



COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Street address: 629 East Main Street, Richmond, Virginia 23219

Mailing address: P.O. Box 1105, Richmond, Virginia 23218

www.deq.virginia.gov

Molly Joseph Ward
Secretary of Natural Resources

David K. Paylor
Director

(804) 698-4020
1-800-592-5482

July 24, 2017

Mr. Michael Liberati
DuPont Corporate Remediation Group
Chestnut Run Plaza 715-236
Wilmington, DE 19805

VIA ELECTRONIC MAIL

**Re: Revised 2016 Short Term Monitoring Report
Former DuPont Waynesboro Plant, Area of Concern 4
Waynesboro, Virginia
EPA ID# VAD003114832**

Dear Mr. Liberati:

This letter acknowledges the receipt and review of the Revised 2016 Short Term Monitoring Report (Report), submitted to the Virginia Department of Environmental Quality, Office of Remediation Programs (Department) by AECOM on behalf of the E.I du Pont Nemours and Company (DuPont).

The Department accepts the report as complete.

If you have any additional technical questions, you may contact me at 703-583-3825 or by email at Kurt.Kochan@deq.virginia.gov.

Sincerely,

A handwritten signature in cursive script, appearing to read "Kurt W. Kochan".

Kurt W. Kochan
Corrective Action Project Manager
Office of Remediation Programs

cc: DuPont Waynesboro Correspondence File
Brett Fisher, Calvin Jordan, VDEQ-CO
Ceil Mancini, Josh Collins, AECOM

2016 Short-Term Monitoring Report

Former DuPont Waynesboro Site, Area of Concern 4
Waynesboro, Virginia

Submitted on behalf of:
E.I. du Pont de Nemours and Company

Submitted by:
AECOM
625 West Ridge Pike
Suite E-100
Conshohocken, PA 19428

Project Number: 60394083
Date: March 2017; Revised June 2017

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Acronym List

Acronym	Explanation
μm	Micrometer
μg/kg	Micrograms per kilogram
ADQM	Analytical Data Quality Management
AOC	Area of Concern
BMA	Bank Management Area
°C	Degrees Celsius
COC	Chain-of-Custody
CRG	Corporate Remediation Group
cm	Centimeter
DuPont	E.I. du Pont de Nemours and Company
DVM	Data Verification Module
dw	Dry weight
EDD	Electronic Data Deliverable
EIM	Environmental Information Management (Locus Technologies)
EPA	U.S. Environmental Protection Agency
EPW	Evaluation of Planned Wetlands
Hg	Mercury
IHg	Inorganic mercury
IRM	Interim Remedial Measure
LiDAR	Light detection and ranging
LTM	Long-term Monitoring
LWD	Large woody debris
MeHg	Methylmercury
mg/kg	Milligrams per kilogram
ng/L	Nanograms per liter
NRDC	Natural Resources Defense Council
ORP	Oxidation-Reduction Potential
QA/QC	Quality Assurance/ Quality Control
RBP	Rapid Bioassessment Protocols
RCRA	Resource Conservation and Recovery Act
RRM	Relative river mile
SC	Specific conductivity
SOP	Standard operating procedure
SRST	South River Science Team
STM	Short-term Monitoring
THg	Total mercury
USM	Unified stream methodology
VDEQ	Virginia Department of Environmental Quality
WWTP	Wastewater Treatment Plant
ww	Wet weight

Executive Summary

Interim measures are being implemented by E.I. du Pont de Nemours and Company (DuPont) in accordance with the United States Environmental Protection Agency (EPA) Resource Conservation and Recovery Act (RCRA) Corrective Action Permit No. VAD003114832, to address mercury contamination historically released to the South River from the former DuPont facility in Waynesboro, Virginia (Site). Riverbank soils impacted by these historical releases are currently the primary source of mercury loading to the South River and as such, are the focus of the planned interim measures (URS, 2012; Anchor QEA et al., 2015).

Short-term monitoring (STM) is being conducted in an adaptive management framework to evaluate the performance of the interim measures and proposed remedial approach. STM is intended to evaluate the approach over a short period of time ranging from two to 10 years and is limited in spatial extent immediately adjacent to a particular bank management area (BMA). Biotic and abiotic measurement endpoints included in the STM program are categorized into the following performance metrics: Bank Stability, Mercury Loading/Exposure, and Riparian/Aquatic Habitat.

Although bank erosion is the primary mercury transport pathway from riverbanks, other transport and exposure pathways are also possible. The ability to differentiate between local sources of mercury (e.g., bank soils) and mercury loading from upriver is essential in the assessment of remedy effectiveness. STM includes the measurements of total mercury (THg) and methylmercury (MeHg) in biotic and abiotic media in both near-bank and mid-channel environments to support the differentiation of local (i.e., bank) sources and sources from upriver. Following remedy implementation, these data, in context with the Long-term Monitoring (LTM) program data, will provide input to potential source identification (i.e., bank vs. upriver).

Results of the 2016 STM efforts indicate that riverbanks at each STM station are generally stable with isolated areas of erosion, which is consistent with previous estimates (Anchor QEA et al., 2015). Invasive plant species are present at each STM station and in some instances they are the dominant species within the BMA. Riparian and aquatic habitat values at the STM stations evaluated in 2016 were generally good, with the exception of impacts associated with invasive species and increased substrate embeddedness.

Mercury concentrations in biotic and abiotic media generally followed spatial and temporal trends documented in previous investigations, including the Ecological Study of the South River and a Segment of the South Fork Shenandoah River (URS, 2012), the Pilot Bank Study (URS, 2014), and the 2015 pre-remediation STM (AECOM, 2016). Mercury concentrations in most media generally increased with distance downriver and media from near-bank environments are generally higher than those measured in mid-channel environments. While inorganic mercury (IHg) and MeHg concentrations in bulk sediment, pore water, periphyton, and transplanted *Corbicula* were somewhat variable, they appeared to be locally influenced by areas of elevated THg in bank soils; this finding is consistent with previous data collected as part of the Pilot Bank Study (Anchor QEA and URS, 2013).

Monitoring activities will continue in 2017. The specific scope and monitoring stations of the 2017 STM will be dictated by locations of BMAs targeted for remediation. Monitoring

events will continue to document conditions prior to the implementation of the remedy on a broader scale.

In addition to their relationship with primary RCRA remedial goals, monitoring activities include components related to conclusions from the multi-year study (Ecological Study) conducted as part of a consent decree with the Natural Resources Defense Council (NRDC) and Virginia Chapter of the Sierra Club, and the Remediation Proposal, which was part of the final settlement agreement between DuPont and NRDC in 2013 (URS, 2012; Anchor QEA and URS, 2013). As noted in the Ecological Study and the Remediation Proposal, some aspects of the STM and LTM may change depending on whether the results have material impact on current or future remedial decisions. The adaptive management framework remedial strategy will form the foundation of the approach to data collection and use in determining remedy effectiveness, and whether modifications to certain aspects of the remedy are necessary. DuPont will continue to undertake interim remedial measures (IRMs) and monitoring with technical collaboration with the Virginia Department of Environmental Quality (VDEQ) and the South River Science Team (SRST).

1.0 Introduction

1.1 Background

Interim measures are being implemented by E.I. du Pont de Nemours and Company (DuPont) in accordance with the United States Environmental Protection Agency (EPA) Resource Conservation and Recovery Act (RCRA) Corrective Action Permit No. VAD003114832, to address mercury contamination historically released to the South River from the former DuPont facility in Waynesboro, Virginia (Site).

The Site used mercury compounds (e.g., mercuric sulfate) to produce acetate flake and yarn from 1929 to 1950. The majority of the mercury from the process wastes was recovered at an on-site retort facility. Inadvertent mercury releases during that period were remediated in accordance with applicable waste management practices of the time. Riverbank soils impacted by these historical releases are currently the primary source of mercury loading to the South River and as such, are the focus of the planned interim measures for the river (URS, 2012; Anchor QEA et al., 2015).

Phase 1 interim measures are focused on bank stabilization, which will be implemented at Bank Management Areas (BMAs) beginning with the first two relative river miles (RRM), RRM 0 to RRM 2. A combination of source area removal (for Primary BMAs) and structural and vegetative stabilization (for Secondary BMAs) will be used to reduce mercury transport from eroding banks. Primary Removal BMAs consist of banks that contribute disproportionately higher total mercury (THg) loading between RRM 0 and RRM 2 (approximately 40%). THg loading from Secondary Stabilization BMAs, where the remedy involves stabilization only, is substantial but less than loading from the removal BMAs.

The Phase 1 Interim Measures are further divided into Phase 1A and Phase 1B based on land ownership. Phase 1A BMAs include the City of Waynesboro (City-owned) BMAs at Constitution Park and the Wastewater Treatment Plant (WWTP). The remaining City-owned BMAs and privately-owned BMAs from RRM 0 to RRM 2 are classified as Phase 1B BMAs. Short- and Long-term Monitoring (STM and LTM, respectively) are being conducted to evaluate the performance of the interim measures and proposed remedial approach. STM data, presented in this annual report, are intended to provide input to assessment of the remedial approach over a short period of time ranging from two to 10 years and is limited to a specific spatial extent immediately adjacent to a particular BMA.

The interim measures and monitoring strategy were developed largely from conclusions drawn from the multi-year study (Ecological Study) conducted in collaboration with the Natural Resources Defense Council (NRDC) and Virginia Chapter of the Sierra Club, and the Remediation Proposal, which was part of the final settlement agreement between DuPont and NRDC in 2013 (URS, 2012; Anchor QEA and URS, 2013). Additionally, a Pilot Bank Stabilization project (Pilot Bank Study) was performed to test the hypothesis that stabilization of mercury contaminated riverbanks would reduce mercury transport and exposure in near-bank environments. The Pilot Bank Study was implemented in 2009 near RRM 0.1, just downstream from the former DuPont Waynesboro facility. The primary objective of the Pilot Bank Study was to reduce riverbank erosion rates and particle-associated mercury loading to the river through bank stabilization; annual post-stabilization monitoring has indicated that mercury concentrations in near-bank sediment, pore water, and transplanted *Corbicula fluminea*

(*Corbicula*) tissue are decreasing as a result of bank stabilization (Anchor QEA and URS, 2013).

Some aspects of the LTM and STM may change depending on whether the results obtained have a material impact on current or future remedial decisions. This condition, in addition to how data are collected and used in determining remedy effectiveness, is consistent with DuPont's plan to perform the program in an enhanced adaptive management framework with the technical collaboration of the VDEQ and the SRST.

STM data are specifically used to evaluate the following:

- Bank stability
- THg and methylmercury (MeHg) concentrations in:
 - § Sediment
 - § Pore water
 - § Periphyton
 - § Transplanted Asiatic clam (*Corbicula fluminea*)
- Riparian and aquatic habitat

STM reporting will occur annually; LTM reporting will occur every three years. LTM data are intended to provide input to a system-wide assessment of the remedial approach over a longer timeframe (10+ years).

1.2 Purpose

As outlined above, several measurable metrics and success criteria have been included in the STM effort to document bank stability and its relationship with mercury loading to the South River in response to remedial actions. These metrics and success criteria were selected for inclusion in the STM, in part, based on the preliminary success of the Pilot Bank Study (Anchor QEA and URS, 2013). Although the data presented in this report reflect pre-remediation (baseline) conditions, the findings of the Pilot Bank Study are a comparable framework when evaluating success of the interim measures based on review of the pending post-remediation STM data.

Although bank erosion is the primary mercury transport pathway from riverbanks, other pathways are also possible. The measurement of THg and MeHg in near-bank sediments, pore water and periphyton alone may not be sufficient to differentiate between local (i.e., bank) sources and sources further upstream. Thus, the STM dataset will be evaluated in context with the LTM program, which encompasses a broader distribution of sampling locations, upstream and downstream of the BMAs. LTM data to be considered as part of the STM data evaluation include, but are not limited to, data associated with surface water, mid-channel periphyton, transplanted *Corbicula*, and bank stability.

This report summarizes the sampling methodology and results from the June and October 2016 STM sampling events, which were conducted to assess pre-remediation conditions. These baseline data will be used to assess the effectiveness of bank remedial actions to be implemented at the BMAs. As stated above, post-remediation STM data may also be evaluated in the context of the findings of the Pilot Bank Study when evaluating the success of the interim measures (Anchor QEA and URS, 2013).

The 2016 STM sampling events included only those stations that are located adjacent to BMAs anticipated to be included in the first phase of construction (i.e., STM-01, STM-05,

and STM-07; see Figure 1 and Figure 2) as outlined in the AOC 4 Short-term Monitoring 2016 Monitoring Locations memorandum (dated May 9, 2016). Additional STM stations will be included in future events as the remedial design progresses for other BMAs.

Regional climatic conditions in 2016 were typical, as the South River stream discharge was similar to the 62-year median daily discharge for the majority of the year (see Figure 3). Interim measures at the Constitution Park BMA (i.e., STM-01) began in November 2016. As such, the 2017 STM events will collect the first post-remediation data. The 2017 data collected at other STM stations will be considered baseline data; however, special attention will be given to look for evidence of the perturbation to the broader river system due to the interim measures at Constitution Park.

1.3 Report Organization

This STM Report includes the following sections:

- Section 2 describes the methods implemented during STM, already provided in the 2015 Annual Report, reiterated here for completeness.
- Section 3 summarizes results of the 2016 baseline STM activities.
- Section 4 reviews the data quality assessment.
- Section 5 provides the conclusions of the 2016 baseline STM data.
- Section 6 lists the references cited in this report.

2.0 Methods

The following sections briefly summarize the methods used in the 2016 STM events; this summary was also provided in the 2015 Annual Report (AECOM, 2016); they are provided again here for completeness. No deviations from the standard operating procedures (SOP) provided in the Final AOC 4 STM Plan (URS, 2015) took place during the 2016 monitoring. Table 1 provides an overview of the STM monitoring plan design, including performance objectives, metrics, success criteria, and potential adaptive management outcomes.

Each of the datasets targeted were focused on a specific performance goal directed at bank stability, mercury loading, and mercury exposure. Additional ancillary datasets primarily focused on riparian and aquatic habitat were also collected to address stakeholder concerns. Biotic and abiotic media samples collected during the 2016 STM sampling events were analyzed for THg and MeHg; inorganic mercury (IHg) was calculated as the difference between THg and MeHg. The following paragraphs describe the methods used to measure environmental attributes that affect the transport and exposure to mercury in the system.

2.1 Bank Stability

Bank erosion is an important mechanism of THg loading to the South River. Bank areas with elevated mercury concentrations that are also erosive will result in higher system loading. Bank stabilization, to reduce erosion in areas of high loading, is the focus of the Phase 1 interim measure. Baseline BMA bank stability data will be used as a reference for post-remediation stabilized banks.

As described in the Final Interim Measures Design, Implementation and Monitoring Work Plan (Anchor QEA et al., 2015), baseline bank topography for the first two river miles was documented in March 2014 by conducting a shore-based light detection and ranging (LiDAR) survey. To further document pre-remediation bank stability, conditions were visually evaluated during the June and October 2016 STM events. A photographic log of key bank features documented at STM-01, STM-05, and STM-07 is provided in Appendix A.

2.2 Mercury Loading and Exposure

Monitoring metrics that represent good indicators of mercury loading include abiotic media such as sediment, that can serve as a transport or exposure medium. Biotic media, at the lowest trophic level such as periphyton, are also sensitive indicators of loading and exposure. Methods to measure these metrics are provided in this section.

2.2.1 Sediment

Near-bank sediment THg and MeHg concentrations can be influenced by localized bank erosion and depositional processes and provide a direct measurement of mercury loading to the system. Deposition can occur in areas of relatively slower flow, including quiescent areas near the banks, and downstream of large woody debris (LWD) and near-bank obstructions (URS, 2012). Sediment data collected as part of the 2016 efforts will be used to characterize pre-remedial, near-bank sediment mercury concentrations, as a basis for comparison with post-remedy conditions.

Sediment samples were collected in June and October 2016 following standard operating procedure SRSE-2 (URS, 2015). Bulk sediment samples were collected at transects spaced approximately 100 to 200 feet apart, from near-bank environments at STM-01, STM-05, and STM-07 (see Figure 2). The samples were collected by direct pushing dedicated 2-inch acetate cores to a depth of 15 centimeters (cm) at each individual transect. The sediment samples collected at each individual transect were characterized, and then thoroughly homogenized in a stainless-steel bowl prior to being transferred to laboratory-supplied bottleware, and preserved on dry ice. Samples were submitted to Cebam Analytical (Bothell, Washington) under proper chain-of-custody (COC) procedures.

2.2.2 Filtered Pore Water

Pore water refers to the aqueous phase occupying sediment interstitial spaces. It is an important medium for mercury transfer between the solid (sediment) and aqueous phases. Conditions in the interstitial spaces can also be conducive to mercury methylation.

Pore water samples were collected in June and October 2016 following procedures outlined in SOP SRPW-1 (URS, 2015). Pore water samples were co-located with bulk sediment samples (i.e., collected at transects along STM-01, STM-05, and STM-07, spaced approximately 100 to 200 feet apart; see Figure 2). The samples were collected from near-bank, undisturbed, shallow sediments, 5 to 10 cm below the sediment surface, with a decontaminated push-point sampler (i.e., Henry Probe). They were field-filtered using 0.45-micrometer (μm) syringe-tip filters.

In situ water quality parameters for the unfiltered pore water and the overlying ambient surface water were monitored and compared to validate the collection of representative pore water samples. A Myron 6P meter was used to document water quality parameters, including temperature, specific conductivity (SC), oxidation-reduction potential (ORP) and pH. Samples were preserved at 4 degrees Celsius ($^{\circ}\text{C}$), and submitted to Cebam Analytical (Bothell, Washington) for analysis.

2.2.3 Periphyton

Epilithic periphyton (i.e., algae and suspended solids associated with streambed substrates) plays an important role in the trophic transfer of MeHg in the South River (URS, 2012). Mercury concentrations in periphyton are expected to respond to the effects of the bank stabilization by declining along with a decrease in sediment concentrations.

