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Site-Specific Methylmercury Water Quality Criterion Stream Study Plan:

Unnamed Tributary to Rambo Run and Unnamed Tributary to Ebaughs Creek
York County, Pennsylvania

Revised August, 2016

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µg/L	Micrograms per Liter
µm	Micrometer
AWQC	Ambient Water Quality Criteria
$AWQC_{MeHg}$	Ambient Water Quality Criteria for filtered Methylmercury
$AWQC_{THg}$	Ambient Water Quality Criteria for Total Mercury
BAF	Bioaccumulation Factor
C_t	Mercury Concentration in Tissue
COA	Consent Order Agreement
COC	Chain-of-Custody
DELT	Deformities Erosions Lesions and Tumors
EPA	Environmental Protection Agency
PADEP	Pennsylvania Department of Environmental Protection
f_d	Water column translation factor
ft.	Feet
FMeHg	Filtered Methylmercury
g	Grams
L/kg	Liters per Kilogram
MDE	Maryland Department of the Environment
MDL	Method Detection Limit
MeHg	Methylmercury
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mm	Millimeters
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NBMC	North Branch of Muddy Creek
NPDES	National Pollution Discharge Elimination System
PADEP	Pennsylvania Department of Environmental Protection
QA/QC	Quality Assurance/Quality Control
THg	Total Mercury
TMDL	Total Maximum Daily Load
TRC	Tissue Residue Concentration
UNT	Unnamed Tributary
YCSWRA	York County Solid Waste and Refuse Authority
YSI	Yellow Spring Instruments

1 Introduction

The York County Solid Waste and Refuse Authority (YCSWRA) owns and operates the York County Sanitary Landfill (Landfill) located in Hopewell Township, York County, Pennsylvania. The Landfill operated from 1974 to 1997 receiving municipal and industrial waste which was placed into lined (40 acres) and unlined (135 acres) cells at the 306 acre facility. Various volatile organic compounds associated with the unlined cells were detected in groundwater in 1983; a pump and treat system comprised of 17 extraction wells and air stripping towers was put into service in 1985. The air stripping towers discharge treated groundwater effluent from two outfalls under National Pollutant Discharge Elimination System (NPDES) Permit Number PA0081744. Outfall 001 discharges into an Unnamed Tributary (UNT) to Rambo Run (UNT-Rambo Run), while Outfall 002 discharges into an UNT to Ebaughs Creek (UNT-Ebaughs Creek). Each of these two receiving streams has limited watershed area and stream discharge above the YCSWRA outfalls. In the absence of the outfalls, stream flow would be greatly reduced within the headwaters of the streams. Both outfalls have documented total mercury (THg) concentrations above the Pennsylvania surface water quality, human health criterion of 0.05 micrograms/liter (µg/L), yet are consistently below the Pennsylvania Fish and Aquatic Life Continuous (0.77 µg/L) and Maximum (1.4 µg/L) water quality criteria as outlined in 25 Pa. Code Chapter 93.8c (PADEP, 2009), as well as below the Maximum Contaminant Level (drinking water standard) of 2.0 µg/l.

On November 30, 2011, YCSWRA met with the Pennsylvania Department of Environmental Protection (PADEP) regarding the application for renewal of NPDES Permit No. PA0081744, submitted May 27, 2011. At that time, PADEP informed YCSWRA that they would need to either:

a. Meet a discharge limit of 0.05 µg/L for THg at the point of discharge due to the limited assimilative capacity of the receiving waterbodies; or
b. Develop a site-specific ambient water quality criterion for methylmercury ($AWQC_{MeHg}$) and translation factor (f_d) to convert the $AWQC_{MeHg}$ to a site-specific ambient water quality criterion for THg ($AWQC_{THg}$), which would then be applied as the NPDES discharge limits for Outfall 001 and 002.

The YCSWRA and PADEP entered into a Consent Order Agreement (COA) on August 20, 2015, to perform a site-specific stream study (Stream Study) to develop an $AWQC_{MeHg}$ for Rambo Run and Ebaughs Creek for the purposes of determining NPDES THg discharge limits that are protective of human health. This work plan presents the proposed approach for conducting the Stream Study as outlined in the June 29, 2016 letter from PADEP and is separated into the following sections:

- Section 1 – Introduction and Background;
- Section 2 – Environmental Setting
- Section 3 – Study Approach and Data Evaluation;
- Section 4 – Reporting;
- Section 5 – Health and Safety; and,
- Section 6 - References.

1.1 Background

The United States Environmental Protection Agency (EPA) publishes recommended ambient water quality criteria (AWQC) guidance under Section 304(a) of the Federal Clean Water Act, which are intended to be protective of designated uses including aquatic life and human health (EPA, 2010). In 2001, the EPA published a tissue-based $AWQC_{MeHg}$ (0.3 milligrams per kilogram [mg/kg]) and strongly encourages states and authorized tribes to adopt this criterion or any sound, scientifically based approach for MeHg or THg into their water quality standards (EPA, 2010). PADEP has not yet adopted the EPA 2001 $AWQC_{MeHg}$ into its statewide water quality standards at this time; however, it is under consideration for the next triennial review

(PADEP, 2015). As outlined in the COA and presented in the previous section, PADEP is permitting YCSWRA to conduct the Stream Study as a mechanism to determine a scientifically defensible THg NPDES discharge limit for Outfalls 001 and 002 under the authority of 25 Pa. Code Chapter 93.8d; this approach is consistent with the EPA *Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion* (EPA, 2010).

2 Environmental Setting

Rambo Run and Ebaughs Creek can be generally described as high gradient, cold water, headwater streams with limited anthropogenic impacts. Both streams have largely undisturbed riparian corridors consisting of mature forested areas and early successional habitats within agricultural lands. Each of the stream segments included in the 2014 Pennsylvania Integrated Waters Report for the Rambo Run and Ebaughs Creek watersheds were listed as Category 2, or non-impaired waters with one exception (PADEP, 2014). One stream segment of Ebaughs Creek downstream of the Stewartstown wastewater treatment plant was designated as a Category 5 or, Impaired Stream requiring development of a total maximum daily load (TMDL) for chlorine.

A site visit was conducted on August 14, 2015 to document ecological characteristics and evaluate potential sampling locations on the UNT-Rambo Run and UNT-Ebaughs Creek. The area surveyed during the site visit included the headwaters of each creek and subsequent locations of Outfalls 001 and 002, for several miles downstream terminating at the confluence of Rambo Run with the North Branch of Muddy Creek (NBMC) and the Maryland state line for Ebaughs Creek (Figure 2-1). Stream width, depth, substrate type, adjacent land use, and suitability of fish habitat to support higher trophic level fish were evaluated at multiple potential sampling locations. This information is summarized in Sections 2.2.1 and 2.2.2 below.

2.1 Rambo Run

Rambo Run is a first order high-gradient stream designated as Exceptional Value, located in Hopewell Township, Pennsylvania (Figure 2-1; PSIE, 2013). YCSWRA Outfall 001 is located at the headwaters of the UNT-Rambo Run with limited upstream watershed area. Upstream of the outfall a culvert provides limited discharge associated with a storm water retention basin on the northern portion of the closed and capped Landfill and an intermittent spring which once provided water for a farm house located on the Naylor Winery property. Downstream of Outfall 001 the stream flows for approximately eight miles in a northeasterly direction until the confluence with the NBMC. At Outfall 001, the UNT-Rambo Run is a small stream approximately two to four feet (ft.) wide with an average water depth of less than one foot. Stream width, water depth and discharge increase several miles downstream of Outfall 001 as base flow and multiple first and second order streams including Rambo Run join the UNT-Rambo Run. At the confluence with the NBMC, Rambo Run is a third order headwater stream with an average width of 15 ft. and water depths of one to two ft. deep in the deepest plunge pools and runs. Land use within the Rambo Run watershed is largely comprised of deciduous and coniferous forests, agricultural and residential lands with less than 1% of the area mapped as wetlands (Table 2-1, Figure 2-2).

Aquatic habitats capable of supporting robust populations of legal sized gamefish in the UNT-Rambo Run and Rambo Run may be limited. Although five miles of the UNT-Rambo Run are designated as Wild Trout supporting waters, and the upper three miles of the stream are designated as a Class A brown trout (*Salmo trutta*) fishery, much of this reach is dominated by narrow stream widths and water depths less than 6”[PFBC, 2015a; PFBC, 2015b (Figure 2-2)]. The availability of apex predatory gamefish will be evaluated within this reach during the qualitative fish community survey outlined in Section 3.1 below.

Fish tissue mercury concentrations documented in the UNT-Rambo Run are consistent with other data for trout collected from Pennsylvania waters as well as regional state and commercial hatcheries (Brightbill et al., 2004; Horowitz et al., 2007). Total mercury data collected during the PADEP (2012) tissue sampling event indicated that mercury concentrations in two brown trout samples from Rambo Run (collected approximately 3.5 and 5 miles downstream of Outfall 001) were an order of magnitude less (0.036 mg/kg and 0.038 mg/kg) than the EPA recommended fish tissue-based $AWQC_{MeHg}$ of 0.3 mg/kg.

The presence of stocked brown and brook trout (*Salvelinus fontinalis*) within the watershed will introduce some degree of uncertainty to the Stream Study. A roughly one-mile reach of the UNT-Rambo Run (between Rock Jim Road and Cross Mill Road) receives annual trout stockings from the Hopewell Fish and Game Association. Approximately 700 brown trout, brook trout and rainbow trout (*Oncorhynchus mykiss*) are stocked annually within this reach. Stocked trout typically display several morphological differences compared to wild fish which are easily identifiable to experienced fisheries biologists, including diminished skin pigmentation and eroded fin margins. While determining if a fish is native vs. stocked is possible, the presence of stocked brown and brook trout will inherently introduce some degree of uncertainty. Wild rainbow trout have not been

documented in York County (PFBC, 2015b); any rainbow trout collected will be assumed to have been stocked and will not be used in the study.

2.2 Ebaughs Creek

The UNT-Ebaughs Creek is a first-order, high gradient stream designated as a Cold Water Fishery located in Hopewell Township, Pennsylvania (Figure 2-1). YCSWRA Outfall 002 is located at the headwaters of the UNT-Ebaughs Creek with a limited upstream watershed and minimal flow upstream of the point of discharge. The stream flows north to south from the point of discharge approximately six miles before crossing the Maryland state line. At the point of discharge the stream is very narrow and shallow; no more than four feet (ft.) wide and less than six inches in depth. A 2-acre private impoundment is located approximately 0.12 miles downstream of Outfall 002. Below the impoundment, stream width, depth and discharge increase from base flow and as the main stem of Ebaughs creek, a second order stream, multiple first order streams, and discharge from the Stewartstown wastewater treatment plant join the UNT-Ebaughs Creek. By the time Ebaughs Creek crosses into Maryland, it has an average width of 15-20 ft. wide with water depths of 1-2 ft. deep in the deepest pools and runs. Land use within the Ebaughs Creek watershed is largely comprised of deciduous and coniferous forests, agricultural and residential lands with less than 1% of the area mapped as wetlands (Table 2-1, Figure 2-2).

Based upon the stream characteristics (e.g. water depths, stream width) documented during the site visit, aquatic habitats capable of supporting robust populations of legal-sized gamefish in the UNT-Ebaughs Creek and Ebaughs Creek are likely limited to the lower three miles of the stream between Bridgeview Road approximately 2 miles downstream of Outfall 002 and the Maryland state line. Within this reach larger sized fish (i.e. 6-10 inches) were observed at several locations (Figure 2-3). The availability of apex predatory gamefish will be evaluated at these locations during the qualitative fish community survey outlined in Section 3.1 below.

Fish tissue mercury concentrations within Ebaughs Creek have not been documented. After crossing into Maryland, Ebaughs Creek becomes a second order tributary to Deer Creek which was not listed as impaired on the Draft 2014 Maryland Integrated Report (MDE, 2014). The Maryland Department of the Environment (MDE) has adopted the EPA recommended tissue based $AWQC_{MeHg}$.

Similarly to Rambo Run, the presence of stocked brown and brook trout within the watershed will introduce some degree of uncertainty to the Stream Study for Ebaughs Creek. A roughly one-mile reach of Ebaughs Creek (between Orchard and Blevins Road) receives annual trout stockings from the Hopewell Fish and Game Association; approximately 700 brown trout, brook trout and rainbow trout are stocked annually within this reach.

3 Approach

The Stream Study will follow a phased implementation approach intended to select the most representative sampling stations for fish tissue and surface water sampling. A qualitative fish community survey will be conducted first to determine the species and relative abundance of apex predator fish [e.g., trout, American eel (*Anguilla rostrata*)] within each stream. This data will then be used to identify potential locations where a sufficient population of apex predator fish exists to meet the objectives of the study.

The surface water and fish tissue sampling programs to derive the site-specific $AWQC_{MeHg}$ will begin following the qualitative fish community survey at the sampling location nearest to the subject outfall on each stream where fish populations meet the objectives of the study. The one-year monthly surface water sampling program will begin in fall 2016 and continue for twelve consecutive months, concluding in September, 2017. Fish tissue samples will be collected in the fall for two consecutive years; once at the start of the surface water sampling program in 2016, and once at the end of the 12 month surface water sampling program in 2017. Surface water samples to be used in the calculation of the site-specific translator factor will be collected approximately 25' downstream of each subject outfall from the well mixed effluent and receiving water. Complete details of the sampling approach are provided in the following sections; a proposed study schedule is presented in Table 3-1.

Data collected for use in the development of the site-specific water concentration-based $AWQC_{MeHg}$ and the translator factor which will be used to convert it to a site-specific water-concentration-based $AWQC_{THg}$ will be collected in accordance with EPA and PADEP Guidance as outlined in Section 4.0. A brief summary of the process to determine these values and necessary intermediate calculations is outlined below:

1) Translation of the EPA 2001, tissue concentration based $AWQC_{MeHg}$ to a water concentration-based $AWQC'_{MeHg}$;
    a. Determination of the site-specific bioaccumulation factor (BAF);
2) Translation of the water concentration-based $AWQC_{MeHg}$ to a water-concentration-based $AWQC_{THg}$;
    a. Determination of the site-specific MeHg to THg translator factor.

The end result of the Stream Study will be a site-specific, water concentration-based $AWQC_{THg}$ which PADEP will use in their development of the NPDES permit limits for YCSWRA Outfalls 001 and 002 respectively, through the process and authority outlined in 25 Pa. Code Chapter 93.8d.

The sections below provide specific details on field sampling, analytical methodology and quality assurance/quality control (QA/QC).

3.1 Qualitative Fish Community Survey

A qualitative fish community survey was performed on March 14, 2016 on Rambo Run and Ebaughs Creek to identify sampling stations with apex predatory fish (i.e., Trophic Level 3 or 4) in sufficient densities to support the objectives of the study (Table 3-2). Three Ebaughs Creek reaches and four Rambo Run reaches were sampled where either historical sampling identified the presence of wild brook trout and brown trout or where trout were observed during the reconnaissance effort (Figure 3-1 and Figure 3-2). Sampling methodology followed the approach outlined in the Pennsylvania Semi-Quantitative Fish Protocol for Streams (PADEP, 2013).

At each station, a 150-200 meter reach was sampled in a single pass using two backpack electrofishers. Electrofishing began at the downstream terminus of the reach and commenced upstream in a side to side manner thoroughly covering available habitats. Game fish (i.e., trout, white sucker, American eel, etc.) were netted and held in flow-through live pens outside of the sampling reach until sampling was completed; non-game fish (i.e., forage fish) were not collected or identified; however, non-game species observed were noted. Collected gamefish were processed as soon as possible following completion of sampling to minimize holding and handling times. Total length (mm) and weight (g) were measured and recorded for all individual fish of each game species; all other fish collected were enumerated. Deformities, erosions, lesions and tumors (DELT) were documented on field data sheets and particular attention was paid to eroded fins and coloration as these can be indicators of stocked trout. Following processing, fish were returned to the water at the site of capture with minimal handling. Sampling

stations were considered viable if at least six individual trophic level 3 or 4 fish of the same species and of legal size (i.e. 7" for trout) were documented.

3.2 Surface Water Sampling

Surface water data to be used in the calculation of the site-specific $AWQC_{MeHg}$ and translator factor will be collected monthly for a period of twelve consecutive months. Sampling will be conducted in accordance with the guidance and principles outlined in EPA Method 1669 *Sampling Ambient Water for Determination of Metals at EPA Water Quality Criteria Levels* (EPA, 1996), using the "clean hands-dirty hands" technique. Sampling will be conducted under baseline or non-storm conditions, which are most representative of typical ecological exposure.

Surface water samples will be collected at each sampling station as described in Table 3-2, Figure 3-1 and Figure 3-2. Sampling locations were determined at the conclusion of the qualitative fish community survey in consultation with PADEP and EPA. Samples collected for use in the calculation of the site-specific $AWQC_{MeHg}$ will be collected at the stations where fish tissue are to be collected (stream stations); samples collected for the translator factor will be collected approximately 25 feet downstream of each outfall in the well mixed effluent (outfall stations). Samples will be collected with a diaphragm pump and field filtered (0.45 micrometer (µm) pore size) as necessary before being placed into laboratory supplied unpreserved bottleware[1]. Immediately after collection, surface water samples will be carefully packaged, placed on wet ice in a cooler and shipped under proper chain-of-custody (COC) via overnight courier to Brooks Applied Laboratories, a Pennsylvania accredited laboratory.

Samples will be preserved at the analytical laboratory within 48 hours of collection and analyzed for both unfiltered THg and filtered [i.e. dissolved] MeHg in accordance with EPA Methods 1631 and 1630, respectively (EPA 2002; EPA 1998). An analytical sample matrix summarizing analytical methods, associated method detection limits (MDLs) and QA/QC sample acceptance criteria are presented in Table 3-3. Further details regarding project QA/QC are provided in Section 3.4 below and in the Quality Assurance Project Plan (QAPP; Appendix A).

Water quality parameters and stream discharge will be measured *in situ* during surface water sample collection. *In situ* water quality parameters will be measured using a Yellow Springs Instruments (YSI) 556 (or equivalent) multi-parameter water quality meter including temperature, dissolved oxygen (at a minimum during tissue collection events), pH, and specific conductivity. The objectives of the water quality monitoring are to characterize the range of physical and chemical conditions of the UNT-Rambo Run and UNT-Ebaughs Creek. Discharge measurements will also be collected concurrent with surface water sampling using an OTT MF-Pro electro-magnetic flow meter. Discharge data combined with the analytical data may be used in the development of a mercury mass balance for the receiving streams to characterize the relative contribution of site-related mercury inputs.

