based - Kinzua Creek 2
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	0.000034	97	0.00000098	3	NA	NA	0.000035
Anthracene	0.000019	75	0.00000610	25	0.000000012	0	0.000025
Fluorene	0.000011	47	0.000012	53	0.000000037	0	0.000023
Naphthalene	0.0000079	43	0.000010	56	0.000000055	0	0.000018
Phenanthrene	NA	NA	0.000014	100	0.000000030	0	0.000014
Total Low Molecular Weight PAHs	0.000071	62	0.000043	38	NA	NA	0.00011
High Molecular Weight PAHs							
Benzo(a)anthracene	0.00014	70	0.000059	30	NA	NA	0
Chrysene	0.00012	24	0.00039	76	NA	NA	0.00051
Total High Molecular Weight PAHs	0.00026	37	0.00045	63	NA	NA	0.00071
SVOCs							
Benzaldehyde	0.0048	100	NA	NA	NA	NA	0.0048
Metals							
Aluminum	0.26	43	0.34	56	0.0057	1	0.61
Barium	0.073	100	0.00022	0	0.000014	0	0.074
Cadmium	0.0060	97	0.00017	3	NA	NA	0.0061
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0
Chromium	0.00094	74	0.00032	25	0.0000052	0	0.0013
Cobalt	0.017	94	0.0011	6	0.000029	0	0.018
Copper	0.62	99	0.0066	1	0.00021	0	0.63
Iron	1.4	43	1.9	57	0.025	1	3.4
Lead	0.018	90	0.0020	10	0.000031	0	0.020
Manganese	0.13	98	0.0021	2	0.00058	0	0.135
Mercury	0.00089	99	0.000010	1	NA	NA	0.00090
Nickel	0.016	36	0.0062	14	0.021	49	0.043
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.83	60	0.0050	0	1	39	1.4
Silver	0.0020	100	0.0000010	0	NA	NA	0.0020
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.0013	38	0.0022	62	NA	NA	0.0035
Zinc	0.0077	98	0.00019	2	0.0000033	0	0.0079

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.
NTV = No toxicity value.

Table 50
Hazard Quotients - Belted Kingfisher - LOAEL-based - Kinzua Creek 2
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Crayfish		Sediment		Surface Water		Total HQ
	HQ	% Contribution	HQ	% Contribution	HQ	% Contribution	
PAHs							
Low Molecular Weight PAHs							
Acenaphthylene	0.000038	97	0.0000012	3	NA	NA	0.000039
Anthracene	0.000021	74	0.0000075	26	0.0000000042	0.01	0.000028
Fluorene	0.000012	46	0.000014	54	0.000000012	0	0.000027
Naphthalene	0.0000089	42	0.000012	58	0.000000019	0	0.000021
Phenanthrene	NA	NA	0.000017	100	0.000000010	0	0.000017
Total Low Molecular Weight PAHs	0.000080	60	0.000052	40	NA	NA	0.00013
High Molecular Weight PAHs							
Benzo(a)anthracene	0.0000014	68	0.00000065	32	NA	NA	0
Chrysene	0.0000013	23	0.0000044	77	NA	NA	0.0000057
Total High Molecular Weight PAHs	0.0000027	35	0.0000050	65	NA	NA	0.0000078
SVOCs							
Benzaldehyde	NTV	NTV	NA	NA	NA	NA	0
Metals							
Aluminum	0.033	41	0.047	59	0.00022	0	0.080
Barium	1.7	100	0.0055	0	0.000094	0	1.7
Cadmium	0.072	97	0.0022	3	NA	NA	0.074
Calcium	NTV	NTV	NTV	NTV	NTV	NTV	0.0
Chromium	0.050	72	0.019	27	0.000083	0	0.070
Cobalt	0.017	93	0.0012	7	0.0000092	0	0.018
Copper	1.2	99	0.015	1	0.00012	0	1.25
Iron	NTV	NTV	NTV	NTV	NTV	NTV	0
Lead	0.18	89	0.021	10	0.00010	0	0.20
Manganese	0.13	98	0.0023	2	0.00019	0	0.14
Mercury	0.019	99	0.00021	1	NA	NA	0.019
Nickel	0.0057	54	0.0024	23	0.0024	23	0.010
Potassium	NTV	NTV	NTV	NTV	NTV	NTV	0
Selenium	0.42	83	0.0028	1	0.086	17	0.51
Silver	0.029	100	0.000016	0	NA	NA	0.029
Sodium	NTV	NTV	NTV	NTV	NTV	NTV	0
Vanadium	0.00074	37	0.0013	63	NA	NA	0.0020
Zinc	0.039	98	0.0010	2	0.0000051	0	0.040

Shading indicates HQ >1.0.
Note: Results rounded to two significant digits.
NA = Not available, COPEC not detected in medium.
NTV = No toxicity value.

Table 51
Summary of Hazard Quotients - Mink
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Meade Run		Threemile Run 2		Kinzua Creek 1		Kinzua Creek 2	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
PAHs								
Low Molecular Weight PAHs								
Acenaphthylene	NC	NC	0.000025	0.000005	0.0000032	0.00000064	0.00017	0.000035
Anthracene	0.000025	0.0000049	0.000031	0.0000062	0.000032	0.0000064	0.00012	0.000025
Fluorene	0.0000001	0.00000002	0.000026	0.0000052	8.2E-09	1.6E-09	0.00011	0.000023
Naphthalene	NC	NC	0.000027	0.0000055	0.0000069	0.0000014	0.000092	0.000018
Phenanthrene	0.00000091	0.00000018	0.000037	0.0000073	0.000011	0.0000021	0.000069	0.000014
Total Low Molecular Weight PAHs	0.000026	0.0000051	0.00015	0.000029	0.000053	0.000011	0.00057	0.00011
High Molecular Weight PAHs								
Benzo(a)anthracene	0.00031	0.000062	0.00024	0.000049	NC	NC	0.00098	0.0002
Chrysene	0.00034	0.000068	0.00029	0.000059	0.000012	0.0000023	0.0026	0.00051
Total High Molecular Weight PAHs	0.00065	0.00013	0.00054	0.00011	0.000012	0.0000023	0.0035	0.00071
SVOCs								
Benzaldehyde	0.0084	0.0017	0.031	0.0063	0.0091	0.0018	0.024	0.0048
Metals								
Aluminum	1.8	0.37	4.7	0.94	4.9	0.98	3	0.61
Barium	0.46	0.093	0.23	0.047	0.5	0.1	0.37	0.074
Cadmium	0.1	0.01	0.051	0.0051	0.064	0.0064	0.061	0.0061
Calcium	NC	NC	NC	NC	NC	NC	NC	NC
Chromium	0.0043	0.00087	0.006	0.0012	0.0074	0.0015	0.0063	0.0013
Cobalt	0.0089	0.0044	0.034	0.017	0.02	0.0099	0.035	0.018
Copper	0.62	0.31	1.1	0.53	0.8	0.4	1.2	0.63
Iron	7.1	0.71	81	8.1	20	2	34	3.4
Lead	0.037	0.019	0.041	0.022	0.022	0.012	0.038	0.02
Manganese	0.24	0.048	0.48	0.096	0.43	0.087	0.67	0.13
Mercury	0.003	0.0006	0.0047	0.00093	0.0069	0.0014	0.0045	0.0009
Nickel	0.044	0.022	0.069	0.035	0.028	0.014	0.086	0.043
Potassium	NC	NC	NC	NC	NC	NC	NC	NC
Selenium	1.3	0.65	1.3	0.63	1.4	0.7	2.8	1.4
Silver	0.01	0.002	0.01	0.002	0.00063	0.00013	0.01	0.002
Sodium	NC	NC	NC	NC	NC	NC	NC	NC
Vanadium	0.19	0.097	0.0072	0.0036	0.008	0.004	0.007	0.0035
Zinc	0.03	0.012	0.021	0.0085	0.023	0.0091	0.02	0.0079

Shading indicates HQ >1.0.

Note: Results rounded to two significant digits.

NC = Not calculated. Either COPEC not detected in medium or no toxicity value available.

Table 52
Summary of Hazard Quotients - Kingfisher
Kinzua Creek Watershed Tar Sites
McKean County, PA

COPEC	Meade Run		Threemile Run 2		Kinzua Creek 1		Kinzua Creek 2	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
PAHs								
Low Molecular Weight PAHs								
Acenaphthylene	NC	NC	0.000028	0.0000057	0.0000037	0.00000073	0.0002	0.000039
Anthracene	0.000028	0.0000057	0.000036	0.0000073	0.000036	0.0000073	0.00014	0.000028
Fluorene	0.00000012	0.000000025	0.000031	0.0000062	0.00000001	0.000000002	0.00013	0.000027
Naphthalene	NC	NC	0.000032	0.0000064	0.0000081	0.0000016	0.00011	0.000021
Phenanthrene	0.0000011	0.00000023	0.000045	0.000009	0.000012	0.0000025	0.000085	0.000017
Total Low Molecular Weight PAHs	0.00003	0.0000059	0.00017	0.000035	0.000061	0.000012	0.00066	0.00013
High Molecular Weight PAHs								
Benzo(a)anthracene	0.0000033	0.00000065	0.0000028	0.00000056	NC	NC	0.00001	0.0000021
Chrysene	0.0000036	0.00000073	0.0000033	0.00000065	0.00000013	0.000000027	0.000028	0.0000057
Total High Molecular Weight PAHs	0.0000069	0.0000014	0.0000061	0.0000012	0.00000013	0.000000027	0.000039	0.0000078
SVOCs								
Benzaldehyde	NC	NC	NC	NC	NC	NC	NC	NC
Metals								
Aluminum	0.25	0.049	0.65	0.13	0.66	0.13	0.4	0.08
Barium	4.2	2.1	2.2	1.1	4.5	2.3	3.4	1.7
Cadmium	0.49	0.12	0.25	0.063	0.31	0.078	0.3	0.074
Calcium	NC	NC	NC	NC	NC	NC	NC	NC
Chromium	0.26	0.047	0.36	0.065	0.44	0.079	0.39	0.07
Cobalt	0.023	0.0046	0.088	0.018	0.053	0.011	0.092	0.018
Copper	1.9	0.64	3.1	1	2.5	0.83	3.7	1.3
Iron	NC	NC	NC	NC	NC	NC	NC	NC
Lead	0.39	0.2	0.45	0.22	0.24	0.12	0.4	0.2
Manganese	0.25	0.051	0.51	0.1	0.47	0.094	0.68	0.14
Mercury	0.025	0.012	0.039	0.019	0.056	0.028	0.038	0.019
Nickel	0.042	0.0084	0.064	0.013	0.026	0.0053	0.052	0.01
Potassium	NC	NC	NC	NC	NC	NC	NC	NC
Selenium	0.7	0.35	0.67	0.33	0.77	0.38	1	0.51
Silver	0.29	0.029	0.29	0.029	0.019	0.0019	0.29	0.029
Sodium	NC	NC	NC	NC	NC	NC	NC	NC
Vanadium	0.27	0.053	0.01	0.0021	0.011	0.0023	0.01	0.002
Zinc	0.29	0.058	0.22	0.044	0.23	0.047	0.2	0.04

Shading indicates HQ >1.0.

Note: Results rounded to two significant digits.

NC = Not calculated. Either COPEC not detected in medium or no toxicity value available.

APPENDIX C
KINZUA CREEK BENTHIC INVERTEBRATE ASSESSMENT REPORT

U.S. Environmental Protection Agency, Region 3
Laboratory Services and Applied Science Division
Field Services Branch

Final Report
May 1, 2020

Kinzua Creek Tar Site Benthic Invertebrate Assessment

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Background

The Field Services Branch (FSB) of the EPA Region 3 Laboratory Services and Applied Science Division was asked by the EPA Region 3 Superfund Biological Technical Assistance Group (BTAG) to help investigate the possible impairment of aquatic life use attributable to wood tar contamination in upper Kinzua Creek, PA. This area was once a producer of wood charcoal with unusable wood tar as a byproduct. Waste wood tar deposits can be found along the mainstem Kinzua Creek and its tributaries.