Periphyton sampling was conducted in accordance with SOP SRTI-1 (URS, 2015). Three composite samples were collected from near-bank environments at the downstream extent of each STM during the June and October 2016 sampling events; three composite samples were also collected from mid-channel environments for comparison with LTM data (see Figure 2). Samples were collected from similar surface water depths and flow regimes at each STM, within each environment (i.e., near-bank and mid-channel).

Samples were collected using a decontaminated plastic spatula to scrape periphyton off streambed cobbles until a suitable sample mass was obtained; descriptions (i.e., texture, color, general abundance, etc.) of all periphyton samples were documented upon collection. Each sample was gently rinsed with site water to remove coarse substrates (i.e., fine-medium sands and gravel). Upon inspection, any invertebrates found in the sample were removed prior to placing the sample in laboratory-supplied bottleware and

preserving on dry ice. Samples were submitted to Cebam Analytical (Bothell, Washington) for analysis.

2.2.4 Asiatic Clam

Corbicula were included as a monitoring element in the STM program because of its important role in the South River aquatic and terrestrial food webs, and its sedentary nature. *Corbicula* were collected from a reference location in Middle River and deployed at the 2016 STM stations for a five-week exposure period, in June and October 2016, to measure mercury uptake. *Corbicula* were deployed at the downstream extent of each STM station in order to capture the cumulative influence of the associated BMAs (see Figure 2). Two deployment types were used to evaluate potential differences in mercury exposure to *Corbicula*:

- Epifauna (caged): *Corbicula* were contained in porous sleeves and suspended in the water column, off of the substrate, via frame-cages.
- Infauna (seeded): *Corbicula* were tagged and seeded directly into the sediment.

Similar to the periphyton sampling strategy, two environments were sampled at each 2016 STM station in June (i.e., near-bank and mid-channel); only near-channel clams were deployed in October 2016, in accordance with the STM Plan (URS, 2015). Three composite transplanted *Corbicula* samples were collected per deployment type (i.e., seeded and caged) from near-bank environments at the downstream extent of each STM (June and October 2016). Additionally, three composite transplanted *Corbicula* samples (caged only) were collected from mid-channel environments at the downstream extent of each STM (June 2016 only). *Corbicula* were depurated for 24 hours in aquaria filled with distilled water, processed, frozen and submitted to a Cebam Analytical (Bothell, Washington) for analysis.

2.3 Riparian and Aquatic Habitat

Bank stabilization can provide a positive effect on the function of the existing riparian and associated aquatic habitats. This section describes the methods used to evaluate the ecological attributes of these habitats.

2.3.1 Riparian Vegetation

Riparian vegetation plays an important role in bank stability and habitat quality for ecological receptors. It also provides value to stakeholders and the public at large in terms of the way the banks are viewed. Riparian vegetative communities for the following strata were assessed at two plots per station during each of the 2016 STM field events:

- Herbaceous: 1-meter diameter around the center of the plot
- Shrub/sapling: 3-meter diameter around the center of the plot
- Tree/vine: 10-meter diameter around the center of the plot

The dominant vascular plant species were identified to the lowest practical taxon, and the percent areal cover was quantified for each stratum.

2.3.2 Rapid Bioassessment Protocol

The pre-remedy quality of the substrate, channel morphology, bank structure, and riparian vegetation was evaluated at each STM station in the spring and fall of 2016

using modified Rapid Bioassessment Protocols (RBPs) (Barbour et al., 1999). Specific metrics assessed included the following:

- Epifaunal substrate/available cover
- Embeddedness
- Pool substrate characterization
- Sediment deposition
- Bank stability (subject bank only)
- Vegetative protection
- Riparian vegetative zone width

The RBP scoring system assigns a numerical score that fits into one of four condition categories: optimal, suboptimal, marginal, or poor.

2.4 Ancillary STM Habitat Metrics

Ancillary STM habitat metrics were included as part of the 2016 pre-remedy monitoring effort to address stakeholder concerns regarding preserving high-quality ecological habitats within the City of Waynesboro but are not part of the RCRA STM program. The methods used to collect these ancillary data included evaluation of planned wetlands (EPW), unified stream methodology (USM), and benthic community evaluations. The ancillary STM habitat metrics are summarized in Appendix B.

2.5 Data Evaluation

Two primary objectives of the data evaluation are as follows:

- Establish pre-remediation baseline conditions against which post-remedial conditions can be compared.
- Establish relationships among sampling matrices to determine relatedness and potential sampling redundancies.

The 2016 STM data presented in this report summarize pre-remediation conditions. The purpose of this report is to qualitatively assess the pre-remediation STM data collected in 2016 in the context of the 2015 STM data (AECOM, 2016). The objective of this qualitative data assessment is to establish a baseline data set (i.e., 2015-2016) to use as a benchmark for evaluation of post-remediation conditions.

Subsequent annual STM reports will include analyses of available pre- and post-remediation data to evaluate potential statistically significant temporal (i.e., annual and seasonal), spatial (e.g., mid-channel vs. near-bank), and pre-and post-remediation differences among media for each BMA. Subsequent annual STM reports will also include statistical evaluations of potential relationships among abiotic and biotic monitoring media; the degree of relatedness between monitoring media will be used to understand the potential mobilization of mercury from bank soils to the adjacent aquatic compartment and identify potential redundancies. These evaluations will be integrated with the findings from the Pilot Bank Study (Anchor QEA and URS, 2013) to help inform the STM approach

3.0 Results and Discussion

The following sections summarize results from the 2016 STM events. Each of the datasets describes existing, pre-remediation conditions for bank stability, mercury loading, and mercury exposure.

3.1 Bank Stability

Results from the March 2014 LiDAR survey describe existing, pre-remediation bank conditions, and are summarized below as well as presented in Section 4.3 and Appendix A of the Final Interim Measures Design, Implementation and Monitoring Work Plan (Anchor QEA et al., 2015). This information has also been included in the 2015 STM Report and is being repeated here for completeness.

- Average bank height at the STM-01 is 9.5 feet, with bank angles ranging from 15 to 20 degrees; the average sediment load is $6.1 (10^3 \text{ kg/year})$.
- STM -05 is comprised of two BMA areas (North Park A and North Park B); average bank heights range from 8.9 to 12.4 feet with bank angles ranging from 25 to 70 degrees. Average sediment loading rates at STM-05 range from 6.7 to 8.9 (10^3 kg/year).
- STM-07 includes three BMA areas (North Park C, WWTP-A, and WWTP-B); average bank heights range from 8 to 11.7 feet, with bank angles ranging from 16 to 60 degrees. Average sediment loading rates at STM-07 range from 4 to 8.3 (10^3 kg/year).

Visual reconnaissance performed in June 2016 confirmed the results of the LiDAR survey at STM-01, STM-05, and STM-07; specifically, isolated areas of bare soil, undercutting, and exposed roots were documented at these areas. Access paths to the river, generally present near areas of active public use such as Constitution Park and North Park, were present at a number of locations throughout the monitoring stations (see Appendix B and Figure B-1). A photographic log of key bank features documented at STM-01, STM-05, and STM-07 in 2016 is provided in Appendix A.

3.2 Mercury Loading and Exposure

Bank erosion is the primary mercury transport pathway from riverbanks among other possible pathways. The ability to differentiate between local sources of mercury (e.g., bank soils) and mercury loading from upstream is paramount in being able to evaluate remedy effectiveness. The measurement of THg and MeHg in near-bank sediments, pore water, and periphyton alone may not be sufficient to differentiate between local (i.e., bank) sources and sources further upstream. Following remedy implementation, these data in context with the LTM monitoring program surface water data, mid-channel periphyton, and *Corbicula* data, which span a larger area, will be used to help evaluate the efficacy of the interim remedial measure (IRM) and aid in the interpretation of results (i.e., bank loading vs. upstream or systemic changes). The IRM success criteria were selected based upon the findings of the Pilot Bank Study. As such, success of the interim measures may also be evaluated in the context of the findings of the Pilot Bank Study (Anchor QEA and URS, 2013).

3.2.1 Sediment

Sediment mercury (Hg) concentrations were generally consistent between years 2015 and 2016, and seasons [spring (June) and fall (October)] (see Figure 4). Although co-located historical sediment data are not available for direct comparison, baseline STM data collected in 2015 and 2016 were generally consistent with historical sediment data trends within the RRM 0-2 reach of the South River (URS, 2012). Mean IHg concentrations in bulk sediments at STM-01, STM-05 and STM-07 were 13.0, 26.9 and 7.76 milligrams per kilogram (mg/kg) dry weight, respectively (see Table 2). Mean MeHg concentrations in bulk sediments at STM-01, STM-05 and STM-07 were 14.7, 18.4, and 9.35 micrograms per kilogram (µg/kg) dry weight, respectively (see Table 2). Among all BMA's, ambient (i.e. 'base-level') Hg concentrations in near-bank sediment collected as part of the STM program generally reflect reach-wide (RRM 0-2) Hg concentrations (URS, 2012; URS, 2014; AECOM, 2016). It is anticipated that sediment Hg concentrations will continue to reflect Hg concentrations on particles suspended in the water column, as was documented at the Pilot Bank Study. As remedial efforts proceed and more BMAs are addressed, it is anticipated that ambient Hg concentrations on suspended particles in the water column, sediment, and other aquatic media, will begin to decline.

Concentrations of THg in near-bank sediment and surficial bank soil were generally similar at STM-01. The highest concentrations of THg in sediment were generally observed at transect D, approximately 50 feet downriver from elevated THg concentrations observed in surficial soil (see Figure 5). These data confirm that localized bank erosion is likely a transport pathway at STM-01. Erosion of bank soils with elevated THg concentrations enter the river and accumulate a short distance downstream in near-bank sediments. Interim measures at STM-01 began in November 2016 and are anticipated to be complete by the end of first quarter of 2017. As part of the interim measures at STM-01, the area of elevated THg concentrations in surficial bank soils will have been removed and/or capped, thus eliminating the bank erosion transport pathway. Based upon the findings of the Pilot Bank Study, after this pathway is eliminated, it is anticipated mercury reductions in near-bank sediments will be measureable within 1-3 years.

A similar relationship exists at STM-05, where elevated THg concentrations in surficial bank soil are observed near STM transects D and E; THg concentrations in near-bank sediment slightly increase with distance downstream from STM transect E to G. Likewise, elevated THg concentrations in surficial bank soil are observed near STM transects G and H; THg concentrations in near-bank sediment also increase slightly with distance downstream from STM-05 transect H to J (see Figure 6). Similar to STM-01, these data indicate that erosion of surficial bank soils with elevated THg are entering the river and accumulating in localized near-bank sediment deposits. The two areas of elevated THg in surficial bank soils at STM-05 correspond with the extent of anticipated impacted-soil removal as part of the IRM efforts. Based on migration pathways outlined above, if impacted soils are addressed as part of the interim measures, a reduction in concentrations of THg in downriver near-bank sediments is anticipated.

Elevated concentrations of THg in surficial bank soil and near-bank sediment at STM-07 are more spatially paired relative to STM-05. For instance, elevated THg concentrations in near-bank sediment are observed near STM transects D and G, immediately adjacent to the highest THg concentrations observed in surficial bank soil (see Figure 7).

Differences in hydrologic, streambed and bank geophysical characteristics are observed among the BMAs. In the specific case of STM-07, the co-located instances of high THg

concentrations observed in surficial soil and near-bank sediment may be attributed to these environmental conditions (i.e., erosion of Hg-impacted soils are quickly deposited as near-bank sediment due to low energy streamflow adjacent to the bank under baseline conditions; Figure 7). Similar to STM-01 and STM-05, anticipated interim measures for STM-07 will likely reduce the concentrations of THg in near-bank sediments. Post-remediation monitoring intends to evaluate these parameters (e.g., hydrologic and bank geophysical conditions) as part of the evaluation of remedial success.

3.2.2 Filtered Pore Water

Concentrations of IHg in filtered pore water were generally consistent between years (2015 and 2016) and seasons [spring (June) and fall (October)] (see Figure 8). MeHg concentrations in filtered pore water were generally greater in the spring compared to the fall, among all STM stations and monitoring years (see Figure 8). Mean IHg concentrations in filtered pore water at STM-01, STM-05, and STM-07 were 25.7, 24.6, and 6.48 nanograms per liter (ng/L), respectively. Mean MeHg concentrations were 5.1, 2.21, and 0.84 ng/L, respectively (see Table 3). Although co-located historical pore water data are not available for direct comparison, base-level THg concentrations in near-bank pore water collected as part of the STM program generally reflect reach-wide (RRM 0-2) THg concentrations (URS, 2012; URS, 2014; AECOM, 2016); the BMA-specific base-level pore water THg concentrations are anticipated to begin to decline as more BMAs are addressed.

A general relationship exists between near-bank filtered pore water and co-located sediment samples for each of the three STM stations monitored in 2016. For instance, at STM-01, concentrations of THg in filtered pore water and near-bank sediment were generally correlated. Specifically, elevated THg concentrations in both filtered pore water and near-bank sediment were observed at STM transect D, indicating that at STM-01 interstitial pore water Hg is influenced by near-bank deposited sediments (see Figure 5).

At STM-05, however, the relationship between filtered pore water and near-bank sediment was not as apparent. The highest THg concentrations observed in filtered pore water at STM-05 were at STM transect F; whereas the THg concentrations observed in near-banks sediment were at STM transect G (see Figure 6). This indicates that the elevated THg concentrations in filtered pore water, in this area of STM-05, may be influenced by other potential variables, such as the geophysical condition of the sediment.

At STM-07, two transects with elevated THg concentrations in filtered pore water (transects G and K) also had elevated concentrations of THg in co-located sediment (see Figure 7). However, further upriver, this relationship was less apparent; STM transect C had elevated THg concentrations in filtered pore water, but elevated concentrations in near-banks sediment were not apparent until the next downriver STM transect D (see Figure 7). This indicates that THg concentrations in filtered pore water, along this area of STM-07, but along the majority of STM-07, interstitial pore water Hg is likely influenced by deposited sediments.

Based on the findings of the Pilot Bank Study, elevated Hg concentrations in filtered pore water at STM-01, STM-05, and STM-07 should be reduced as a result of the anticipated interim measures. Post-remediation conditions will be monitored at STM-01 in 2017.

3.2.3 Periphyton

Concentrations of IHg and MeHg in epilithic periphyton for all STM events [2015 and 2016, spring (June) and fall (October)] are shown in Figure 9. Concentrations of IHg and MeHg in 2016 epilithic periphyton samples are summarized in Table 4. A summary of results is provided below:

- With the exception of near-bank periphyton collected in the spring, IHg and MeHg concentrations in epilithic periphyton were generally consistent among samples for both years (2015 and 2016) (see Figure 9).
- IHg and MeHg concentrations in near-bank and mid-channel periphyton were generally higher at the more downstream stations, STM-05 and STM-07 (see Figure 9).
- IHg and MeHg concentrations in periphyton were generally higher in near-bank environments than in mid-channel environments (see Figure 9).
- Near-bank IHg periphyton concentrations were comparable in the spring and fall; however, concentrations of MeHg were generally higher in the periphyton samples collected in the spring (see Figure 9). Previous investigations have documented that MeHg concentrations in various in-stream media increase when surface water temperatures reach 12°C to 16°C (URS, 2012); higher MeHg concentrations in periphyton measured in the spring are likely attributable the seasonally-influenced in-stream methylation rates.

Brent (2010) demonstrated that mercury accumulation in periphyton can serve as an indicator of changes to proximal mercury loading in the South River. The anticipated interim measures will likely reduce IHg and subsequently MeHg concentrations in near-bank periphyton as a result of decreased Hg in near-bank abiotic media (e.g., sediment and pore water). Post-remediation conditions will be monitored at STM-01 in 2017.

3.2.4 Asiatic Clam (*Corbicula*)

Concentrations of IHg and MeHg measured in transplanted caged and seeded *Corbicula* in June and October 2016 are provided in Table 5; IHg and MeHg concentrations measured in transplanted caged and seeded *Corbicula* for all STM events [2015 and 2016, spring (June) and fall (October)] are shown in Figure 10. A summary of the results is provided below:

- IHg and MeHg concentrations in transplanted and seeded *Corbicula* were generally consistent among samples for both years (2015 and 2016) (see Figure 10).
- Similar to periphyton, MeHg concentrations in *Corbicula* tissue were generally higher in both caged and seeded *Corbicula* in the spring compared to the fall (see Figure 10), likely attributable to the seasonally-influenced, in-stream methylation rates.
- MeHg tissue concentrations were generally higher in near-bank environments compared to mid-channel environments (see Figure 10).
- MeHg tissue concentrations were generally higher in seeded than in caged *Corbicula* (see Figure 10); this increase was more apparent in the spring than the fall.

Similar to the results of the Pilot Bank Study (Anchor QEA and URS, 2013), it is anticipated that once interim measures are in place, IHg and MeHg concentrations in

near-bank transplanted *Corbicula* will decrease as a result of declining concentrations in near-bank sediment and pore water. Post-remediation conditions will be monitored at STM-01 in 2017.

3.3 Riparian and Aquatic Habitat

3.3.1 Riparian Vegetation

Riparian vegetation conditions were surveyed in 2016 at the three STM stations adjacent to Phase 1 BMAs. Riparian vegetation conditions were generally similar between the spring and the fall for all three stations. Non-native, invasive plant species were present at all three stations in the spring and in the fall, and in some instances, dominated the plant community [e.g., Japanese knotweed (*Fallopia japonica*) at STM-01].

The riparian vegetative survey results are provided in Table 6 and summarized below:

- Tree stratum: Collectively, black locust (*Robinia pseudoacacia*), black walnut (*Juglans nigra*), and silver maple (*Acer saccharinum*) had the greatest percent cover for all three stations. Non-native, invasive species were not present in the tree stratum at any of the 2016 STM stations.
- Sapling/shrub stratum: Tartarian honeysuckle (*Lonicera tatarica*) had the highest percent cover for this stratum for all three stations. The Persian silk tree (*Albizia julibrissin*) and multiflora rose (*Rosa multiflora*) are non-native, invasive, woody plants that represented minor components (0-5% each) at STM-05. No non-native sapling/shrubs were present at STM-01 or STM-07.
- Herbaceous plant stratum: Japanese knotweed, a non-native, invasive plant, represented a substantial portion of the herbaceous plant community at STM-01 (60% to 80% cover). Other herbaceous plant species observed at STM-01 include curly dock (*Rumex crispus*), garlic mustard (*Alliaria petiolata*), lesser burdock (*Arctium minus*), common blackberry (*Rubus allegheniensis*), and Pennsylvania blackberry (*Rubus pensilvanicus*) ($\leq 10\%$ each). The non-native Japanese knotweed was the only herbaceous species observed at STM-07 (0 to 10% cover). No herbaceous species were observed at STM-05.