Specific details regarding sample collection, QA/QC and health and safety elements are provided in Standard Operating Procedures SW-01 and SW-02 (Appendix A).

3.3 Fish Tissue Sampling

Fish tissue samples used in determination of the site-specific bioaccumulation factor and subsequent ambient water quality criteria for methylmercury ($AWQC_{MeHg}$) will be collected at the Ebaughs Creek EC-02 (Figure 3-2) and the Rambo Run RR-01 stations (Figure 3-1), based on the results from the qualitative fish community survey. These stations represent the locations closest to the YCSWRA outfalls, where adequate densities of apex predatory fish (i.e. brown trout and American eel) of legal harvest size were documented. Upon receipt of PADEP concurrence on the above referenced sampling locations, the YCSWRA will notify adjacent property owners to secure access permission for the Stream Study. Annual fish tissue sampling for derivation of site-specific $AWQC_{MeHg}$ will occur between August and October of each year of the study. Three composite fish tissue samples made up of two to five individual fish per composite will be targeted for collection at a single location on each tributary. Composite samples will be made up such that the smallest fish in the composite is at least 75% of the length of the largest fish in the composite. If at least six individual fish are not collected at a given location, three individual fish tissue samples will be submitted for analysis.

[1] This method is a performance-validated alternative to Method 1669, as allowed by EPA Method 1669 that has been demonstrated to preclude contamination of samples and blanks as required by the original method.

Field sampling procedures will be conducted using similar methodologies to those outlined in Section 3.1, with the exception that only target fish species (i.e., brown trout and American eel) will be retained. Total length (mm) and weight (g) data will be measured and recorded for each individual fish prior to segregating the fish into composite samples based upon length. Individual fish will be wrapped in aluminum foil with the dull side toward the sample and labeled prior to being placed into a sealable plastic bag with the other fish in the composite. Samples will be shipped frozen on dry ice under proper COC procedures via overnight courier to a certified laboratory. Specific details regarding sample collection, field QA/QC and health and safety are provided in the fish tissue Standard Operating Procedure, FT-01 (Appendix A).

Fish tissue samples will be prepared for analysis at Brooks Applied Laboratories by methods consistent with those outlined in the EPA *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories* (EPA, 2000a). Fish tissue samples will be prepared as skinless fillets as mercury is differentially concentrated in muscle tissue and few consumers in the general population eat the skin of the fish (EPA, 2000a). Samples will be analyzed for total mercury by EPA Method 1631 E (EPA, 2002). The use of total mercury concentrations in fish tissue as a conservative surrogate for methylmercury concentrations is consistent with EPA guidance and other studies documenting that 80-100% of total mercury in adult fish tissue is in the form of methylmercury (Bloom, 1992; EPA, 2000b; EPA, 2001; EPA, 2010). An analytical sample matrix summarizing analytical methods, associated MDLs and QA/QC sample acceptance criteria are presented in Table 3-3. Further details regarding project QA/QC are provided in Section 3.4 below and in the QAPP (Appendix A).

3.4 Quality Assurance and Quality Control

Sampling activities will be conducted in accordance with QA/QC field protocols for collecting environmental measurement data. Field samples will be clearly labeled and handled according to AECOM COC procedures. Each sample will be labeled using waterproof ink with the sample number, date and time of collection, initials of sampling technician, requested analyses, and method of preservation. A COC form will be prepared to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The times of sample collections and relevant observations will be recorded in the field log.

In addition to field samples, QA/QC samples will be analyzed by the laboratory for each sample matrix. QA/QC samples will include duplicate analyses of submitted sample volumes and matrix spike/matrix spike duplicate (MS/MSD) analyses. Duplicate samples and MS/MSD samples will be analyzed at a rate of five (5) percent of the total samples collected for in the study.

4 Data Evaluation and Reporting

The principal objective of the Stream Study is to determine the $AWQC_{MeHg}$ in each receiving stream, which given site-specific bioaccumulation dynamics, will maintain fish tissue MeHg concentrations below the EPA recommended tissue-based limit, which is protective of human health. Section 4.1 below provides detailed equations for the evaluation of site-specific data collected determine the site-specific water concentration-based $AWQC_{MeHg}$ and the necessary translator factor to convert it to a site-specific water concentration-based $AWQC_{THg.}$ The proposed approach is consistent with and adapted from the following guidance documents:

- Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (EPA, 2000b);
- Water Quality Criterion for the Protection of Human Health: Methylmercury (EPA, 2001);
- Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion (EPA, 2010); and,

Data collected as part of the Stream Study that are not directly utilized in the calculations outlined below (i.e. discharge measurements, *in situ* water quality) will provide additional lines of evidence which will be utilized to evaluate the representativeness of the data utilized in the determination of the $AWQC_{THg}$ and the relative contribution of site-related mercury discharges

4.1 Data Evaluation

In January 2001, EPA published a new methylmercury ambient water quality criterion of 0.3 mg/kg, expressed as a tissue residue concentration (TRC), which is protective of human health (EPA, 2001). The TRC was based upon EPA's 2000 Human Health Methodology to calculate a water quality criterion; however, it is rearranged to solve for a protective concentration in fish tissue (EPA, 2001). EPA established the water quality criterion for methylmercury as a tissue residue concentration based upon the fact that "*human exposures to methylmercury from all media sources except freshwater/estuarine and marine fish are negligible, both in comparison with exposures from fish and compared with the reference dose. Estimated exposure from ambient water, drinking water, nonfish dietary foods, air, and soil are all, on average, at least several orders of magnitude less than those from freshwater/estuarine fish intakes*. *Therefore, these exposures were not factored into the relative source contribution (EPA, 2001).* At the time of this document the PADEP has not adopted EPA's tissue-based $AWQC_{MeHg}$.

The equation for the TRC does not include a BAF or drinking water intake value as exposure to MeHg through drinking water is negligible (EPA 2001). The equation used to calculate the EPA tissue-based $AWQC_{MeHg}$ equation is provided below:

$$TRC = \frac{BW\ X\ (RfD - RSC)}{\sum_{i=2}^{4} FI_i}$$

Where:

TRC	=	Tissue residue concentration; the fish tissue-based water quality criterion for methylmercury in fish tissue (mg/kg)
RfD	=	Reference dose (based on noncancer human health effects) of 0.0001 mg MeHg/kg body weight-day
RSC	=	Relative source contribution (subtracted from the RfD to account for marine fish consumption) estimated to be 2.7×10^{-5} mg MeHg/kg body weight-day
BW	=	Human body weight default value of 70 kg for adults
FI	=	Fish intake at trophic level (TL) i (i = 2, 3, 4); total default intake is 17.5 g fish/day for general adult population.

At the request of PADEP, the current EPA $AWQC_{MeHg}$, based on the TRC, will be modified by using revised national default inputs per EPA recommendation, and by incorporating a drinking water component and a BAF. The following equation will be used to calculate a water concentration-based $AWQC_{MeHg}$ using a site-specific BAF:

$$AWQC_{MeHg} = \frac{[BW\ X\ (RfD - RSC)]}{[DI + (FI\ X\ BAF)]}$$

Where:

$AWQC_{MeHg}$	=	Water concentration-based ambient water quality criterion for methylmercury in milligrams per liter (mg/L)
Rfd	=	Reference dose (based on noncancer human health effects) of 0.0001 mg MeHg/kg body weight-day
RSC	=	Relative source contribution (subtracted from the RfD to account for marine fish consumption) estimated to be 2.7 x 10^{-5} mg MeHg/kg body weight-day
BW	=	Human body weight default value of 80 kg for adults
FI	=	Fish intake at trophic level (TL) i (i = 2, 3, 4); total default intake is 0.022 kg fish/day for general adult population.
DI	=	Water consumption, 2.4 L/day
BAF	=	Bioaccumulation factor for the apex predatory fish in the system (i.e. trophic level 3 of 4) in liters per kilogram (L/kg)

As stated above, this equation also includes drinking water ingestion; however, exposure to MeHg through drinking water is considered negligible (EPA, 2001). With the other inputs to the equation remaining the same, using the updated national default values for body weight, fish consumption and the inclusion of a drinking water exposure source, would result in an $AWQC_{MeHg}$ that is more conservative than the current EPA promulgated TRC of 0.3 mg/kg.

In order to develop the water concentration-based site-specific $AWQC_{MeHg}$, the site-specific BAF must be calculated. The BAF is the ratio of the concentration of THg in the edible tissue of fish that people eat (C_t) to the concentration of dissolved methylmercury in the surrounding waterbody (C_w) occupied by the fish. The BAF will be calculated using the geometric mean of the dissolved methylmercury concentrations in surface water at stream stations and the geometric mean of the total mercury concentration in fish tissue. As discussed in Section 3.3 above, using total mercury concentrations in fish tissue as a conservative surrogate for methylmercury concentrations is consistent with EPA guidance as 80-100% of total mercury in adult fish tissue is in the form of methylmercury (EPA, 2000b; EPA, 2001; EPA, 2010; Bloom, 1992).The equation used to calculate the BAF is:

$$BAF = \frac{Ct}{Cw}$$

Where:

BAF	=	Bioaccumulation factor for apex predatory fish within the system (i.e. trophic levels 3 or 4) in liters per kilogram (L/kg)
Ct	=	Concentration of total mercury (it is assumed that 100% of total mercury is in the form of methylmercury) in fish tissue in mg/kg, wet tissue weight, from tissue samples collected within the stream sections identified in Figure 3-1 as RR-01 and in Figure 3-2 as EC-02.

Cw = Dissolved concentration of methylmercury in water at stream stations in mg/L from water samples collected within the stream sections identified in Figure 3-1 as RR-01 and in Figure 3-2 as EC-02.

NPDES permit limits typically rely on the total recoverable concentration of THg to determine compliance opposed to the dissolved MeHg form. Thus, the $AWQC_{MeHg}$ will be converted to a site-specific $AWQC_{THg}$ through the use of a site-specific translation factor, f_d. The site-specific water concentration-based $AWQC_{THg}$ will be calculated using the following equation:

$$AWQC_{THg} = \frac{AWQC_{MeHg}}{f_d}$$

Where:

$AWQC_{THg}$ = Water concentration-based ambient water quality criterion for THg in mg/L

$AWQC_{MeHg}$ = Water concentration-based ambient water quality criterion for methylmercury in mg/L

f_d = Site-specific water column translation factor

In order to derive the site-specific water concentration-based $AWQC_{THg}$ a site-specific translation factor is required. The translator factor is the fraction of the total recoverable metal that is in the dissolved form. Total mercury and dissolved methylmercury data collected monthly for the duration of the study (at least 12 consecutive monthly samples) will be used to calculate the translator factor. A translator factor will be calculated for each sample individually, and the final translator factor will be calculated as the geometric mean of the individual translator factors. The following equation will be used to determine the translator factor:

$$f_d = \frac{Cd_{MeHg}}{Ct_{Hg}}$$

Where:

f_d = Site-specific water column translation factor

$C_{d\ MeHg}$ = The dissolved concentration of methylmercury at outfall stations in mg/L from water samples collected in the well mixed zone approximately 25 ft. downstream of the NPDES effluents

$C_{t\ Hg}$ = The total recoverable mercury concentration in mg/L from water samples collected in the well mixed zone approximately 25 ft. downstream of the NPDES effluents

4.2 Reporting

Study reporting will be conducted in accordance with requirements set forth in the COA. Monthly reports will be submitted to PADEP outlining major activities accomplished, results received, and findings during the previous month. During the course of the study, any potential modifications to the approved Plan will be submitted under a separate cover with the monthly report for PADEP review and consideration.

The final report for the Stream Study will be submitted within 60 days after the completion of the study; completion of the study is defined as the date in which the final analytical data deliverable is received from the contract laboratory, approximately 28 days after the final sampling event. The final report will present the results and findings of the study, and will include the raw data for fish tissue and surface water in determination of the site-specific water concentration-based $AWQC_{THg.}$ While the final result of the Stream Study will be the derivation of the site-specific water concentration-based $AWQC_{THg}$ for each stream, it is the responsibility of PADEP to establish these values as the NPDES permit limits through the process and authority outlined in 25 Pa. Code Chapter 93.8d.

5 Health and Safety

The proposed field work involves monthly data collections over several miles of streams. Health and safety situations encountered during sampling may include inclement weather, electrical safety (electrofishing), work over water, biological pests, uneven terrain, pinch points and ergonomic concerns. All necessary precautions and safety measures will be implemented to protect field personnel. No field sampling or other activity that poses an unacceptable risk to personal safety will be undertaken. Weather may preclude strict adherence to the sampling schedule outlined in this work plan.

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PFBC, 2015b. Pennsylvania Fish and Boat Commission Wild Trout Waters. Published August 1, 2015. Accessed September 09, 2015. http://fishandboat.com/trout_repro.pdf.

Tables

Table 2-1
Summary of Land Use within the Study Area
Site-Specific $AWQC_{MeHg}$ Determination
York Country Solid Waste and Refuse Authority
York County, PA

Land Use/Land Cover		
	Rambo Run	**Ebaughs Creek**
Forested Lands	33%	26%
Agriculture	57%	53%
Residential	7%	15%
NWI Wetlands	1%	1%

Table 3-1
Project Schedule
Site-Specific AWQCMeHg Determination
York Country Solid Waste and Refuse Authority
York County, PA

Task 1: Work Plan Development	March 2015	July 2016	August 2016	September 2016	October 2016	November 2016 - August 2017	September 2017	October 2017	November 2017	December 2018
a) Work Plan Approval										
b) Qualitative Fish Community Survey										
c) Landowner Coordination										
c) Surface Water Sampling										
d) Fish Tissue Sampling										
f) Final Stream Study Data Evaluation / Report Submittal to PADEP										

Notes:

Final Stream Study Report will be submitted to PADEP within 60 days of the receipt of all analytical data.

Table 3-2
Sampling and Analytical Summary
Site-Specific $AWQC_{MeHg}$ and $AWQC_{THg}$ Determination
York Country Solid Waste and Refuse Authority
York County, PA

Matrix	Analytes	# of Monthly Sampling Events	# of Samples per Monthly Sampling Event at Stream Station[1]	# of Samples per Monthly Sampling Event at Outfall Station[2]
Rambo Run				
Surface Water	THg	12	1	1
	FMeHg	12	1	1
Fish Tissue	THg	2	3	--
Ebaughs Creek				
Surface Water	THg	12	1	1
	FMeHg	12	1	1
Fish Tissue	THg	2	6*	--

Notes:

[1] - Stream station samples will be used to calculate the site-specific BAF and $AWQC_{MeHg}$

[2] - Outfall station samples will be used to calculate the site-specific translator factor (f_d)

THg - Total Mercury

FMeHg - Filtered Methylmercury (0.45µm)