After preliminary discussions in the summer of 2018 with BTAG and the START contractor, Weston Solutions, Inc (WESTON), field work was initiated in October of 2018. Because the index period for macroinvertebrates starts in November, FSB returned in November 2018 to sample macroinvertebrates. To indicate conditions under a worse-case scenario for stress to macroinvertebrates, FSB also sampled macroinvertebrates in July 2019. WESTON collected additional water chemistry samples during this July sampling event.

Sites

BTAG and WESTON provided FSB with the sites of interest to examine aquatic life use impairments (Table 1). FSB chose a reference site, Meade Run, that might represent best available conditions in the upper Kinzua Creek watershed. We chose sites upstream and within the wood tar affected areas of Upper Kinzua Creek and Threemile Run (Figure 1). The reference site was relatively larger, more forested and of higher gradient than both study sites. Kinzua Creek was larger than Threemile Run, while the upstream background KC1 was smaller than all downstream site studies.

Table 1. Sites and locations for sampling in Upper Kinzua Creek

Site Name	Label	Stream	Type	Latitude	Longitude	Watershed_ Area (Km^2)
Reference	REF	Meade Run	Reference	41.73869	-78.78649	14.59
Backus	KC2	Kinzua Creek	Contaminated	41.79850	-78.57615	10.25
Backus Bkg	KC1	Kinzua Creek	Background	41.81312	-78.58243	2.30
Mt. Alton	TR2	Threemile Run	Contaminated	41.78517	-78.60868	5.92

Figure 1. Sampling locations - Kinzua Creek Tar Site Remediation Biological Assessments

Figure 2. Detailed map of Meade Run REF site

Figure 3. Detail of sites at Backus tar remediation area.

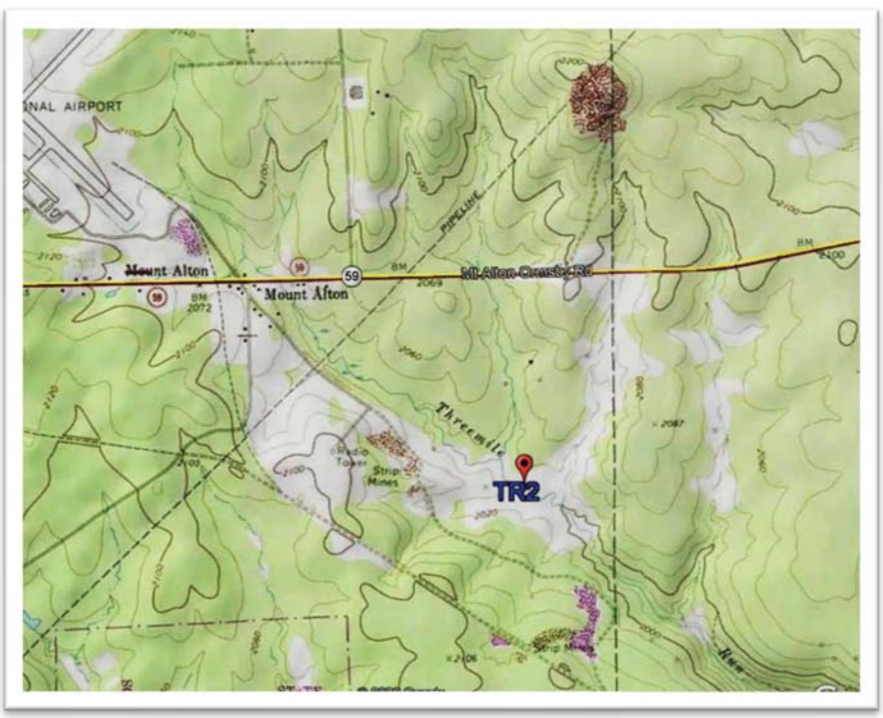

Figure 4. Detail of site at Mt. Alton tar remediation area.

WESTON sampled water and sediment at the sites and FSB collected qualitative habitat data, *in situ* chemical measurements, macroinvertebrates, fish assemblage data, fish for histopathology, and crayfish for contaminant analysis. After fish and crayfish sampling in October 2018, we sampled macroinvertebrates in November (the PADEP index period) and again in the summer (July) to assess the benthic assemblage under warmer, low flow conditions. The fish assemblage data, fish histopathology, and crayfish contaminant analysis are presented in a separate report.

Sampling Methods

Qualitative Habitat Sampling and *in situ* Water Quality

FSB sampled qualitative habitat parameters of EPA's Rapid Bioassessment Protocol as applied by PA Department of Environmental Protection (PADEP), during the November 2018 and July (2019) field visits. We used a YSI EXO Field Meter, calibrated daily, to measure dissolved oxygen, specific conductance, temperature, and pH following FSB Field Operations SOP. We sampled these physicochemical variables during both November and July macroinvertebrate sampling events.

Macroinvertebrates

FSB sampled macroinvertebrates during the Winter and Summer index periods for the Pennsylvania wadeable freestone riffle-run macroinvertebrate assessment method (PADEP 2018). FSB used methods appropriate to PADEP macroinvertebrate assessments as outlined in their monitoring protocols for wadeable riffle-run streams (PADEP 2018). Samples were not collected from the Threemile run background site (TR1) because the stream was not a riffle-run system and comparison to the contaminated site would be confounded by habitat differences between the sites.

FSB processed and identified all macroinvertebrates as per PADEP assessment methodologies (PADEP 2018) that included a random, 200 ± 20% subsample from both Winter (Table 4-6) and Summer (Table 7-8) sampling events. KC2 was randomly selected as a duplicate in the Winter sample (~10% of all samples).

Results

Habitat and Physicochemical Data

During both November and July sampling events, the two contaminated sites had lower habitat scores (Table 2) than background and reference sites. However, these total habitat values were generally adequate to support good macroinvertebrate assemblages. Reductions in localized habitat metrics that might typically affect macroinvertebrates the most were noted at contaminated sites (e.g., embeddedness, sediment deposition, and riparian zone quality). However, the reduced scores of these variables would not necessarily preclude adequate macroinvertebrate colonization.

All sites were generally similar in temperature, pH, dissolved oxygen, and specific conductance with exception of the reference site (Meade Run) that exhibited lower pH and specific conductance (Table 3). During the warmer and lower flow July event, daytime dissolved oxygen (in mg/l and % saturation) was markedly reduced at the contaminated site in Kinzua Creek (KC2).

Table 2. Habitat scores (RBP) for Kinzua Creek Sites from field visits in November 2018 and July 2019.

Habitat Parameters 11/5/2018	Meade (REF)	Kinzua (KC2)	Kinzua (KC1)	Threemile (TR2)
Instream Cover	18	15	17	14
Epifaunal Substrate	18	14	16	14
Embeddedness	18	13	16	14
Velocity/Depth Regime	17	19	15	18
Channel Alteration	19	13	18	17
Sediment Deposition	16	11	14	9
Frequency of Riffles	18	15	15	14
Channel Flow Status	17	17	17	17
Condition of Banks	16	12	13	11
Bank Vegetation Protection	13	12	16	10
Grazing/Disruptive Pressure	19	13	18	14
Riparian Vegetative Zone	16	11	19	14
Total Habitat Score	205	165	194	166

Table 2. (Continued)

Habitat Parameters 7/31/2019	Meade (Ref)	Kinzua (KC2)	Kinzua (KC1)	Threemile (TR2)
Instream Cover	17	15	17	14
Epifaunal Substrate	16	14	15	12
Embeddedness	18	12	15	13
Velocity/Depth Regime	16	15	10	17
Channel Alteration	19	13	18	17
Sediment Deposition	16	12	13	10
Frequency of Riffles	18	15	11	10
Channel Flow Status	15	16	13	7
Condition of Banks	16	12	15	11
Bank Vegetation Protection	16	13	18	12
Grazing/Disruptive Pressure	20	13	19	14
Riparian Vegetative Zone	15	11	19	14
Total Habitat Score	202	161	183	151

Table 3. Physicochemical data measured in November 2018 and July 2019 at all sites.

Chemical Parameter 11/5/2018	Meade (REF)	Kinzua (KC2)	Kinzua (KC1)	Threemile (TR2)
Temperature (°C)	8.5	7.8	7.6	7.6
Dissolved Oxygen (mg/L)	10.73	10.76	10.64	10.75
Dissolved Oxygen (%SAT)	91.7	90.4	88.9	89.9
pH	5.7	6.14	6.04	6.18
Specific Conductance (µS/cm)	19.5	36.3	76	64.5
Chemical Parameter 7/31/2019	Meade (REF)	Kinzua (KC2)	Kinzua (KC1)	Threemile (TR2)
Temperature (°C)	17.4	19.6	20.62	18.89
Dissolved Oxygen (mg/L)	8.93	5.84	9.1	7.8
Dissolved Oxygen (%SAT)	93.1	63.7	101.5	83.9
pH	5.55	6.08	6.87	5.95
Specific Conductance (µS/cm)	24	90	53	105

Macroinvertebrate Assemblage Data

Raw taxonomic data are provided in the appendix. All non-reference sites showed markedly different community composition compared to the reference site (Meade Run). In November, the reference site (Table A1) was dominated by the stonefly *Leuctra*; these stoneflies are generally sensitive to many contaminants and low oxygen conditions but thrive in slightly acidic and colder streams. Midges (Chironomidae) were co-dominant, but not in excessive numbers and most taxa exhibit high to moderate sensitivities. Overall, Meade Run had more sensitive taxa than found at other sites.

Kinzua Creek and Threemile Run sites had markedly different November assemblages compared to Reference (Table A2). Midges (Chironomidae) and hydropsychid caddisflies dominated all samples; however, overall richness was elevated at the contaminated KC2 compared to background. Here, despite having reduced habitat scores, KC2 was larger than the more upland background site (KC1, which abruptly shifted from low gradient to high gradient, and limited natural colonization of some macroinvertebrate taxa found downstream). Seasonality may also play a role at KC1, where headwater streams might endure greater natural stress in early to late autumn (personal observation). This pattern was reversed in the July sample event where KC1 had higher richness that downstream KC2 (see below).

During the July sampling event, the reference site's high-quality invertebrate assemblage persisted and although dominated numerically by Chironomidae, it contained many sensitive taxa (Table A4).

In contrast to November samples, the background site (KC1) in July showed some improvement with several sensitive taxa present, while the contaminated site exhibited decreased richness of sensitive taxa (Table A5). However, *Cheumatopsyche* and Chironomidae dominated samples from both sites (~70% of individuals). Threemile Run (TR2) also displayed high dominance by *Cheumatopsyche* and Chironomidae (Table A6; ~80% of individuals).

Analysis

Macroinvertebrates

We compared the macroinvertebrate assemblage among sites using PADEP's multimetric index (Freestone Index of Biotic Integrity (IBI)). This index consists of six metrics (Taxa Richness, modified EPT richness, Hilsenhoff biotic index, Beck's Index, Shannon Diversity, and % sensitive individuals) that are scored in comparison to PA's statewide reference site scoring distribution (see Chalfant 2012). Values for each metric at study sites are shown in Table 4. In November and July, the IBI indicated that the reference site was relatively high quality, indicated by higher Beck's Index, lower Hilsenhoff Index, and higher % sensitive individuals. All other sites were impaired for the Aquatic Life Use using the IBI. The site in Threemile Run, which had the highest PAH concentrations in sediment, consistently scored poorly on the IBI with the lowest score in July. In November, the contaminated site (KC2) biologically outperformed its background site (KC1). In July, a different scenario was observed where KC1 outperformed KC2 considerably. We believe this shift was partially due to seasonality and the headwater position of KC1 as well as a potential lack of colonization. PAH desorption from sediment and solubility in surface water both increase with increasing temperatures (Hiller et al. 2008). The patterns that we observed suggest that differences in IBI response might be occurring between the colder higher flow November versus flow and warmer conditions in July when temperatures were approximately 3-fold higher. In July, macroinvertebrates were potentially more severely impacted at tar contaminated sites due to higher organism exposure. Figure 5 depicts IBI scores among seasons and compared to the seasonal impairment threshold established by PADEP.