Interim measures at STM-01 (Constitution Park) began in November 2016 and were completed by the end of February 2017; post-remediation riparian vegetation monitoring will start in 2017. Based on the current remedial schedule, monitoring of riparian vegetation at STM-05 and STM-07 will continue to document 2017 pre-remediation conditions.

3.3.2 Rapid Bioassessment Protocol

RBP scores varied throughout the area of investigation, generally reflecting the influence of adjacent land use, particularly for STM-01, adjacent to Constitution Park. Most RBP habitat parameters for STM-01 were within the “suboptimal” range; however, scores were largely “marginal” for vegetation protection and riparian vegetation zone due to extensive cover of invasive species (e.g., Japanese knotweed) and anthropogenic influences associated with Constitution Park. As evidenced by results of the Pilot Bank Study (Anchor QEA and URS, 2013), it is anticipated that RBP scores will likely improve at STM-01, based on post-remediation conditions starting in 2017.

STM-05 RBP scores were generally “optimal” or “suboptimal.” However, embeddedness and epifaunal substrate/ available cover were both scored as “marginal” due to numerous stretches of bedrock and a large fine-grained sediment deposit.

RBP scores for STM-07 were mostly within the “optimal” range except for bank stability and riparian vegetation (left bank), which were scored as “suboptimal” and “marginal,” respectively. Riparian vegetation scores for the left bank at STM-07 have been impacted by anthropogenic activities associated with the WWTP and the North Park.

3.4 Ancillary STM Habitat Metrics

Ancillary STM habitat metrics described in Section 2.2.2 are summarized in Appendix B.

4.0 Data Quality Assessment

The 2016 STM analytical data were reviewed in accordance with the DuPont Data Verification Module (DVM) process to determine data usability. The DDR is an internal review process used by the DuPont Corporate Remediation Group (CRG) Analytical Data Quality Management Group (ADQM) to assist with the determination of data quality. The electronic data deliverables received from the laboratory were loaded into the Locus Environmental Information Management (EIM™) database and processed through a series of data quality checks, which are a combination of software (Locus EIM™ database DVM) and manual reviewer evaluations. The review process included comparing available laboratory data deliverables [hardcopy and electronic data deliverable (EDD)] versus the original project specifications, examining the completed chain of custody, and using the automated DVM during the data evaluation.

4.1 Findings

Based on the quality assurance/ quality control (QA/QC) data review conducted, all 2016 STM data are considered usable. No data evaluation qualifiers were applied to the analytical data.

5.0 Conclusions

The 2016 STM events documented pre-remediation, baseline conditions at three STM stations adjacent to Phase 1 BMAs, in accordance with the Final AOC 4 STM Plan (URS, 2015). These data provide a characterization of bank stability and subsequent mercury loading adjacent to the Phase 1 BMAs. Future data collected at these and other STM stations, will be combined and used to evaluate the effectiveness of the IRMs. Effectiveness of the interim measures will be evaluated based on metrics and success criteria that have been established for the STM program (URS, 2015). Success of the interim measures will also be evaluated in the context of the Pilot Bank Study, which has served as a framework for the development of the STM program (Anchor QEA and URS, 2013).

Although this dataset provides a limited “snapshot” of conditions at the time of sampling, several similarities were observed when compared with historical data collected as part of the Ecological Study (URS, 2012). Conclusions based on a review of the 2016 STM data are provided below:

- Bank Stability:
 - § Riverbanks along STM-01, STM-05, and STM-07 are generally stable and lack large areas of extensive erosion; however, isolated areas of erosion, including undercut banks and steep bank slopes with limited vegetation, are present at each monitoring station.
 - § Improvised access paths were present at each location, contributing to localized bank erosion and sediment loading to the South River.
- Mercury Loading and Exposure:
 - § Mercury concentrations generally follow spatial and temporal trends documented in previous investigations (URS, 2012; URS, 2014; AECOM, 2016).
 - § BMA-specific base-level THg concentrations in near-bank sediment and pore water generally reflect broader THg concentrations in RRM 0-2 associated with multiple diffuse sources (URS, 2012; URS, 2014; AECOM, 2016). It is anticipated that sediment THg concentrations will continue to reflect THg concentrations on particles suspended in the water column, as was documented at the Pilot Bank Study.
 - § Mercury concentrations in most media increase with distance downstream from the BMA and are higher in near-bank environments compared to mid-channel.
 - § THg concentrations in near-bank bulk sediment and filtered pore water were generally higher adjacent to, or downstream of riverbanks with elevated THg concentrations in bank soils, i.e., Primary BMAs (removal areas) (see Figures 5, 6, and 7); if warranted, BMA-specific Hg transport models may be developed as more STM data are collected over time.
- Riparian and Aquatic Habitat:
 - § Invasive plant species were present at each monitoring station.
 - § EPA RBP scores were generally “sub-optimal” to “optimal”; however a few “marginal” scores were documented.

The STM program will continue to include monitoring at STM-01, STM-05, and STM-07 and may also be modified to include additional STM stations (e.g., STM-08, right bank across from STM-07, see Figure 1). Additional STM stations may be added depending on the IRM design schedule, to document pre-remedy conditions prior to the implementation of the remedial approach on a broader scale.

With the completion of interim measures at the Constitution Park BMA (STM-01) in February 2017, the 2017 monitoring will be the first post-remediation dataset collected. The 2017 Annual STM report will begin to evaluate the effectiveness of the completed interim measures at Constitution Park in the context of the established success criteria as well as the framework of the Pilot Bank Study (Anchor QEA and URS, 2013). STM data collected in 2017 at other STM stations will still be considered baseline for other BMAs, yet to be addressed.

Consistent with adaptive management principles for AOC 4, the STM approach may be revised based on documented progress towards the achievement of success criteria, contingency actions, and emerging decision analysis options (URS, 2015). More specifically, monitoring data that do not materially impact the remedial decision process may be reduced or eliminated from the STM program with the concurrence of the VDEQ.

6.0 References

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Tables

Table 1
AOC 4 Short-Term Monitoring Plan Summary
2016 Short-Term Monitoring Report
Former DuPont Waynesboro Site, Area of Concern 4

Short-Term Remedial Action Objectives				Monitoring Plan Designs			Adaptive Management Outcomes	
General Objective	Performance Objective	Measurable Metric	Preliminary Success Criteria	General Station Locations	Monitoring Frequency (post construction)	Analytical Parameters	Contingency Actions	Decision Analysis
Reduce Mercury Transport and Exposure	Increase in Bank Stability	Topography	Maintenance of Post-Construction Bank Condition	BMA Evaluated Holistically	Twice Annually for First 3 Years; Post-storm	Continuous Bank Angle / Grade	Structural and/or Vegetative Stabilization	Refine Effectiveness Estimates
		Vegetation	>80% Cover; <10% Invasives	Vegetation Plots at Each BMA	Twice Annually for First 3 Years; Post-storm	Cover and Species Composition	Additional Vegetation Enhancement	Refine Effectiveness Estimates
		Design and Implementation	Landowner Approvals and Permits	BMA Properties	NA	NA	NA	Refine Implementation Estimates
	Reduce Mercury Loading from Bank	Surface Sediment	>75% Mercury Concentration Reduction	Transects Spaced ~100-200' at each BMA	Twice Annually for First 3 Years	IHg and MeHg Concentrations	NA	Refine Effectiveness Estimates
		Pore Water	>75% Mercury Concentration Reduction	Transects Spaced ~100-200' at each BMA	Twice Annually for First 3 Years	IHg and MeHg Concentrations	NA	Refine Effectiveness Estimates
		Periphyton	>75% Mercury Concentration Reduction	Downstream of Representative BMAs (Near-shore)	Twice Annually for First 3 Years	IHg and MeHg Concentrations	NA	Refine Effectiveness Estimates
		Asiatic Clam Sampling	>75% Mercury Concentration Reduction	Downstream of Representative BMAs (Near-shore)	Twice Annually for First 3 Years	IHg and MeHg Concentrations	NA	Refine Effectiveness Estimates
	Reduce In-Channel Mercury Exposure	Periphyton	>50% Mercury Concentration Reduction	Downstream of Representative BMAs (Channel)	Annually for First 10 Years	IHg and MeHg Concentrations	NA	Refine CSM
		Asiatic Clam Sampling	>50% Mercury Concentration Reduction	Downstream of Representative BMAs (Channel)	Annually for First 10 Years	IHg and MeHg Concentrations	NA	Refine CSM
Maintain or Improve Riparian and Aquatic Habitat	Improve Bank Vegetation	Vegetation	>80% Cover; <10% Invasives	Vegetation Plots at Each BMA	Twice Annually for First 3 Years	Cover and Species Composition	Additional Vegetation Enhancement	Refine Effectiveness Estimates
	Improve In-Stream Habitat	Rapid Bioassessment Protocols	Visual Stream Classification	Each BMA Assessed Independently	Quarterly for the First Year and Semi Annually (Q1/Q3) for years 2-10 ¹	Rapid Bioassessment Protocol Scores	NA	Refine Effectiveness Estimates
	Maintain Detrital Input/Stream Shading	Canopy Cover	Achievement of Baseline Canopy Coverage	Transects Spaced ~ 100-200' at each BMA	Annually for First 3 Years	Percent Canopy Coverage (Spherical Densiometer)	Additional Vegetation Enhancement	Refine Effectiveness Estimates
	Maintain Stream Substrate Condition	Wolman Pebble Counts	Maintenance / Improvement of Baseline Conditions	Transects Spaced ~100-200' at each BMA	Annually for First 3 Years	Particle Size Analysis	Structural and/or Vegetative Stabilization	Refine Effectiveness Estimates
	Maintain In-stream Habitat Features	# of In-stream Habitat Features	Maintenance / Improvement of Baseline Conditions	Each BMA Assessed Independently	Twice Annually for First 3 Years	# of In-stream Habitat Features	Structural Stabilization	Refine Effectiveness Estimates
	Habitat Function and Ecological Value	EPW & USM	Maintenance / Improvement of Baseline Conditions	Each BMA Assessed Independently	Annually for first 3 Years	USM Methodology & EPW Non-tidal Stream - Fish FCI	Structural and/or Vegetative Stabilization	Refine Effectiveness Estimates
Maintain or Improve Benthic Community	Maintenance of Benthic Community	Benthic Invertebrate Metrics	Maintenance / Improvement of Baseline Conditions	Four Locations Within the Interim Measures Area (RRM 0.5, RRM 1.0, RRM 1.5, RRM 2.0)	Twice Annually for First 3 Years	300 Organism Sub-count	NA	Refine Effectiveness Estimates
River Access / Aesthetics	Provide Stable River Access Points	Stable Access Points	Maintenance / Improvement of Baseline Conditions	Each BMA Assessed Independently	Twice Annually for First 3 Years	# of Stable and Improvised Access Points	Structural Stabilization	Refine Effectiveness Estimates

Notes:

EPW, Evaluation for Planned Wetlands
 FCI, Functional Capacity Index
 USM, Unified Stream Methodology
 RRM, Relative River Mile
 NA, Not applicable
 IHg, Inorganic mercury
 MeHg, Methylmercury
 CSM, Conceptual Site Model
 BMA, Bank Management Area
 Ancillary habitat/ public access metrics

Table 2
Sediment IHg and MeHg Data Summary
2016 Short-Term Monitoring Report
Former DuPont Waynesboro Site, Area of Concern 4

Sample ID	Sediment Type	IHg (mg/kg dw)			MeHg (µg/kg dw)		
		June 2016 Sampling Date	October 2016 Sampling Date	Mean ± SD	June 2016 Sampling Date	October 2016 Sampling Date	Mean ± SD
STM-01							
A	Bulk	0.24	0.24	13.0 ± 27.4	1.95	3.72	14.7 ± 26.8
B		0.59	0.65		1.85	4.10	
C		0.54	1.09		1.32	4.05	
D		82.7	40.2		83.9	39.2	
E		2.00	1.87		5.18	2.25	
STM-05							
A	Bulk	6.58	4.93	26.9 ± 27.8	24.6	16.4	18.4 ± 13.7
B		10.6	15.0		6.39	7.14	
C		23.4	18.7		26.4	16.6	
D		4.4	2.01		29.5	5.16	
E		14.8	14.9		58.9	28.8	
F		38.0	33.4		10.8	14.3	
G		47.1	88.0		17.4	44.3	
H		19.0	12.6		13	11.0	
I		51.2	18.3		11.0	10.2	
J		106	8.34		11.4	5.77	
STM-07							
A	Bulk	3.98	1.79	7.76 ± 6.98	1.41	1.23	9.35 ± 8.43
B		7.46	3.86		16.4	7.30	
C		2.68	5.81		1.5	2.64	
D		17.98	19.1		17.2	17.6	
E		7.12	2.67		12.0	6.56	
F		6.78	2.11		5.41	1.32	
G		22.9	21.5		31.1	19.6	
H		4.20	3.65		4.87	6.76	
I		5.13	4.20		10.9	7.84	
J		3.82	1.94		4.30	2.48	
K		3.93	18.0		2.15	25.0	

Notes:

IHg, Inorganic mercury

MeHg, Methylmercury

mg/Kg, Milligrams per kilogram

µg/kg, Micrograms per kilogram

dw, Dry weight

Mean ± SD, Arithmetic mean ± standard deviation

Table 3
Filtered Pore Water IHg and MeHg Data Summary
2016 Short-Term Monitoring Report
Former DuPont Waynesboro Site, Area of Concern 4

Sample ID	FIHg (ng/L)			FMeHg (ng/L)		
	June 2016 Sampling Event	October 2016 Sampling Event	Mean ± SD	June 2016 Sampling Event	October 2016 Sampling Event	Mean ± SD
STM-01						
A	2.58	3.91	25.7 ± 43.1	1.22	1.32	5.1 ± 10.5
B	14.23	11.39		1.47	1.16	
C	4.67	3		4.73	0.19	
D	142	49.27		34.7	2.16	
E	15.81	10.32		3.49	0.22	
STM-05						
A	37.82	11.91	24.6 ± 38.4	6.29	0.57	2.21 ± 3.40
B	10.27	3.15		1.63	0.28	
C	5.1	9.49		0.9	0.4	
D	3.07	8.68		0.84	0.58	
E	7.49	7.16		8.51	2.54	
F	159.31	20.11		13.39	0.72	
G	93.65	53.11		3.15	1	
H	3.41	5		1.09	0.14	
I	10.85	14.56		0.25	0.37	
J	9.26	19.32		0.34	1.13	
STM-07						
A	7.86	4.8	6.48 ± 4.41	4.44	0.03	0.84 ± 1.11
B	1.6	1.54		0.2	0.02	
C	15.44	11.57		0.37	0.18	
D	2.43	2.35		0.17	0.02	
E	13.41	4.25		1.19	0.66	
F	4.67	3.93		2.43	0.98	
G	7.08	4.49		0.42	0.19	
H	5.42	5.41		0.58	1.18	
I	8.5	2.7		2.6	1.96	
J	9.31	7.8		0.29	0.1	
K	16.28	1.68		0.32	0.12	

Notes:

FIHg, Inorganic mercury (filtered fraction)

FMeHg, Methylmercury (filtered fraction)

Mean $\pm$ SD, Arithmetic mean $\pm$ standard deviation

Table 4
Periphyton IHg and MeHg Data Summary
2016 Short-Term Monitoring Report
Former DuPont Waynesboro Site, Area of Concern 4

Sample Date	Environment	IHg (µg/kg ww)		MeHg (µg/kg ww)	
		Concentration Range	Mean ± SD	Concentration Range	Mean ± SD
STM-01					
June & Oct. 2016	Near Bank	37.4 - 467	168 ± 162	0.26 - 0.82	0.48 ± 0.19
June 2016	Mid-Channel	121 - 332	199 ± 116	0.27 - 0.35	0.32 ± 0.04
STM-05					
June & Oct. 2016	Near Bank	550 - 1345	883 ± 318	0.39 - 1.20	0.79 ± 0.37
June 2016	Mid-Channel	193 - 253	223 ± 30.0	0.09 - 0.13	0.12 ± 0.02
STM-07					
June & Oct. 2016	Near Bank	875 - 3565	1720 ± 1007	1.02 - 4.17	1.98 ± 1.14
June 2016	Mid-Channel	235 - 268	248 ± 17.6	0.78 - 1.26	1.04 ± 0.24

Notes:

IHg, Inorganic mercury

MeHg, Methylmercury

 $\mu\text{g/kg ww}$, Micrograms per kilogram, wet weightMean $\pm$ SD, Arithmetic mean $\pm$ standard deviation

Table 5
Corbicula IHg and MeHg Data Summary
2016 Short-Term Monitoring Report
Former DuPont Waynesboro Site, Area of Concern 4