* Both brown trout and American eel will be sampled in Ebaughs Creek

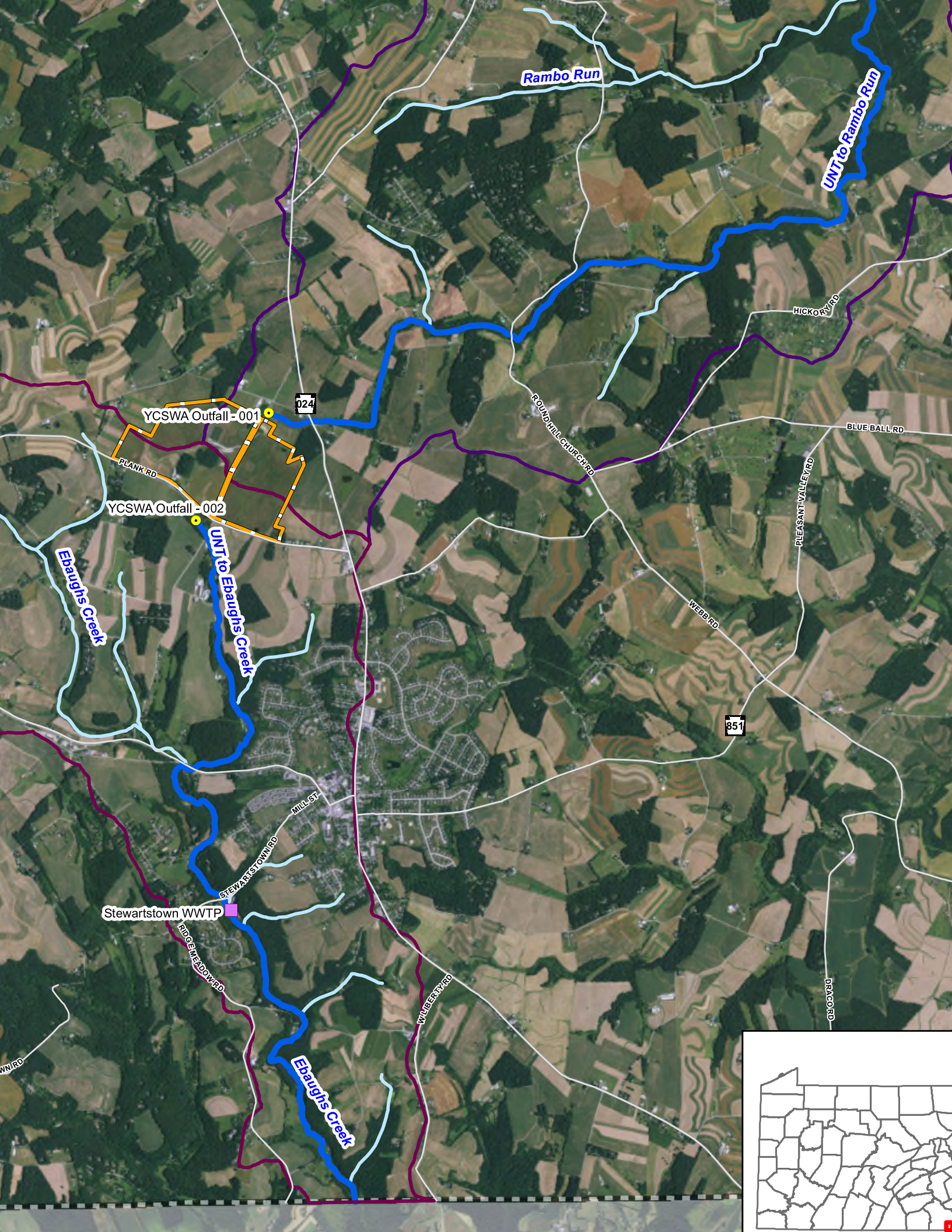
-- not collected

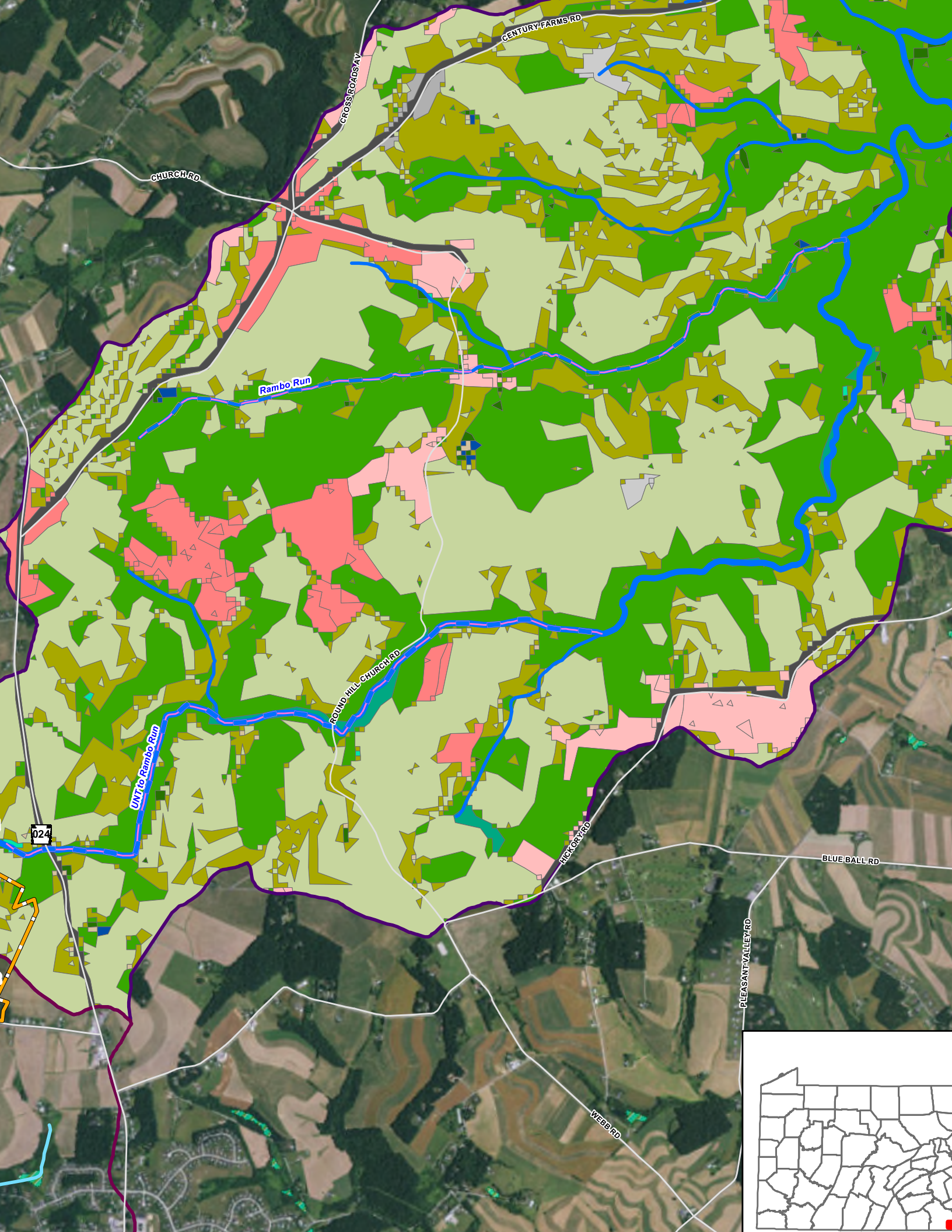
York Country Solid Waste and Refuse Authority
York County, PA

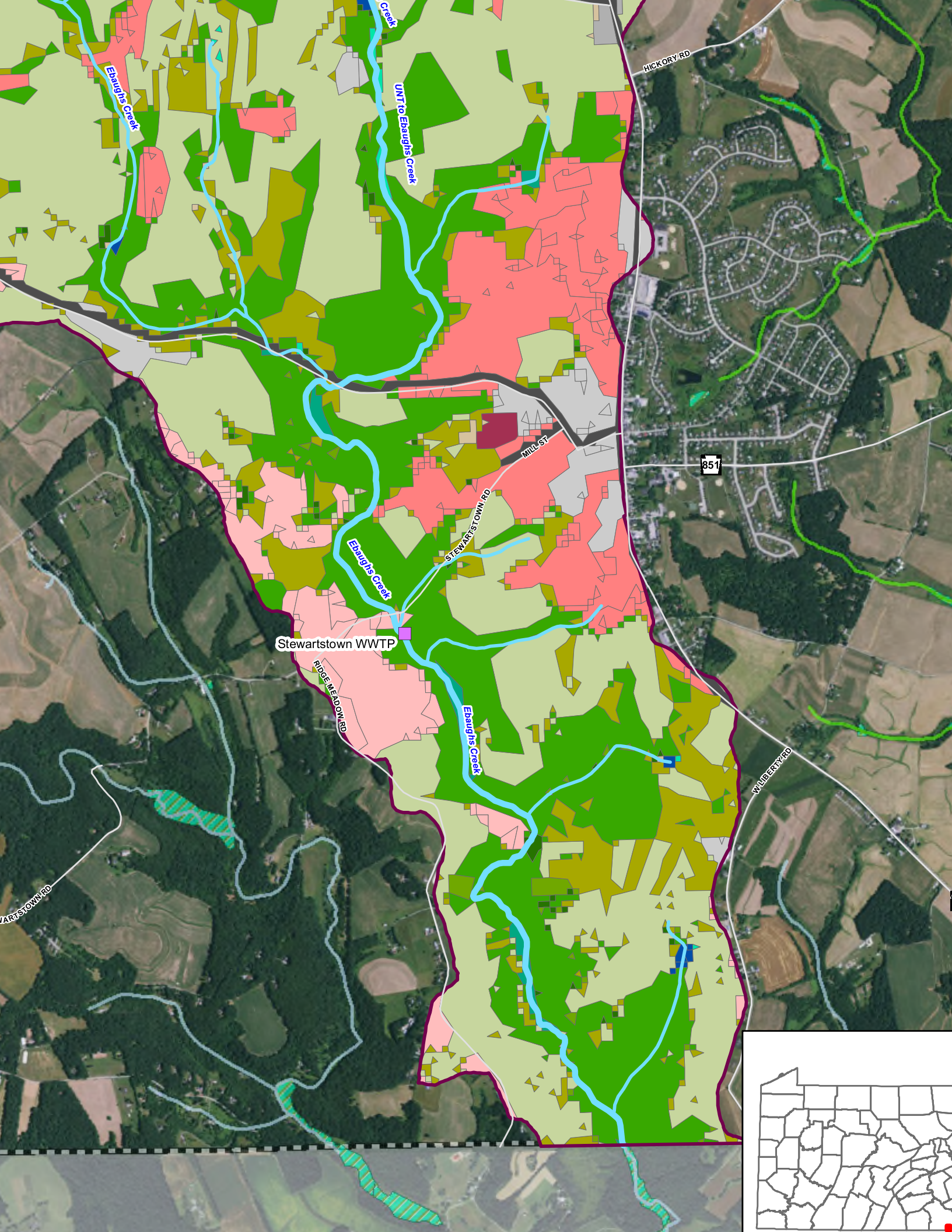
Media	Analyte	Analytical Method	Field Precision % RPD (Field Dup)	Laboratory Precision % RPD (LCSD)	Laboratory Accuracy % Recovery (LCS)	Laboratory Precision % RPD (MSD or Lab DUP)	Laboratory Accuracy % Recovery (MS)	Laboratory Reporting Limit (MDL)	Laboratory Reporting Limit (RL)	Project Reporting Limit (RL)
Surface Water	THg	EPA 1631	30	24	85 - 115	24	71 - 125	0.15 ng/L	0.40 ng/L	0.40 ng/L
	FMeHg	EPA 1630 Modified	30	35	67 - 133	35	65 - 135	0.02 ng/L	0.05 ng/L	0.05 ng/L
dult Fish Tissue	THg	EPA 1631E	N/A	30	75 - 125	30	70 - 130	0.12 ng/g	0.40 ng/g	0.40 ng/g
	% Total Solids / % Dry Weight	Standard Methods 2540G	N/A	N/A	N/A	15%	N/A	0.10%	0.1 ng/g	0.1 ng/g

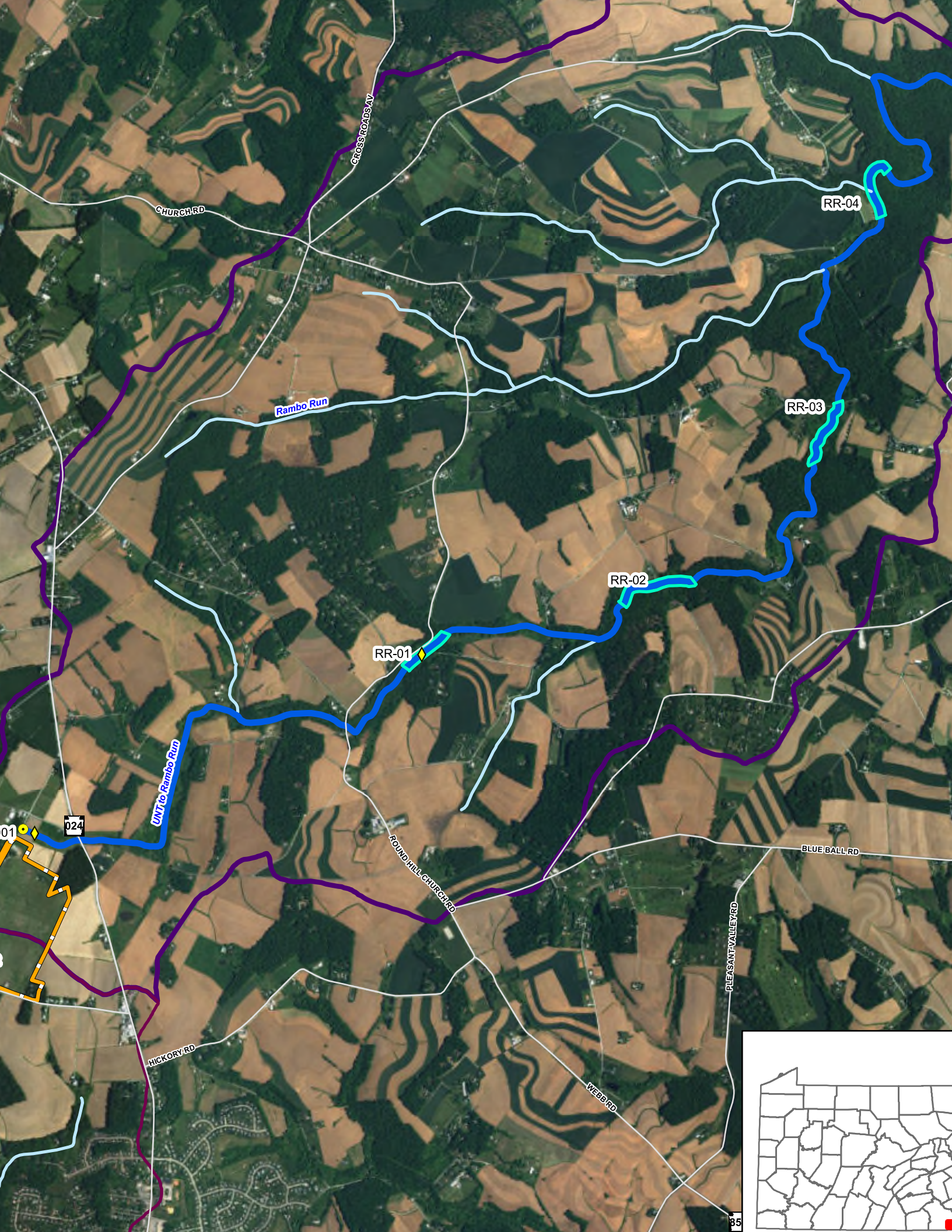
es:
g - Total mercury
eHg - Filtered MeHg (0.45µm)
g - Nanograms per gram
L - Nanograms per liter
- Not analyzed; LCS and LCSD will not be run for % solids analysis
d duplicates are not collected for biological media but instead a laboratory duplicate is analyzed from the same parent material after homogenization

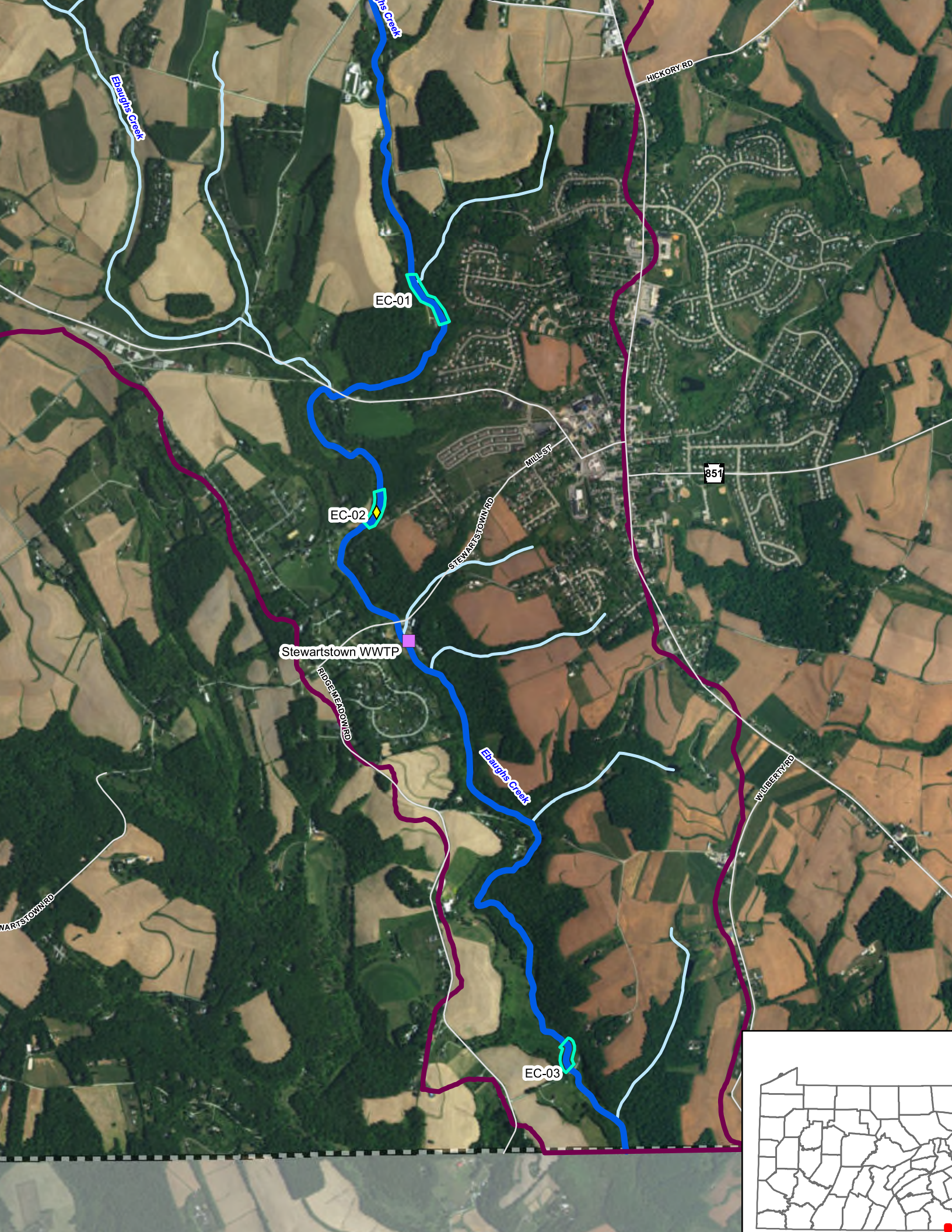
Figures


Rambo Run
UNT to Rambo Run
HICKORY RD
024
YCSWA Outfall - 001
ROUND HILL CHURCH RD
BLUE BALL RD
PLANK RD
YCSWA Outfall - 002
PLEASANT VALLEY RD
Ebaughs Creek
UNT to Ebaughs Creek
WEBB RD
851
MILL ST
STEWARTSTOWN RD
Stewartstown WWTP
RIDGEMEADOW RD
WILBERT RY RD
DRACO RD
Ebaughs Creek


CENTURY FARMS RD
CROSS ROADS AV
CHURCH RD
Rambo Run
ROUND HILL CHURCH RD
UNT to Rambo Run
024
HICKORY RD
BLUE BALL RD
PLEASANT VALLEY RD
WEBB RD


Ebaughs Creek
UNT to Ebaughs Creek
HICKORY RD
MILL ST
851
STEWARTSTOWN RD
Ebaughs Creek
Stewartstown WWTP
RIDGE MEADOW RD
Ebaughs Creek
W LIBERTY RD


CROSS ROADS AV
CHURCH RD
RR-04
Rambo Run
RR-03
RR-02
RR-01
UNT to Rambo Run
024
ROUND HILL CHURCH RD
BLUE BALL RD
PLEASANT VALLEY RD
HICKORY RD
WEBB RD


Ebaughs Creek
HICKORY RD
EC-01
MILL ST
851
EC-02
STEWARTSTOWN RD
Stewartstown WWTP
RIDGEMEADOW RD
Ebaughs Creek
WILBERT RD
EC-03

Appendix A.
Quality Assurance Project Plan

QUALITY ASSURANCE PROJECT PLAN

SITE-SPECIFIC METHYLMERCURY WATER QUALITY CRITERION STREAM STUDY PLAN for

UNNAMED TRIBUTARY TO RAMBO RUN AND UNNAMED TRIBUTARY TO EBAUGHS CREEK

YORK COUNTY, PENNSYLVANIA

Prepared For:

York County Solid Waste and Refuse Authority

Prepared By:

AECOM

625 West Ridge Pike, Suite E-100

Conshohocken, PA 19428

AECOM Project #60432741

July 15, 2016

SECTION A – PROJECT MANAGEMENT

A.1 Title of Plan and Approval

Quality Assurance Project Plan

UNNAMED TRIBUTARY TO RAMBO RUN AND UNNAMED TRIBUTARY TO EBAUGHS CREEK

Prepared By:

AECOM

_____ **Date:** _____

Joshua Collins, AECOM, Project Manager

_____ **Date:** _____

Michael Shadle, AECOM, Quality Assurance Officer

_____ **Date:** _____

Richard Hazenstab, YCSWRA, Coordinator Operations and Environmental Programs

_____ **Date:** _____

Maria Bebenek, PADEP, Program Manager

_____ **Date:** _____

Amanda Royal, Brooks Applied Lab, Laboratory Project Manager

A.2 Table of Contents

TABLES

A.3 Distribution List

This Quality Assurance Project Plan (QAPP), and any subsequent modifications to this QAPP, shall be distributed to the following people for their review and records:

- **Richard Hazenstab, YCSWRA, Coordinator of Operations and Environmental Programs**
  2700 Blackbridge Road
  York, PA 17406
  (717) 845-1066

- **Joshua Collins, AECOM, Project Manager**
  625 West Ridge Pike, Suite E-100, Conshohocken, PA 19148
  (610) 832-3585

- **Michael Shadle, AECOM, Quality Assurance Officer**
  4048 Cox Road, Glen Allen, VA 23060
  (804) 290-2488

- **Amanda Royal, Brooks Applied Lab, Laboratory Project Manager**
  18804 North Creek Parkway, Suite 100, Bothell, WA 98011
  (206) 632-6206

- **Maria Bebenek, PADEP, Program Manager**
  909 Elmerton Avenue
  Harrisburg, PA 17110
  (717) 705-4707

A.4 Project/Task Organization

The various quality assurances, field, laboratory, and management responsibilities of key personnel are defined in the table below.