Table 4. Macroinvertebrate metrics comprising the Freestone IBI for November and July samples.

November 2018	KC1	KC2	KC2 (dup)	TR2	Meade REF
Freestone IBI	**26.2**	**46.3**	**41.1**	**26.9**	**64.0**
Richness	11	20	17	14	19
EPT Richness	2	9	7	4	10
Becks Index	2	5	3	1	10
Hilsenhoff Index	5.87	5.23	5.27	5.92	2.03
Shannon Diversity	1.47	2.19	2.09	1.19	1.92
% Sensitive Indiv	5.0	18.0	15.8	3.0	69.2

July 2019	KC1	KC2	TM2	Meade REF
Freestone IBI	**40.0**	**31.2**	**23.5**	**66.1**
Richness	19	12	10	25
EPT Richness	5	5	1	10
Becks Index	11	3	3	20
Hilsenhoff Index	5.57	5.58	5.66	3.78
Shannon Diversity	1.71	1.51	1.14	2.57
% Sensitive Indiv	11.0	7.9	3.8	41.5

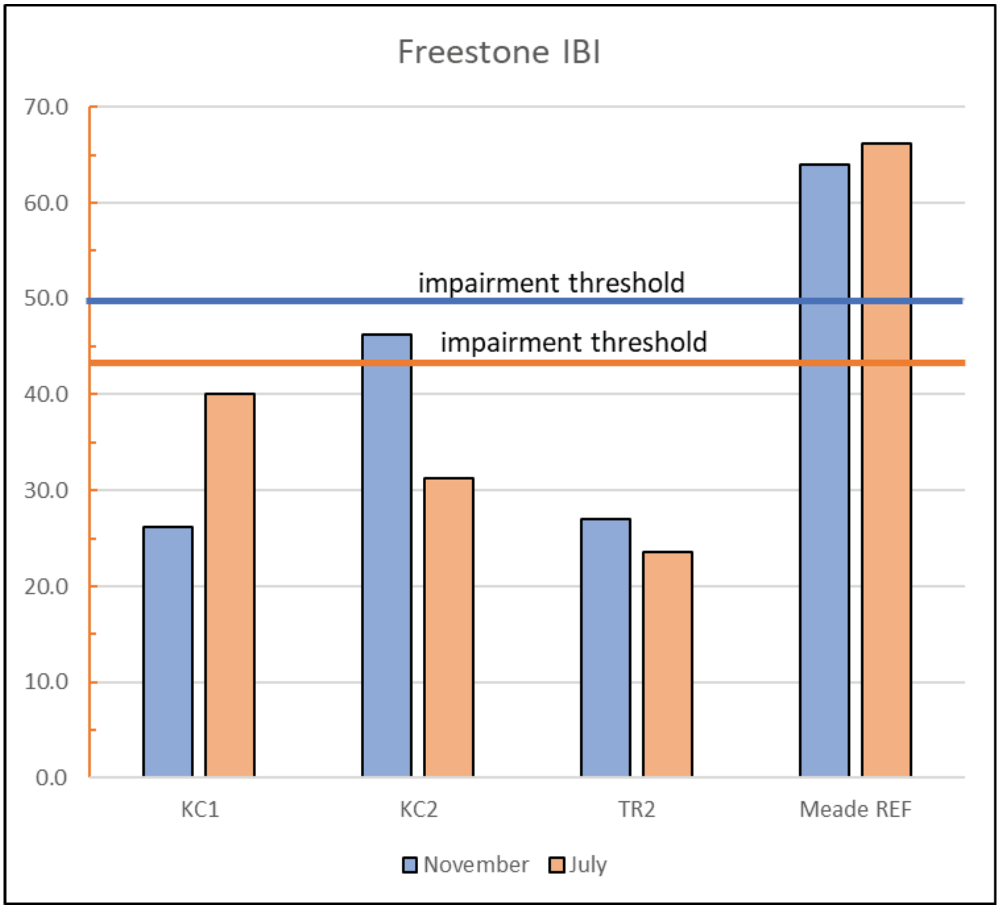

Figure 5. Freestone Index of Biotic Integrity (PADEP 2018) for sites sampled in Winter and Summer in Kinzua Creek, Threemile Run, and Meade Run. Lines indicate impairment thresholds for both index periods.

Potentially reduced macroinvertebrate physiological condition at tar contaminated sites was also observed. We frequently found specimens with tar deposited on gills and body integument or internally, at contaminated sites (Figure 6 and 7). We believe these deposited and ingested contaminants could be affecting overall macroinvertebrate health.

Figure 6. Tar deposits on macroinvertebrates from KC2 in summer. Clockwise from left, *Maccaffertium* gills, *Maccaffertium* mouthparts, *Caecidotea* and *Hydropsyche*, *Cheumatopsyche* and *Maccaffertium* (integument and gills).

Figure 7. Midges (Chironomidae) with internal tar material (ingested tar) at KC2 in summer compared to a clean specimen (bottom) from REF.

Conclusion

Macroinvertebrates

All Kinzua sites were impaired and with markedly reduced IBI scores compared to the unimpaired reference site (Meade Run). Threemile Run, which had the highest PAH contamination in sediments, scored consistently poor in both seasons. We detected a pattern of reduced IBI and metric scores at KC2 compared to PADEP impairment thresholds, which was greater during low flow summer when the assemblage might be most susceptible. In contrast, the IBI at the background site, KC1, increased considerably in low-flow summer sampling. Habitat and seasonal variation in IBI scores led to an inability to clearly distinguish and diagnose impairment causation between the two Kinzua Creek sites. It was apparent that specimens collected at contaminated sites in summer had deposits of tar on or within their bodies, possibly causing direct toxicity. Ruling out overall habitat conditions and general physicochemical characteristics at contaminated sites (i.e., they should support an attaining macroinvertebrate community), the presence of wood tar deposits is likely limiting biological potential.

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Appendix

Table A1. Macroinvertebrate counts from Meade Run Reference Site Winter Sample.

Meade (REF)	Taxon	Count
11051805	*Leuctra*	93
11051805	Chironomidae	27
11051805	*Paracapnia*	16
11051805	*Stenacron*	13
11051805	*Rhyacophila*	8
11051805	*Habrophlebia*	7
11051805	*Polycentropus*	7
11051805	*Maccaffertium*	5
11051805	*Taeniopteryx*	5
11051805	*Allocapnia*	3
11051805	*Lanthus*	2
11051805	Oligochaeta	2
11051805	*Nigronia*	1
11051805	*Diploperla*	1
11051805	*Ceratopsyche*	1
11051805	*Limnephilus*	1
11051805	*Limnophila*	1
11051805	*Chelifera*	1
11051805	*Dicranota*	1

Table A2. Macroinvertebrate counts from Kinzua Creek Winter Samples

Kinzua Background (KC1)	Taxon	Count
11051801	Chironomidae	87
11051801	*Cheumatopsyche*	76
11051801	*Caecidotea*	34
11051801	*Prosimulium*	10
11051801	*Pisidium*	4
11051801	*Eurylophella*	3
11051801	Oligochaeta	3
11051801	*Hydropsyche*	2
11051801	*Acerpenna*	1
11051801	*Taeniopteryx*	1
11051801	Nematoda	1

Kinzua Contaminated (KC2)	Taxon	Count
11051802	Chironomidae	44
11051802	*Cheumatopsyche*	41
11051802	*Taeniopteryx*	11
11051802	*Hydropsyche*	9
11051802	*Prosimulium*	7
11051802	*Maccaffertium*	6
11051802	*Acerpenna*	5
11051802	*Habrophlebia*	5
11051802	*Caenis*	4
11051802	Oligochaeta	4
11051802	*Eurylophella*	3
11051802	*Allocapnia*	2
11051802	*Hemerodromia*	2
11051802	*Tipula*	1
11051802	*Orconectes*	1
11051802	*Stenacron*	1
11051802	*Baetisca*	1
11051802	*Leuctra*	1
11051802	*Chimarra*	1
11051802	*Bezzia*	1

Kinzua Contaminated DUP (KC2)	Taxon	Count
11051803	Chironomidae	50
11051803	*Cheumatopsyche*	49
11051803	*Caecidotea*	39
11051803	*Maccaffertium*	12
11051803	*Habrophlebia*	11
11051803	*Taeniopteryx*	11
11051803	*Hydropsyche*	8
11051803	*Prosimulium*	7
11051803	*Caenis*	5
11051803	*Stenacron*	2
11051803	*Eurylophella*	2
11051803	*Chimarra*	2
11051803	*Allocapnia*	1
11051803	*Nigronia*	1
11051803	*Hydroptila*	1
11051803	Oligochaeta	1
11051803	*Ormosia*	1

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Table A3. Macroinvertebrate counts from Threemile Run Winter Sample.

Threemile Contaminated (TR2)	Taxon	Count
11051804	Chironomidae	144
11051804	*Hydropsyche*	12
11051804	*Cheumatopsyche*	11
11051804	*Hemerodromia*	9
11051804	Oligochaeta	6
11051804	*Dasyhelea*	4
11051804	*Allocapnia*	3
11051804	*Taeniopteryx*	3
11051804	*Simulium*	2
11051804	*Tipula*	1
11051804	*Chimarra*	1
11051804	*Acerpenna*	1
11051804	*Eurylophella*	1
11051804	*Bezzia*	1

Table A4. Macroinvertebrate counts from Meade Run Reference Site Summer Sample.

Meade (REF)	Taxon	Count
7311904	Chironomidae	47
7311904	*Leuctra*	32
7311904	*Simulium*	24
7311904	*Baetis*	20
7311904	*Promoresia*	20
7311904	*Ceratopsyche*	12
7311904	*Rhyacophila*	12
7311904	*Diplectrona*	11
7311904	*Heptagenia*	9
7311904	*Paracapnia*	4
7311904	*Peltoperla*	3
7311904	*Diploperla*	3
7311904	*Cheumatopsyche*	3
7311904	*Cambarus*	2
7311904	*Polycentropus*	2
7311904	*Dicranota*	2
7311904	Oligochaeta	2
7311904	*Neoplasta*	2
7311904	*Stenacron*	1
7311904	*Sweltsa*	1
7311904	*Soyedina*	1
7311904	*Lanthus*	1
7311904	*Hexatoma*	1
7311904	*Rhagovelia*	1
7311904	*Oulimnius*	1

Table A5. Macroinvertebrate counts from Kinzua Creek Summer Samples.

Kinzua Background (KC1)	Taxon	Count		Kinzua Contaminated (KC2)	Taxon	Count
7311903	*Cheumatopsyche*	92		7311901	*Cheumatopsyche*	76
7311903	Chironomidae	59		7311901	Chironomidae	76
7311903	*Caecidotea*	23		7311901	*Hydropsyche*	34
7311903	*Diplectrona*	7		7311901	*Maccaffertium*	12
7311903	*Boyeria*	4		7311901	*Caecidotea*	7
7311903	*Leuctra*	3		7311901	*Hemerodromia*	2
7311903	*Dicranota*	3		7311901	*Antocha*	2
7311903	*Pisidium*	3		7311901	*Isonychia*	1
7311903	*Cambarus*	2		7311901	*Acerpenna*	1
7311903	*Maccaffertium*	2		7311901	*Ephemera*	1
7311903	*Antocha*	2		7311901	*Paraleptophlebia*	1
7311903	Oligochaeta	2		7311901	*Eurylophella*	1
7311903	*Rhagovelia*	2				
7311903	*Procloeon*	1				
7311903	*Diphetor*	1				
7311903	*Lype*	1				
7311903	*Glossosoma*	1				
7311903	*Ectopria*	1				
7311903	*Optioservus*	1				

Table A6. Macroinvertebrate counts from Threemile Run Summer Sample.