Sample Date	Environment	IHg (µg/kg ww)		MeHg (µg/kg ww)	
		Concentration Range	Mean ± SD	Concentration Range	Mean ± SD
STM-01					
June 2016	Near-Bank Seeded	9.64 - 20.3	14.5 ± 5.41	13.3 - 26.2	17.9 ± 7.18
	Near-Bank Caged	14.0 - 23.8	17.5 ± 5.49	9.76 - 17.2	12.5 ± 4.13
	Mid-Channel Caged	11.5 - 24.8	16.2 ± 7.42	5.39 - 6.47	5.83 ± 0.57
October 2016	Near-Bank Seeded	15.1 - 19.2	17.1 ± 2.08	8.35 - 9.91	9.08 ± 0.78
	Near-Bank Caged	13.4 - 17.0	15.6 ± 1.94	7.39 - 8.01	7.62 ± 0.34
STM-05					
June 2016	Near-Bank Seeded	32.2 - 42.8	39.0 ± 5.95	39.6 - 56.1	47.7 ± 8.25
	Near-Bank Caged	38.7 - 59.2	50.8 ± 10.7	20.6 - 36.8	29.9 ± 8.4
	Mid-Channel Caged	9.7 - 22.9	16.2 ± 6.59	5.13 - 8.56	7.07 ± 1.76
October 2016	Near-Bank Seeded	17.8 - 24.8	20.9 ± 3.6	10.2 - 12.9	11.7 ± 1.41
	Near-Bank Caged	18.0 - 22.6	20.7 ± 2.41	8.49 - 10.6	9.62 ± 1.06
STM-07					
June 2016	Near-Bank Seeded	20.1 - 62.1	47.5 ± 23.8	18.9 - 58.4	41.9 ± 20.5
	Near-Bank Caged	31.1 - 59.3	42.5 ± 14.8	22.6 - 25.8	24.4 ± 1.61
	Mid-Channel Caged	10.6 - 28.0	20.1 ± 8.77	3.68 - 10.3	7.71 ± 3.54
October 2016	Near-Bank Seeded	22.1 - 27.3	25.0 ± 2.64	13.7 - 15.7	14.7 ± 1.00
	Near-Bank Caged	18.3 - 22.2	20.5 ± 2.01	6.16 - 7.53	6.82 ± 0.69

Notes:

IHg, Inorganic mercury

MeHg, Methylmercury

µg/kg ww, Micrograms per kilogram, wet weight

Mean ± SD, Arithmetic mean ± standard deviation

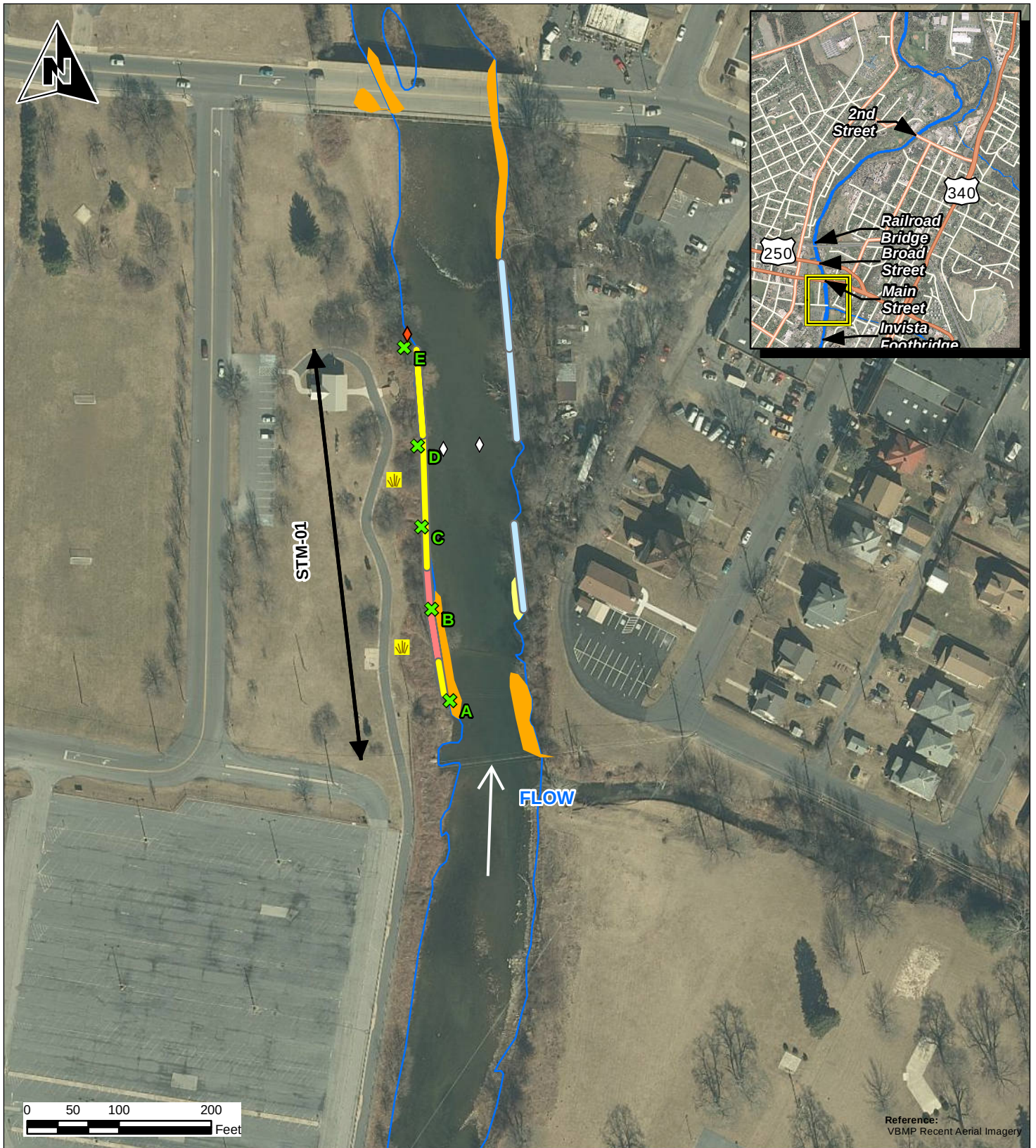
Table 6
Riparian Vegetative Survey Summary
2016 Short-Term Monitoring Report
Former DuPont Waynesboro Site, Area of Concern 4

Vegetative Species		Absolute % Cover ¹	
Scientific Name	Common Name	Spring 2016	Fall 2016
STM-01			
Tree/Vine Stratum			
<i>Robinia pseudoacacia</i>	Black Locust	0-40	0-40
<i>Platanus occidentalis</i>	American Sycamore	0-10	0-10
Sapling/Shrub Stratum			
<i>Robinia pseudoacacia</i>	Black Locust	0-10	0-10
<i>Lonicera tatarica</i>	Tartarian honeysuckle	0-70	0-70
<i>Phytolacca americana</i>	American Pokeweed	NA	0-5
Herbaceous Stratum			
<i>Fallopia japonica</i>	Japanese-Knotweed	60-80	60-80
<i>Rumex crispus</i>	Curly Dock	0-5	0-5
<i>Alliaria petiolata</i>	Garlic Mustard	5-10	5-10
<i>Arctium minus</i>	Lesser Burdock	5-5	5-5
<i>Rubus allegheniensis</i>	Common Blackberry	0-10	0-10
<i>Rubus pensilvanicus</i>	Pennsylvania Blackberry	0-10	0-10
STM-05			
Tree/Vine Stratum			
<i>Juglans nigra</i>	Black Walnut	60-70	60-70
<i>Robinia pseudoacacia</i>	Black Locust	0-15	0-15
<i>Platanus occidentalis</i>	American Sycamore	0-20	0-20
<i>Catalpa speciosa</i>	Northern Catalpa	0-15	0-15
Sapling/Shrub Stratum			
<i>Lonicera tatarica</i>	Tartarian honeysuckle	40-50	40-50
<i>Juglans nigra</i>	Black Walnut	0-30	0-30
<i>Cornus amomum</i>	Silky Dogwood	0-15	0-15
<i>Rhus typhina</i>	Staghorn Sumac	0-15	0-15
<i>Acer platanoides</i>	Norway Maple	0-10	0-10
<i>Rosas multiflora</i>	Multiflora Rose	0-5	0-5
<i>Quercus montana</i>	Chestnut Oak	0-5	0-5
<i>Albizia julibrissin</i>	Persian Silk Tree	0-5	0-5
Herbaceous Stratum			
None Observed	NA	NA	NA
STM-07			
Tree/Vine Stratum			
<i>Rhus typhina</i>	Staghorn Sumac	0-50	0-50
<i>Juglans nigra</i>	Black Walnut	40-50	40-50
<i>Robinia pseudoacacia</i>	Black Locust	0-20	0-20
<i>Acer negundo</i>	Ash-Leaf Maple	0-10	0-10
<i>Platanus occidentalis</i>	American Sycamore	0-10	0-10
Sapling/Shrub Stratum			
<i>Lonicera tatarica</i>	Tartarian honeysuckle	40-75	40-75
<i>Lonicera maackii</i>	Amur Honeysuckle	0-10	0-10
Herbaceous Stratum			
<i>Fallopia japonica</i>	Japanese-Knotweed	0-10	0-10

Notes:

- 1, Represents the range observed between two riparian vegetative survey plots per Short-term Monitoring station.
- NA, Not applicable

Figures



AECOM

625 West Ridge Pike, Suite E-100
Conshohocken, PA 19428
Phone: (610) 832-3500 Fax: (610) 832-3501

Job: 60487139

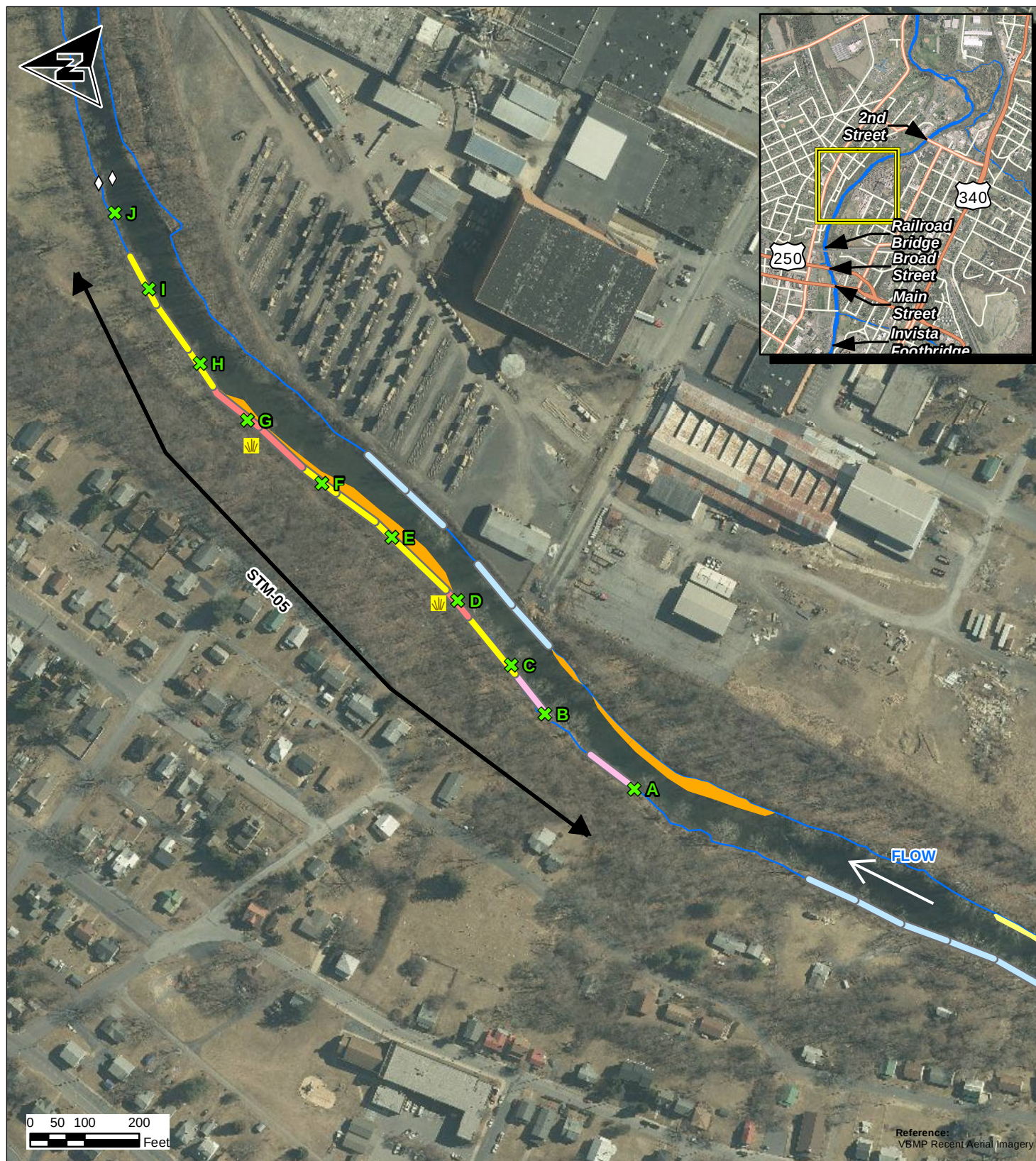
Prepared by: DCB/PJL

Checked by: SD

Date: 3/2/2017

Figure 2: Sheet 1 of 3
Short-Term Monitoring Stations Overview Map
2016 Short-Term Monitoring Report

Former Dupont Waynesboro Site, Area of Concern 4
Waynesboro, Virginia



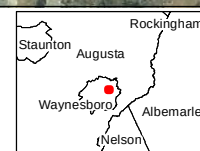
Legend

- ◇ Spring/Fall Periphyton/Clam
- ✕ Sediment/PoreWater/Canopy/Pebble Count
- ✕ Vegetative Plots
- Extent of Short-term Monitoring Location
- Clay and Silt Deposits
- Fine Sand Deposits
- Shoreline

Bank Management Area

- BMAs not included in 2016 STM monitoring program
- Phase 1A Primary BMAs
- Phase 1A Secondary BMAs
- Phase 1B Primary BMAs
- Phase 1B Secondary BMAs

Reference:
VBMP Recent Aerial Imagery



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Conshohocken, PA 19428
Phone: (610) 832-3500 Fax: (610) 832-3501

Job: 60487139

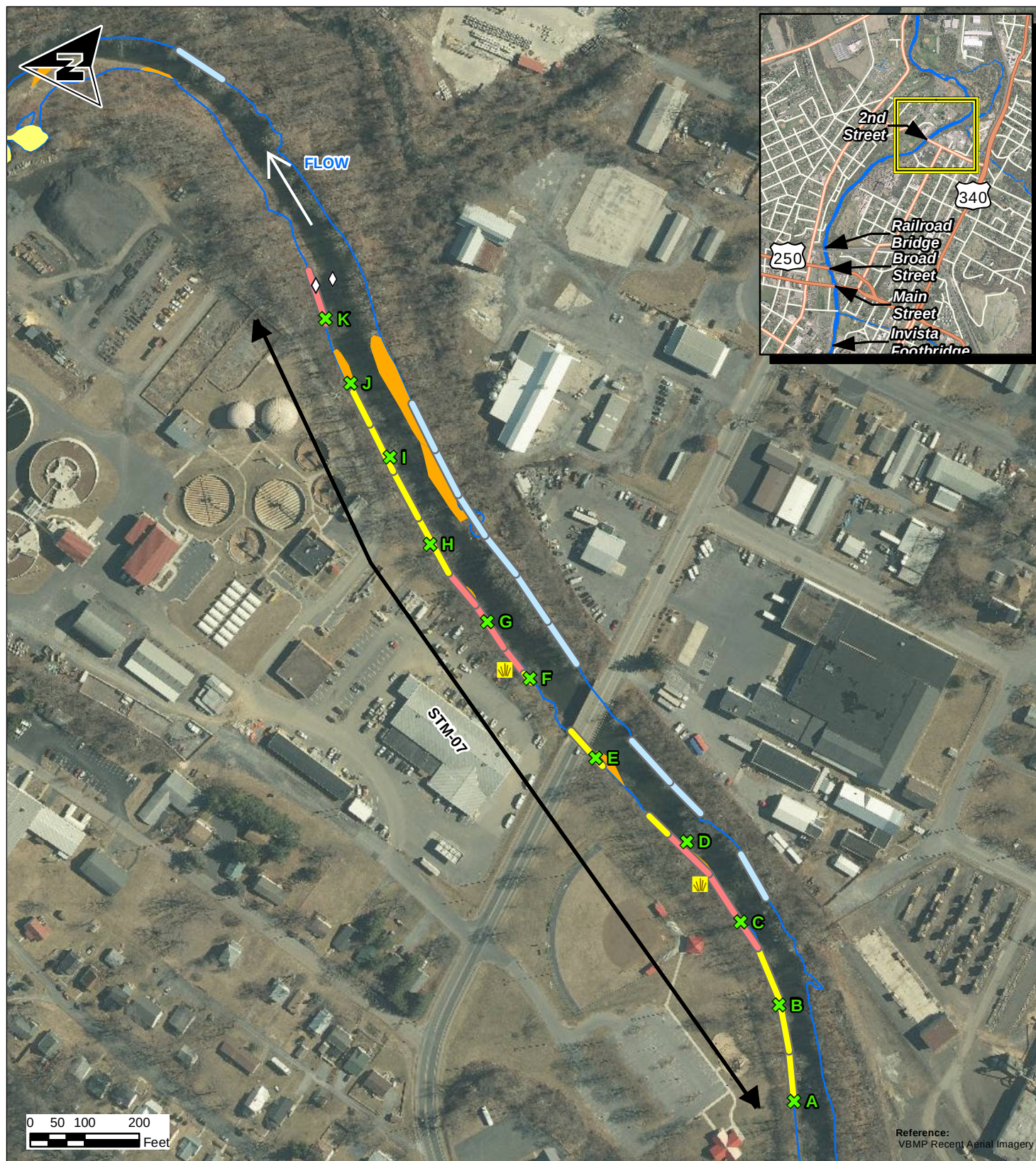
Prepared by: DCB/PJL

Checked by: SD

Date: 3/2/2017

Figure 2: Sheet 2 of 3 Short-Term Monitoring Stations Overview Map 2016 Short-Term Monitoring Report

Former Dupont Waynesboro Site, Area of Concern 4
Waynesboro, Virginia



Legend

- ◇ Spring/Fall Periphyton/Clam
- ✕ Sediment/PoreWater/Canopy/Pebble Count
- ↔ Extent of Short-term Monitoring Location
- 🌱 Clay and Silt Deposits
- 🌱 Vegetative Plots
- 🌱 Fine Sand Deposits
- 🌊 Shoreline

Bank Management Area

- 🔵 BMAs not included in 2016 STM monitoring program
- 🔴 Phase 1A Primary BMAs
- 🟡 Phase 1A Secondary BMAs
- 🟠 Phase 1B Primary BMAs
- 🟡 Phase 1B Secondary BMAs

Reference:
VBMP Recent Aerial Imagery



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625 West Ridge Pike, Suite E-100
Conshohocken, PA 19428
Phone: (610) 832-3500 Fax: (610) 832-3501