Management Responsibilities

PADEP Program Manager- Maria Bebenek

The Project Manager has the overall responsibility for activities on the project relating to PADEP.

Project Manager (PM) – Joshua Collins

The PM will be the primary point of contact and will have primary responsibility for technical, financial, and scheduling matters for each investigation. The PM's duties include:

- Procure and supervise subcontractor services
- Review subcontract work and approve subcontract invoices
- Assign duties to the project staff and orient the staff to the needs and requirements of the project as they relate to the project objectives
- Prepare schedules for the completion of each portion of the project
- Establish a project record-keeping system
- Overall responsibility for overseeing completion of all tasks
- Review documents for compliance with appropriate work plans and the project QAPP
- Review all major project deliverables for technical accuracy and completeness
- Close out projects

Quality Assurance Officer (QAO) - Michael Shadle

The QAO will be independent of PM, but will communicate data quality issues through the PM. Some of the responsibilities of the QAO include:

- Develop a QAPP
- Monitor and verify all work that is performed in accordance with the QAPP, or any other applicable procedures
- Perform or oversee all data validation, as required
- Coordinate with analytical laboratories over all work product
- Oversee all quality aspects of the project, and make revisions to quality documents as needed

Senior Technical Reviewer – Dana McCue (AECOM); J.R. Flanders (EHS Support)

The Senior Technical Reviewer's duties include:

- Peer review documents for technical accuracy
- Provide input into field investigations, as necessary

Laboratory Responsibilities

The following laboratories will provide organic and inorganic analytical services for the analysis of surface water and fish tissue samples:

- Brooks Applied Labs, 18804 North Creek Parkway, Suite 100, Bothell, WA 98011

The laboratories must maintain the relevant registrations, certifications, and/or accreditations to provide analytical data in support of the surface water and fish tissue sampling activities.

Laboratory

The Laboratory PM will report directly to the AECOM PM. The Laboratory PM's duties include:

- Ensure all resources and manpower of the laboratory are available on an as-required basis
- Review and approve final analytical reports prior to submission to AECOM
- Resolve data quality and data reporting issues, as required, for IP and AECOM

Laboratory Sample Custodian

The Laboratory Sample Custodian will report any vial breakage, chain of custody discrepancies, or other issues related to sample receipt to the Laboratory PM. Responsibilities of the Laboratory Sample Custodian include:

- Receive and inspect incoming sample containers
- Record the conditions of the incoming sample containers
- Maintain sample custody and integrity
- Sign appropriate documents following review
- Verify chains-of-custody
- Notify Laboratory technical staff of sample receipt and inspection
- Assign a unique identification number to all samples, and enter each into the sample-receiving log
- Initiate transfer of the samples to appropriate laboratory sections for storage prior to analysis
- Control and monitor access/storage of samples and extracts (NOTE: Dependent upon the required data deliverable)

Laboratory Technical Staff

The laboratory technical staff will be responsible for sample analysis and implementation of corrective actions. The staff will report directly to their department supervisor.

Field Responsibilities

Field Team Leader

The Field Team Leader will support the AECOM PM. The Field Team Leader is responsible for managing and coordinating the day-to-day activities of the various technicians under his/her supervision. The Field Team Leader is a highly experienced environmental professional and will report directly to the Project Manager. Field Team Leader’s responsibilities include:

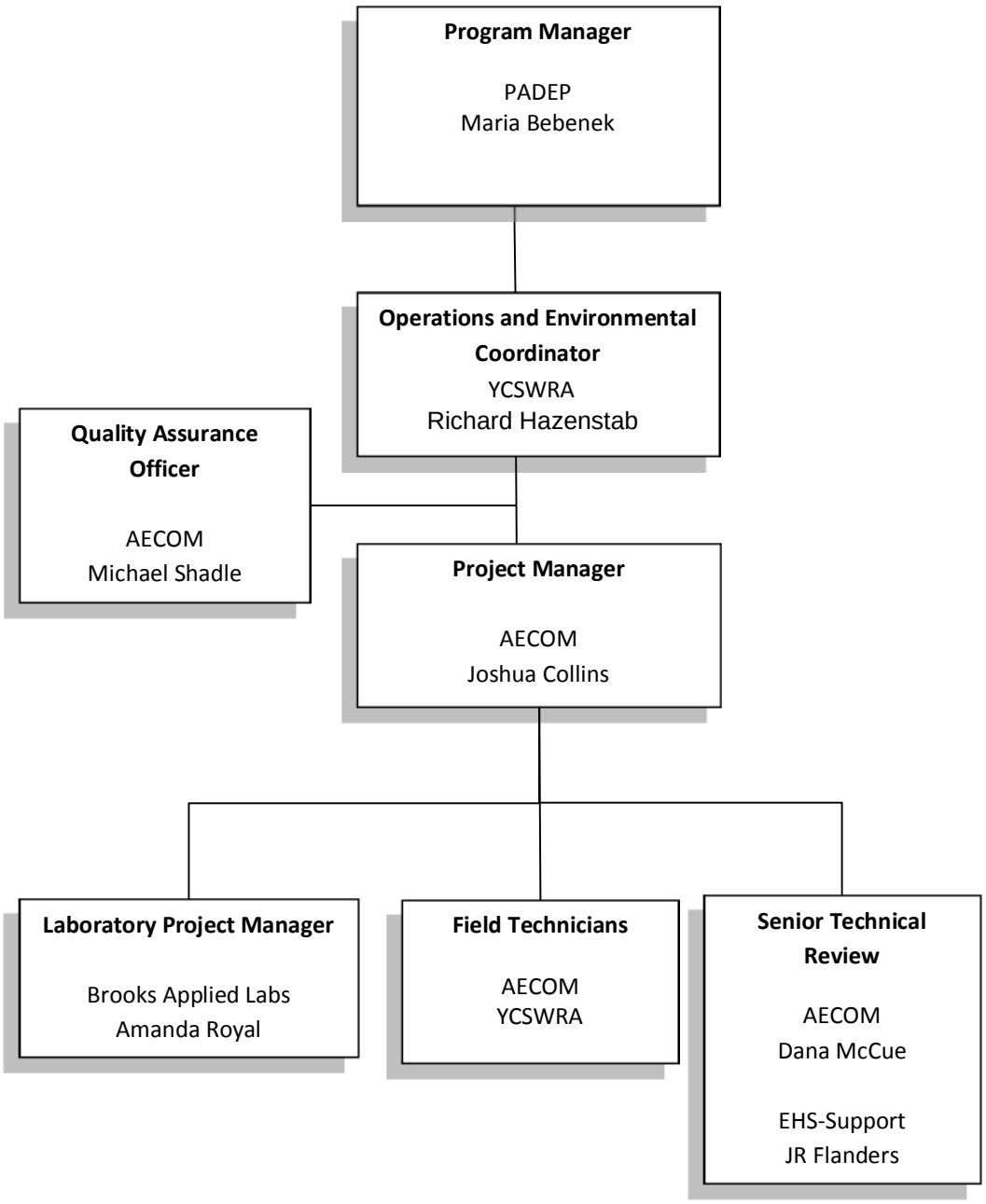
- Coordinate field-related activities with the PM
- Coordinate and manage field staff
- Review technical data provided by the field staff including field measurement data

- Adhere to work schedules provided by the PM
- Write text and graphics required for field team efforts
- Coordinate and oversee technical efforts of client technicians assisting the field team. Identify problems at the field level, resolve difficulties in conjunction with the Project Manager, implement and document corrective action procedures, and act as liaison between the field team and management

Field Technical Staff

The field technical staff for this project will be drawn from a pool of corporate resources. The technical staff will collect and analyze data, and prepare various task reports and support materials. All of the designated technical team members are experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work. Personnel in training must conduct field activities under the direct supervision of experienced professionals.

Organization Chart



A.5 Problem Definition/Task Description

A description of the history of the site, the existing problem, and goals and objectives are provided in **Sections 1 and 2** of the revised YCSWRA Stream Study Work Plan.

A.6 Data Quality Objectives (DQOs) & Criteria

Data quality objectives (DQOs) are qualitative and quantitative statements to ensure that data of known and appropriate quality are obtained during the investigation. The quality of the data must be sufficient to fulfill the overall objective of the specific investigation.

The DQO process is an iterative process where various options for implementing a project are explored, dissected, and recombined. The feasibility and costs of various options are estimated, and then the most advantageous option is selected and developed into project work plans that will be implemented.

The DQOs for the sampling activities defined in the revised YCSWRA Stream Study Work Plan have been determined by evaluating five factors:

1. **Data needs and uses:**

Surface Water Samples

Surface water samples will be collected monthly for a period of one year at locations defined in the Stream Study Work Plan and used in the calculation of the site-specific $AWQC_{MeHg}$ and a translator factor which will be used to convert $AWQC_{MeHg}$ to $AWQC_{THg}$. All samples collected will be sent to an off-site Pennsylvania accredited laboratory (Brooks Applied Labs) for the analyses presented in **Table 1** of this QAPP. Analytical data reported by the laboratory will then be used to make the following determinations:

- Development of the site-specific water concentration-based $AWQC_{MeHg}$ and the translator factor which will be used to convert $AWQC_{MeHg}$ to $AWQC_{THg}$.

- The site-specific, water concentration-based $AWQC_{THg}$ will be used by PADEP in the development of the NPDES permit limits for YCSWRA Outfalls 001 and 002.

Fish Tissue Sampling

Three composite fish tissue samples will be made up of approximately two to five individual fish per composite at a single location on each tributary. Samples will be collected annually between August and October each year of the study. These data are used in determining of the site-specific $AWQC_{MeHg}$. All samples collected will be sent to an off-site Pennsylvania accredited laboratory (Brooks Applied Labs) for the analyses presented in **Table 1** of this QAPP. Analytical data reported by the laboratory will then be used to make the following determinations:

- A site-specific BAF (bioaccumulation factor) will be calculated in order to develop the water concentration-based $AWQC_{MeHg}$.

2. **Parameters of Interest:**

A table listing all potential analyses, including methods, preservation requirements, and holding times, is provided as **Table 1**.

3. **Level of Concern:**

Tables listing all analytes, methods, reporting limits and matrix-specific screening values are provided in **Tables 3, 4, and 5**.

4. **Required Analytical Level:**

The laboratory will analyze the appropriate number of QC samples as defined in **Table 1** of the work plan as well as the level of QC defined in **Section B.5**.

5. Required Detection Limits:

The laboratory will analyze samples at the lowest reasonable dilution factors to ensure that all reporting limits and method detection limits are as low as possible. Reporting limits raised due to dilution factors will be reviewed on a case by case basis.

Data quality and utility depend on many factors, including sampling method, sample preparation, analytical method, quality control, and documentation. Data quality is evaluated in the data assessment process. Specifically, the assessment process focuses on evaluating whether the data quality meets the accuracy, precision, and sensitivity requirements (i.e., DQOs) established for the project. All data will be assessed using method specifications and contractual requirements. Any anomalies will be identified and assessed for potential bias and imprecision. See Section D for a description of data report deliverables and the data review process.

Data quality will be assessed using the criteria specified in **Table 2**.

Data Quality Indicators (DQIs)

The overall QA objective when conducting site investigations is to develop and implement procedures for field sampling, laboratory analysis, COC, and reporting that will provide results fit for the intended data use.

Data quality indicators have been established by the USEPA (USEPA 2002) and are used to help satisfy the QA objective. These data quality indicators assess the adequacy of the data in relation to their intended use and are applicable in the laboratory and in the field. The data quality indicators, which include precision, accuracy, completeness, representativeness, comparability and sensitivity, are discussed in this section. This section also discusses decision rules and the level of quality control effort that should be incorporated into any site specific sampling plan.

Precision

Precision is a measure of the degree to which two or more measurements are in agreement.

Field Precision

Field precision is assessed through the collection and measurement of field duplicates. Laboratory precision and sample heterogeneity also contribute to the uncertainty of field duplicate measurements. This uncertainty is taken into account during the data assessment process. **Table 2** summarizes the criteria for assessing field precision.

Laboratory Precision

Laboratory precision shall be assessed through the analysis of matrix spike/matrix spike duplicate samples (MS/MSD), laboratory control samples/laboratory control sample duplicates (LCS/LCSD) and laboratory replicate samples. MS/MSDs and LCS/LCSDs shall meet the control limits specified in either the appropriate analytical methodology or laboratory-derived control limits. For MS/MSD recoveries outside of the control limits, if additional sample volume is present, the MS/MSD should be reanalyzed. If additional sample volume is not present, an evaluation on the results of the parent sample shall be performed to determine the extent of the potential matrix interference. For LCS/LCSD outliers, the laboratory shall re-extract and reanalyze the LCS/LCSD. **Table 2** summarizes the criteria for assessing laboratory precision.

Accuracy

Accuracy is the measurement of the reproducibility of the sampling and analytical methodology.

Field Accuracy

Accuracy in the field is assessed through the use of equipment blanks and through compliance to all sample handling, preservation, and holding time requirements. All associated equipment blank results should be non-detect when analyzed by the laboratory. Any contaminant detected in associated equipment blank shall be evaluated against laboratory blanks (preparation or method) and evaluated against associated field samples. Equipment blank contamination shall be addressed with field sampling technicians in respect to improving decontamination procedures. **Table 2** summarizes the criteria for assessing field accuracy.

Laboratory Accuracy

Laboratory accuracy is assessed by evaluating the %Rs of MS/MSD samples, LCSs, surrogate compounds (organics only), and the results of method preparation blanks. MS/MSD, LCS, and surrogate %Rs shall be compared to either method-specific control limits or laboratory-derived control limits. Sample volume permitting, samples displaying outliers should be reanalyzed. All associated preparation blanks should be non-detect when analyzed by the laboratory. If preparation, method, or other laboratory prepared blanks display positive detections, the laboratory should evaluate the cause for the potential contamination, re-prep and re-analyze blanks and associated field samples, if necessary. The data reviewer will evaluate any contaminant detected in an associated preparation blank against associated field samples. Preparation blank contamination shall be addressed with laboratory technicians in respect to improving decontamination procedures. **Table 2** summarizes the criteria for assessing laboratory accuracy.

Completeness

Completeness is the ratio of usable data (i.e., non-rejected data) to requested data, expressed as a percent.

Field Completeness

Field completeness is a measure of the amount of valid field measurements obtained from all the measurements taken and recorded during the project, expressed as a percent. **Table 2** summarizes the criteria for assessing field completeness.

Laboratory Completeness

Laboratory completeness is the ratio of total number of samples analyzed and verified as acceptable compared to the number of samples submitted to the fixed-base laboratory for analysis, expressed as a percent. **Table 2** summarizes the criteria for assessing laboratory completeness.

Representativeness

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary.

Measures to Ensure Representativeness of Field Data

Representativeness is dependent upon the adequate design of the sampling program and will be satisfied by ensuring that the work plan is followed and that specified sampling and analysis techniques are used. This is performed by following the WP and this QAPP. All field technicians shall be given copies of appropriate documents prior to sampling events and are required to read, understand, and follow each document as it pertains to the tasks at hand.

Measures to Ensure Representativeness of Laboratory Data

Representativeness in the laboratory is ensured by compliance to nationally-recognized analytical methods, meeting sample holding times, and maintaining sample integrity while the samples are in the laboratory's possession. This is performed by following all applicable EPA methods, laboratory-

issued standard operating procedures, the laboratory's Quality Assurance Manual, any WPs, and this QAPP. The laboratory is required to be properly certified and accredited, and will be supplied with this QAPP, and will have all employees read, understand, and follow any and all applicable laboratory-supplied documents.

Comparability

Comparability is an expression of the confidence with which one data set can be compared to another.

Measures to Ensure Comparability of Field Data

Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the sampling plan is followed and that sampling is performed according to the standard operating procedures or other project-specific procedures. This is performed by following the work plan and this QAPP. All field technicians shall be given copies of appropriate documents prior to sampling events and are required to read, understand, and follow each document as it pertains to the tasks at hand.

Results from previous rounds of sampling may be used for comparison to more current sampling events to assist in determining trends or filling in data gaps.

Measures to Ensure Comparability of Laboratory Data

Analytical data will be comparable when similar sampling and analytical methods are used as documented in the QAPP. Comparability will be controlled by requiring the use of specific nationally-recognized analytical methods and requiring consistent method performance criteria. Comparability is also dependent on similar QA objectives.

Sensitivity

Sensitivity is the ability of the instrument or method to detect target analytes at the levels of interest. The PM shall select, with input from the laboratory and QA personnel, sampling and analytical procedures that achieve the required levels of detection and QC acceptance limits that meet established performance criteria. Concurrently, the PM will select the level of data assessment to ensure that only data meeting the project DQOs are used in decision-making. **Tables 3 and 4** of the QAPP lists the reporting limits and project criteria required to meet the necessary sensitivity requirements of the project.

Measures to Ensure Sensitivity of Field Data

Field equipment shall be used that can achieve the required levels of detection for analytical measurements in the field. In addition, the field sampling staff shall collect and submit full volumes of samples as required by the laboratory for analysis, whenever possible. Full volume aliquots will ensure achievement of the required limits of detection and allow for reanalysis if necessary. **Table 1** summarizes the volume necessary to achieve the detection limits.

Measures to Ensure Sensitivity of Laboratory Data

The contract laboratory shall include a calibration standard at the reporting limit (i.e., practical quantitation limit). The laboratory will attempt to analyze samples at the lowest dilution factor possible.