Threemile Contaminated (TR2)	Taxon	Count
7311902	Chironomidae	123
7311902	*Cheumatopsyche*	25
7311902	*Hydropsyche*	20
7311902	*Leuctra*	7
7311902	*Hemerodromia*	3
7311902	*Psephenus*	2
7311902	*Orconectes*	1
7311902	*Stenelmis*	1
7311902	*Sialis*	1
7311902	Oligochaeta	1

APPENDIX D
KINZUA CREEK TAR SITE ASSESSMENT- FISH ASSEMBLAGE REPORT

U.S. Environmental Protection Agency, Region 3
Laboratory Services and Applied Science Division
Field Services Branch

Final Report
May 1, 2020

Kinzua Creek Tar Site Assessment – Fish Assemblage

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Background

The Field Services Branch (FSB) of the EPA Region 3 Laboratory Services and Applied Science Division was asked by the EPA Region 3 Superfund Biological Technical Assistance Group (BTAG) to help investigate the possible impairment of aquatic life use attributable to wood tar contamination in upper Kinzua Creek, PA. This area was once a producer of wood charcoal with unusable wood tar as a byproduct. Waste wood tar deposits can be found along the mainstem Kinzua Creek and its tributaries.

After preliminary discussions in the summer of 2018 with BTAG and the START contractor, Weston Solutions, Inc (WESTON), field work was initiated in October of 2018. Because the index period for macroinvertebrates starts in November, FSB returned in November 2018 to sample macroinvertebrates. To indicate conditions under a worse-case scenario for stress to macroinvertebrates, FSB also sampled macroinvertebrates in July 2019. WESTON collected additional water chemistry samples during this July sampling event.

Sites

BTAG and WESTON provided FSB with the sites of interest to examine aquatic life use impairments (Table 1). FSB chose a reference site, Meade Run, that might represent best available conditions in the upper Kinzua Creek watershed. We chose sites upstream and within the vicinity of wood tar deposits of Upper Kinzua Creek and Threemile Run (Figure 1). The reference site was relatively larger, more forested and of higher gradient than both study sites. Kinzua Creek downstream (KC2) was larger than Threemile Run, while the upstream site (KC1) was smaller than all downstream site studies.

Table 1. Sites and locations for sampling in Upper Kinzua Creek

Site Name	Label	Stream	Type	Latitude	Longitude	Watershed_ Area (Km^2)
Reference	REF	Meade Run	Reference	41.73869	-78.78649	14.59
Backus	KC2	Kinzua Creek	Contaminated	41.79850	-78.57615	10.25
Backus Bkg	KC1	Kinzua Creek	Upstream	41.81312	-78.58243	2.30
Mt. Alton	TR2	Threemile Run	Contaminated	41.78517	-78.60868	5.92

Figure 1. Sampling locations - Kinzua Creek Tar Site Remediation Biological Assessments

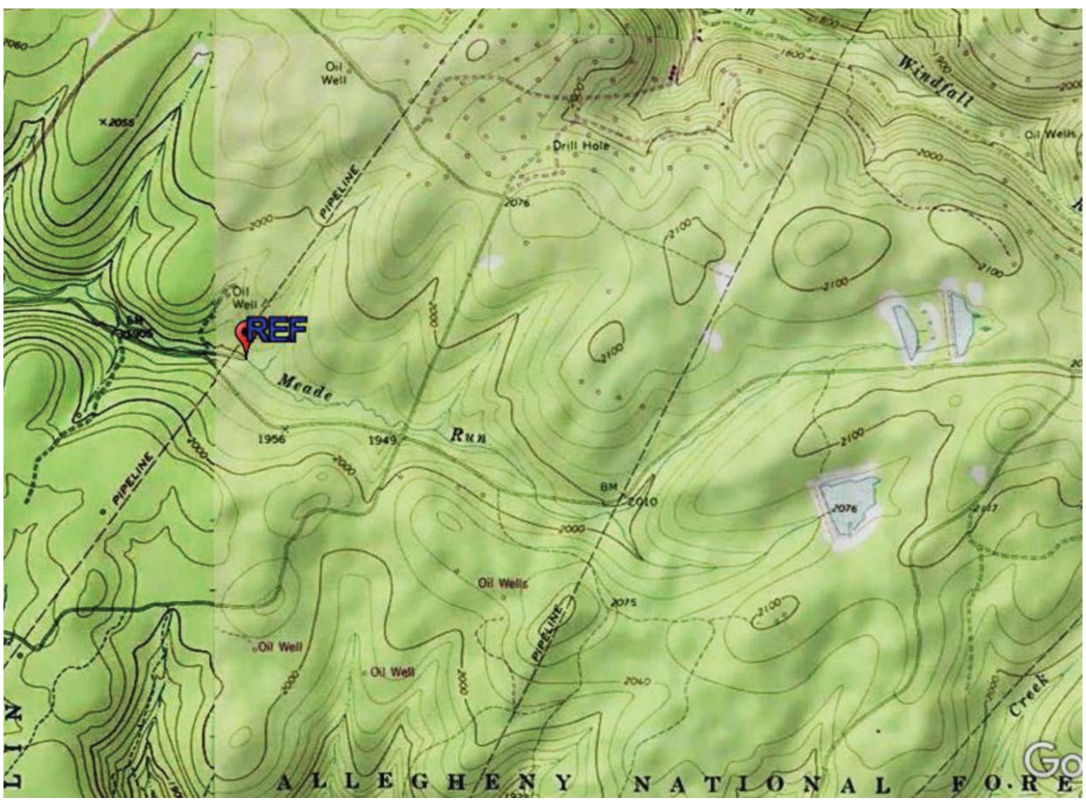

Figure 2. Detailed map of Meade Run REF site

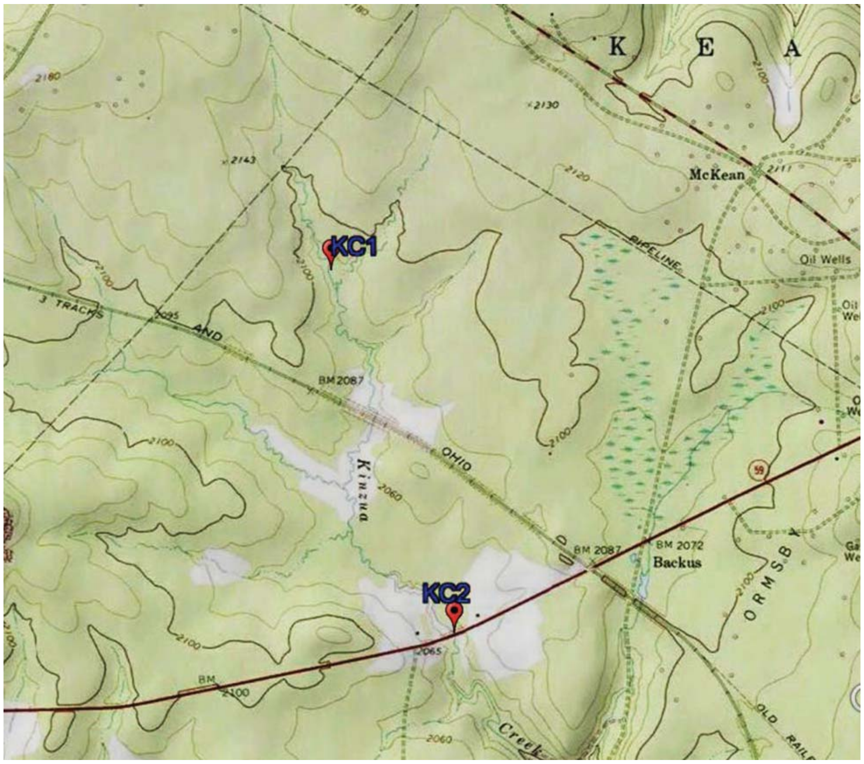

Figure 3. Detail of sites at Backus tar remediation area.

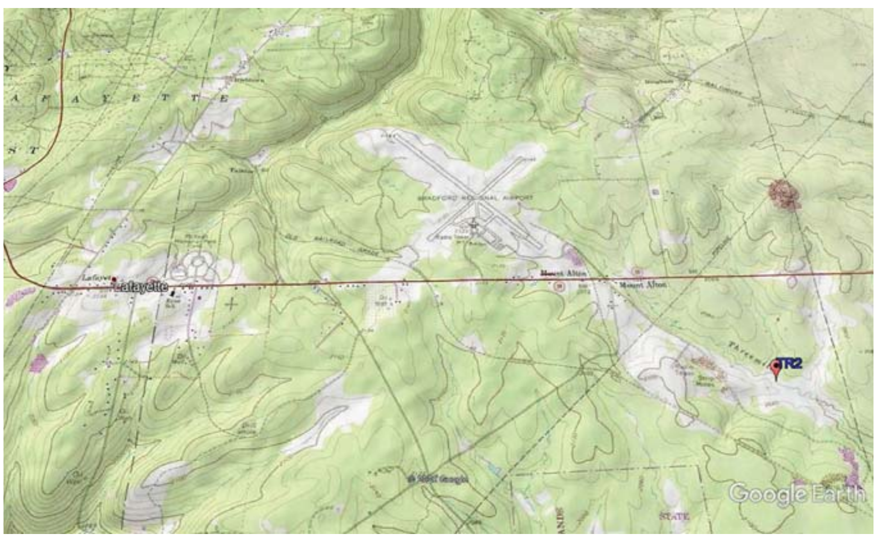

Figure 4. Detail of site at Mt. Alton tar remediation area.

WESTON sampled water and sediment at the sites and FSB collected qualitative habitat data, *in situ* chemical measurements, macroinvertebrates, fish assemblage data, fish for histopathology, and crayfish for contaminant analysis. After fish and crayfish sampling in October 2018, we sampled macroinvertebrates in November (the PADEP index period) and again in the summer (July) to assess the benthic assemblage under warmer, low flow conditions. The macroinvertebrate, habitat, and in-situ chemical data can be found in the Kinzua Creek Tar Site Benthic Invertebrate Assessment.

Sampling Methods

FSB sampled fish using the National Rivers and Streams Assessment (NRSA) fish sampling protocol (USEPA 2017) with a backpack electrofisher (MLES ExStream). We collected fish at all sites over three days in October 2018. A thunderstorm interrupted fish sampling at Kinzua Creek (KC2) on 10/3/2018, increasing flow and turbidity and requiring us to finish sampling on the next day. Accordingly, we did not collect relative abundance data for this site because catch efficiency decreased over the duration of the sampling event.

We intended to capture the same species across all sites for histopathology but failed, so provided a sample to the histopathology lab of whatever fish we encountered in sufficient numbers. We collected all crayfish as bycatch during electrofishing and met our goals for crayfish tissue weight. These data will be reported by WESTON.

Results

Fish assemblage data reflected the cool water of study sites (Table 2).

Table 2. Fish collected in Meade Run, Threemile Run, and Kinzua Creek in October. Tolerance Value data are summarized from a Biological Condition Gradient for the Appalachian Mountains (VADEQ, In Prep). Data for the Kinzua Creek downstream site (KC2) are shown as P-Present or A-Abundant. Bolded taxa indicate sensitive species.