Job: 60487139

Prepared by: DCB/PJL

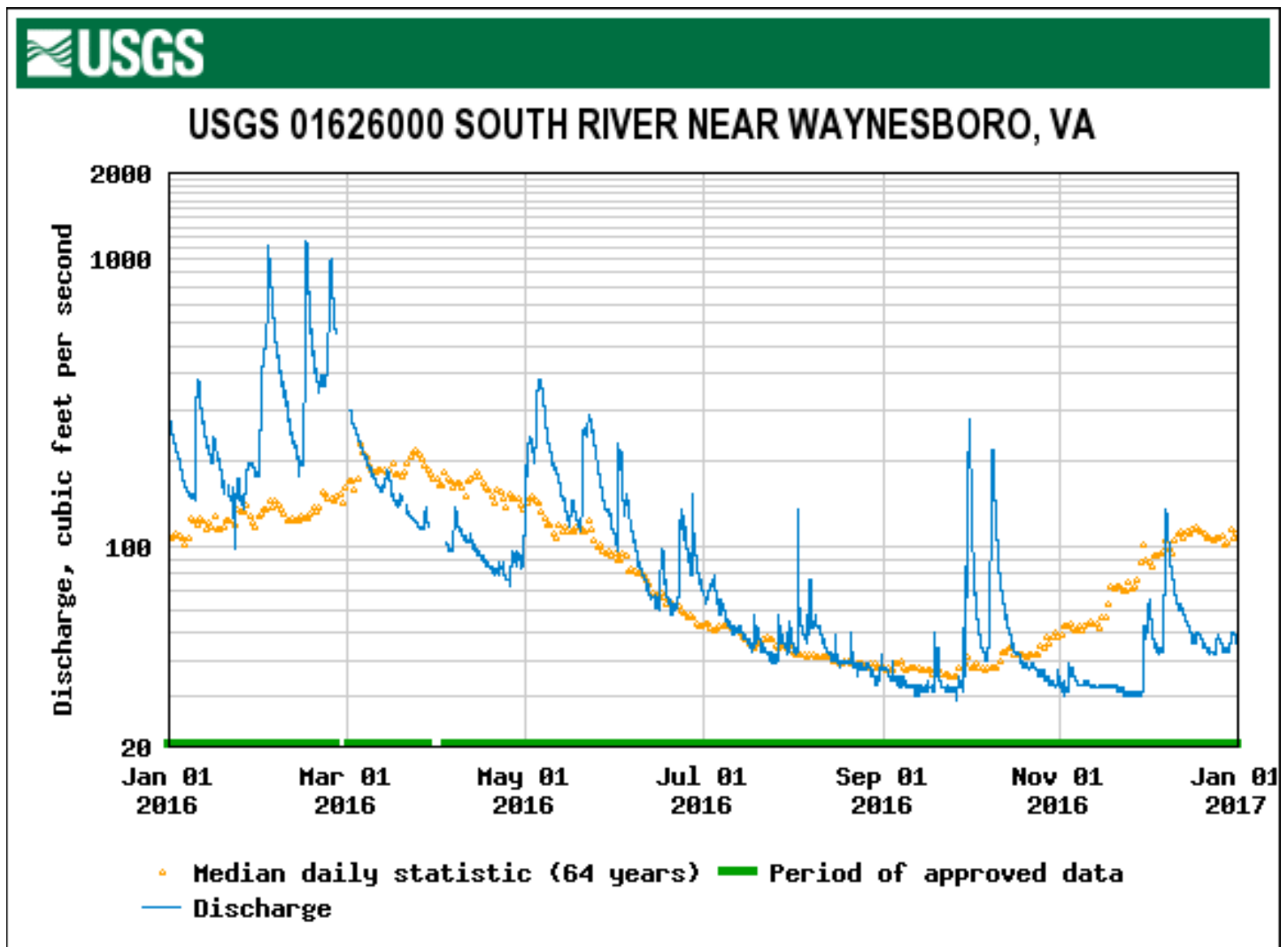
Checked by: SD

Date: 3/2/2017

Figure 2: Sheet 3 of 3 Short-Term Monitoring Stations Overview Map 2016 Short-Term Monitoring Report

Former Dupont Waynesboro Site, Area of Concern 4
Waynesboro, Virginia

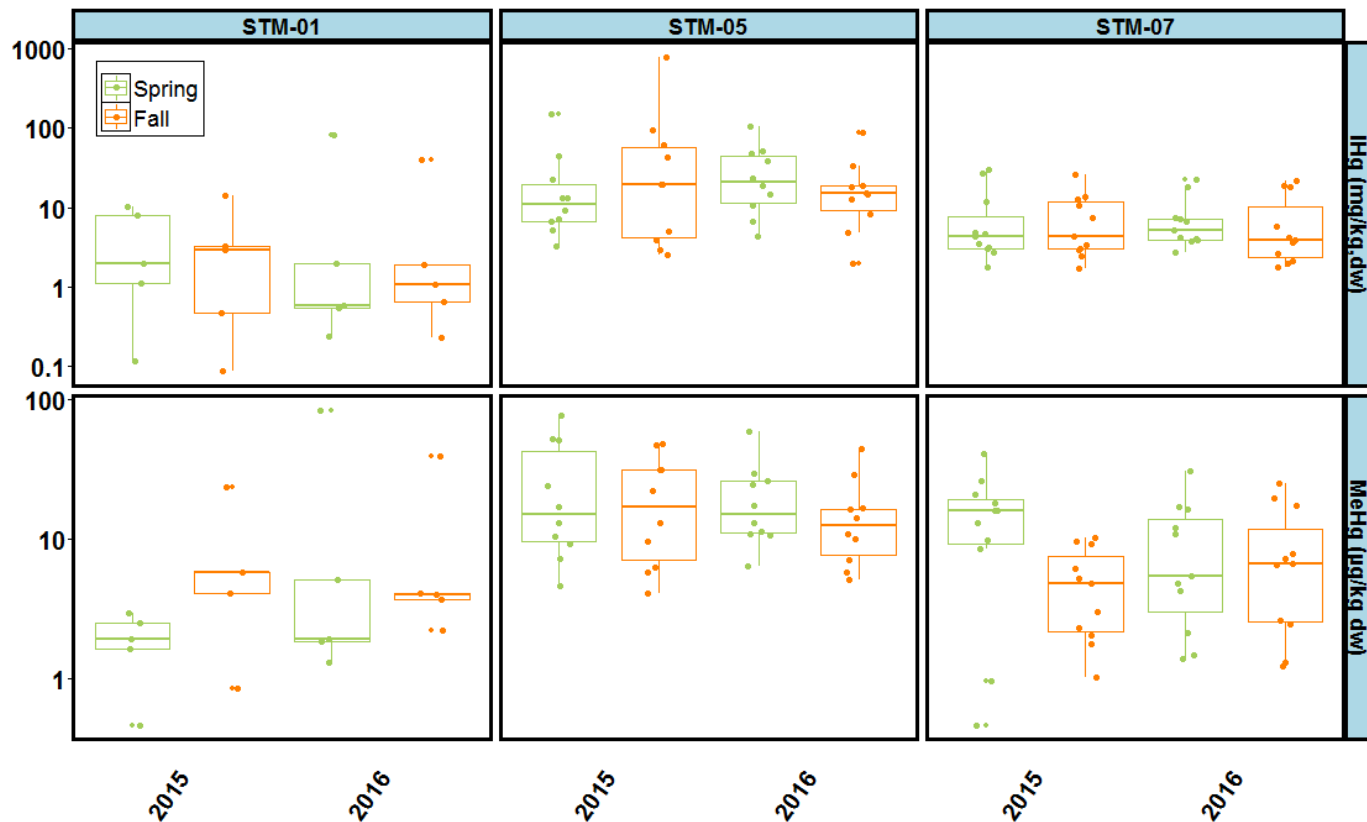
Figure 3
2016 Discharge Data at USGS Station # 01626000
2016 Short-Term Monitoring Report
Former DuPont Waynesboro Site, Area of Concern 4



Source:

https://nwis.waterdata.usgs.gov/nwis/uv?cb_00060=on&cb_00065=on&format=gif_stats&site_no=01626000&period=&begin_date=2016-01-01&end_date=2016-12-31 (Accessed on 3/6/2017)

Figure 4
 Summary of Mercury Concentrations in Sediment
 2016 Short-Term Monitoring Report
 Former DuPont Waynesboro Site, Area of Concern 4



Notes:

IHg, Inorganic mercury

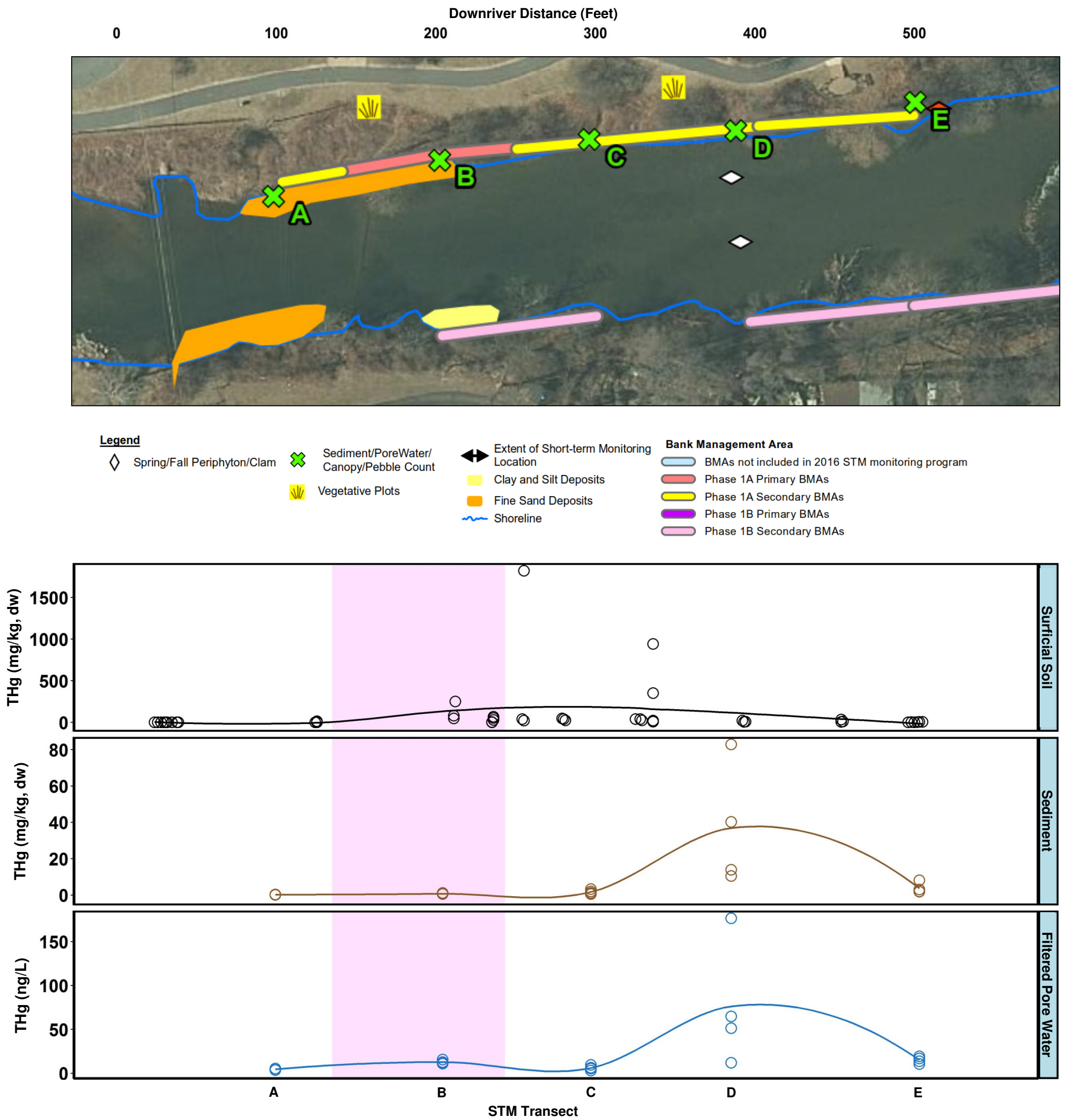
MeHg, Methylmercury

mg/Kg, Milligrams per kilogram

µg/kg, Micrograms per kilogram

dw, Dry weight

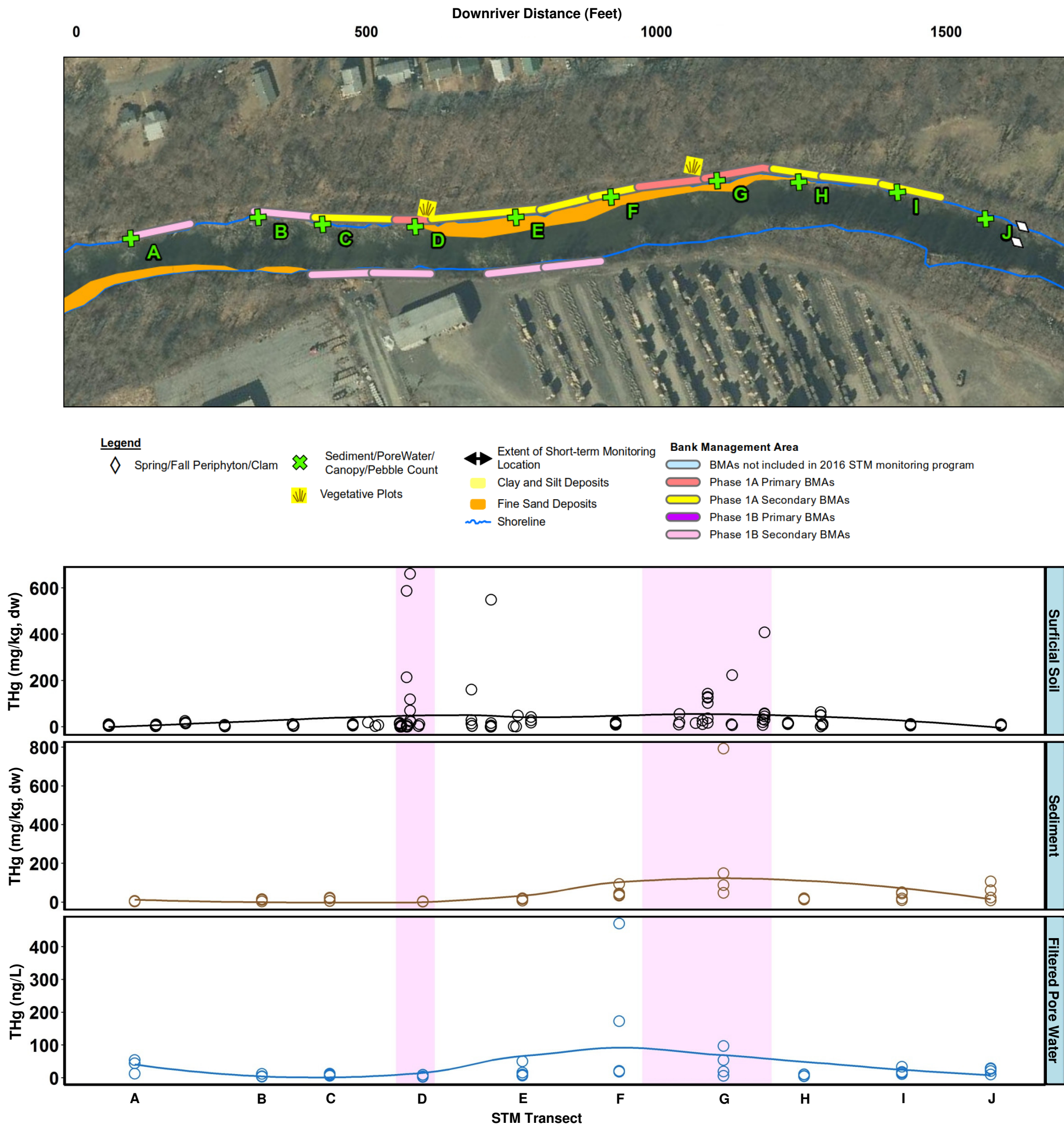
Figure 5
Total Mercury Concentrations in Surficial Bank Soil, Sediment, and Filtered Pore Water- STM-01
2016 Short-term Monitoring Report
Former DuPont Waynesboro Site, Area of Concern 4



Notes:

Data shown are total mercury (THg) concentrations on surficial bank soil [miligrams per kilogram (mg/kg), dry weight (dw)], near-bank sediment (mg/kg dw), and near-bank filtered pore water [nanograms per liter (ng/L)]; sediment and pore water data were collected as part of the spring and fall STM events conducted in 2015 and 2016. Data are fit with loess curves to show spatial relationships of THg among the sample media. Pink shaded areas represent bank segments where removal of mercury-impacted soils are anticipated.