Level of Quality Control Effort

Equipment blank, method blank, field duplicate, and MS samples may be analyzed to assess the quality of the data resulting from the field sampling and analytical programs. A list of the matrix, number, and frequency of samples is provided in **Table 5**.

- Equipment blanks, consisting of reagent water, will be submitted to the analytical laboratory to provide the means to check for effectiveness of decontamination procedures

- Field duplicates are analyzed to assess the accuracy and precision of the data from the field sampling program.
- Preparation blanks are generated within the laboratory and used to assess contamination resulting from laboratory procedures.
- MS/MSD samples are analyzed to assess sampling and analytical reproducibility and provide information about the effect of the sample matrix on the preparatory and measurement methodology.

The sampling frequency of field QC samples will be one field duplicate for every 20 or fewer investigative samples. Equipment blanks are not required when dedicated or disposable equipment is being used. Depending on area-specific circumstances, one MS/MSD sample will be collected for every 20 or fewer investigative samples for surface water and fish tissue samples.

A.7 Document and Records

Records will be maintained in the AECOM Conshohocken Office documenting all activities and data related to field sampling and chemical analysis at the laboratory. Results of data verification and validation activities will also be documented. Procedures for documentation of these activities are described in this section. Components of field documentation are discussed below.

The QAPP, HASP, and the WP will be provided to every project participant listed in **Section A.3**. Any revisions or amendments to any of the documents that comprise the HASP, WP, or QAPP will also be provided to those individuals.

Field Documentation

Field records that will be maintained include:

- Field log books
- Photo documentation
- Field data and sample collection information forms
- Sample tracking/chain of custody forms

Laboratory Documentation

All activities and results related to sample analysis will be documented at the laboratory. Internal laboratory documentation procedures are described in the laboratory QA plans.

The analytical laboratories will provide a data package for each sample delivery group or analysis batch. The primary function of the QAPP is to describe specific quality assurance and quality control procedures that will be performed by the laboratory to provide analytical data of known and documented quality. It will contain all information required for a complete QA review, including the following:

- Chain-of-custody and cooler receipt forms
- A summary of analyte concentrations and method reporting limits
- Laboratory data qualifier codes appended to analyte concentrations, as appropriate
- Sample preparation, extraction, dilution, and cleanup logs
- Results for method and calibration blanks
- Results for QA/QC checks: LCSs, matrix spike samples, and matrix spike duplicate samples

Data will be delivered in electronic format to the AECOM PM, who will be responsible for oversight of data verification and validation and for archiving the final data and data quality reports in the project file. Electronic data deliverables will be compatible with Microsoft Excel.

Data Quality Documentation

Section D shows the level of effort for reviewing data. Data review reports will be prepared by AECOM.

Results of the review reports will be summarized in any final reports. Any limitations to the usability of the data will also be discussed in the reports.

All EDDs provided by the laboratory will be verified against the reviewed hardcopy data in the data package. All laboratory-applied qualifiers will remain as the final qualifiers.

SECTION B – DATA GENERATION & ACQUISITION

B.1 Sampling Process Design

The sampling procedures to be used during site investigations will be consistent with the project objectives. Sampling procedures will be performed in accordance with the Work Plan. Details of sampling locations, number of samples and frequency, and sampling rationale are provided in the Work Plan. Sample container, preservation, and holding time requirements are listed in **Table 1**.

Sample Numbering

Each sample that is collected will be designated by a sample name. Samples will be labeled using nomenclature to be determined by the field technician. Field QC samples will be identified by the following nomenclature:

Matrix –Station-Sample#	Field Sample
Parent Sample ID-DUP	Field duplicate sample (QC sample)
EBK-[*date*]	Equipment blank sample (QC sample)

All new samples will be designated with nomenclature from the above list; unless previous investigations in the area have either specific nomenclature or previous nomenclature. In this case, the nomenclature will continue from the last sampling event. All sample nomenclature shall remain consistent from sampling event to sampling event.

QA/QC samples will be designated by a three-letter code followed by the six-digit sample collection date. For example, an equipment blank collected on August 14, 2016 would be designated EBK-081416.

MS/MSD samples are never submitted as blind samples to the laboratory, nor are they logged in and assigned tests as separate samples within the laboratory. However, samples designated in the field to be processed as the MS/MSD, for which extra sample volume has been collected, must be identified as such (i.e., "MS/MSD") on the COC records and sample labels.

Custody Procedures

Sample custody is necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility, which are relevance and authenticity. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files. Final evidence files, as defined below of this document, are maintained under document control in a secure area.

A sample or evidence file is under custody if:

1. The item is in actual possession of a person;
2. The item is in view of the person after being in actual possession of the person;
3. The item was in actual physical possession and subsequently locked up to prevent tampering; or,
4. The item is in a designated and identified secure area.

Field Custody Procedures

Field logbooks will provide the means of recording data collection activities performed during the investigation. As such, entries will be described in as much detail as possible so that persons going to the facility could reconstruct a particular sampling event without reliance on memory.

Field logbooks will be bound field survey books or notebooks. Logbooks will be assigned to field personnel, but will be stored in the document control center when not in use. A project-specific document number will identify each logbook.

The title page of each logbook will contain the following minimum information.

- Logbook number
- Project name and activities
- Project start date
- Project end date

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling team members present. The names of visitors to the site and the purpose of their visit will also be recorded in the field logbook.

Any measurements made and/or samples collected will be recorded. All entries will be made in permanent ink, and each page will be signed and dated as the page is completed. No erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark, which is initialed and dated by the sampler. Whenever a sample is collected, or a measurement is made, a detailed description of the location of the sample will be recorded. All equipment used to make measurements will be identified, and equipment calibration will be included. All field technicians must keep their field logbooks current. Field technicians are responsible for keeping possession of field logbooks until completely filled out. Field logbooks should be stored in a secure location. Once field logbooks are completely filled out, books are stored and archived as described below.

Samples will be collected following the sampling procedures established in accordance with Section **B.2** of this QAPP. The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected, and volume and number of containers. Sample identification numbers will be assigned prior to sample collection. Field duplicate samples will be noted under the sample description with the parent sample location.

The sample packaging and shipment procedures summarized below will ensure that the samples will arrive intact at the laboratory. The sample numbering convention and sample designations are included below. Sample container, preservation, and holding time requirements are listed in **Table 1**.

1. The field sampler is personally responsible for the care and custody of the samples until they are transferred or properly dispatched. Field procedures must be designed such that as few people as possible will handle the samples.
2. All bottles will be identified by the use of sample label or tag with sample number, sampling location, data/time of collection, and type of analysis.
3. Sample labels or tags will be completed for each sample using waterproof ink unless prohibited by weather conditions. For example, a logbook notation would explain that a sharpie was used to fill out the sample label or tag because the ballpoint pen would not function during freezing weather.
4. Sample bags will be pre-labeled.
5. A properly completed hardcopy or electronic COC form will accompany samples. The sample numbers and locations will be listed on the COC forms. When transferring the possession of samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the record. The COC documents record transfer of sample

custody to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage area.

6. Samples will be properly packaged on ice at <6°C or frozen on dry ice for shipment (if required) and dispatched to the laboratory for analysis, with an originally signed custody record enclosed in and secured to the inside top of each sample box or cooler. Shipping containers will be secured with strapping tape and custody seals for shipment to the laboratory. The custody seals will be attached to the front center of the cooler, covering the cooler latch, and covered with clear plastic tape after being signed by the field team leader or their designee. The cooler will be strapped shut with strapping tape in at least two locations.

Laboratory Custody Procedures

When the laboratory receives samples, laboratory personnel examine each cooler's custody seals to verify that they are intact and that the integrity of the environmental samples has been maintained. Laboratory personnel then sign the COC. Laboratory personnel proceed to open the cooler and measure its internal temperature. The temperature reading is noted on the accompanying COC report or other form of documentation. Sample container breakages or discrepancies between the COC and sample labels/tags are recorded upon inspection of the contents of the cooler. All problems or discrepancies noted during this process are to be promptly reported to the laboratory PM for resolution.

Permanent Files

The final evidence file will be the central repository for all documents, which constitute evidence relevant to sampling and analysis activities as described in the QAPP. AECOM is the custodian of the evidence files and maintains the contents of the files for the investigation, including all relevant records, report, logs, field notebooks, pictures, subcontractor reports, and data reviews in a secured, limited-access area and under custody of the AECOM PM. Final evidence files will be maintained in secure archival storage for a minimum period of five years.

The permanent file will include at a minimum:

- Field logbooks
- Field data and data deliverables
- Photographs
- Laboratory data deliverables
- Data validation reports
- Data assessment reports
- Progress reports
- QA reports
- Interim project reports
- All custody documentation

B.2 Sampling Methods

Various methods are used for the sampling of surface water and fish tissue matrices. All extraction and analytical methods are listed in **Table 1.**

Surface Water Sampling

- Surface water samples will be collected using the techniques and procedures described in **Appendix A – SOP SW-01**.

Fish Tissue Sampling

- Fish tissue samples will be collected using the techniques and procedures described in **Appendix A – SOP FT-01**.

B.3 Sampling Handling & Custody

Sample labels will be securely affixed to each sample container bag. Sample labels will clearly identify the particular sample, and delineate the following information:

- Site name
- Sample identification
- Sampler's initials
- Date and time the sample was collected
- Sample preservation, and
- Analysis requested

All samples will be maintained in accordance with the following chain of custody procedures. A sample is in custody when it is:

- In a person's physical possession
- In view of that person after he/she has taken possession
- Secured by that person so that no one can tamper with the sample
- Secured by that person in an area which is restricted to authorized personnel

A chain-of-custody record must always be maintained from the time of sample collection until final deposition. Every transfer of custody will be noted and signed for with a copy of the record being kept for each individual who endorsed it. At a minimum, the COC will include the following information:

- Contractor name and address
- Sample identification number
- Sample location
- Sample collection time and date
- Sample information, i.e., matrix, number of bottles collected, container type, etc.
- Names of samplers
- Signatures of all individuals who have had custody of the samples

When preparing sample containers for shipment, they will be securely sealed. The custody seals will be used to demonstrate that a sample container has not been opened or tampered with. The individual who has sample custody shall always sign, date, and affix the custody seal to the sample container in such a manner that it cannot be opened unless it is broken. When samples are not under direct control of the individual responsible for them, they will be stored in a container which will be affixed with a custody seal.

Samples will then be in an appropriate transport container (i.e., cooler) and packed with an appropriate absorbent material. All sample containers will be packed with wet ice or dry ice as required to maintain an appropriate temperature. A temperature blank will be added to each cooler. All sample documentation will then be sealed in a zip-lock bag to prevent water damage and affixed to the underside of a cooler lid. The cooler lid will then be closed and affixed with a custody seal accordingly. Samplers will transport environmental samples directly to the laboratory within 24 hours of sample collection, if necessary, have a laboratory designated courier pick-up the samples from the site, or utilize an overnight delivery service within 24 hours of sample collection, if necessary. Samples with extended analysis holding times may be held over for longer than 24 hours.

All of the appropriate USDOT regulations for packing, marking/labeling, and shipping hazardous materials will be followed. Air carriers who transport hazardous materials, like Federal Express, will comply with the current edition of the IATA Dangerous Goods Regulations. The IATA regulations detail the procedures to be used to enable the proper shipment and transportation of hazardous materials by a common air carrier. Following all of the current IATA regulations will ensure compliance with the U.S. DOT.

B.4 Analytical Methods

A laboratory capable of providing reliable data that meets the data quality objectives stated in Section A.6 of this QAPP shall perform all analyses. Where applicable, analyses shall be performed using the following regulatory agency-approved analytical reference:

- Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Third Edition, December, 1996
- Standard Methods for the Examination of Water & Wastewater, 22nd Edition, 2013

The AECOM PM shall ensure that laboratories (primary or subcontracted) generating data in support of the project maintain the relevant state and federal government regulatory accreditations, certifications, and/or registrations to perform the required analyses (e.g., NELAP).

Listings of target compounds/analytes, method detection limits, and reporting limits for each laboratory are presented in **Tables 3 and 4**. Contract analytical laboratories are responsible for establishing and implementing laboratory SOPs based on the requested methods. Surface water and fish tissue samples will be analyzed by the methods listed in **Table 1**.

B.5 Quality Control

QC procedures and checks are used to assess the precision and accuracy of analytical data. Field QC checks are used to identify potential problems associated with sample handling and sampling procedures. Laboratory QC checks are used to identify potential problems associated with sample preparation and analysis.

Blanks

Blanks may include but will not be limited to equipment blanks.

An equipment blank is created by pouring reagent water through or onto the decontaminated sampling equipment. Blanks will be collected at a frequency of one per 20 field samples when non-dedicated equipment is used. The equipment blank demonstrates the cleanliness of the sampling equipment and/or the effectiveness of the decontamination process. It is used to indicate potential contamination from ambient air as well as from sampling instruments used to collect and transfer samples from point of collection into sample containers.

Field Quality Control Checks

To check the quality of data from field sampling efforts, blanks and duplicate samples will be collected for analysis. Field QC samples (field duplicates and MS/MSDs) will be collected at a frequency of one per 20 investigative samples. Field QC samples will be treated as separate samples with regard to identification, log-in, and shipment. Analytical results for field duplicates will be reported with the field sample data.

Field Duplicate Samples

Field duplicate samples will be collected at a minimum frequency of one per sampling location per event. The field duplicate shall be identified as "DUP" (see **B.1**). Field duplicate samples will not be collected for fish tissue samples.

Matrix spike/matrix spike duplicate Samples

Matrix spike samples may be collected to assess the effects of matrix on the accuracy and precision of the analyses. MS/MSD samples would be collected at a frequency of one in 20 samples for surface water samples.

Laboratory Quality Control Checks

The analytical laboratory has a QC program to ensure the reliability and validity of the analysis performed at the laboratory. The Contract Laboratory Quality Manual is attached in Appendix C. All analytical procedures are documented in writing as SOPs and each SOP includes a QC section that addresses the minimum QC requirements for the procedure. The internal QC checks differ slightly for each procedure, but generally include the following:

- Preparation blanks
- Instrument blanks
- Laboratory replicate samples
- MS/MSDs
- LCS
- Serial dilution

All data obtained will be properly recorded. The laboratory will reanalyze any samples associated with nonconforming quality control checks, if sufficient volume is available. It is expected that sufficient volumes/weights of samples will be collected to allow for reanalysis when necessary. There may be situations where the laboratory may use all of the sample volume for dilutions, and that there will not be sufficient volume remaining to reanalyze due to nonconformance. In this case, the laboratory shall contact the AECOM PM or AECOM QAO for further instruction.

Data Quality Indicators

The overall QA objective when conducting site investigations is to develop and implement procedures for field sampling, laboratory analysis, COC, and reporting that will provide results fit for the intended data use.

Data quality indicators have been established by the USEPA (USEPA, 2002) and are used to help satisfy the QA objective. These data quality indicators assess the adequacy of the data in relation to their intended use and are applicable in the laboratory and in the field. The data quality indicators, which include precision, accuracy, completeness, representativeness, comparability and sensitivity, are discussed in this section. This section also discusses decision rules and the level of quality control effort that should be incorporated into any site specific sampling plan. DQIs are summarized in **Table 2** of the QAPP.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

Preventive Maintenance

Field Instrument Preventive Maintenance

Field instruments will be checked and calibrated daily before use. Calibration checks will be documented in the field log book. Critical spare parts such as tape, batteries, etc., will be kept on-site during field activities to reduce potential downtime. Backup instruments and equipment will be available on-site or within overnight shipment to minimize delays in the field schedule.

Laboratory Instrument Preventive Maintenance

All laboratory instruments shall be maintained in accordance with manufacturer's specifications. The contract laboratory must have a program and schedule for preventive maintenance of major equipment to minimize downtime. A list and supply of critical spare parts and consumable materials shall be maintained to prevent disruptions in sample processing. Designated, experienced laboratory employees must regularly perform routine scheduled maintenance and repair of all instruments. All maintenance that is performed must be documented in the laboratory's operating records.

B.7 Instrument/Equipment Calibration Frequency

All field instrumentation should be used as it is intended. Improper usage of any field instrumentation may result in improper or invalid data collection and may also result in possible personal injury. Always consult the user manual to determine the intended use of the instrument.

Calibration Procedures and Frequency

This section briefly describes the calibration procedures and frequency at which these procedures will be performed for both field and laboratory instruments. The user is directed to the manufacturer's manual for a more detailed discussion on the calibration procedures for each instrument used.

Field Instrument Calibration

All field instrumentation shall be calibrated or verified under controlled conditions prior to field use utilizing manufacturer's recommended operating procedures. Daily performance checks shall be conducted prior to the start of each sampling day. Instrument calibration must be recorded in a field-sampling logbook or on a field instrument calibration sheet.

Laboratory Instrument Calibration

Calibration procedures for specific laboratory instruments will consist of initial calibrations (calibration points vary by method), initial calibration verifications, and continuing calibration verifications. SOPs must be established within the laboratory for all analytical and administrative procedures. The SOP, as well as the applicable methods themselves, for each analysis performed in the laboratory will describe the calibration procedures, their frequency, acceptance criteria, and the conditions that will require recalibration. In all cases, the initial calibration will be verified using an independently traceable calibration verification solution.

The laboratory must maintain a sample logbook or electronic logbook for each instrument and

analysis that will contain the following minimum information:

- Instrument identification
- Analyst
- Calibration solutions run and results
- The samples associated with each calibration

B.8 Inspection/Acceptance of Supplies & Consumables

The quality of supplies and consumables used during sample collection and laboratory analysis can affect the quality of the project data. All equipment that comes into contact with the samples and extracts must be sufficiently clean to prevent detectable contamination and quality control procedures.

During sample collection, solvents of appropriate, documented purity will be used for decontamination. Solvent containers will be dated and initialed when they are opened. The quality of laboratory water used for decontamination will be documented at the laboratory. All containers will be provided by the laboratory. All containers will be visually inspected prior to use, and any suspect containers will be discarded.

Reagents of appropriate purity and suitably cleaned laboratory equipment will also be used for all stages of laboratory analysis. Details for acceptance requirements for supplies and consumables at the laboratories are provided in the laboratory SOPs and QA plans. All supplies will be obtained from reputable suppliers with appropriate documentation or certification. Supplies will be inspected to confirm that they meet use requirements, and certification records will be retained by the laboratory.

B.9 Data Acquisition Requirements for Non-Direct Measurements

Existing data from the previous investigations may used for any decision-making.

