

Memorandum

To	Michael Liberati, DuPont CRG Ralph Stahl, DuPont CRG	Page	1 of 7
CC	Nancy Grosso, DuPont CRG Ceil Mancini, AECOM		
Subject	LTM Program Assessment and Recommended Modifications Former DuPont Waynesboro Site, Area of Concern 4		
From	Bill Reese, AECOM Joshua Collins, AECOM		
Date	March 23, 2018		

This memorandum provides the basis and summary of recommended modifications to the Long-term Monitoring (LTM) Program, consistent with adaptive management principles for Area of Concern (AOC) 4. The modifications have been reviewed with the South River Science Team (SRST) and other stakeholders; comments received from those interested parties are considered in the final recommendations proposed in this memorandum. Modifications are based on identification of monitoring media that do not provide unique information to support the AOC 4 remedial decision process. With the concurrence of the Virginia Department of Environmental Quality (VDEQ), the following LTM Program modifications are recommended:

- Reduction in monitoring frequency,
- Elimination of analytes,
- Elimination of sampling locations, and
- Elimination of monitoring elements.

After the implementation of these modifications, the LTM Program will be re-evaluated periodically as progress of the (interim measures) IMs continues. Specific monitoring media may be added, reduced, or eliminated from the LTM Program, depending on relevant trends in the data. This approach is consistent with the adaptive management strategy. Concurrence of VDEQ will again be sought if additional modifications to the LTM Program are warranted.

The memorandum provides background of the data analysis approach, a summary of recommendations, and the path forward. Attachments to this memorandum include:

- Table 1: Summary of Recommended Program Modifications,
- Figure 1: Long-Term Monitoring Program Stations, and
- Attachment A: Revision to Long-term Monitoring Plan- Fish Tissue Sampling and Analyses, DuPont Former Waynesboro Site, Area of Concern 4, Virginia (Approved by VDEQ on 9/15/2015).

BACKGROUND

IMs are currently being implemented by E.I. du Pont de Nemours and Company (DuPont) in accordance with the requirements set forth in the site's U.S. Environmental Protection Agency (EPA) Resource Conservation and Recovery Act (RCRA) Corrective Action Permit (Final Hazardous Waste Permit for Corrective Action-Renewal EPA ID No. VAD003114832, issued September 24, 2009; amended February 4, 2014).

The purpose of the IMs is to address historical mercury releases to the South River from the former DuPont facility in Waynesboro, Virginia (site). The IMs and monitoring strategy for AOC 4 were developed largely from conclusions drawn from the multi-year study (Ecological Study) and the Remedial Proposal (URS, 2012; Anchor QEA and URS, 2013), both of which were conducted under a Consent Decree between DuPont, the Natural Resources Defense Council (NRDC), and the Virginia Chapter of the Sierra Club (U.S. District Court, 2005).

LTM is being conducted to evaluate the performance of the IMs and proposed remedial approach. The LTM program evaluates potential system-wide changes to mercury transport and exposure in the South River and South Fork Shenandoah (SFS) River over longer temporal and spatial scales relative to the short-term monitoring (STM). LTM monitoring element categories include Aquatic and Terrestrial Ecological Exposure, Human Health Exposure, and Water and Habitat Quality. During the development of the LTM Plan, the AOC 4 RCRA requirements incorporated in the current LTM Program were discussed and agreed upon by multiple stakeholders, with the understanding that they exceed what is typically required under RCRA, and might be revisited once monitoring data were collected and assessed.

The AOC 4 LTM Baseline Report (AECOM, 2017) documents pre-remediation conditions from 2014 to 2016, and serves as the basis for comparison with post-remediation data; the latter aims to document reduction in mercury concentrations in biotic and abiotic media in South River and SFS River. Baseline LTM data typically have limited annual variability and are generally consistent with historical concentrations and spatial trends established in previous investigations (AECOM, 2017). Additionally, statistically significant seasonal differences were not apparent for most of the baseline LTM data (AECOM, 2017). Concentrations of total mercury (THg), inorganic mercury (IHg), and methylmercury (MeHg) are significantly correlated between several monitoring media in the aquatic ecological exposure, terrestrial ecological exposure, and human health exposure groups. These conclusions suggest data redundancies and provide an opportunity to optimize the LTM Program by reducing or eliminating monitoring of media that do not provide uniquely usable information to support the AOC 4 remedial decision process. Media-specific monitoring modifications also provide an opportunity to more closely harmonize the LTM Program with VDEQ's 100-Year Monitoring Program for surface water and fish.

The approach to assessing the current elements of the LTM Program is provided in the following section.

APPROACH

All available LTM data [Baseline (from 2014 through 2016) as well as 2017] were assessed for redundancies or monitoring media that do not satisfy LTM Program data quality objectives. Monitoring data were statistically evaluated for THg/MeHg relationships for each medium using linear regression ($R^2 \geq 0.75$) to assess potential data redundancies. This approach was previously used as part of the basis to modify adult bass monitoring to include THg analysis only on fish tissue plugs (see Attachment A). With concurrence of VDEQ, this

consensus-based program modification conserved both financial and fisheries resources by replacing lethal capture with tissue plug sampling.

Statistically significant relationships between aquatic and terrestrial ecological, and human exposure media were evaluated using one-tailed F-tests ($\alpha=0.05$). A non-metric multidimensional scaling (NMDS) approach, based on a Bray-Curtis dissimilarity matrix, was used with an analysis of similarities (ANOSIM) to evaluate significant annual and seasonal variations per medium; specifically, analysis of variance (ANOVA; $\alpha=0.05$) and analysis of covariance (ANCOVA; $\alpha=0.05$) were used to identify potential monitoring frequency reductions for adult and young-of year (YOY) bass.