Scientific Name	Common Name	REF	KC2	KC1	TR2	TR1		BCG TV
		10/2/2018	10/3/2018	10/3/2018	10/4/2018	10/4/2018		
Salvelinus fontinalis	**Brook Trout**	6						2.6
Cottus bairdii	**Mottled Sculpin**	23						3.0
Clinostomus elongatus	**Redside Dace**		P	37	1	11		2.0
Luxilus cornutus	Common Shiner	1	P		83	19		4.0
Notemigonus crysoleucas	Golden Shiner		P		5	1		4.5
Rhinichthys obtusus	W. Blacknose Dace		P	182	30	9		5.8
Semotilus atromaculatus	Creek Chub		A	21	8	27		5.7
Etheostoma flabellare	Fantail Darter		P		4			3.8
Etheostoma nigrum	Johnny Darter		P		9	4		3.8
Catostomus commersonii	White Sucker		P	26	9	6		5.0
Hypentelium nigricans	Northern Hog Sucker				1			4.7
Ameiurus nebulosus	Yellow Bullhead		P		3			4.3
Lepomis cyanellus	Green Sunfish		P	18	13	9		5.4
Lepomis gibbosus	Pumpkinseed		P	1	4			4.4

Analysis

Fishes

The Meade Run reference site was considerably different than other study sites with lower species richness despite a larger watershed area. Meade Run was also more forested than other sites as well as higher gradient and exhibited lower pH and specific conductance. Meade Run was also the coldest site and the only site with native Brook Trout. It is likely that, historically, prior to the loss of the riparian forest in upper Kinzua Creek and Threemile Run, the fish assemblages would have been more similar to those in Meade Run.

There is no fish analog to the macroinvertebrate IBI in Pennsylvania. A look at the data from the context of tolerance values, indicates that the reference stream is dominated by fish that are intolerant and indicators of reference condition. Sites in Threemile Run and Kinzua Creek are dominated by more tolerant fish.

The Biological Condition Gradient (BCG) (Davies and Jackson, 2006), is a concept that provides a context to see biological assemblages as they change in response to stress. In the Appalachian Mountains of West Virginia and Virginia, we are in the process of developing a BCG model for fish. This model was built in the Appalachians and some of the fish present in our study sites are not included in the model. Also, with the exception of the Reference and KC2, all of our sites are smaller than what was included in the BCG model. However, we can approximate the gradient based on our experience with the model and Pennsylvania streams.

The BCG ranks streams, based on the experience of biologists with the taxa in those streams, from BCG Level 1, a stream with structural and functional biological integrity like that in pristine conditions through Level 6, a stream with extreme changes in the structure of the assemblage (Figure 5). The Meade Run reference site is what we would expect in a Level 2 stream. All the other sites are more like Level 4 streams that might well degrade to Level 5. We saw no Brook Trout in either Kinzua Creek or Threemile Run. The Redside Dace, though present at the impact sites, were in far lesser numbers. We saw Green Sunfish in higher than expected numbers in both streams. In the development of the Thermal Fish Index, Wertz (in prep) noted that cooler stream temperatures seem to ameliorate stress for stream fishes. We believe that we see this in Kinzua Creek and Threemile Run. Without the cool water, its likely we would see much poorer condition of these assemblages.

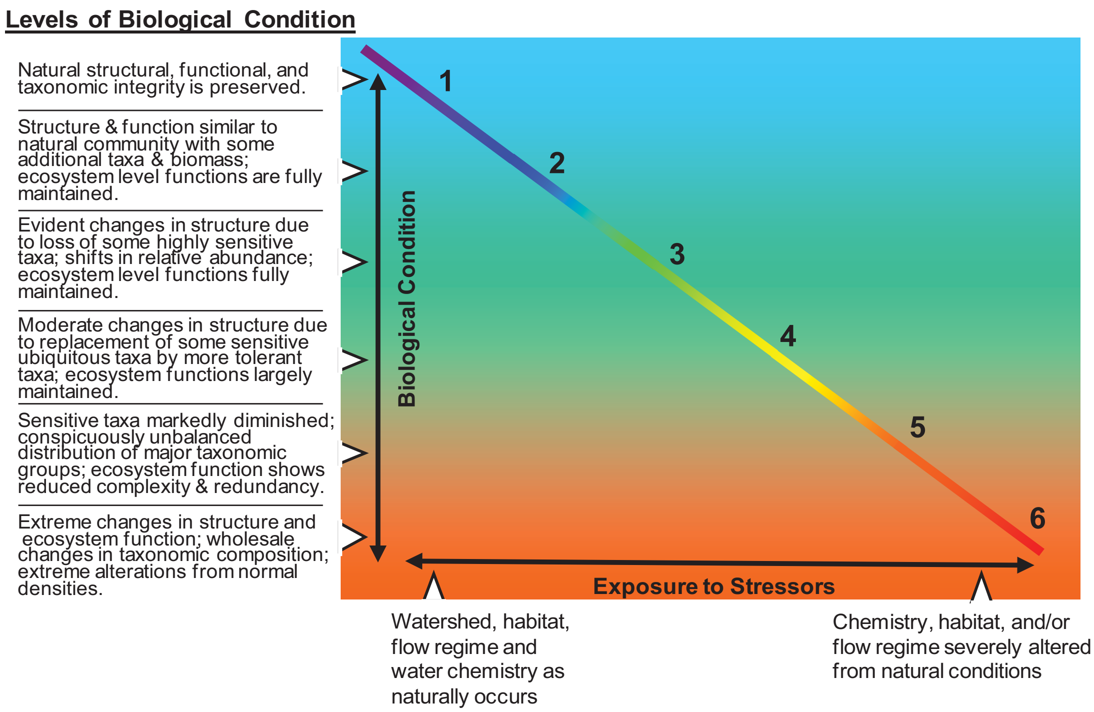

Figure 5. The Biological Condition Gradient (BCG), modified from Davies and Jackson 2006. BCG models conceptualize and model the changes a biological assemblage experiences in response to stress.

Conclusion

Fish assemblages in Kinzua Creek and Threemile Run both show evidence of stress to their fish assemblages. Both have potential to be much better than they are currently. This is evident in the reference site and the presence of some intolerant fish species within the Kinzua watershed. Cool water in these streams seems to ameliorate some of the stress. Removal of wood tar deposits will eliminate any stress due to contamination and enable regrowth of the riparian corridor, necessary for recovering this stream ecosystem.

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APPENDIX E
ASSESSMENT OF MICROSCOPIC PATHOLOGY IN FISHES COLLECTED AT SITES IMPACTED BY WOOD TAR IN PENNSYLVANIA REPORT

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Assessment of Microscopic Pathology in Fishes Collected at Sites Impacted by Wood Tar in Pennsylvania

Open-File Report 2020–1024

U.S. Department of the Interior
U.S. Geological Survey

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U.S. Geological Survey
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U.S. Geological Survey, Reston, Virginia: 2020

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Suggested citation:
Walsh, H.L., Blazer, V.S., Mazik, P.M., Sperry, A.J., and Pavlick, D., 2020, Assessment of microscopic pathology in fishes collected at sites impacted by wood tar in Pennsylvania: U.S. Geological Survey Open-File Report 2020–1024, 14 p., https://doi.org/10.3133/ofr20201024.

ISSN 2331-1258 (online)

Acknowledgments

This project was funded by the U.S. Environmental Protection Agency (EPA), Region 3, and by the U.S. Geological Survey's Environmental Health (Contaminant Biology) and Cooperative Fish and Wildlife Research Unit programs. The authors thank the EPA Wheeling office personnel for fish collections and associated field data.

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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
yard (yd)	0.9144	meter (m)
	Volume	
ounce, fluid (fl. oz)	0.02957	liter (L)
pint (pt)	0.4732	liter (L)
quart (qt)	0.9464	liter (L)
gallon (gal)	3.785	liter (L)
	Mass	
ounce, avoirdupois (oz)	28.35	gram (g)
pound, avoirdupois (lb)	0.4536	kilogram (kg)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F=(1.8\times°C)+32$$

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$°C=(°F-32)/1.8$$

Abbreviations

BG1 Meade Run site

KC1 Kinzua Creek site

KC2 Backus Creek site

PAHs polycyclic aromatic hydrocarbons

TR1 Threemile Run site

TR2 Mt. Alton site

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By Heather L. Walsh,[1] Vicki S. Blazer,[1] Patricia M. Mazik,[1] Adam J. Sperry,[1] and Diana Pavlick[2]

Abstract

In an effort to determine whether fish populations in an area affected by wood tar waste exhibited health effects, fish were collected and analyzed with histopathology. Multiple species, including Mottled Sculpin (*Cottus bairdii*), Creek Chub (*Semotilus atromaculatus*), White Sucker (*Catostumus commersonii*), Redside Dace (*Clinostomus elongatus*), Common Shiner (*Luxilus cornutus*), and Western Blacknose Dace (*Rhinichthys obtusus*) were sampled from a reference site, Meade Run, and potentially affected streams, Kinzua Creek and Threemile Run, in northwestern Pennsylvania. A full histopathological evaluation was conducted to identify microscopic abnormalities potentially associated with wood tar exposure. The evaluation identified primarily parasites associated with tissue changes. These included microsporidian parasites in the ovaries of Common Shiner and Western Blacknose Dace; myxozoan cysts in the muscle of Common Shiner, Creek Chub, and Western Blacknose Dace; trematode cysts in the muscle of Creek Chub, Redside Dace and Common Shiner; and coccidia in spleen or pancreas of Creek Chub and Common Shiner. Microscopic abnormalities potentially associated with chemical exposure included ceroid/lipofuscin deposits in the meninges of the olfactory lobe of the brain in Common Shiner, Western Blacknose Dace, and Creek Chub, as well as bile duct proliferation and a biliary tumor in Creek Chub. Overall, the findings did not reveal significant microscopic pathology consistent with exposure to wood tar waste.

Introduction

Kinzua Creek is a 42.6-kilometer tributary of the Allegheny River in northwestern Pennsylvania. The former Day Chemical Company facility located in the area converted lumber to charcoal, methanol, and acetic acid. Wood tar is a tar-like waste generated by the chemical process and deposited into the ground. The material, which contains phenolic compounds and polycyclic aromatic hydrocarbons (PAHs), formed lagoons and flowed into the creek. Land use in the watershed is primarily forested with some residential area bordering the forests. Two sites (Mt. Alton and Backus) were identified by the U.S. Environmental Protection Agency (EPA) Region 3 Superfund Biological Technical Advisory Group for remediation of wood tar waste. The assessment plan was to sample fish for health-surveys from a site upstream from the Backus site on Kinzua Creek (KC1) and immediately below the impacted Backus site (KC2). Additionally, a site upstream from the Mt. Alton site on Threemile Run (TR1) and immediately below the Mt. Alton site (TR2) on Threemile Run were sampled. Meade Run (BG1), a tributary of Kinzua Creek not impacted by wood tar waste, was sampled as a reference (table 1; fig. 1).

[1]U.S. Geological Survey.

[2]West Virginia University.

Table 1. Site information for fish collections at potential wood tar impacted sites.