B.10 Data Management

Data for this project will be generated in the field and in the laboratory. The final repository for sample information for the sample collection efforts described in the WP will be Microsoft Excel data tables. Final data summary tables will be created using Microsoft Excel.

Sample Documentation

All sample documents will be legibly written in ink. Any corrections or revisions to sample documentation shall be made by lining through the original entry and initialing any changes. To reiterate these requirements, the following sub-sections are provided to outline sample documentation procedures which will be employed when conducting this investigation.

Field Data

Data that are generated during sample collection and sample preparation will be manually entered into the field logbooks and chains-of-custody. These data include location coordinates, location names, sampling dates, sample identification codes, and additional sampling information (i.e., water depth, sample type, etc.). All entries will be reviewed for accuracy and completeness by a second individual, and any errors will be corrected before the data are approved for release to data users.

Field Logbook

The field logbook is a descriptive notebook detailing site activities and observations so that an accurate and factual account of field procedures may be reconstructed. All entries will

be signed by individuals who are making them. All field logbook entries will document the following specifics:

- Site name
- Names of personnel on site
- Dates and times of all entries
- Descriptions of all site activities, including site entry and exit times
- Noteworthy events and discussions
- Weather conditions
- Site observations
- Identification and description of samples and locations
- Dates and times of sample collections and chain of custody information
- Records of photographs
- Site sketches
- All relevant and appropriate information delineated in field data sheets and sample labels

Laboratory Data

A variety of manually entered and electronic instrument data are generated at the laboratories. Data are manually entered into:

- Standard logbooks
- Storage temperature logs
- Balance calibration logs
- Instrument logs
- Sample preparation and analysis worksheets
- Maintenance logs
- Individual laboratory notebooks
- Results tables for conventional analyses (i.e., total solids)

All data collected from each laboratory instrument, either manually or electronically, are reviewed and confirmed by analysis before reporting.

Archival Procedures

The permanent file will be the central repository for all documents, which constitute evidence relevant to sampling and analysis activities as described in the QAPP. AECOM is the custodian of the permanent files and maintains the contents of the files for the investigation, including all relevant records, report, logs, field notebooks, pictures, subcontractor reports, and data reviews in a secured, limited-access area. Records, files, reports, log books, etc. which are complete and considered final will be either scanned onto CD or simply placed in file boxes and sent to Iron Mountain for long term storage. All boxes will be labeled with retraceable information pertaining to contents of file box, date of archival, and date of destruction. Permanent files will be maintained in secure archival storage for a minimum period of five years.

SECTION C – ASSESSMENT AND OVERSIGHT

C.1 Assessments and Response Actions

Performance and Systems Audits

Performance audits are usually conducted after data production systems are operational and are generating data. Performance audits consist of two types: internal and external. Internal performance audit check samples will be submitted to the laboratories and will consist of equipment blanks and field duplicates as described in Section B.5 and Table 5. Analytical results from these internal performance check samples will be used throughout the project to assess data from environmental samples for accuracy and precision.

External audit performance audit check samples are submitted by external regulatory agencies to assess whether a contractor's laboratory is generating data within acceptable control limits. Brooks Applied Labs Laboratory has recently undergone regulatory agency audits for continued NELAC certification. Additional external audits are not expected to be performed unless unfavorable data trends or notification of loss of certification warrants additional audits.

Corrective Action

Corrective action is the process of identifying and implementing measures to counter unacceptable procedures or out of control performance that impact data quality. Corrective action can occur during field activities, laboratory analysis, data validation, and data assessment. All corrective action proposed and implemented must be documented in the QA Reports to Management. Corrective action would only be implemented after approval by the PM, or his designee. If immediate corrective action is required, approvals secured by telephone from the PM would be documented in an additional memorandum.

For nonconformance problems, a formal corrective action plan will be developed and implemented at the time the problem is identified. The person who identifies the problem is responsible for notifying the PM. Any nonconformance with the established procedures in the QAPP or work plan will be identified and corrected in accordance with the QAPP. The PM, or his designee, will issue a nonconformance report for each of the nonconforming conditions. If at all possible, the error should be corrected. If the error cannot be corrected, the laboratory must include the reasons why the error cannot be corrected in the case narrative. Corrective measures are deemed adequate when they prevent recurrence of the problem.

Field Corrective Action

Corrective action in the field may be required when the sample network is changed (e.g., more/less samples, sampling location other than those specified in the description of work or if sampling procedures and/or field analytical procedures require modification due to unexpected conditions). The field staff, in consultation with the Field Team Leader, will recommend corrective action. The PM will approve the corrective measures that will be implemented by the field team. It will be the responsibility of the PM to ensure that the corrective action has been implemented and was effective in resolving the problem.

If the corrective action will supplement the description of work submitted to the client (i.e., additional surface water sample locations) using existing and approved procedures in the QAPP, corrective action approved by the PM will be documented. If corrective action results in fewer samples (or analytical fractions), alternate locations, etc., that may prevent project QA objectives from being achieved, it will be necessary that all levels of project management concur with the proposed action.

Corrective action resulting from internal field audits will be implemented immediately if data may be adversely affected due to unapproved or improper use of approved procedures. The PM will

identify deficiencies requiring action. The Field Team Leader and field staff will then implement the corrective actions. Corrective action will be documented in QA Reports to the entire project team.

Field corrective action is initiated and conducted by any individual performing or supervising field activities. Ultimately, the field supervisor must inform the PM (verbally or in a written report) of the problems encountered and the measures taken, if any, to solve them. The PM documents the details and files the report(s) in the project files.

The PM is responsible for periodic follow-ups to ensure that corrective measures are complete and effective. The PM shall report on issue-closure and recurring problems or trends in the annual reports to management.

Laboratory Corrective Action

Corrective action in the laboratory may occur prior to, during, and after initial analysis. A number of conditions such as broken sample containers, multiple phases, low/high pH readings, and potentially high concentration samples may be identified during sample log-in or just prior to analysis. Following consultation with laboratory analysts and section leaders, it may be necessary for the Laboratory Project or Quality Manager to approve the implementation of certain types of corrective action. The following conditions during or after analysis may automatically trigger corrective action: dilution of samples, additional sample extract cleanup, automatic reinjection/reanalysis when certain QC criteria are not met, etc. The bench chemist will identify the need for corrective action. If the nonconformance prevents the achievement of project objectives, it will be necessary to inform the Laboratory PM of the need for corrective action as per the laboratory QA Manual.

Corrective actions are performed prior to release of the data from the laboratory. If corrective action does not rectify the situation, the laboratory will contact the Laboratory PM. Depending upon the severity of the situation, the Laboratory PM may contact the AECOM PM for instructions or the laboratory will narrate the situation within the data package case narrative.

A standard operating procedure shall be established to provide for the initiation, documentation and ultimate closure of corrective action issues within the laboratory. The procedure shall include the following.

- Predetermined limits for QC data acceptability, beyond which corrective action is initiated
- A procedure for implementation and documentation of corrective action
- Identification of the staff members responsible for initiating corrective action and also the individual responsible for approving the corrective action

Corrective Action During Data Review and Data Assessment

The need for corrective action may be identified during data review or data assessment. Potential types of corrective action may include resampling by the field team or re-injection/reanalysis of samples by the laboratory.

These actions are dependent upon the ability to mobilize the field team, and whether the data to be collected are necessary to meet the required QA objectives (e.g., the holding time for samples is not exceeded). If the data reviewer identifies a situation requiring corrective action, it is the AECOM PM who will be responsible for approval and implementation of corrective action, including resampling, during data assessment.

Assessment Procedures for Data Usability

Data review procedures will be performed on the laboratory data to assess accuracy, precision, representativeness, completeness, comparability (method compliance) and sensitivity of the

aqueous and fish tissue sample data to determine if it is adequate for its intended use.

Once review procedures are complete, the PM shall conduct a final data assessment to determine if the QA objectives have been satisfied and if the data is usable for decision-making purposes (e.g. characterization and risk assessment).

Determination of Data Usability

The level of data assessment will be determined by the PM. The DQOs specified in the work plan will be used as criteria for determining the usability of the data. All data from the sampling events will be assessed using the criteria set forth in USEPA Methodologies, as they apply to the analyses used.

Final Data Assessment and Reporting

The field and laboratory data collected during this investigation will be used to achieve the project objectives. The QC results associated with each analytical parameter for each matrix will be compared to the QC limits. Only data generated in association with QC results meeting these objectives will be considered useable for decision-making purposes. In addition, the data obtained will be both qualitatively and quantitatively assessed on a project-wide, matrix-specific, parameter-specific, and unit-specific basis. The PM and the QAO will perform this assessment. The results will be presented and discussed in monthly status reports as well as in the final report.

SECTION D – DATA REVIEW AND USABILITY

D.1 Data Review, Verification, and Validation

Data Reduction, Review and Reporting

All data generated through field activities or by the laboratory operation will be reduced and reviewed prior to reporting. The laboratory will not disseminate data until it has been subjected to these procedures, which are summarized in the subsections below.

Data Reduction

Field Data Reduction Procedures

All field data will be written into field logbooks and log sheets immediately after measurements are taken. If errors are made, results will be legibly crossed out, initialed and dated by the field member, and corrected in a space adjacent to the original (erroneous) entry.

Laboratory Data Reduction Procedures

All raw analytical data will be recorded in numerically identified laboratory notebooks or within electronic media. Data are recorded in the notebook or electronic media along with other pertinent information, such as the laboratory sample identification number. Other details will also be recorded, such as the analytical methods used, name of analyst, the date of analysis, matrix of sample, sample dilution factors, sample results, and the raw data. Each page of the notebook shall be signed and dated by the analyst. Copies of any strip chart printouts (such as GC) will be maintained on file. All notebooks are peer-reviewed to ensure that all required documentation is complete.

For most analyses, data reduction involves the comparison of samples to a standard reference curve. Samples (or extracts) must be analyzed within the concentration range of the calibration curve. By diluting the sample to bring that constituent of highest concentration within the concentration range of the curve, the other analytes may be diluted out of the concentration range. Typically, these data are reported as "not detected" at an elevated reporting limit. All analytes must be reported from the lowest secondary dilution(s) possible in order to achieve the lowest reporting limits possible. This may require the laboratory to prepare, analyze, and report the results from more than one dilution. Non-detected values above the undiluted reporting limit of the analytical method are unacceptable unless due to matrix interference. Detected concentrations between the RLs and MDLs will be reported as estimated (i.e., "J" concentrations).

Results are calculated from the raw data using the formula given in the. Analytical results for fish tissue samples will be calculated and reported on a dry weight basis with the percent solids measurement.

QC data (e.g., LCS and MS/MSDs) will be compared to the acceptance criteria. Data summaries will be peer reviewed. Unacceptable data will be appropriately qualified in the project report. Case narratives will be prepared which will include information concerning data that fall outside acceptance limits, and any other anomalous conditions encountered during sample analysis. The report is compiled for the laboratory PM's signature prior to submittal to the consultant.

Data Review

The DQOs specified in Section A.6 of this QAPP will be used as criteria for determining the usability of the data. All data from the sampling events will be assessed using EPA methodologies and qualified using the assessment criteria set forth in the documents described in **Section C.1**.

The data reviewer must identify his/her organizational affiliation in the data review report. **Section A.6** describes the data quality indicators that will be assessed to determine data quality. Data review procedures will be performed on the laboratory data to assess precision, accuracy, representativeness, completeness, and comparability (method compliance) of the aqueous and fish

tissue data to determine if it is adequate for its intended use.

Data Reporting

Data reporting procedures will be carried out for field and laboratory operations as indicated below.

Field Data Reporting

Field data reporting shall be conducted principally through the transmission of report sheets containing tabulated results of all measurements made in the field, and documentation of all field calibration activities.

Laboratory Data Reporting

The required data report deliverables or "back-up" documentation will depend on the level of data assessment that is necessary to assure the data fitness for decision-making.

All data generated should undergo a data review.

A review should be conducted on all data generated in support of the development of the site-specific water concentration-based $AWQC_{THg}$. These analyses require full QA/QC support and documentation in accordance with USEPA-approved protocols. Analytical laboratory data deliverables is required and will allow for thorough data validation procedures to be followed.

A "Level II" laboratory data package should include at a minimum: brief case narrative or cover letter, sample results summary, QA sample summary, work order receipt report, and chain of custody. The Level II laboratory reports should be submitted electronically. CLP-equivalent laboratory reports will include the following, at a minimum:

For all data:

- A descriptive case narrative identifying any problems encountered during sample receipt, log-in, preparation, and analysis of the samples
- Completed and legible chain-of-custody records for all samples contained within each data package
- A sample chronicle indicating which analyses were requested and performed for the samples contained in the data package
- A summary of the laboratory sample identifications and the correlating field sample identifications, and
- Analytical summary reports for each sample with results, complete sample identifications, the sample dilutions (if necessary), and the individual sample preparation and analysis dates.

The following specific information will be reported for inorganic constituents:

- Analytical results
- MS/MSD results
- Laboratory control sample summary
- Method blank summaries

D.2 Verification and Validation Methods

Field data will be verified during preparation of samples and COCs. Field data and COCs will be reviewed by the PM during field activities.

Procedures for verification and review of laboratory data and field QC samples will be completed as described in **Section C**.

Data will be assessed using the criteria specified in each respective method. Qualifiers will be applied using the requirements specified in the SOPs. All criteria specified in the methods supersede criteria specified in the SOPs.

D.3 Reconciliation with User Requirements

The goal of data review is to determine the quality of each data point and to identify data points that do not meet the project DQOs. Non-conforming data may be qualified as estimated or rejected as unusable during data review if criteria for data quality are not met. Rejected data will not be used for any purpose. An explanation for the rejection of data will be included in any data review reports.

Data qualified as estimated will be used to evaluate the site and will be appropriately qualified in the final database. These data are less precise or less accurate than unqualified data. The data users, in cooperation with the PM and QA Officer, are responsible for assessing the effort of the inaccuracy or imprecision of the qualified data on statistical procedures and other data uses for this study.

Final decisions on data will be assessed by the PM. The PM will determine if data are considered valid and usable or require either re-sampling of data points or additional investigations to further support qualified data. At that time, the PM may request either additional QA/QC measures to reduce potential qualified data or request that certain QA/QC measures be re-evaluated to assess impact on data.

TABLES

Table 1 - Analytical and Extraction Methods, Preservation Requirements, and Extraction and Sampling Holding Times

Surface Water

Requested Analysis	Analytical Method	Extraction Method	Preservation Requirements	Sample Bottles	Extraction Holding Time	Sampling Holding Time
Total Mercury	USEPA 1631	USEPA 1631	Cool to <6°C	2 - 250mL plastic bottles	28 days	90 days
Dissolved Methylmercury	USEPA 1630 Modified	USEPA 1630 Modified	Cool to <6°C	2 - 250mL plastic bottles	48 hrs	180 days

Fish Tissue

Total Mercury	USEPA 1631E	USEPA 1631E	Frozen	Plastic bag	28 days	90 days
Percent Solids	SM2540G	None	None	Plastic bag	None	7 days

Table 2 - Data Quality Indicator Criteria

DQI	Measurement	Matrix	Method	Criteria	Corrective Action
Accuracy	Matrix spike/matrix spike duplicate recoveries	Surface Water	USEPA 1630	65% - 135%	RE-analyze MS/MSD
			USEPA 1631	71% - 125%	
		Fish Tissue	USEPA 1631E	70% - 130%	
	Laboratory Control Sample/Laboratory Control Sample Duplicate recoveries	Surface Water	USEPA 1630	67% - 133%	Re-extract and re-analyze LCS/LCSD
			USEPA 1631	85% - 115%	
		Fish Tissue	USEPA 1631E	75% - 125%	
	Method/Preparation Blanks	Surface Water	USEPA 1630	< RL	Re-extract and re-analyze method/preparation blank
			USEPA 1631	< RL	
		Fish Tissue	USEPA 1631E	< RL	
Completeness	Field Data Completeness	Surface Water	USEPA 1630/ USEPA 1631	100%	Assess data usability and potential data gap issue
		Fish Tissue	USEPA 1631E	100%	
Sensitivity	Method/Preparation Blanks	Surface Water	USEPA 1630/ USEPA 1631	< RL	Re-extract and re-analyze method/preparation blank
		Fish Tissue	USEPA 1631E	< RL	
Representativeness	Field Duplicate	Surface Water	USEPA 1630/ USEPA 1631	Both results >5x RL - 30% RPD	Assess if outliers are from field collection techniques or matrix heterogeneity
				One or both results <5x RL, Absolute difference <1x RL	
Comparability	Based on Analytical Methods and QAPP/FSP	Surface Water	USEPA 1630/ USEPA 1631	Comparison between historical data for qualitative integrity of the data. Comparison between spatially similar samples	Assess potential data usability issue
		Fish Tissue	USEPA 1631E		

Table 2 - Data Quality Indicator Criteria

DQI	Measurement	Matrix	Method	Criteria	Corrective Action
Precision	Field Duplicate	Surface Water	USEPA 1630/ USEPA 1631	Both results >5x RL; RPD 30%	Assess if outliers are from field collection techniques or matrix heterogeneity
				One or both results <5x RL, Absolute difference <1x RL	
	Matrix Spike/Matrix Spike Duplicate %RPDs	Surface Water	USEPA 1630	35%	RE-analyze MS/MSD
			USEPA 1631	24%	
		Fish Tissue	USEPA 1631E	30%	
	Laboratory Control Sample/Laboratory Control Sample Duplicate %RPD	Surface Water	USEPA 1630	35%	Re-extract and re-analyze LCS/LCSD
			USEPA 1631	24%	
		Fish Tissue	USEPA 1631E	30%	
	Laboratory Replicate	Surface Water	USEPA 1630/ USEPA 1631	Both results >5x RL; RPD 30%	Assess if outliers are from laboratory extraction/analytical techniques or matrix heterogeneity
				One or both results <5x RL, Absolute difference <1x RL	
		Fish Tissue	USEPA 1631E	Both results >5x RL; RPD 50%	
				One or both results <5x RL, Absolute difference <2x RL	
			SM2540G	RPD - 15%	

Table 3 - Surface Water Analytes, Laboratory Reporting Limits and Method Detection Limits

Analyte	CAS No.	Analytical Method	Laboratory Reporting Limit (ng/L)	Laboratory Method Detection Limit (ng/L)
Total Mercury	7439-97-6	USEPA 1631	0.4	0.15
Dissolved methylmercury	22967-92-6	USEPA 1630	0.05	0.02

Notes

Reporting Limits (RLs) and method detection limits (MDLs) from Brooks Applied Labs

Table 4 - Fish Tissue Analytes, Laboratory Reporting Limits and Method Detection Limits

Analyte	CAS No.	Analytical Method	Laboratory Reporting Limit (ng/g)	Laboratory Method Detection Limit (ng/g)
Total Mercury	7439-97-6	USEPA 1631E	0.40	0.12
Percent Solids	NA	SM2540G	0.10	0.10

Notes

Reporting Limits (RLs) and method detection limits (MDLs) from Brooks Applied Labs

Table 5 - Number and Frequency of Field Samples and Field Quality Control Samples

Analysis	Matrix	Number of Field Samples	Number of Field Duplicates	Number of Matrix Spike/Matrix Spike Duplicates	Number of Equipmment Blanks[1]
Total Mercury	Surface Water	48	5% (1:20)	5% (1:20)	12
Dissolved Methylmercury	Surface Water	48	5% (1:20)	5% (1:20)	12
Total Mercury	Fish Tissue	18	Not collected	5% (1:20)	Not collected
Percent Solids	Fish Tissue	18	Not collected	Not collected	Not collected

[1] - If dedicated or disposible equipment are used, then the equipment blank is not required

APPENDIX A

STANDARD OPERATING PROTOCOL SW-01: Guidelines for Sampling Ambient Surface Water Using a Diaphragm Pump

STANDARD OPERATING PROCEDURE SW-02: Stream Velocity and Discharge Measurements

STANDARD OPERATING PROCEDURE FT-01: Biological Sampling Guidelines for Fish Tissue Analysis

Standard Operating Protocol SW-01:
Guidelines for Sampling Ambient Surface Water Using a Diaphragm Pump

This method is for the collection and field filtration of ambient surface and subsurface water samples for subsequent determination of total mercury (THg), filtered total mercury (FTHg), methylmercury (MeHg) and filtered methylmercury (FMeHg) at ultra-trace concentrations (THg and FTHg @ > 0.2 nanograms per liter (ng/L), MeHg and FMeHg @ > 0.02 ng/L) using EPA Methods 1631 (THg and FTHg) and EPA Method 1630 (MeHg and FMeHg).