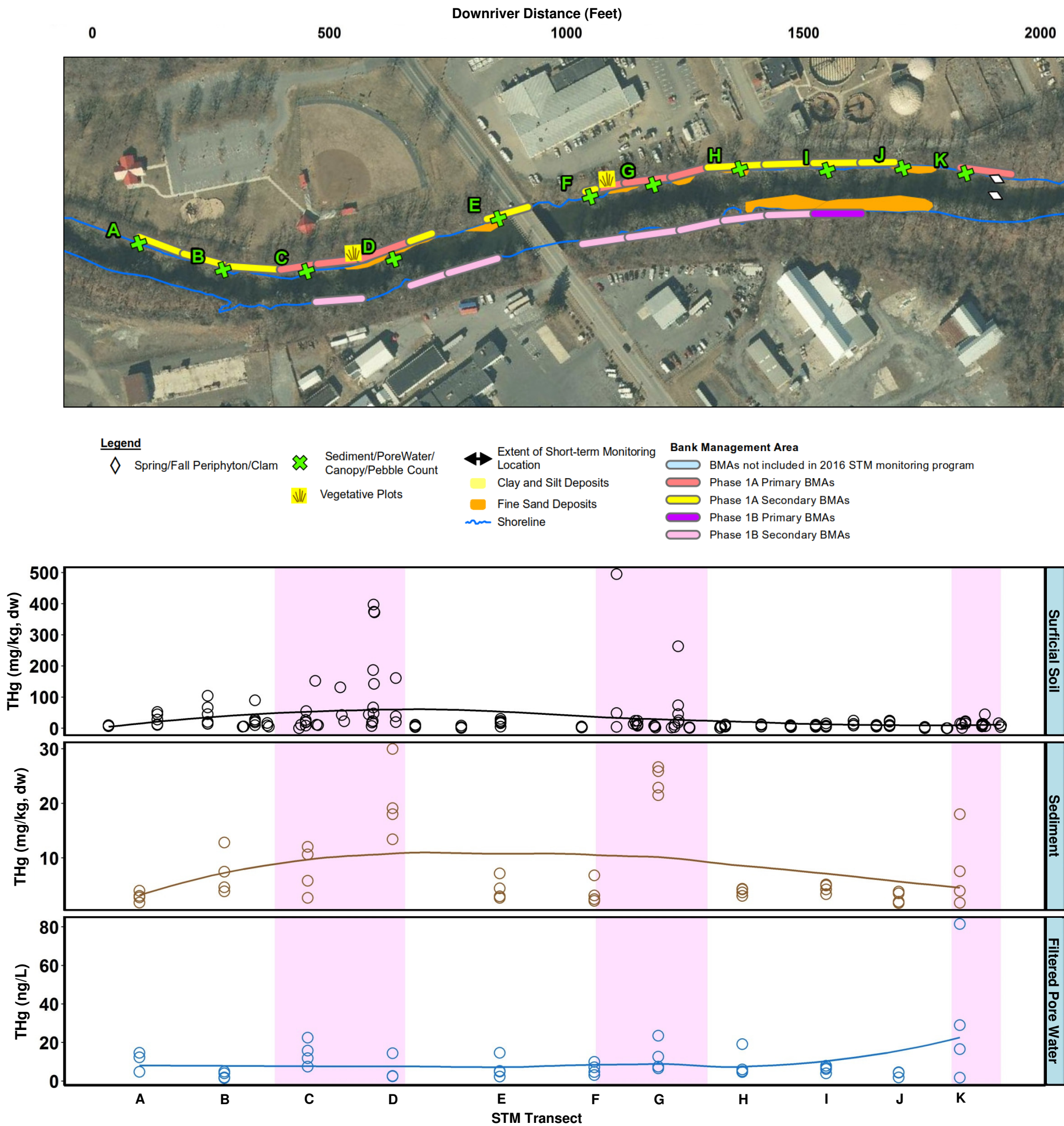
Figure 6
Total Mercury Concentrations in Surficial Bank Soil, Sediment, and Filtered Pore Water- STM-05
2016 Short-term Monitoring Report
Former DuPont Waynesboro Site, Area of Concern 4



Notes:

Data shown are total mercury (THg) concentrations on surficial bank soil [miligrams per kilogram (mg/kg), dry weight (dw)], near-bank sediment (mg/kg dw), and near-bank filtered pore water [nanograms per liter (ng/L)]; sediment and pore water data were collected as part of the spring and fall STM events conducted in 2015 and 2016. Data are fit with loess curves to show spatial relationships of THg among the sample media. Pink shaded areas represent bank segments where removal of mercury-impacted soils are anticipated.

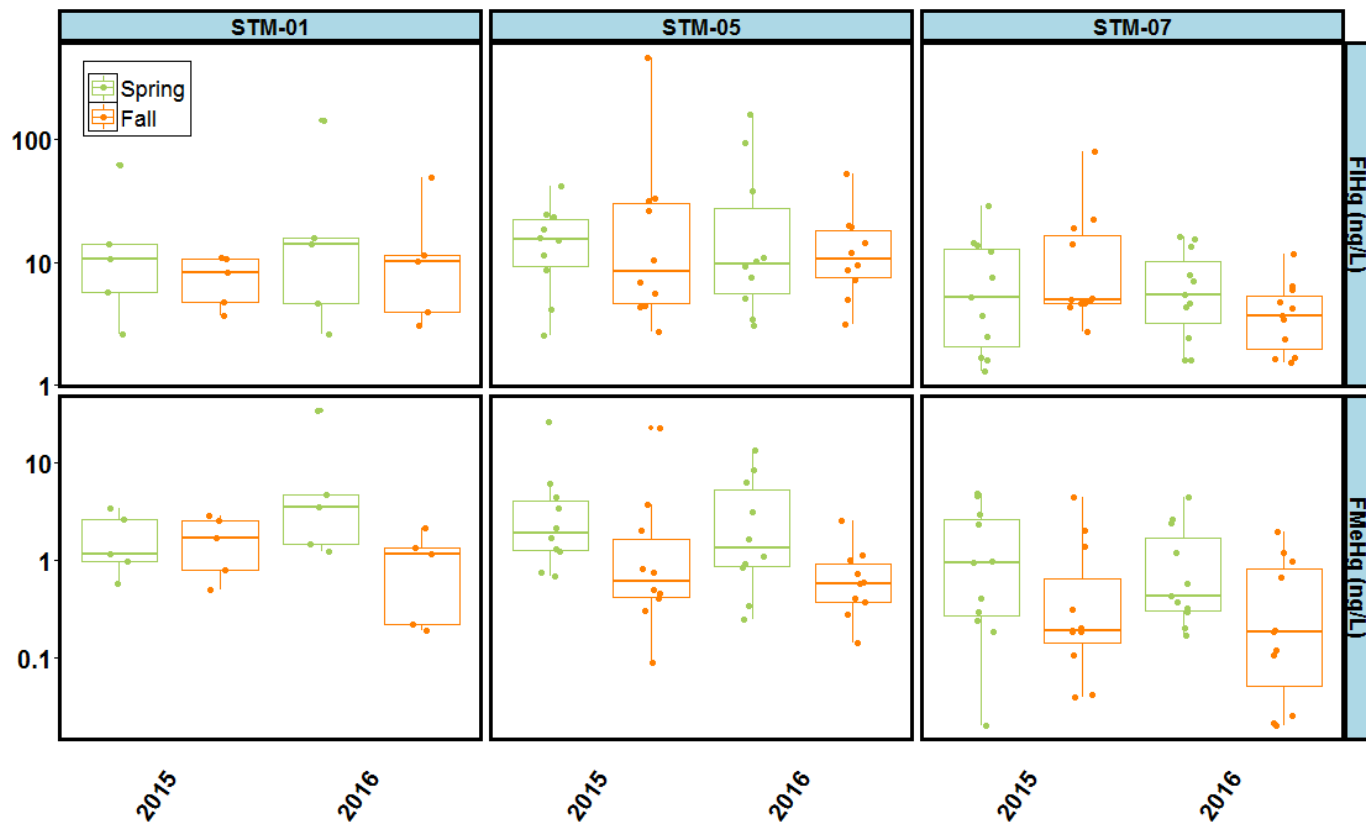
Figure 7
Total Mercury Concentrations in Surficial Bank Soil, Sediment, and Filtered Pore Water- STM-07
2016 Short-term Monitoring Report
Former DuPont Waynesboro Site, Area of Concern 4



Notes:

Data shown are total mercury (THg) concentrations on surficial bank soil [miligrams per kilogram (mg/kg), dry weight (dw)], near-bank sediment (mg/kg dw), and near-bank filtered pore water [nanograms per liter (ng/L)]; sediment and pore water data were collected as part of the spring and fall STM events conducted in 2015 and 2016. Data are fit with loess curves to show spatial relationships of THg among the sample media. Pink shaded areas represent bank segments where removal of mercury-impacted soils are anticipated.

Figure 8
Summary of Mercury Concentrations in Filtered Pore Water
2016 Short-Term Monitoring Report
Former DuPont Waynesboro Site, Area of Concern 4



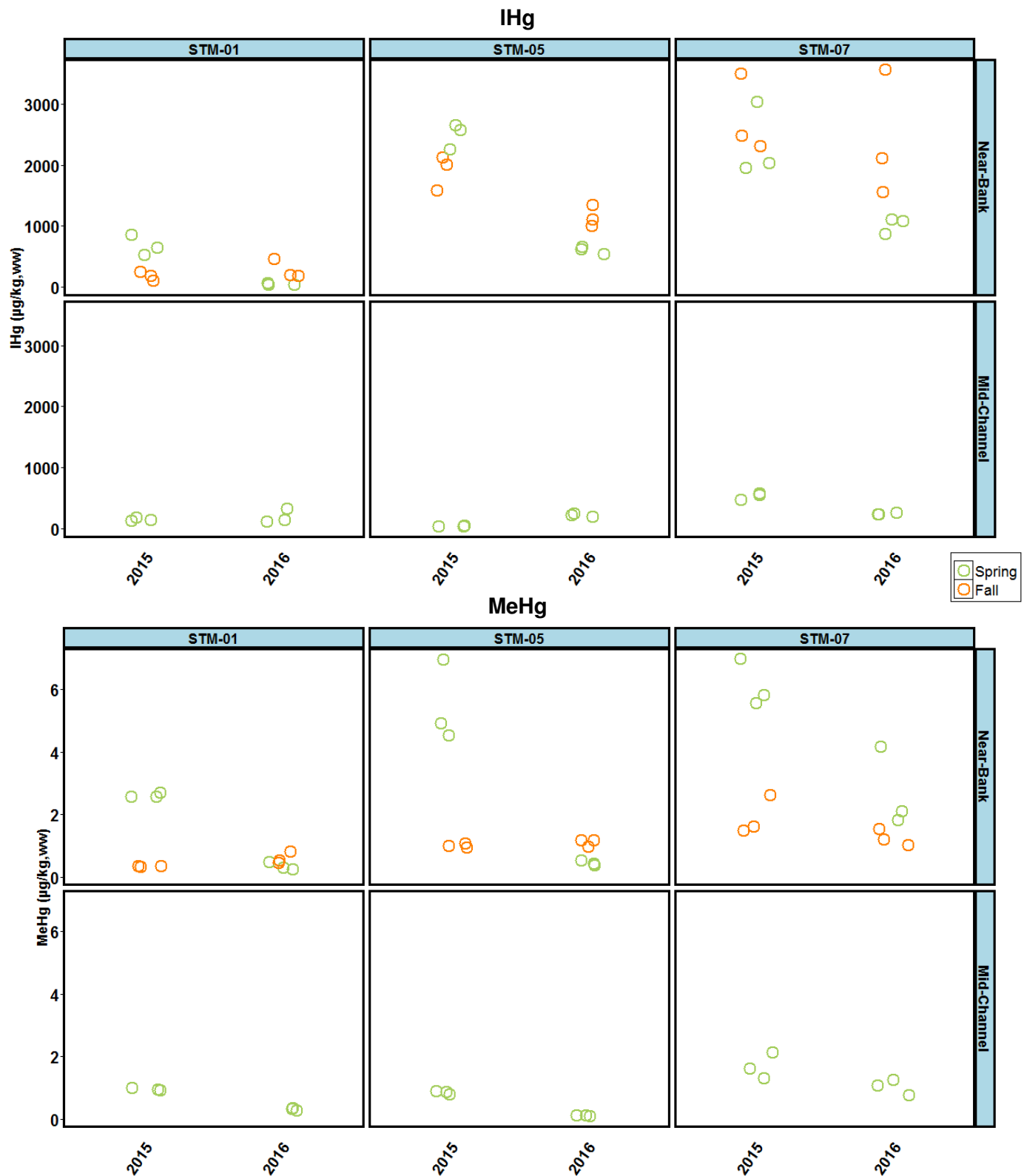
Notes:

FIHg, Inorganic mercury (filtered fraction)

FMeHg, Methylmercury (filtered fraction)

ng/L, nanograms per liter

Figure 9
Summary of Mercury Concentrations in Periphyton
2016 Short-Term Monitoring Report
Former DuPont Waynesboro Site, Area of Concern 4



Notes:

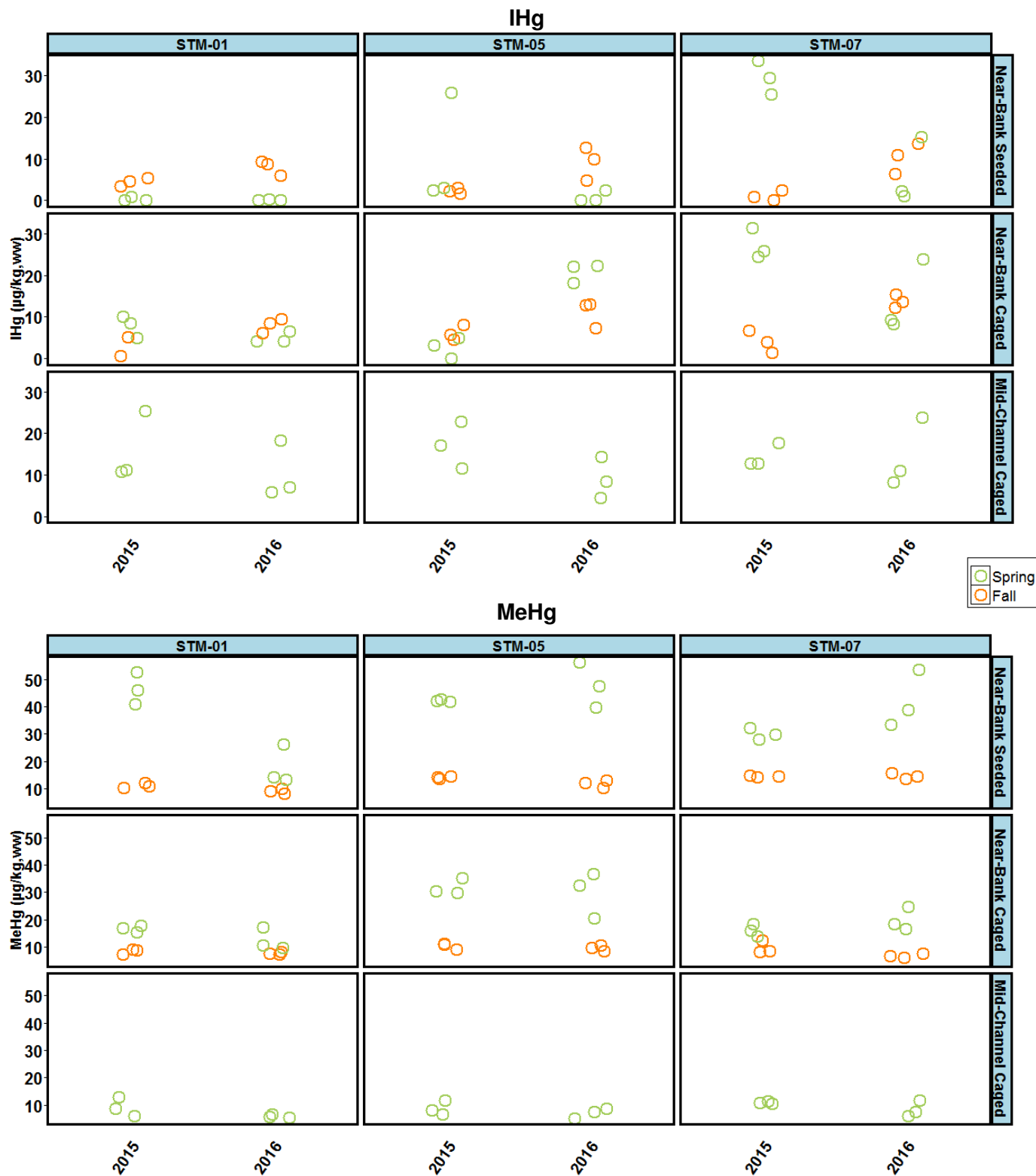
IHg, Inorganic mercury

MeHg, Methylmercury

µg/kg, Micrograms per kilogram

ww, Wet weight

Figure 10
 Summary of Mercury Concentrations in Transplanted Asiatic Clams (*Corbicula*)
 2016 Short-Term Monitoring Report
 Former DuPont Waynesboro Site, Area of Concern 4



Notes:

IHg, Inorganic mercury

MeHg, Methylmercury

µg/kg, Micrograms per kilogram

ww, Wet weight

Apppendices

Appendix A

Photographic Log of Short-Term Monitoring Stations

Client Name: DuPont		Site Location: South River – Short-Term Monitoring	Project No. 60487139
Photo No. 1	Date: 10/10/2016		
Direction Photo Taken: South			
Description: Long view of STM-01 with Invista Plant in the background.			

Photo No. 2	Date: 06/08/2016	
Direction Photo Taken: North		
Description: Long view of STM-01 proximal to transect A. Japanese Knotweed (<i>Reynoutria japonica</i>) on riverbank left.		

Client Name: DuPont		Site Location: South River – Short-Term Monitoring	Project No. 60487139
Photo No. 3	Date: 06/08/2016		
Direction Photo Taken: West			
Description: Improvised access path to the river proximal to STM-01, transect A.			

Photo No. 4	Date: 06/07/2016	
Direction Photo Taken: Northwest		
Description: Erosional bank and attached fine-grained channel margin deposit at STM-05.		

Client Name: DuPont		Site Location: South River – Short-Term Monitoring	Project No. 60487139
Photo No. 5	Date: 06/07/2016		
Direction Photo Taken: North			
Description: Natural LWD (submerged) on left bank of STM-05.			

Photo No. 6	Date: 10/11/2016	
Direction Photo Taken: North		
Description: Overhanging vegetation with undercut banks beneath at STM-05. Large woody debris present along the bank.		

Client Name: DuPont		Site Location: South River – Short-Term Monitoring	Project No. 60487139
Photo No. 7	Date: 06/07/2016		
Direction Photo Taken: Northeast			
Description: Extensive exposed roots at the toe of slope at STM-05 downstream of Transect C. Leaning American sycamore (with orange flagging) due to undercutting.			

Photo No. 8	Date: 06/07/2016	
Direction Photo Taken: North		
Description: Improvised access path to river at STM-07 with exposed soil.		

Client Name: DuPont		Site Location: South River – Short-Term Monitoring	Project No. 60487139
Photo No. 9	Date: 10/11/2016		
Direction Photo Taken: North			
Description: Cobble riffle at the upstream extent of STM-07.			

Photo No. 10	Date: 10/12/2016	
Direction Photo Taken: West		
Description: Exposed bedrock on the left bank of STM-07, transect I.		