Site designation	Stream	Site	Latitude (decimal degrees)	Longitude (decimal degrees)
BG 1	Meade Run	Reference	41.73869	78.78649
TR 1	Threemile Run	Upstream of Mt. Alton	41.79409	78.62258
TR 2	Threemile Run	Mt. Alton	41.78517	78.60868
KC 1	Kinzua Creek	Upstream of Backus	41.81312	78.58243
KC 2	Kinzua Creek	Backus	41.79850	78.57615

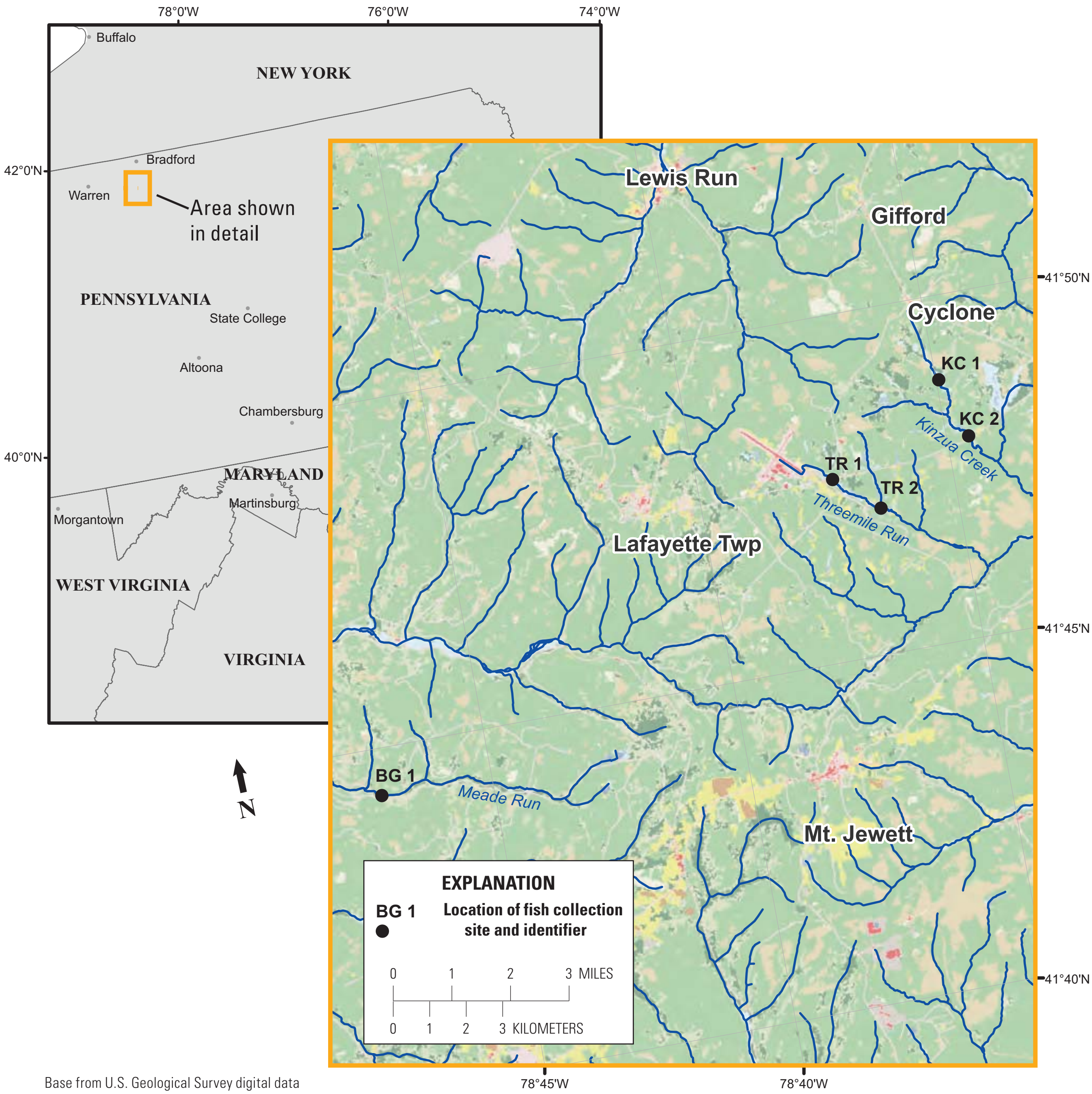

Figure 1. Fish collection sites on Kinzua Creek (KC), Threemile Run (TR), and Meade Run (BG), Pennsylvania.

Methods

Field Methods

Sites were selected by EPA Region 3 and the fish were sampled by the EPA Freshwater Biology team from Wheeling, West Virginia. The incidence of deformities, fin erosion, lesions, and tumors (DELTs), as described by Sanders and others (1999), were documented. The EPA team preserved the fish in a 10-percent buffered formalin to be used for histopathological assessment. For the histopathology subsamples, as many as 30 random fish of the two most numerous species at each site were examined and preserved. The following species were collected for histopathology: Creek Chub (*Semotilus atromaculatus*), White Sucker (*Catostumus commersonii*), Common Shiner (*Luxilus cornutus*), Western Blacknose Dace (*Rhinichthys obtusus*), Mottled Sculpin (*Cottus bairdii*), and Redside Dace (*Clinostomus elongatus*). Individual species and sample sizes varied among sites (table 2). Preserved samples were transported to the U.S. Geological Survey Leetown Science Center. Total body lengths were only provided by the field crew for the Meade Run fishes.

Histopathology

Preserved samples were processed in two ways. If fish were small (<10 centimeters), whole fish were placed into decalcification solution (Thermo Scientific Richard-Allan Scientific Decalcifying Solution, ThermoFisher Scientific, Waltham, Mass.) for 1–3 days. Once decalcified, a cut was made behind the opercles to remove the head. The head was cut longitudinally into two pieces and placed into 1–2 cassettes. The tail area was removed, and the body cut longitudinally and both pieces placed in 1–2 cassettes depending on size. For larger fish, individual organs (liver, posterior and anterior kidney, spleen, heart, gills, any specific lesions) were removed.

Tissue samples were placed in cassettes, routinely processed through graded alcohols, and embedded into paraffin. Blocks were sectioned at 5 micrometers (µm) and stained with hematoxylin and eosin (Luna, 1992). Slides were examined for any abnormalities at the microscopic level.

Table 2. Summary of fish species, sample number, and visible abnormalities observed at wood tar assessment sites.

[DELTs, deformities, fin erosions, lesions, or tumors]

Site	Site designation	Species	Total number of individuals	Number of fish with DELTs
Meade Run	BG 1	Mottled Sculpin	23	0
Threemile Creek upstream	TR 1	Creek Chub	27	1
	TR 1	White Sucker	1	1
	TR 1	Redside Dace	4	0
Threemile Creek Mt. Alton	TR 2	Common Shiner	35	0
	TR 2	Western Blacknose Dace	30	0
	TR 2	White Sucker	1	1
Kinzua Creek upstream	KC 1	Western Blacknose Dace	30	0
	KC 1	Creek Chub	30	0
Kinzua Creek Backus	KC 2	Creek Chub	30	0

Results

The same species were not consistently collected at both upstream and downstream sites or at the reference site. Species collected include Mottled Sculpin (BG1), White Sucker (TR1, TR2), Western Blacknose Dace (TR2, KC1), Creek Chub (TR1, KC1, KC2), and Common Shiner (TR2). Detailed information and histological findings are detailed by site below.

Meade Run

At the reference site, Meade Run (BG1), only Mottled Sculpin were collected on October 1, 2018, and preserved for histopathology. These were not collected at either Kinzua Creek or Threemile Run sites, making a true comparison to a reference site impossible. Nine male, 13 female, and 1 unidentified Mottled Sculpin, ranging in length from 50 to 115 millimeters, were collected. None were observed to have external abnormalities or significant internal lesions (table 3).

Threemile Run

Fish were sampled at two sites on Threemile Run on October 3, 2018, an upstream site (TR1) and the Mt. Alton impacted site (TR2). One White Sucker, 4 Redside Dace, and 27 Creek Chub were collected at TR1 (table 4).

At the upstream site (TR1), the White Sucker was noted as having a tumor by visual examination. Microscopically, no actual neoplasia was noted; however, there were some areas of epidermal hyperplasia. There were two male and two female Redside Dace collected; the ovaries of the females contained many atretic eggs (fig. 2*A*) with no obvious cause.

There were 13 female, 13 male, and 1 undetermined Creek Chub. Ovaries from two of the females had atretic eggs. All of the males were immature with undeveloped testes. One fish had coccidia parasites in the spleen (fig. 2*B*). Ceroid/lipofuscin accumulations, indicative of oxidative damage, were present within the meninges of the olfactory lobe of the brain (fig. 2*C*) of 15 percent (4 out of 27) of the Creek Chub. The most common observation at this site was the presence of

Table 3. Meade Run (BG1) site Mottled Sculpin observations.

[F, female; M, male]

Fish number	Length (millimeters)	Sex	External abnormalities	Microscopic observations
BG1-1	115	M	None	None
BG1-2	105	F	None	None
BG1-3	107	M	None	None
BG1-4	90	M	None	None
BG1-5	92	F	None	None
BG1-6	75	M	None	None
BG1-7	84	F	None	None
BG1-8	82	M	None	None
BG1-9	72	M	None	None
BG1-10	62	M	None	None
BG1-11	82	Unknown	None	None
BG1-12	73	F	None	None
BG1-13	75	F	None	None
BG1-14	80	F	None	None
BG1-15	61	M	None	None
BG1-16	64	F	None	None
BG1-17	55	F	None	None
BG1-18	52	M	None	None
BG1-19	66	F	None	None
BG1-20	61	F	None	None
BG1-21	52	F	None	None
BG1-22	50	F	None	None
BG1-23	54	F	None	None

Table 4. Observations of fish collected at the Threemile Run upstream site (TR1).

[DELTs, deformities, fin erosions, lesions, or tumors; F, female; M, male; NG, no gonad]

Fish number	Species	Sex	External DELTs	Microscopic observations	
				Trematode cysts	Other
TR1-CC1	White Sucker	F	Tumor	No	Epidermal hyperplasia
TR1-CS1	Redside Dace	M	None	Yes	None
TR1-CS2	Redside Dace	F	None	Yes	Atretic eggs, inflammation
TR1-CS3	Redside Dace	M	None	Yes	None
TR1-CS4	Redside Dace	F	None	Yes	Atretic eggs
TR1-SA1	Creek Chub	M	None	No	None
TR1-SA2	Creek Chub	F	Lesion	Yes	Erosion and inflammation
TR1-SA3	Creek Chub	F	None	Yes	Atretic eggs, inflammation
TR1-SA4	Creek Chub	M	None	Yes	None
TR1-SA5	Creek Chub	F	None	No	Brain ceroid
TR1-SA6	Creek Chub	F	None	No	None
TR1-SA7	Creek Chub	F	None	No	Brain ceroid
TR1-SA8	Creek Chub	M	None	No	Coccidia in spleen
TR1-SA9	Creek Chub	F	None	No	None
TR1-SA10	Creek Chub	M	None	Yes	None
TR1-SA11	Creek Chub	F	None	No	Brain ceroid
TR1-SA12	Creek Chub	F	None	No	None
TR1-SA13	Creek Chub	NG	None	No	None
TR1-SA14	Creek Chub	F	None	Yes	None
TR1-SA15	Creek Chub	M	None	No	None
TR1-SA16	Creek Chub	M	None	No	None
TR1-SA17	Creek Chub	M	None	Yes	None
TR1-SA18	Creek Chub	M	None	No	None
TR1-SA19	Creek Chub	M	None	No	None
TR1-SA20	Creek Chub	M	None	No	None
TR1-SA21	Creek Chub	M	None	No	None
TR1-SA22	Creek Chub	M	None	No	None
TR1-SA23	Creek Chub	F	None	No	None
TR1-SA24	Creek Chub	M	None	Yes	None
TR1-SA25	Creek Chub	M	None	Yes	None
TR1-SA26	Creek Chub	F	None	Yes	Brain ceroid, atretic eggs
TR1-SA27	Creek Chub	F	None	No	None