The method is applicable to lakes, streams, estuaries, and the ocean; however, it is not intended for sampling effluents at industrial facilities or for sampling very small streams and seepages where the flow rate is likely to be less that the nominal flow rate of the diaphragm pump (3 gpm). This method will be used whether sampling by wading or from bridges. The method is based on general guidance and principles outlined in EPA Method 1669 *Sampling Ambient Water for Determination of Metals at EPA Water Quality Criteria Levels* (July 1996). It is a "performance validated" alternative to Method 1669, as allowed and encouraged by EPA Method 1669, that has been demonstrated to preclude contamination of samples and blanks as required by the original method.

Equipment

The following equipment/supplies may be used to collect surface water samples:

- ☐ Diaphragm pump – Shurflo Model 2088-433-344 (or similar), 12 volt (V) DC, 3.3 gallons per minute (gpm) flow
- ☐ Submersible pump - Forestry Suppliers 12V DC Battery-Operated Purge Pumps
- ☐ Tubing – Cole Parmer, C-flex, 3/8" ID x 5/8"OD, Cat# 06424-79
- ☐ Hydro weight – Coated iron (not lead) downrigger weight [5, 10, or 15 pound (lbs)]
- ☐ In-line capsule filter; high capacity, with barb fitting (0.45 μm pore size)
- ☐ Battery or power pack: 12 V deep cycle battery or portable power pack (e.g., Xantrex Xpower 300)
- ☐ Sample bottles – 250 milliliter (mL) borosilicate glass, IChem Series 300 or equivalent lab specified bottle type
- ☐ Hydrochloric acid – high purity, pretested for mercury content, used to field preserve water samples (for mercury and methylmercury analysis).
    - Note: Although field preservation of mercury samples is acceptable, it is preferable to ship samples immediately after collection so that they can be acidified by the laboratory within 48 hours of collection. Parker and Bloom (2005) provide detailed and current supporting scientific background for these recommendations regarding preservation and storage of water samples for mercury analysis.

- ☐ Reagent water – water in which mercury and potentially inferring substances are not detected at the minimum detectable level (MDL) of the analytical method used for analysis of samples *or* are detected at concentration no greater than three times the MDL (e.g., typical MDL for total mercury by EPA Method 1631 is 0.20 ng/L, thus the allowable total mercury in reagent water should be < 0.6 ng/L).
- ☐ Powder-free Nitrile gloves
- ☐ Pencils and waterproof/permanent marking pens
- ☐ Sampling location maps
- ☐ Global Positioning System (GPS) unit
- ☐ Camera
- ☐ Appropriate health and safety equipment
- ☐ Ziploc bags or similar dry storage materials
- ☐ Cooler
- ☐ Ice
- ☐ Paper towels
- ☐ Field notebook/field data sheets
- ☐ Chain-of-custody (COC) forms
- ☐ Custody seals

Decontamination Procedures

The following is a list of equipment/supplies and procedures needed to perform decontamination:

- ☐ C-Flex Tubing
  When employed as described in this method, this product has demonstrated repeatedly to be acceptably clean from the manufacturer's packaging without laboratory precleaning and may be used within the same waterbody to collect samples from multiple locations without risk of cross-contamination. As a precaution, sampling should always proceed from the cleanest locations to the most contaminated.
- ☐ Diaphragm and Submersible Pump
  Reagent water should be flushed through the pump at the end of each sampling day and the pump drained of any water that is not expelled by operation. No other cleaning is needed. The pump should be stored in a clean polyethylene bag or dedicated cooler.

The use of any chemicals, to clean pump, tubing, or filters in the field is generally discouraged because such treatment may change the properties of the materials of which these items are constructed. In addition, inefficient flushing of such chemicals may cause sample contamination. If suspicion exists that any of these items may have been contaminated with mercury or with substances that might interfere with unbiased sampling and analysis for mercury, the item(s) should be discarded or transferred to a qualified laboratory for cleaning and testing.

Contamination and Interference

Avoidance of sample and apparatus contamination is of paramount importance for this method. The most important factors in avoiding/reducing sample contamination are 1) an awareness of potential sources of contamination and 2) strict attention to work being performed. The following procedures should be followed to prevent contamination and interference:

- The continuous pumping apparatus (pump, tubing, hydro weight) should only be removed from its clean container (cooler or plastic bag) just prior to sampling. When not being used, the system should be stored in a clean plastic bag or a dedicated cooler.
- Sampling personnel must wear clean, nonpowdered gloves during all operations involving handling of the apparatus and sample bottles. Gloves should be changed if there is any suspicion that the gloves have contacted surfaces that could be contaminated.
- The specific items comprising the apparatus have been demonstrated to effectively avoid contamination when deployed and operated as described in this method. Do not substitute items or change procedures without first demonstrating that the substitution or procedural change maintains sample integrity.
- Adhere strictly to the rules provided in subsequent sections with regard to flushing rates and times to avoid contamination carryover. Whenever possible, conduct sampling sequentially from sites of lower to higher known or expected contamination.
- Do not use the apparatus to sample effluents known or suspected to contain elevated mercury concentrations. This method is intended only for ambient samples of lakes, rivers, estuaries, and the ocean.

Surface Water Sample Collection, Filtration, and Handling

The setup of equipment for surface water sample collection is shown in Photographs 1 and 2. The following procedures will be used to collect surface water samples from wading or by boat:

- Select surface water sampling locations in accordance with study objectives.
- Sampling sites should exhibit a high degree of cross-sectional homogeneity. Because mixing is principally governed by turbulence and water velocity, the selection of a site immediately downstream of a riffle area will ensure good vertical mixing. Horizontal mixing occurs in constrictions in the channel.
- Look for and avoid flow eddies that often occur near banks and in-stream obstructions.
- Avoid sample locations very near heavily traveled roads, bridges, and overhead utilities. If these features cannot be avoided, then sample upstream and sample during periods when these features are least likely to introduce contamination into the river.
- Plan sampling activity to collect samples known or suspected to contain the lowest concentrations of mercury first, finishing with samples known or suspected to contain the highest concentrations.
- Follow “Clean hands – Dirty hands” sampling techniques below using a diaphragm pump with the intake tube resting on the bottom of the water body.

“Clean hands – Dirty hands” Sampling Technique

Upon arrival at the sampling site, one member of the two-person sampling team is designated as "dirty hands;" the second member is designated as "clean hands." All operations involving contact with the sample bottle and the transfer of the sample from the sample pumping system to the sample bottle are handled by the individual designated as "clean hands." "Dirty hands" is responsible for preparation of the sample pumping system, operation of the pump, and all other activities that do not involve direct contact with the sample or sample container.

- "Dirty hands" deploys the weighted sample line into a water mass not affected by the presence of the samplers.
- "Dirty hands" activates the pump and times pump running time prior to indicating to "clean hands" that sampling for unfiltered analytes can begin.
- "Clean hands" opens sample bottle and rinses it twice with sample water prior to filling and recapping. If additional unfiltered samples are to be collected, the same procedure is followed for additional bottles.
- "Dirty hands" pinches the sample line on the suction side and installs a capsule filter on the discharge line. Then "dirty hands" flushes several liters of sample water through the filter at a flow rate held low enough (by pinching the suction line) to avoid excessive back pressure in the filter.
- "Clean hands" opens sample bottle and rinses it twice with sample water prior to filling and recapping. If additional filtered samples are to be collected, the same procedure is followed for additional bottles.
- "Dirty hands" secures the pumping system by returning the weighted sample line and pump to a dedicated plastic bag or clean cooler.
- "Clean hands" rebags the water samples and places them on ice in a cooler.

In general, water samples are not field-preserved other than by chilling and maintaining in the dark due to the increased risk of contamination. *However, when there is uncertainty about the elapsed time for arrival at an analytical laboratory and methylmercury is to be requested, samples should be field-preserved with hydrochloric acid as specified in EPA Method 1630.*

Field Quality Assurance/Quality Control

Field quality assurance/quality control (QA/QC) samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling. Strict adherence to the procedures described above in the section titled "Contamination and Interference" will assure collection of uncompromised sediment samples.

Field/Equipment Blanks

It is necessary to collect equipment blank samples each day that sampling occurs or whenever the pump or tubing is changed to demonstrate that contamination has been controlled.

Duplicate Sample

Frequency of duplicates is identified in the work plan. Additional field duplicates may be collected if conditions suggest the need for more or more are specified in the work plan.

Matrix Spikes and Matrix Spike Duplicates

Separate samples for matrix spikes (MS) and matrix spike duplicates (MSD) do not have to be collected unless the laboratory requests because these analyses can be run by most laboratories using an actual sample.

Method Performance (QA/QC)

Recent results for field blanks and equipment blanks for mercury and methylmercury are summarized in Table 1. Because most laboratories that are qualified to run EPA Method 1631 can detect total mercury above the typical MDL (0.2 ng/L) even in the highest quality water that can be prepared, it is always necessary to request analysis of the water used to prepare equipment blanks. Methylmercury should not be detected in either field blanks or equipment blanks, and total mercury and methylmercury in blanks should not exceed two times the MDL.

Table 1
Results for Field and Equipment Blanks Prepared Following EPA Method 1631

		Field Blank (Source Water)		Pump+Tubing Blank		Pump+Tubing+Filter Blank	
Date	Site	Total Hg	Methyl Hg	Total Hg	Methyl Hg	Total Hg	Methyl Hg
Sep 04	ME	<0.03		<0.06		<0.04	
Oct 04	ME	<0.03		<0.07		<0.03	
Jan 05	VA	0.30	<0.012			0.59	<0.012
Mar 05	VA	0.19				0.15	
Mar 05	VA	0.22				0.21	
Mar 05	VA	0.22				0.32	
Mar 05	VA	0.21				0.23	
Mar 05	VA	0.21				0.38	
Jan 05	NJ	0.09	0.003			<0.08	<0.004
Jan 05	NJ	0.06				0.06	
Aug 04	NJ	0.07				0.25	
Aug 04	NJ	0.30	<0.023			0.67	<0.003
May 04	NJ	0.42	<0.007			0.20	<0.013

Note: Units are ng/L

Sample Identification, Handling, and Chain-of-Custody

Samples will be identified, handled, and recorded as described in this sampling guideline. Each sample container has a sample label affixed to the outside. The sampler marks each label using waterproof ink with the following information:

- ☐ Project name
- ☐ Sample identification number

- ☐ Date and time of collection
- ☐ Initials of sampling technician
- ☐ Requested analysis
- ☐ Method of preservation

Sample containers will be packed in bubble wrap to minimize breakage or damage to samples and placed in plastic coolers. Paperwork will be put in a Ziploc bag and placed on top of the sample containers or taped to the inside lid of the cooler. The cooler will be taped closed and a signed custody seal will be affixed to the side of the cooler. Laboratory address labels will be placed on top of the cooler.

All samples are expected to contain low levels of contamination and will be packaged and shipped as environmental samples in accordance with applicable federal and state regulations. All shipments containing dry ice will conform to federal, state, and carrier regulations. Standard procedures to be followed for shipping environmental samples to the analytical laboratory are outlined below.

- ☐ All environmental samples collected will be transported to the laboratory by AECOM personnel, shipped through Federal Express or equivalent overnight service, or picked up by a lab courier.
- ☐ Shipments will be scheduled to meet holding time requirements.

The laboratory will be notified to be prepared to receive a shipment of samples. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed.

AECOM has established a program of sample COC that will be followed during sample handling activities in both field and laboratory operations. The primary purpose of COC procedures is to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The Task Manager or his/her designee will be responsible for monitoring compliance with COC procedures.

Tracing sample possession will be accomplished using the COC record. A COC entry will be recorded for every sample, and a COC record will accompany every sample shipment to the laboratory. At a minimum, the COC record will contain the following information for each sample:

- ☐ Sample number and identification of sampling point
- ☐ Date and time of collection
- ☐ Sample type
- ☐ Number, type, and volume of sample container(s)
- ☐ Sample preservative
- ☐ Analysis requested
- ☐ Name, address, and phone number of laboratory or laboratory contact
- ☐ Signature, dates and times of persons in possession

- ☐ Any necessary remarks or special instructions

Once the COC is complete and the samples are ready for shipment, the COC will be placed inside the shipping container, and the container will be sealed. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping.

Field Logbook and Field Data Sheet

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation will be recorded in the field logbook and/or field data sheets. Entries will include the following, as applicable:

- ☐ Project name and number
- ☐ Name of sampler and field personnel
- ☐ Date and time of sample collection
- ☐ Sample number, location, and depth
- ☐ Sampling method
- ☐ Sampling media
- ☐ Sample type
- ☐ Sample physical characteristics
- ☐ Observations at the sampling site (e.g., weather conditions)
- ☐ Summary of daily tasks and information concerning sampling changes, scheduling modifications, and change orders dictated by field conditions

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook or data sheet for a particular site. Site-specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel.

Health and Safety Procedures

To avoid incidents or injuries during sampling, the following health and safety procedures should be followed:

- ☐ Toxic or otherwise harmful concentrations of mercury and methylmercury are unlikely to be encountered while sampling ambient surface water. However, sampling crews should be trained in the hazards of mercury and how to minimize risks of exposure.
- ☐ Collecting samples in cold weather, especially around cold waterbodies, carries the risk of hypothermia, and collecting samples in extremely hot and humid weather carries the risk of dehydration and heat stroke. Sampling team members should wear adequate clothing for protection in cold weather and should carry an adequate supply of water or other liquids for protection against dehydration in hot weather.

- Sampling team members must cover exposed skin and/or use sunscreen for protection against sunburn and melanoma.
- When working on all waterbodies, sampling teams must develop and employ an emergency response plan, including the use of an onshore monitor that is accountable for the whereabouts of the team. The monitor can request aid if team fails to report in at end of workday and can provide assistance to rescuers or team under any scenario where an emergency situation exists.

References

Parker, J.L. and N.S. Bloom. 2005. "Preservation and Storage Techniques for Low-Level Aqueous Mercury Speciation." *Science of the Total Environment*, 337:253-263.

USEPA. 1996. *Method 1669-Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels*. July 1996. U.S. Environmental Protection Agency, Office of Water, Engineering and Analysis Division (4303), 401 M Street SW, Washington, DC 204460

USGS. 2006. Collection of water samples (ver. 2.0): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A4, September, accessed February 20, 2009 at http://pubs.water.usgs.gov/twri9A4/

Photographs

Photograph 1. Use of clean cooler to protect sample inlet line and hydro weight from contamination when sampling from a boat in deeper water. Round yellow object on end of C-flex tubing is plastic screen to prevent end of inlet line from touching sediment or sucking in algae or other debris. Hydro weight (yellow sphere with fin) is typically only required where current is very swift (>0.5 m/s) and is tethered a foot or more below the sample inlet.

Photograph 2. Use of the continuous pumping system to collect water samples from a shallow stream. The inlet end of the tubing (out of picture) is screened and weighted. Capsule filter is shown installed on the discharge line from the pump.

Standard Operating Procedure SW-02
Stream Velocity and Discharge Measurements

The purpose of collecting in-stream velocity measurements is to determine the discharge at each location under various stream flow conditions. The detailed procedures for measuring in-stream velocity for use in discharge calculations are provided below.

Equipment

The following equipment/supplies may be used to collect velocity measurements:

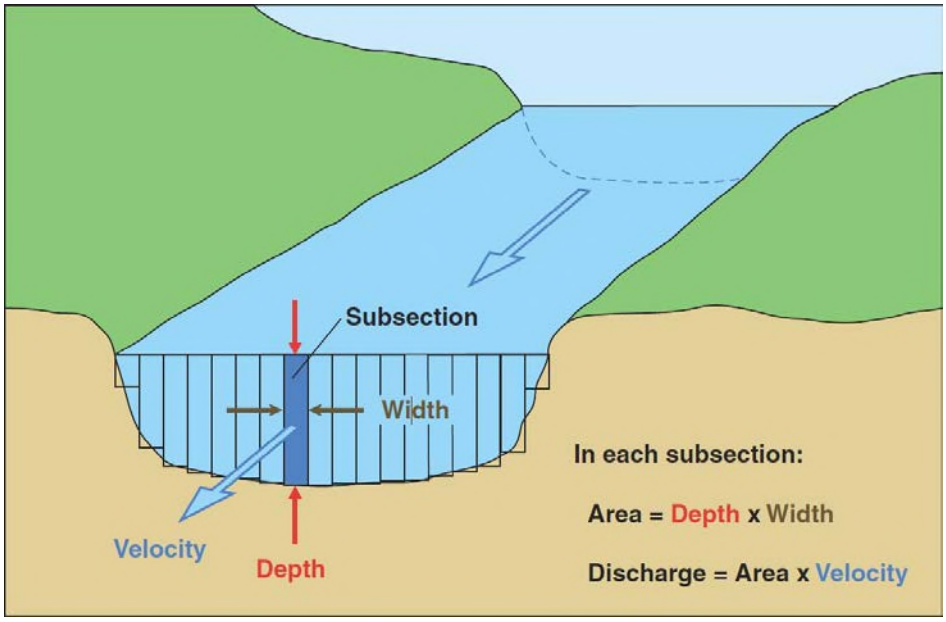
- ☐ OTT MF pro Flow Meter with a 3 meter (m) cable
- ☐ Top-setting wading rod
- ☐ Graduated tagline or survey tape
- ☐ Tent stakes or similar with mallet
- ☐ Life vests
- ☐ Field notebook/field data sheets
- ☐ Pencils and waterproof/permanent marking pens
- ☐ Stream section sampling diagram
- ☐ Camera
- ☐ Appropriate health and safety equipment (gloves, waders/hip boots, safety glasses, first aid kit, reflective vests etc.)