Client Name: DuPont		Site Location: South River – Short-Term Monitoring	Project No. 60487139
Photo No. 11	Date: 10/11/2016		
Direction Photo Taken: Northwest			
Description: Erosional area with significant undercutting and exposed roots on the left bank at STM-07 proximal to transect J.			

Photo No. 12	Date: 06/07/2016	
Direction Photo Taken: Northeast		
Description: Gravel bar at the downstream extent of STM-07.		

Appendix B

Ancillary Short-Term Monitoring Metrics

Appendix B

Ancillary Short-Term Monitoring Habitat Metrics

AOC 4 2016 Short-Term Monitoring Report

Former DuPont Waynesboro Site, Virginia

This appendix presents a summary of ancillary habitat-specific metrics conducted during the 2016 pre-interim measures, baseline Short-Term Monitoring (STM) events. These ancillary parameters are being evaluated to address stakeholder concerns regarding preservation of existing ecological habitats during the implementation of the Phase I interim measures and are not part of the Virginia Department of Environmental Quality (VDEQ) approved STM Plan under the Resource Conservation and Recovery Act (RCRA).

Canopy Cover

Canopy cover was assessed using a spherical densiometer to quantify the percent canopy cover at each STM station in the spring of 2016. The spherical densiometer is a concave mirror that is divided into 96 cells. The number of cells with open sky (out of 96 available) were recorded. Four densiometer readings (i.e., number of cells with open sky) were collected from the middle of the river (one facing each compass direction), co-located with each sediment and pore water sampling transect. The arithmetic mean was calculated for the four readings collected at each transect, which was then used to determine the overall arithmetic mean percent (%) open sky and % canopy cover for each STM station. Overall, mean percent canopy cover at STM-01, STM-05, and STM-07 was 14.8%, 32.0%, and 35.0%, respectively (see Table B-1).

Aquatic/Riparian Habitat

Additional assessments of aquatic and riparian habitat, similar to the EPA Rapid Bioassessment Protocols (RBPs), were conducted [i.e., Evaluation of Planned Wetlands (EPW), and Unified Stream Methodology (USM)] with the goal of documenting baseline habitat quality and ecological function.

Evaluation for Planned Wetlands

The Evaluation for Planned Wetlands (Bartoldus et al., 1994) is an assessment methodology that can be used to evaluate pre- and post-restoration/creation ecological function and value of an ecosystem, typically a wetland. For this assessment, only the Non-Tidal Fish assessment (EPW Fish) was conducted as other elements of the EPW are redundant with the RBP metrics already conducted as part of the Area of Concern (AOC) 4 STM Plan. The EPW Fish Functional Capacity Index (FCI) is composed of 20 monitoring elements that are separated into the following four categories: limiting factors, food/cover, reproduction, and water quality. Individual scores for each element were averaged within the four categories to determine the overall FCI which ranges from zero to one, with 0 being a limited ecological value and 1 representing a high ecological value. The EPW assessment was conducted in the fall of 2016; the EPW Fish scores for STM-01, STM-05, and STM -07 were 0.58, 0.62, and 0.55, respectively, indicating a moderate functional capacity for fish populations.

Unified Stream Methodology

The USM was completed in accordance with *Unified Stream Methodology for Use in Virginia* (U.S. Army Corps of Engineers (USACE) and VDEQ, 2007). This approach was used to evaluate potential impacts to the South River by assigning a Reach Condition Index (RCI) for

each STM station. The RCI is based on the condition of the channel, riparian corridor, and instream habitat, as well as the extent of channel alteration. The RCI ranges from 0.5 to 1.5, with streams in poorer condition scoring lower. The USM assessment was conducted in the fall of 2016; RCIs for STM-01, STM-05, and STM-07 were 1.08, 1.18, and 1.05, respectively.

In addition to overall habitat quality, the location, quantity, and approximate size of in-stream habitat features [i.e., large woody debris (LWD)], adjacent to each STM station were characterized and located using a hand-held Global Positioning System (GPS) (see Figure B-1). Presence of in-stream LWD features was monitored twice in 2016, once in the spring and once in the fall; one, 12, and seven in-stream LWD features were observed along STM-01, STM-05, and STM-07, respectively.

River access paths to the river were also surveyed twice in 2016, once in the spring and once in the fall, and located using GPS (see Figure B-1). Eight river access paths to the river, of varying degrees of apparent use, were observed; the river access path observations included four paths at STM-01, four paths at STM-05, and five paths at STM-07. Generally, greater apparent use of the river access paths was evident at STM-01 and the upgradient reach of STM-07, presumably due to the proximity to Constitution Park and North Park, respectively (see Figure B-1).

Benthic Community

Benthic communities were sampled in accordance with EPA RBP methodologies (Barbour et al., 1999) at four locations. Of note, these locations do not directly correspond to STM-01, STM-05, and STM-07; rather, they are spaced approximately 0.5 relative river miles (RRMs) between RRM 0 and RRM 2. At each location, three replicate samples were collected along a gradient of transitional/riffle habitats; each replicate sample was a composite of samples collected at the left, middle, and right points of the wetted stream channel using a standard Surber sampler (see Figure B-1).

Benthic community samples were collected twice in 2016, once in the spring and once in the fall. Preserved benthic community samples were submitted to a laboratory for taxonomic analysis. Results from the benthic community assessment will be compared to post-remediation results as an additional evaluation of overall habitat quality. Descriptive statistics (arithmetic mean $\pm$ standard deviation) of select metrics are provided in Table B-2.

Benthic invertebrate communities are relatively diverse and generally comparable among the sampling locations (i.e., RRM 0.5, RRM 1.0, RRM 1.5, and RRM 2.0) and sampling events [i.e., spring (June) and fall (October)]. However, among all sampling locations, % Diptera/Oligochaeta decreased in October compared to June, likely attributable to increased adult Dipteran emergence between June and October.

Substrate Characterization

Pebble counts are used to assess substrate distribution. Wolman pebble counts (Wolman, 1954) were conducted at each STM sampling transect during the October 2016 monitoring event; 20 data points were collected along each transect, equally spaced, spanning from left bank to right bank. However, water depth and/or flow prevented data collection at some locations.

Substrate sizes were generally evenly distributed throughout all STMs. Sand/fines were observed at a high ratio throughout STM-01 and STM-05, whereas bedrock was observed at a high ratio at STM-07 (see Figure B-2). Of note, although a large amount of Class 1 substrates (i.e., sand/fines) were documented at STM-01 and STM-05, this does not necessarily represent

the presence of large fine-grained deposits, but rather fine-grained substrates that have settled between larger substrates in the riverbed (i.e., embeddedness). The D_{50} (median) substrate size classes for STM-01, STM-05, and STM-07 were 32 millimeters (mm) (coarse gravel), 45 mm (very coarse gravel), and 32 mm (coarse gravel), respectively.

Summary

Additional habitat/ecological function metrics were evaluated to document existing conditions prior to implementation of the Phase 1 Interim Measures for AOC 4. The data summarized above will add to the baseline dataset for which post-remediation datasets will be compared. Overall, habitat and ecological function at the areas evaluated can be generally described as moderate to optimal, which is consistent with the findings of the EPA RBPs conducted as part of the AOC 4 STM program. Canopy cover was low- to moderate (e.g., < 50%) on average at each STM station. Channel substrates were moderately embedded; however, relatively diverse benthic invertebrate communities were documented throughout the RRM 0-2 reach.

Consistent with adaptive management principles for AOC 4, the STM approach may be revised based on documented progress towards the achievement of success criteria, contingency actions, and emerging decision analysis options (URS, 2015). Specifically, monitoring data that do not materially impact the remedial decision process may be reduced or eliminated from the STM program.

References

- AECOM. 2017. *2016 Short-Term Monitoring Report*. Former DuPont Waynesboro Site, Area of Concern 4, Waynesboro, Virginia. Prepared by AECOM. March 2017.
- Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. *Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates and fish*. Second Edition. EPA 841-B-99-002. USEPA Office of Water, Washington, D.C.
- Bartoldus, C.C., E.W. Garbisch, and M.L. Kraus. 1994. *Evaluation for Planned Wetlands (EPW)*. Environmental Concern Inc., St. Michaels, MD. 327 pp. USACE and VDEQ. 2007. Unified Stream Methodology for use in Virginia.
- USACE and VDEQ. 2007. *Unified Stream Methodology for Use in Virginia*.
- Wolman, M.G., 1954. *A method of sampling coarse river-bed material*. Trans. Am. Geophys. Union 35, 951– 956.

Table B-1
Average Canopy Cover
Appendix B Ancillary Short-Term Monitoring Metrics
2016 Short-Term Monitoring Report
Former DuPont Waynesboro Site, Area of Concern 4

Transect ID	Mean Densimeter Reading ¹	Mean Open Sky (%) ¹	Overall Mean Open Sky (%)	Overall Mean Canopy Cover (%)
STM-01				
A	94.0	97.9	85.2	14.8
B	78.0	81.3		
C	92.0	95.8		
D	82.0	85.4		
E	63.0	65.6		
STM-05				
A	33.5	34.9	68.0	32.0
B	54.0	56.3		
C	61.0	63.5		
D	68.0	70.8		
E	69.0	71.9		
F	91.0	94.8		
G	75.0	78.1		
H	70.0	72.9		
I	60.0	62.5		
J	71.0	74.0		
STM-07				
A	74.0	77.1	65.0	35.0
B	47.0	49.0		
C	71.0	74.0		
D	39.0	40.6		
E	80.0	83.3		
F	68.0	70.8		
G	68.0	70.8		
H	57.0	59.4		
I	43.0	44.8		
J	70.0	72.9		
K	69.0	71.9		

Notes:

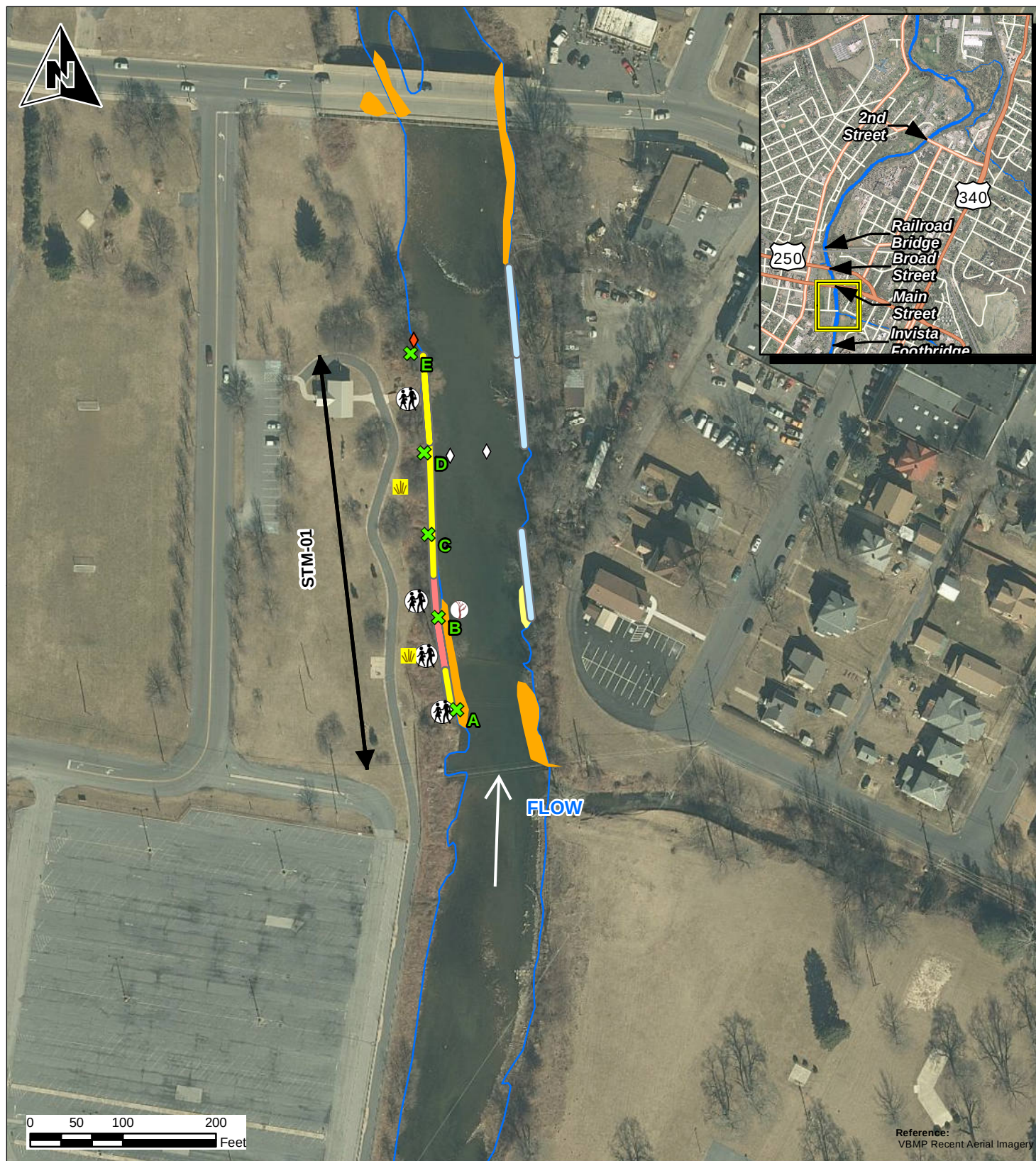
1, Canopy cover was assessed using a spherical densimeter, a concave mirror giving the user a view of the sky and canopy cover above. The mirror is divided into 96 cells; the number of cells with open sky (out of 96 available) were recorded and converted to the proper metric desired. Four densimeter readings (i.e., number of cells with open sky) were collected from the middle of the river, co-located with each sediment and pore water sampling transect; the arithmetic mean was calculated for the four readings collected at each transect. The overall arithmetic mean % open sky and % canopy cover were then calculated for STM-01, STM-05 and STM-07.

Table B-2
Benthic Community Assessment Metrics
Appendix B Ancillary Short-Term Monitoring Metrics
2016 Short-Term Monitoring Report
Former DuPont Waynesboro Site, Area of Concern 4

Metric	Sampling Station / Mean $\pm$ SD			
	RRM 0.5	RRM 1.0	RRM 1.5	RRM 2.0
June 2016				
Corrected Abundance (n)	1396 $\pm$ 217	1507 $\pm$ 448	1286 $\pm$ 466	861 $\pm$ 305
Taxa Richness	30.0 $\pm$ 4.00	28.7 $\pm$ 4.73	36.0 $\pm$ 3.61	29.3 $\pm$ 1.53
% EPT	54.7 $\pm$ 12.7	66.9 $\pm$ 3.02	24.6 $\pm$ 7.53	52.1 $\pm$ 6.84
% Diptera/Oligochaeta	30.0 $\pm$ 9.96	20.2 $\pm$ 1.00	59.0 $\pm$ 18.7	25.3 $\pm$ 3.03
Shannon's H	1.03 $\pm$ 0.08	0.98 $\pm$ 0.02	1.04 $\pm$ 0.13	1.02 $\pm$ 0.05
Pielou's J	0.70 $\pm$ 0.03	0.68 $\pm$ 0.04	0.67 $\pm$ 0.06	0.69 $\pm$ 0.04
Hilsenhoff Biotic Index	4.22 $\pm$ 0.17	4.30 $\pm$ 0.11	4.70 $\pm$ 0.21	4.40 $\pm$ 0.06
October 2016				
Corrected Abundance (n)	1482 $\pm$ 610	805 $\pm$ 448	856 $\pm$ 384	1006 $\pm$ 569
Taxa Richness	24.0 $\pm$ 3.46	26.3 $\pm$ 0.58	26.7 $\pm$ 1.53	24.7 $\pm$ 2.08
% EPT	50.8 $\pm$ 20.5	56.3 $\pm$ 12.3	39.6 $\pm$ 6.72	49.8 $\pm$ 7.49
% Diptera/Oligochaeta	4.45 $\pm$ 1.19	3.28 $\pm$ 1.34	5.66 $\pm$ 0.61	4.32 $\pm$ 2.42
Shannon's H	0.90 $\pm$ 0.02	0.91 $\pm$ 0.07	0.98 $\pm$ 0.02	0.86 $\pm$ 0.07
Pielou's J	0.66 $\pm$ 0.03	0.63 $\pm$ 0.05	0.69 $\pm$ 0.01	0.62 $\pm$ 0.04
Hilsenhoff Biotic Index	4.64 $\pm$ 0.15	4.45 $\pm$ 0.10	4.85 $\pm$ 0.15	4.62 $\pm$ 0.06

Notes:

Mean $\pm$ SD, Arithmetic mean $\pm$ standard deviation
EPT, Ephemeroptera, plecoptera, and trichoptera



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Conshohocken, PA 19428
Phone: (610) 832-3500 Fax: (610) 832-3501