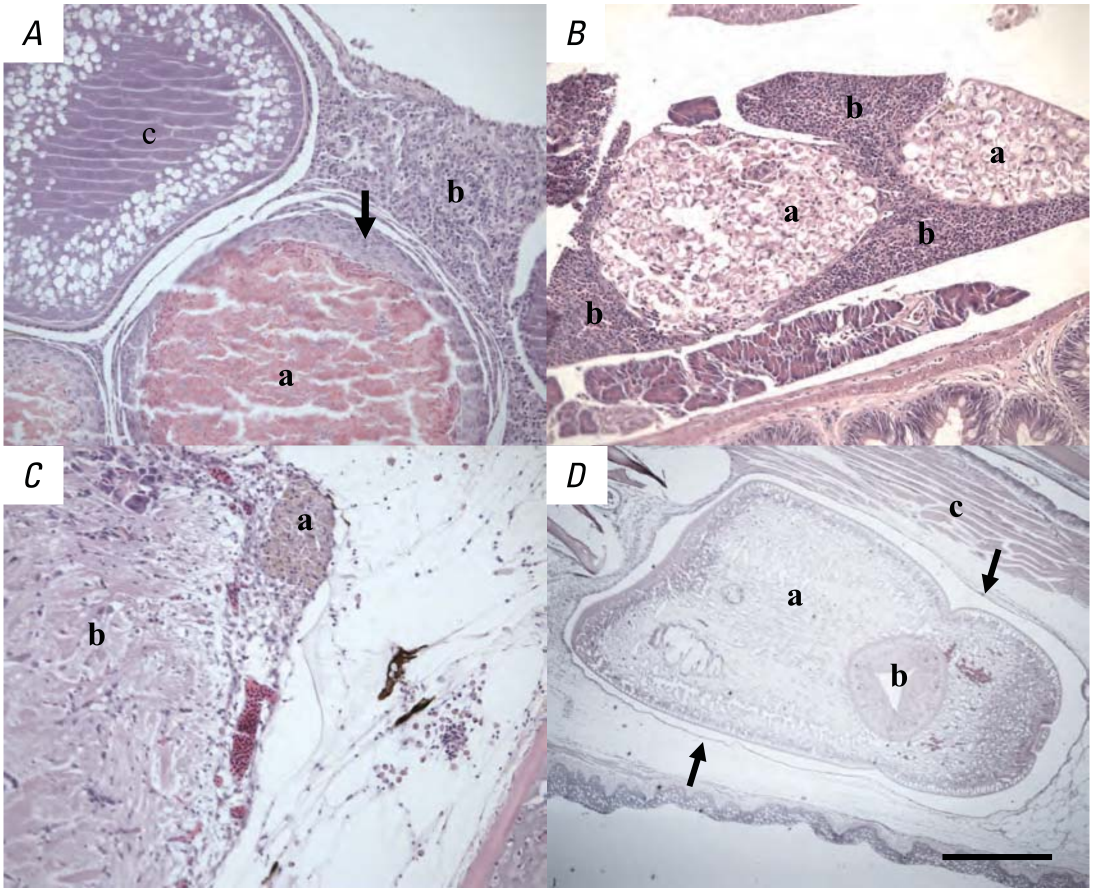

Figure 2. Microscopic observations in Redside Dace and Creek Chub collected at the Threemile Run upstream site (TR1). *A*. Ovarian tissue of Redside Dace with atretic eggs (a) with chronic inflammation within the oocyte (arrows) and in the surrounding tissue (b). Normal oocytes in the cortical alveolar stage (c) are present. Scale bar equals 50 micrometers (µm). *B*. Coccidial parasites (a) within the spleen (b) of a Creek Chub. Scale bar equals 50 µm. *C*. Yellowish-brown ceroid/lipofuscin pigment (a) in the meninges of the olfactory lobe (b) of the brain of a Creek Chub. Scale bar equals 50 µm. *D*. Large trematode (a) with a sucker (b). located under the musculature (c) around the gills. The trematode is within a cyst (arrows). Scale bar equals 50 µm.

trematode cysts (fig. 2*D*). Encysted trematode metacercariae were present in all of the Redside Dace and 33 percent (9 out of 27) of the Creek Chub (table 4).

At the Mt. Alton site on Threemile Run (TR2), 1 White Sucker and 35 Common Shiner were collected on October 3, 2018. The White Sucker, a female, had a visible lesion that was microscopically identified as epidermal erosion with inflammation. No visible abnormalities were observed on the Common Shiners. All but two of the shiners were female (table 5).

Large encysted trematode metacercariae were observed in 23 percent (8 out of 35) of the Common Shiners, primarily in the musculature and connective tissue around the gills. The ovaries of 45 percent (15 out of 33) Common Shiners contained ovarian lesions, including atretic eggs and granulomatous inflammation in association with the presence of a microsporidian parasite within the oocytes (table 5). In some fish the majority of oocytes were normal with a few infected (fig. 3*A*); whereas in others the majority of the oocytes were infected (fig. 3*B*). The parasite location, appearance, and the inflammatory response induced (fig. 3*C*) were similar to *Ovipleistophora ovariae* (previously described as *Pleistophora ovariae*; Pekkarinen and others, 2002) reported from Golden Shiner, *Notemigonus crysoleucas* (Summerfelt, 1964). Ceroid/lipofuscin deposits in the olfactory lobe meninges were observed in 29 percent (10 out of 35) of the Common Shiners. Incidental findings included myxozoan cysts in the cartilage and gills of two fish, and coccidia in the spleen and pancreas of two fish (table 5).

Fourteen females, 13 males, and 3 unidentified Western Blacknose Dace were also collected at the Mt. Alton site (table 6). The most common finding (30 percent; 9 out of 30) was ceroid/lipofuscin deposits in the meninges of the olfactory lobe of the brain, similar to those observed in the Common Shiner (fig. 2*C*). Two of the ovaries also had atretic eggs with microsporidian parasites similar to the Common Shiner (fig. 3).

Table 5. Observations of Common Shiner collected at the Threemile Run Mt. Alton site (TR2).

[F, female; M, male; NA, not applicable]

Fish number	Sex	External abnormalities	Microscopic observations		
			Trematode cysts	Ovarian lesions[1]	Other
TR2-LC1	F	None	Yes	Yes	Myxozoan in cartilage
TR2-LC2	F	None	No	No	None
TR2-LC3	F	None	No	No	Inflammation around eye
TR2-LC4	F	None	Yes	Yes	Brain ceroid
TR2-LC5	F	None	No	No	None
TR2-LC6	F	None	No	No	Brain ceroid
TR2-LC7	F	None	No	Yes	Brain ceroid
TR2-LC8	F	None	No	Yes	Brain ceroid
TR2-LC9	F	None	Yes	Yes	Brain ceroid
TR2-LC10	F	None	Yes	Yes	None
TR2-LC11	F	None	No	No	Brain ceroid, coccidia in pancreas
TR2-LC12	F	None	No	No	Myxozoan cyst in gill
TR2-LC13	F	None	No	No	None
TR2-LC14	F	None	Yes	Yes	None
TR2-LC15	F	None	No	No	None
TR2-LC16	F	None	Yes	Yes	None
TR2-LC17	F	None	Yes	Yes	None
TR2-LC18	F	None	Yes	Yes	None
TR2-LC19	M	None	No	NA	None
TR2-LC20	M	None	No	NA	None
TR2-LC21	F	None	No	Yes	Coccidia in spleen
TR2-LC22	F	None	No	Yes	Brain ceroid
TR2-LC23	F	None	No	No	Brain ceroid
TR2-LC24	F	None	No	No	None
TR2-LC25	F	None	No	No	None
TR2-LC26	F	None	No	No	None
TR2-LC27	F	None	No	No	None
TR2-LC28	F	None	No	Yes	None
TR2-LC29	F	None	No	No	None
TR2-LC30	F	None	No	No	None
TR2-LC31	F	None	No	No	None
TR2-LC32	F	None	No	No	None
TR2-LC33	F	None	No	Yes	Brain ceroid
TR2-LC34	F	None	No	Yes	None
TR2-LC35	F	None	No	No	Brain ceroid

[1]Ovarian lesions included atretic oocytes containing microsporidian parasites and associated inflammation.

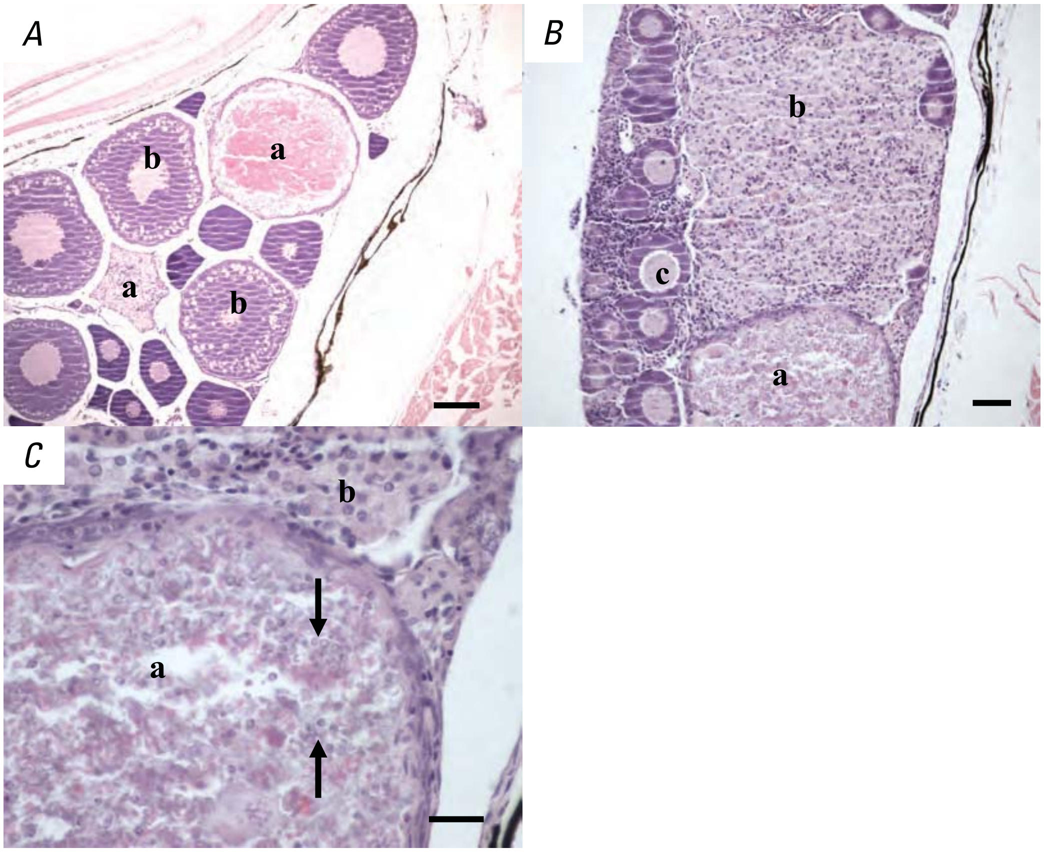

Figure 3. Microscopic observations in Common Shiner collected at the Mt. Alton site (TR2) of Threemile Run. *A*. Atretic oocytes (a) among the normal oocytes (b) within the ovary. Scale bar equals 10 micrometers (µm). *B*. Oocytes (a) filled with microsporidian parasites Large areas of the ovary are replaced by chronic inflammatory response (b) with small areas of normal oocytes (c). Scale bar equals 50 µm. *C*. Higher magnification of an infected oocyte (a) illustrating the small microsporidian spores (arrows) and surrounding inflammation (b). Scale bar equals 20 µm.

Kinzua Creek

Twenty female and 10 male Western Blacknose Dace were collected at the upstream site on Kinzua Creek (KC1). Ceroid/lipofuscin deposits within the olfactory lobe meninges were observed in 17 percent (5 out of 30) of the individuals. Incidental findings included trematode and myxozoan cysts. Focal granulomas, indicative of a chronic inflammatory reaction, were noted in 27 percent (8 out of 30) of the Western Blacknose Dace from this site (table 7). The cause of this inflammatory reaction was not determined.

Thirteen female, 13 male, and 4 undetermined Creek Chub were collected at the upstream Kinzua Creek site. Small focal areas of inflammation of unknown etiology in the muscle (fig. 4*A*) or skin, myxozoan cysts in the muscle (fig. 4*B*), a cholangiocarcinoma (bile duct neoplasm; fig. 4*C*), and trematode cysts were observed (table 8).