Velocity Measurements

General Theory

Discharge is the volume of water moving down a stream or river per unit of time, commonly expressed in cubic feet per second or gallons per day. In general, river discharge is computed by multiplying the area of water in a channel cross section by the average velocity of the water in that cross section:

$$\text{discharge} = \text{area} \times \text{velocity}$$



The stream cross section (transect) is divided into units of width (subsections) and the velocity and depth are measured at each. Discharge (area of a single subsection times the velocity measured) is calculated for each subsection. The resulting values are summed to obtain the instantaneous discharge for the stream at that transect.

Subsection width will be measured using steel or fiberglass tape. Subsection depth will be measured with the OTT MF Pro flow meter, by using a wading rod.

Based on depth measurements at each subsection the appropriate USGS protocol described below will be used to collect data.

- Water depth less than 2.5ft – Use the one point method with the sensor set at 60% of the depth below the surface.
- Water depth greater than 2.5ft- Use the two point method by collecting velocity data at 20% and 80% of the depth below the water surface.

The velocity of the streamflow is measured using a current meter. This study will use an OTT MF pro Flow Meter with a 12 meter (m) or 30 m cable. The OTT MF pro is an electromagnetic flow meter that measures water velocity and automatically calculates discharge (based on USGS and ISO methods) and graphs velocity data in real-time. The unit allows trends to be visualized quickly in the field. The electromagnetic sensor has no minimum velocity requirement, no moving parts, requires no calibration, and is not affected by organic matter in the sampling area. The sensor can be attached to either a wading rod, if in-stream sampling is possible, or a sounding weight, if it is necessary to sample from a bridge.

Transect selection: Per USGS protocol (Turnipseed and Sauer, 2010), division into 25 to 30 subsections is typically sufficient for a well-chosen transect on a larger stream. If the stream is narrow or the transect is very smooth and the velocity distribution is very consistent, it is possible to decrease the number of substations (OTT, 2012).

Stream Width		Number of substations
Feet	Meters	
< 1.6	< 0.5	5 to 6
> 1.6 and < 3.3	> 0.5 and < 1	6 to 7
> 3.3 and < 9.8	> 1 and < 3	7 to 12
> 9.8 and < 16.4	> 3 and < 5	13 to 16
> 16.4	≥ 5	≥ 22

Make the distance between the subsections so that no individual section contains more than 5% of the discharge. Subsections should not have equal widths across the entire cross-section unless the discharge is well-distributed. Distances between subsections should be smaller where water depth and flow velocities change significantly. Places where depth and velocities frequently change significantly include bank areas, vertical or steep slopes, ledges in divided cross-sections and transitions from the main stream bed to the bank edge. Subsections should also be located at points of significant changes in the profile of the stream bed.

The measurement cross-section should be set perpendicular to the flow direction. Cross-sections must not contain still areas, counter currents or eddies. Although cross-sections should not contain eddies, due to siting constraints, it may be difficult to avoid this. In the event that sampling must occur from a cross-section containing an eddy, the OTT MF Pro unit will record eddies flows correctly as negative values (if wading and using a top-set wading rod). However, if sampling from a bridge, the sounding weight will always orient into the direction of the flow and velocity measurements of eddies will be recorded incorrectly as positive values. These measurements will be noted in the field and the data will be corrected during the data analysis phase.

Although stream transects established near bridges offer limited choices, the following guidelines should be used when choosing the upstream or downstream side of the bridge. Access, traffic patterns and safety should also be considered when making this decision.

- The channel should have as much straight run as possible. If the length of the straight run is limited, the length upstream from the profile should be two times the downstream length.
- The channel should be free of flow disturbances. The site should not have contributing side-streams, outgoing side-streams or obstructions.
- The flow should not have visible swirls, eddies, vortices, back-flow or dead zones. This issue is difficult to avoid when sampling from a bridge.
- Do not select areas immediately downstream from sharp bends or obstructions.
- Do not select areas with converging or diverging flow (approaches to a flume) or vertical drops.
- Do not select areas immediately downstream from sluice gates or places where the channel spills into a body of stationary water.

Velocity Measurements via Wading

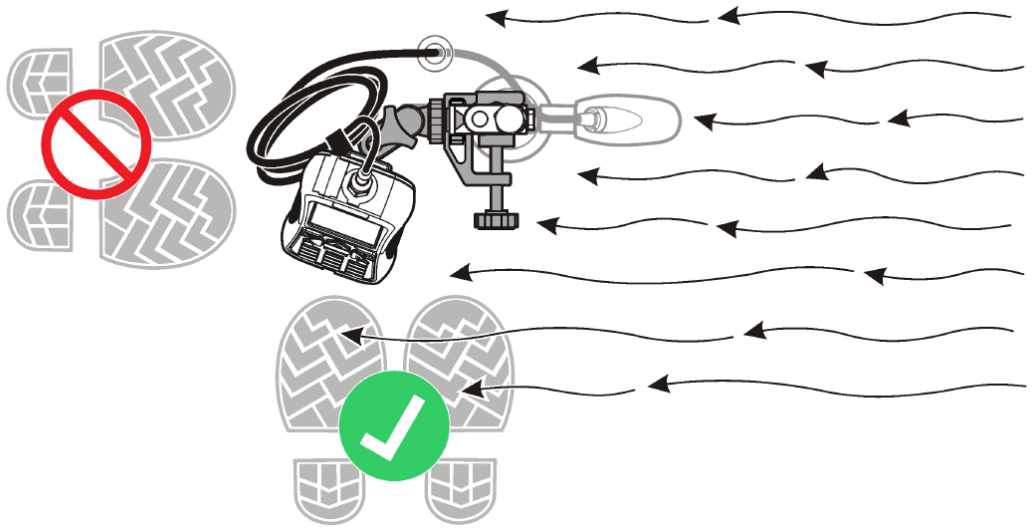
The measurement transect will be selected during the initial sampling event. The same transect will be used during wading velocity measurements over various flow conditions. Affix the graduated tagline or survey tape securely to either end of the transect using

either natural features (trees or rocks), tent stakes, or similar. Draw the line taught as close to the surface of the water as possible. Determine the appropriate number and position of subsections for the transect. The general procedure to take velocity measurements in river and stream cross-section transects is described below.

Make the first measurement in a transect at the right edge of water (REW) (facing downstream). Make each subsequent measurement moving toward the left bank.

- Note the initial stage on the staff gage
- Conduct a velocity measurement at each station across the transect. The portable meter shows and stores the depth (+/- 0.504 inches) and measured velocity (+/- 0.05 ft/s) information for each station. Velocity measurements recorded will be averaged over 10 seconds at each station.
- When the stream profile is completed, the meter automatically calculates the total discharge.
- Note the final stage on the staff gage.
- Note time and discharge for each transect to relate to in-situ water-level loggers.

For accurate measurement results, stand to the side of the instrument as in the figure below:



From OTT 2012

From Turnipnseed and Sauer 2010.

Refer to the Operation manual for the OTT MF pro Flow Meter for detailed instructions about the operation of the flowmeter and handheld unit. Calibration of the unit is not necessary unless a velocity offset has been chosen (which should not occur during the study). Please refer to the user manual (pg. 33) for instructions on clearing a velocity offset.

Field Logbook and Field Data Sheet

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation will be recorded in the field logbook and/or field data sheets. Entries will include the following, as applicable:

- Project name and number
- Name of sampler and field personnel
- Date and time of data collection
- Location
- Sampling method
- Observations at the sampling site (e.g., weather conditions)
- Summary of daily tasks and information concerning sampling changes, scheduling modifications, and change orders dictated by field conditions

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook or data sheet for a particular site. Site-

specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel.

Technical Support

The following technical support is available if problems are encountered with the instrumentation:

- Hach Hydromet Technical Support & Service
  P.O. Box 389
  Loveland, C 80539
  Tel: 800-949-3766 opt. 2
  970-669-3050 opt. 2
  Fax: 970-461-3921
  E-Mail: techsupport@hachhydromet.com

References

Buchanan, T. J., and Somers, W. P., 1969, Discharge measurements at gaging stations: U.S. Geol. Survey Techniques Water Resources Inv., book 3, chap. A8, 65 p. URL: http://pubs.usgs.gov/twri/twri3a8/html/pdf.html

OTT. 2012. Operating Instructions for the OTT MF pro Portable Velocity System. DOC026.53.80211 07/2012, Edition 3

Turnipseed, D.P., and Sauer, V.B., 2010, Discharge measurements at gaging stations: U.S. Geological Survey Techniques and Methods book 3, chap. A8, 87 p. http://pubs.usgs.gov/tm/tm3-a8/

Standard Operating Procedure FT-01: Biological Sampling Guidelines for Fish Tissue Analysis

Fish tissue sampling procedures generally follow *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories* (USEPA 2000).

Equipment

The following equipment/supplies may be used to collect fish tissue samples:

- ☐ Collection equipment, including a tote-barge electrofisher and/or backpack electrofisher
- ☐ Insulated dip nets
- ☐ Insulated rubber gloves
- ☐ Insulated chest waders/rubber boots
- ☐ Field book/field data sheets
- ☐ Global positioning system (GPS)
- ☐ Live wells/pens for holding fish
- ☐ Measuring board
- ☐ Electronic scale
- ☐ Tray for the electronic scale
- ☐ Nitrile gloves
- ☐ Sample container labels
- ☐ Cooler
- ☐ Dry ice
- ☐ Chain-of-Custody (COC) forms
- ☐ Custody seals
- ☐ Field data sheets
- ☐ Paper towels
- ☐ Aluminum foil
- ☐ Tables and chairs
- ☐ Camera
- ☐ Pencils and waterproof/permanent marking pens
- ☐ Decontamination supplies
    - Brushes
    - Wash tubs

- Buckets
- Sponges and paper towels
- Formula 409 (low mercury-content cleaner)
- DI or distilled water
- Hand-held sprayers or spray bottles
- Trash bags
- Plastic sheeting
- Appropriate personal protective equipment (PPE)

- ☐ Scientific collector's permit and field identification guides, as necessary
- ☐ Appropriate health and safety equipment

Decontamination Procedures

Before each sampling event, the measuring board and tray for weighing will be thoroughly cleaned and rinsed with DI or distilled water to prevent potential sample contamination. Following decontamination, the equipment will be wrapped in clean plastic sheeting or trash bags to prevent contact with dust and unclean surfaces.

Fish Tissue Collection Procedures

Wading will be considered if the water depth is shallow and the substrate is cohesive enough to make wading feasible. Caution will be used when conducting sampling by wading.

All collection permits will be obtained well in advance of the target sampling period to allow for flexibility in the timing of sampling.

The following procedures will be used for electrofishing:

- ☐ Electrofish areas of potential fish habitat using a tote-barge mounted or backpack electrofisher.
- ☐ Wearing insulated rubber gloves and boots and using nets with insulated handles, collect fish stunned by the electrical field.
- ☐ Place all target fish in buckets or a livewell for the duration of the sampling effort.
- ☐ If sufficient numbers of target species are present, continue to shock until the required number of individuals of target species is obtained.
- ☐ If sufficient individuals of target species cannot be collected in a reasonable period of time, document sampling efforts and sample available fish.

Sample Processing

- ☐ Identify fish to species
- ☐ Record fish total length (mm), weight (g), and morphological or histopathological anomalies on the field data sheet.

- Sampling conditions (e.g., water depth, time of sampling, general observations of the weather) should also be noted on the field data sheet.

To the extent practical, consistent sampling techniques are to be used at all sampling stations for consistency and comparability.

Field Quality Assurance/Quality Control Samples

Field quality assurance/quality control (QA/QC) samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling.

Equipment Blank Samples

An equipment rinsate sample of sampling equipment is not needed.

Duplicate Samples

Field duplicate samples will not be collected for fish tissue. A laboratory duplicate will be analyzed from the same parent sample after homogenization. Duplicates will be analyzed at a rate of 5%.

Matrix Spikes and Matrix Spike Duplicates

Matrix spikes (MS) and matrix spike duplicate (MSD) samples will be selected at the laboratory from composite samples with sufficient sample mass to perform the analyses. MS and MSD samples are prepared at the laboratory by dividing a control sample into two aliquots, then spiking each with identical concentrations of specific analytes. The spike samples are then analyzed separately, and the results are compared to evaluate the effects of the sample matrix on the analytical accuracy and precision. MS/MSD samples will be analyzed at a rate of 5%.

Sample Identification, Handling, and Chain-of-Custody

Samples will be identified, handled, and recorded as described in this sampling guideline. The sample parameters for analysis, preservation, and handling are specified in the Phase I system characterization. Each sample container has a sample label affixed to the outside. The sampler marks each label using waterproof ink with the following information:

- Project name
- Sample identification number
- Date and time of collection
- Initials of sampling technician
- Requested analysis
- Method of preservation

Sample containers will be placed into plastic coolers for protection during shipment. Dry ice will be placed around sample containers and additional cushioning material will be added to the cooler, if necessary. Paperwork (i.e., signed Chain-of-Custody forms) will be put in a Ziploc bag and placed on top of the sample containers or taped to the inside lid of the cooler. The cooler

will be taped closed and a signed custody seal will be affixed to the side of the cooler. Laboratory address labels will be placed on top of the cooler.

All samples are expected to contain low levels of contamination and will be packaged and shipped as environmental samples in accordance with applicable federal and state regulations. All shipments containing dry ice will conform to federal, state, and carrier regulations. Standard procedures to be followed for shipping environmental samples to the analytical laboratory are outlined below.

- All environmental samples collected will be transported to the laboratory by AECOM personnel, shipped through Federal Express or equivalent overnight service, or picked up by a lab courier.
- Shipments will be scheduled to meet holding time requirements.

The laboratory will be notified to be prepared to receive a shipment of samples. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed.

AECOM has established a program of sample COC that will be followed during sample handling activities in both field and laboratory operations. The primary purpose of COC procedures is to document the possession of the samples from collection through shipping, storage, and analysis to data reporting and disposal. The Task Manager or his/her designee will be responsible for monitoring compliance with COC procedures.

Tracing sample possession will be accomplished using the COC record. A COC entry will be recorded for every sample, and a COC record will accompany every sample shipment to the laboratory. At a minimum, the COC record will contain the following information for each sample:

- Sample number and identification of sampling point
- Date and time of collection
- Sample type
- Number, type, and volume of sample container(s)
- Sample preservative
- Analysis requested
- Name, address, and phone number of laboratory or laboratory contact
- Signature, dates and times of persons in possession
- Any necessary remarks or special instructions

Once the COC is complete and the samples are ready for shipment, the COC will be placed inside the shipping container, and the container will be sealed. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping.

Field Logbook and Field Data Sheet

The most important aspect of documentation is thorough, organized, and accurate record keeping. All information pertinent to the investigation will be recorded in the field logbook and/or field data sheets. Entries will include the following, as applicable:

- ☐ Project name and number
- ☐ Name of sampler and field personnel
- ☐ Date and time of sample collection
- ☐ Sample number, location, and depth
- ☐ Sampling method
- ☐ Sampling media
- ☐ Sample type
- ☐ Observations at the sampling site (e.g., weather conditions)
- ☐ Summary of daily tasks and information concerning sampling changes, scheduling modifications, and change orders dictated by field conditions

Field investigation situations vary widely. No general rules can include each type of information that must be entered in a logbook or data sheet for a particular site. Site-specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel.

Health and Safety Procedures

To avoid incidents or injuries during sampling, the following task-specific health and safety procedures should be followed:

- ☐ Toxic or otherwise harmful concentrations of metals or other constituents are unlikely to be encountered while sampling fish tissue in rivers and streams. However, sampling crews should be trained in the general hazards of field sampling (e.g., waterborne pathogens) and how to minimize risks of exposure.
- ☐ Operating in or around waterbodies carries the inherent risk of drowning. U.S. Coast Guard approved personal flotation devices must be worn when operating or sampling from a boat, when sampling in more than a few feet of water, or when sampling in swift currents.
- ☐ Collecting samples in cold weather, especially around cold waterbodies, carries the risk of hypothermia, and collecting samples in extremely hot and humid weather carries the risk of dehydration and heat stroke. Sampling team members should wear adequate clothing for protection in cold weather and should carry an adequate supply of water or other liquids for protection against dehydration in hot weather.
- ☐ Sampling team members must cover exposed skin and/or use sunscreen for protection from sun exposure.

References

USEPA. 2000. *Guidance for assessing chemical contaminant data for use in fish advisories: Volume 1 Fish sampling and analysis. Third Edition*. U.S. Environmental Protection Agency. EPA 823-B-00-007.

APPENDIX B

Comprehensive Quality Assurance Plan for Brooks Applied Labs, LLC, Revision 001, February 2016

SOP #BAL-3101-003 – BRL Procedure for EPA Method 1631, Appendix to (1/01): Total Mercury in Tissue, Sludge, Sediment, and Soil by Acid Digestion and BrCl Oxidation by Cold Vapor Atomic Fluorescence Spectrophotometry (CVAFS), Revision 003, June 2016

SOP #BAL-3100-001 – Procedure for EPA Method 1631, Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrophotometry (CVAFS), Revision 001, February 2016

SOP #BAL-3200-001 – Determination of Methyl Mercury by Aqueous Phase Ethylation, Trap Pre-Collection, Isothermal GC Separation, and CVAFS Detection: BRL Procedure for EPA Method 1630 (Aqueous Samples) and EPA Method 1630, Modified (Solid Samples), Revision 001, February 2016

SOP #BAL-0304-001 – Sample Homogenization, Revision 0016, February 2016