Job: 60487139

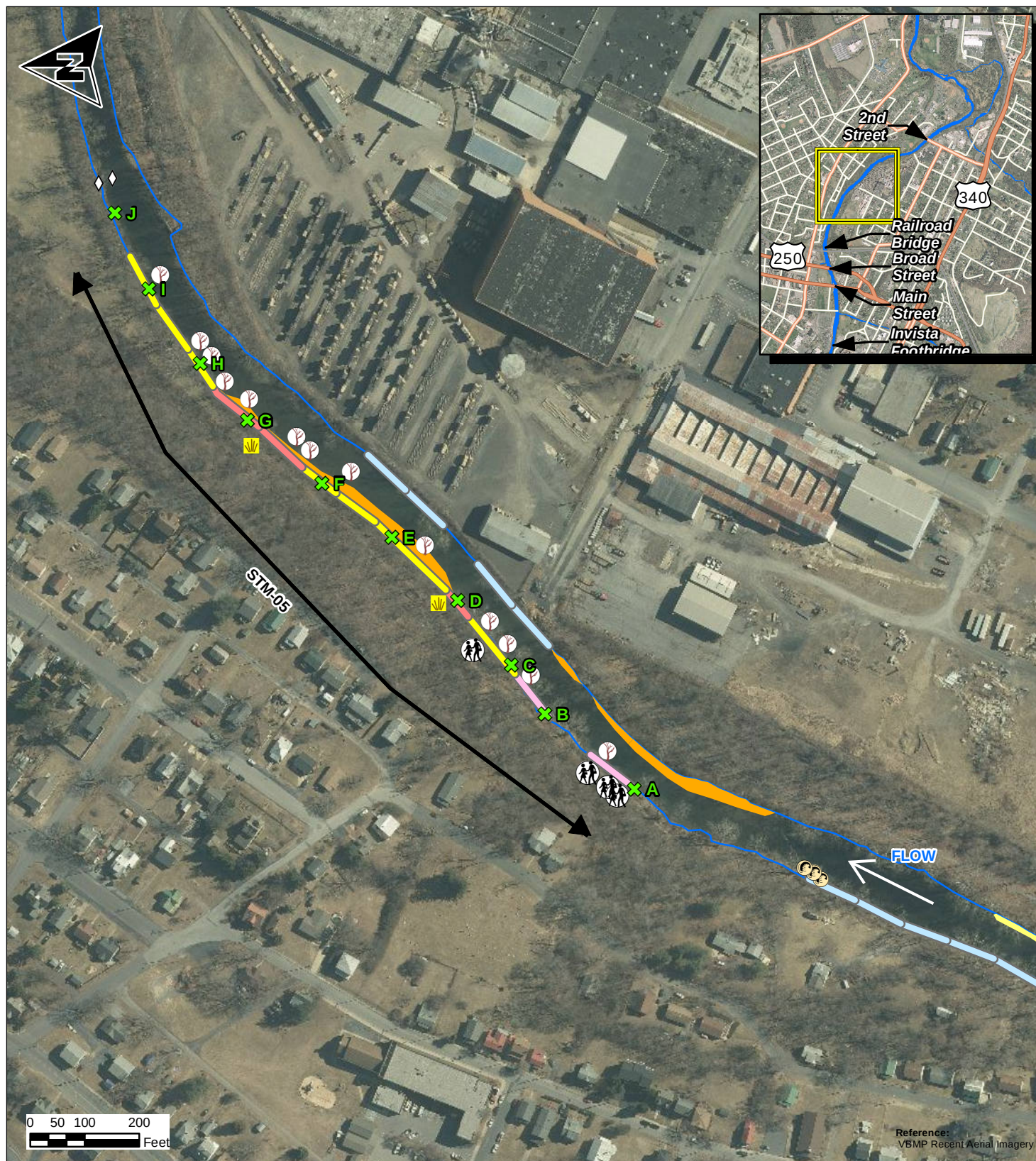
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Checked by: SD

Date: 3/2/2017

Figure B-1: Sheet 1 of 4
Short-Term Monitoring Stations Overview Map
Appendix B Ancillary STM Habitat Metrics
2016 Short-Term Monitoring Annual Report

Former Dupont Waynesboro Site, Area of Concern 4 Waynesboro, VA



Legend

- ◇ Spring/Fall Periphyton/Clam
- ⊗ Sediment/PoreWater/Canopy/Pebble Count
- ⊙ Benthic Community
- ⊙ Large Woody Debris
- ⊙ Vegetative Plots
- ⊙ River Access

- ↔ Extent of Short-term Monitoring Location
- Clay and Silt Deposits
- Fine Sand Deposits
- Shoreline

Bank Management Area

- BMAs not included in 2016 STM monitoring program
- Phase 1A Primary BMAs
- Phase 1A Secondary BMAs
- Phase 1B Primary BMAs
- Phase 1B Secondary BMAs

Reference:
VBMP Recent Aerial Imagery



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625 West Ridge Pike, Suite E-100
Conshohocken, PA 19428
Phone: (610) 832-3500 Fax: (610) 832-3501

Job: 60487139

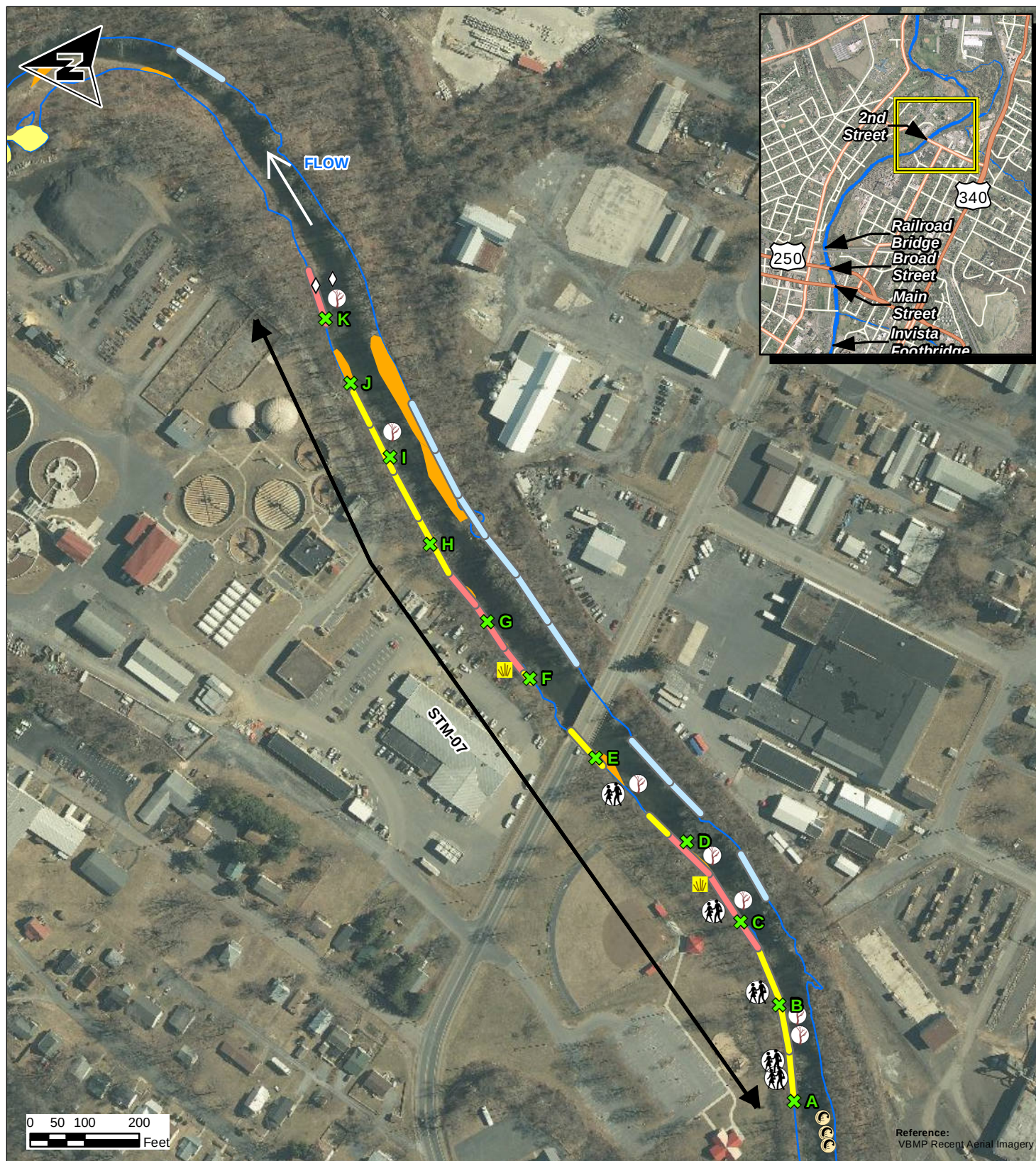
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Figure B-1: Sheet 2 of 4 Short-Term Monitoring Stations Overview Map Appendix B Ancillary STM Habitat Metrics 2016 Short-Term Monitoring Annual Report

Former Dupont Waynesboro Site, Area of Concern 4 Waynesboro, VA



Legend

- ◇ Spring/Fall Periphyton/Clam
- ⊗ Sediment/Porewater/Canopy/Pebble Count
- ⊙ Benthic Community
- ⊙ Large Woody Debris
- ⊙ Vegetative Plots
- ⊙ River Access

- ↔ Extent of Short-term Monitoring Location
- Clay and Silt Deposits
- Fine Sand Deposits
- Shoreline

Bank Management Area

- BMAs not included in 2016 STM monitoring program
- Phase 1A Primary BMAs
- Phase 1A Secondary BMAs
- Phase 1B Primary BMAs
- Phase 1B Secondary BMAs



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Conshohocken, PA 19428
Phone: (610) 832-3500 Fax: (610) 832-3501

Job: 60487139

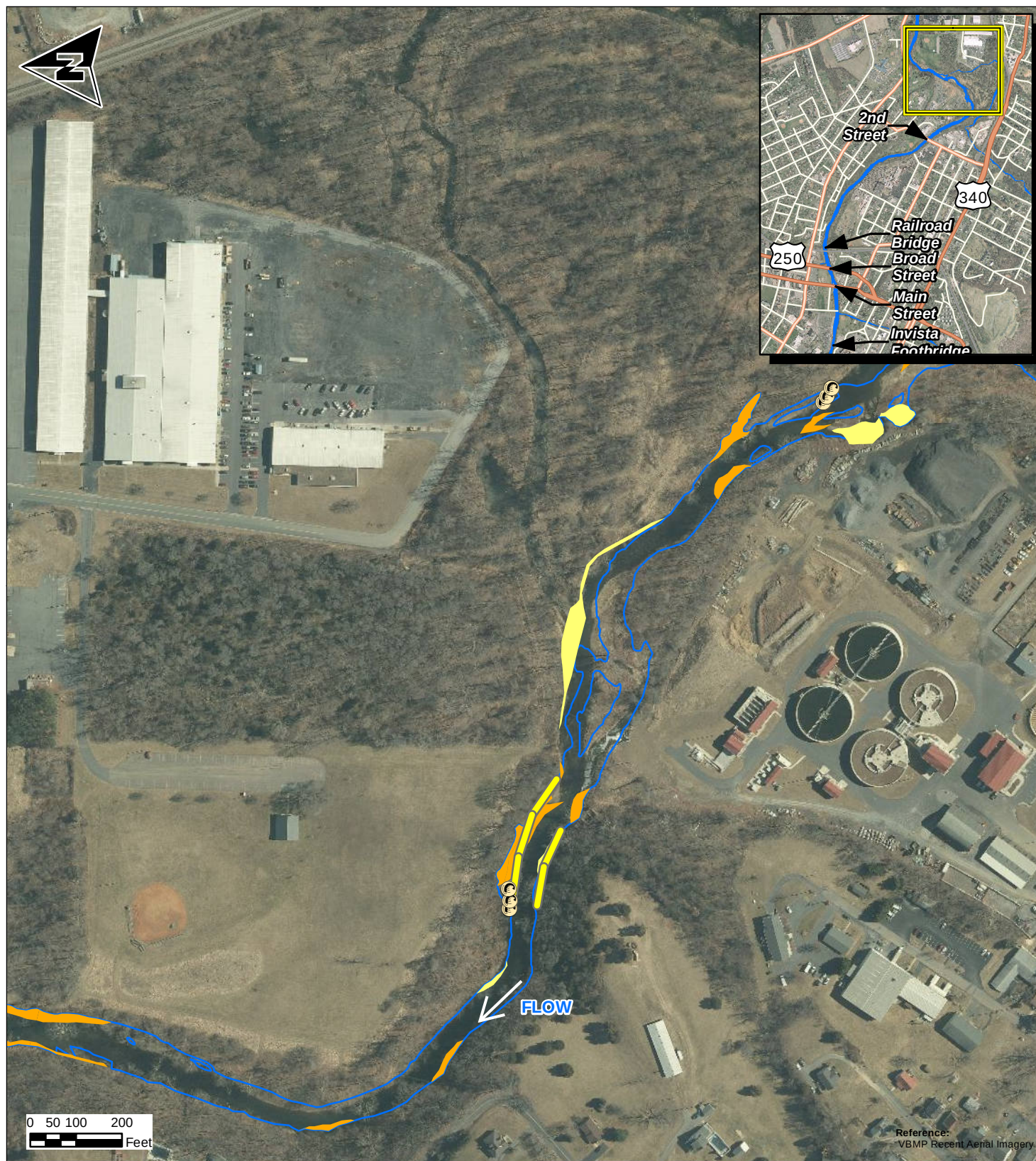
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Figure B-1: Sheet 3 of 4 Short-Term Monitoring Stations Overview Map Appendix B Ancillary STM Habitat Metrics 2016 Short-Term Monitoring Annual Report

Former Dupont Waynesboro Site, Area of Concern 4 Waynesboro, VA



Legend

- ◇ Spring/Fall Periphyton/Clam
- ✕ Sediment/PoreWater/Canopy/Pebble Count
- ⊙ Benthic Community
- ⊙ Large Woody Debris
- ⊙ Vegetative Plots
- ⊙ River Access

- ↔ Extent of Short-term Monitoring Location
- Yellow Clay and Silt Deposits
- Orange Fine Sand Deposits
- Blue Shoreline

Bank Management Area

- Blue BMAs not included in 2016 STM monitoring program
- Red Phase 1A Primary BMAs
- Yellow Phase 1A Secondary BMAs
- Purple Phase 1B Primary BMAs
- Pink Phase 1B Secondary BMAs

Reference:
VBMP Recent Aerial Imagery



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625 West Ridge Pike, Suite E-100
Conshohocken, PA 19428
Phone: (610) 832-3500 Fax: (610) 832-3501

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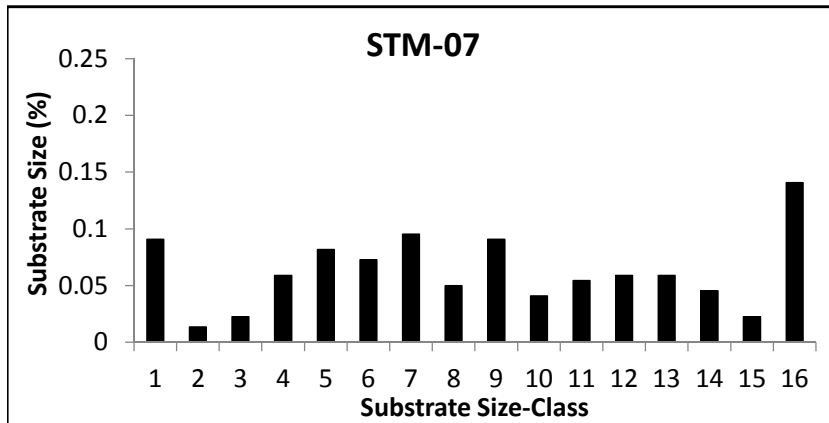
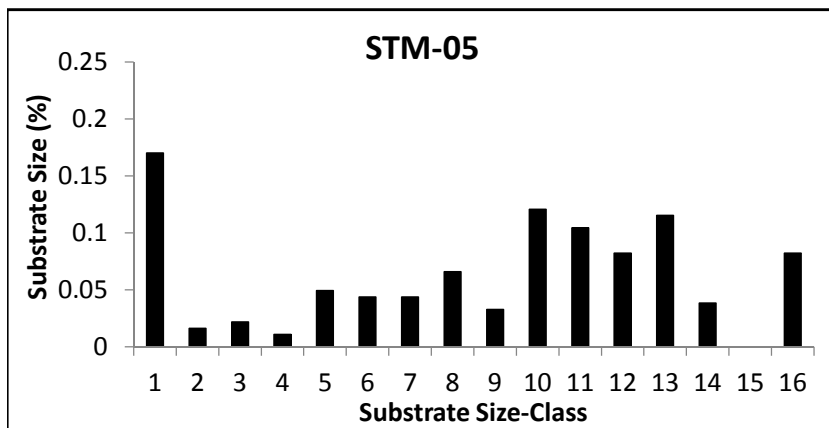
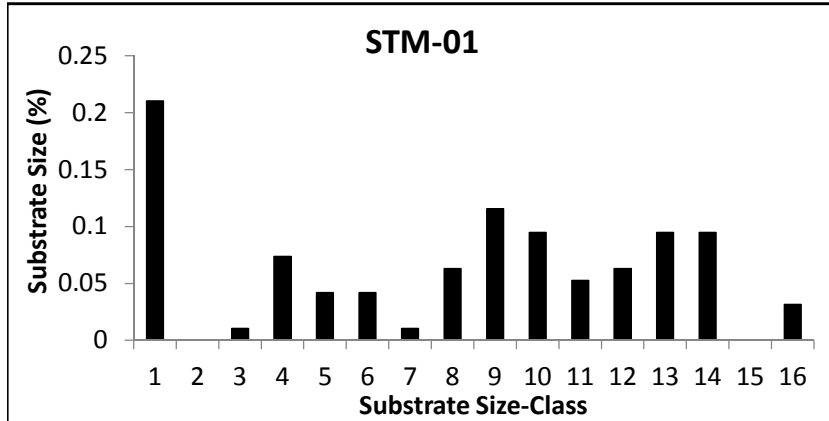
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Figure B-1: Sheet 4 of 4 Short-Term Monitoring Stations Overview Map Appendix B Ancillary STM Habitat Metrics 2016 Short-Term Monitoring Annual Report

Former Dupont Waynesboro Site, Area of Concern 4 Waynesboro, VA

Figure B-2
Substrate Grain Size Survey Summary
Appendix B Ancillary Short-Term Monitoring Metrics
2016 Short-Term Monitoring Report
Former DuPont Waynesboro Site, Area of Concern 4



Substrate Size Class Descriptions		
Substrate Size-Class	Size Range (mm)	Description
1	0 - 2.0	Sand/Fines
2	2.0 - 2.8	Very Fine Gravel
3	2.8 - 4.0	Very Fine Gravel
4	4 - 5.6	Fine Gravel
5	5.6 - 8.0	Fine Gravel
6	8 - 11.0	Medium Gravel
7	11 - 16	Medium Gravel
8	16 - 22.6	Coarse Gravel
9	22.6 - 32	Coarse Gravel
10	32 - 45	Very Coarse Gravel
11	45 - 64	Very Coarse Gravel
12	64 - 90	Small Cobble
13	90 - 128	Medium Cobble
14	128 - 180	Large Cobble
15	180 - 300	Very Large Cobble
16	>300	Boulder/Bedrock