At the Kinzua Creek Backus site (KC2), 8 male and 22 female Creek Chub were collected (table 9). Similar to Creek Chub collected at KC1, bile duct proliferation in the liver, myxozoan and trematode cysts, and inflammation in the muscle were observed. Additionally, brain ceroid was also observed in two individuals (7 percent) and pancreatic inflammation in two individuals. An unusual response was observed in the ovary of one fish, with microsporidian parasites within the oocytes where numerous rodlet cells were observed within the inflammation (fig. 4*D*).

Table 6. Threemile Creek Mt. Alton site (TR2) Western Blacknose Dace observations.

[F, female; M, male; NG, no gonad]

Fish number	Sex	Microscopic observations
TR2-RA1	F	Myxozoan cyst in gills
TR2-RA2	F	Brain ceroid, gill trematode
TR2-RA3	F	Brain ceroid
TR2-RA4	F	Brain ceroid, atretic eggs with microsporidian
TR2-RA5	M	None
TR2-RA6	F	Brain ceroid, atretic eggs with microsporidian
TR2-RA7	NG	Pancreatic inflammation
TR2-RA8	M	None
TR2-RA9	F	None
TR2-RA10	F	None
TR2-RA11	F	None
TR2-RA12	M	Brain ceroid
TR2-RA13	M	None
TR2-RA14	F	Brain ceroid, epidermal hyperplasia with giant cells in skin
TR2-RA15	M	Brain ceroid
TR2-RA16	M	Brain ceroid
TR2-RA17	M	Brain ceroid
TR2-RA18	F	None
TR2-RA19	M	None
TR2-RA20	M	None
TR2-RA21	F	Pancreatic inflammation
TR2-RA22	F	None
TR2-RA23	NG	None
TR2-RA24	NG	None
TR2-RA25	M	None
TR2-RA26	F	None
TR2-RA27	F	None
TR2-RA28	M	None
TR2-RA29	M	None
TR2-RA30	M	None

Table 7. Kinzua Creek upstream site (KC1) Western Blacknose Dace observations.

[F, female; M, male]

Fish number	Sex	Microscopic observations
KC1-RA1	M	None
KC1-RA2	F	Brain ceroid
KC1-RA3	F	Bile duct myxozoan
KC1-RA4	M	None
KC1-RA5	M	Brain ceroid
KC1-RA6	F	Focal inflammation in skin
KC1-RA7	M	Brain ceroid
KC1-RA8	M	Focal inflammation in muscle
KC1-RA9	F	Bile duct myxozoan
KC1-RA10	M	Brain ceroid
KC1-RA11	F	None
KC1-RA12	F	None
KC1-RA13	F	None
KC1-RA14	F	Focal inflammation in muscle
KC1-RA15	F	Brain ceroid, focal inflammation in fin
KC1-RA16	F	None
KC1-RA17	F	None
KC1-RA18	F	None
KC1-RA19	M	None
KC1-RA20	F	Focal inflammation in muscle
KC1-RA21	F	None
KC1-RA22	F	None
KC1-RA23	M	None
KC1-RA24	F	None
KC1-RA25	F	Focal inflammation in muscle
KC1-RA26	F	None
KC1-RA27	M	None
KC1-RA28	M	Focal inflammation in muscle
KC1-RA29	F	None
KC1-RA30	F	Focal inflammation in skin

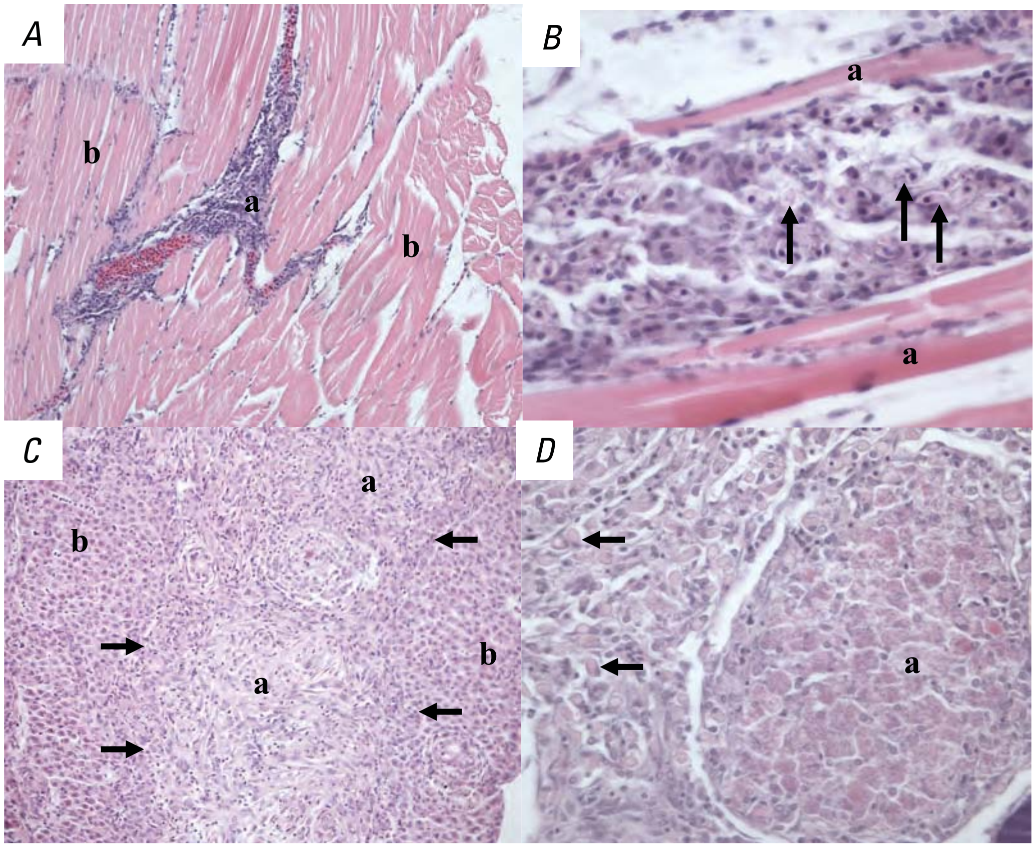

Figure 4. Microscopic observations in Creek Chub collected at Kinzua Creek. *A*. Focal areas of acute inflammation (a) around the skeletal muscle bundles (b). Scale bar equals 50 micrometers (µm). *B*. Myxozoan spores (arrows) within a muscle bundle (a). Scale bar equals 20 µm. *C*. Cholangiocarcinoma (a) composed of disorganized, proliferating bile ducts separated from surrounding hepatic tissue (b) by a poorly defined border (arrows) was observed at the upstream site (KC1). Scale bar equals 50 µm. *D*. Microsporidian parasites infecting oocytes (a), surrounded by inflammation with the presence of rodlet cells (arrows) were observed at the Backus (KC2) site. Scale bar equals 30 µm.

Table 8. Kinzua Creek upstream site (KC1) Creek Chub observations.

[F, female; M, male; NG, no gonad]

Fish number	Sex	Microscopic observations
KC1-SA1	M	None
KC1-SA2	F	Inflammation in skin
KC1-SA3	F	None
KC1-SA4	M	None
KC1-SA5	M	Trematode cysts in muscle
KC1-SA6	M	None
KC1-SA7	F	None
KC1-SA8	M	None
KC1-SA9	F	Muscle myxozoan
KC1-SA10	NG	None
KC1-SA11	F	Inflammation in muscle
KC1-SA12	F	Trematode cysts in muscle
KC1-SA13	M	Inflammation in muscle, myxozoan cysts
KC1-SA14	M	Cholangiocarcinoma
KC1-SA15	M	Muscle myxozoan
KC1-SA16	F	None
KC1-SA17	M	None
KC1-SA18	M	None
KC1-SA19	NG	None
KC1-SA20	F	None
KC1-SA21	NG	None
KC1-SA22	NG	None
KC1-SA23	M	None
KC1-SA24	F	Inflammation in muscle
KC1-SA25	F	Bile duct proliferation
KC1-SA26	M	None
KC1-SA27	F	None
KC1-SA28	F	Inflammation in muscle
KC1-SA29	F	Ovarian atresia with inflammation
KC1-SA30	M	None

Table 9. Kinzua Creek Backus site (KC2) Creek Chub observations.

[F, female; M, male]

Fish number	Sex	Microscopic observations
KC2-SA1	F	None
KC2-SA2	F	None
KC2-SA3	M	Brain ceroid
KC2-SA4	F	Pancreatic inflammation, bile duct proliferation
KC2-SA5	M	Trematode cyst
KC2-SA6	F	Pancreatic inflammation
KC2-SA7	M	None
KC2-SA8	F	None
KC2-SA9	F	Myxozoan in muscle
KC2-SA10	F	Inflammation in muscle
KC2-SA11	F	None
KC2-SA12	F	None
KC2-SA13	M	Brain ceroid
KC2-SA14	M	None
KC2-SA15	M	None
KC2-SA16	F	None
KC2-SA17	F	Atretic eggs, inflammation and rodlet cells in ovary
KC2-SA18	F	None
KC2-SA19	F	None
KC2-SA20	F	None
KC2-SA21	M	None
KC2-SA22	F	None
KC2-SA23	F	None
KC2-SA24	F	Myxozoan in cartilage
KC2-SA25	F	None
KC2-SA26	F	None
KC2-SA27	F	Trematode cyst
KC2-SA28	F	None
KC2-SA29	M	None
KC2-SA30	F	None

Summary

The majority of microscopic abnormalities observed in this study were related to parasitic infections. There were virtually no observable differences in types and severity of parasitic infections and host responses between fish of the same species sampled at the upstream sites and at the impacted sites. The other commonly observed abnormality, ceroid/lipofuscin deposits within the meninges of the olfactory lobe, was also observed in fish collected at both impacted and upstream sites. Although the incidence at the impacted sites was higher, the species of fish was not the same, which confounds the findings. The cause of this type of lesion, an accumulation of autofluorescent chromolipids, is unknown. Lipofuscins have traditionally been considered accumulations of polymerized lipid material associated with aging, whereas ceroids are considered a pathological accumulation of polymerized or oxidized lipid (Porta and others, 2002; Seehafer and Pearce, 2006). A variety of contaminants and other environmental stressors can cause oxidative stress in fish (Srivastava and Reddy, 2017).

Microsporidia, myxozoan, and trematode parasites were observed in numerous fish in this study. The significance of these findings on the health of these fish populations is unknown. Parasitic infections in fish have been used as an indication of environmental health (Marcogliese, 2005) and there are environmental variables such as temperature, contaminants, stream drift, and water quality that affect parasite assemblages in fish (Landsberg and others, 1998; Blasco-Costa and others, 2013). In this study, females with microsporidia infections in their ovaries exhibited a mild to severe inflammatory response and had atretic oocytes. However, the effect of these infections on reproductive health remains unknown. Myxozoan and trematode cysts, on the other hand, were observed mainly in the muscle and initiated minimal host response. In order to fully understand the impact of these parasites and pathogens on the fish sampled from Kinzua Creek and its tributaries, long-term monitoring would need to be considered in order to understand what types and severity of infections are considered normal for these fish populations.

To conclude, there was minimal evidence that the fish in this study responded to contaminants in the wood tar waste at the affected sampling sites. However, histopathology alone may not be an effective tool for analyzing the effects of exposure. In fish, molecular dysfunction, growth inhibition, and behavioral and reproductive effects could occur without histopathological changes.

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Publishing support provided by the West Trenton and
Pembroke Publishing Service Centers

Walsh and others—**Assessment of Microscopic Pathology in Fishes Collected at Sites Impacted by Wood Tar in Pennsylvania**—OFR 2020–1024

ISSN 2331-1258 (online)
https://doi.org/10.3133/ofr20201024