SUMMARY OF RECOMMENDED MODIFICATIONS

Recommendations on modifications to the LTM Program have been developed based on the approach described above. A summary of the current LTM Program scope (URS, 2015) and recommended modifications per exposure group are provided below and in Table 1. Figure 1 shows LTM Program stations, including the proposed modifications summarized in this memorandum.

Aquatic Ecological Exposure

As summarized below, recommended modifications to the aquatic ecological exposure monitoring media include elimination of epilithic periphyton, reduction of mayfly monitoring to one annual event for THg analysis only, and reduction of YOY bass analysis to THg only (see Table 1). While interstitial sediment and transplanted Asiatic clams were assessed for potential monitoring revisions, data supporting modification are insufficient; as a result, no modifications to these media are recommended at this time.

Epilithic Periphyton

The current LTM Program specifies biannual epilithic periphyton monitoring, once every spring and fall, at seven locations from RRM -2.7 to RRM 48; periphyton is analyzed for both THg and MeHg (Table 1).

Concentrations of IHg in periphyton are similar to concentrations of THg in sediment ($R^2 = 0.84$), indicating redundant data among the two aquatic ecological exposure monitoring media. Additionally, concentrations of MeHg in periphyton are influenced by seasonal and annual variations in MeHg production in the aquatic environment of AOC 4; hence, these confounding environmental effects on periphyton, make this medium less likely to provide useful information for remedial decision-making. *Therefore, elimination of epilithic periphyton monitoring from the LTM Program is recommended (Table 1).*

Mayfly

The current LTM Program specifies biannual mayfly monitoring, once every spring and fall, at seven locations from RRM -2.7 to RRM 48; mayfly tissue is analyzed for both THg and MeHg (Table 1).

There were not significant seasonal differences in THg and MeHg concentrations in aquatic ecological exposure media, including mayflies. Monitoring mayfly tissue concentrations once per year will provide a sufficiently reliable indicator of remedy effectiveness. Although not statistically significant, concentrations of MeHg in mayflies appear to be influenced by temporal variations in MeHg production in the aquatic environment of AOC 4, potentially confounding the monitoring approach for remedy effectiveness. Furthermore, concentrations of THg and MeHg are correlated in mayfly

tissue ($R^2 = 0.749$), indicating redundant data. *The reduction of mayfly monitoring to once a year in spring/summer for THg analysis only is recommended; mayfly monitoring will be synchronized with wolf spider monitoring, described below (Table 1).*

YOY Smallmouth Bass

The current LTM Program specifies annual YOY smallmouth bass monitoring, once every fall, at six locations from RRM -2.7 to RRM 48; YOY bass tissue is analyzed for both THg and MeHg (Table 1).

Consistent with adult bass, THg and MeHg concentrations are highly correlated in YOY smallmouth bass tissue ($R^2 = 0.988$); indicating that MeHg data are redundant with THg data. *Therefore, it is recommended to reduce YOY bass analysis to THg only, which is consistent with the revised approach currently being implemented for adult bass (Table 1; Attachment A).*

Terrestrial Ecological Exposure

As summarized below, recommended modifications to the terrestrial ecological exposure monitoring media include elimination of floodplain soils and earthworms, reduction of wolf spider monitoring to THg analysis only, and reduction of Carolina wren monitoring to one event every three years (Table 1).

Floodplain Soil

The current LTM Program specifies annual floodplain soil monitoring, once every summer, at nine locations from RRM -6.2 to RRM 85; floodplain soil is analyzed for THg and MeHg (Table 1).

Widespread floodplain soil mercury concentrations are not expected to measurably change as a result of the implementation of the Phase I IMs; *therefore, it is recommended that floodplain soil be eliminated from the LTM program (Table 1).*

Earthworms

The current LTM Program specifies annual earthworm monitoring, once every summer, at nine locations from RRM -6.2 to RRM 85; earthworm tissue is analyzed for THg and MeHg (Table 1).

Earthworm tissue concentrations typically reflect the soil concentrations in which they live. Since floodplain soil concentrations will not be measurably affected by the Phase I IMs, earthworm tissue concentrations likely will not change as a result of implementation of the IMs, and will not provide useful information for remedial-decision making; *therefore, it is recommended that earthworms be eliminated from the LTM program (Table 1).*

Wolf Spider

The current LTM Program specifies annual wolf spider monitoring, once every summer, at nine locations from RRM -6.2 to RRM 85; wolf spider tissue is analyzed for THg and MeHg (Table 1).

THg and MeHg concentrations in wolf spiders are highly correlated ($R^2 = 0.963$), which indicates that the MeHg data are redundant; *therefore, it is recommended to reduce wolf spider analysis to THg only (Table 1).*

Carolina Wren

The current LTM Program specifies annual Carolina wren monitoring, once every summer, at nine locations from RRM -6.2 to RRM 85; Carolina wren blood is analyzed for THg only (Table 1).

THg concentrations in wolf spiders and Carolina wren are statistically correlated, indicating data redundancy between these two terrestrial receptors; *therefore, it is recommended to reduce monitoring frequency of Carolina wren to once every three years in the spring/summer (Table 1).* The next Carolina wren sampling event will be conducted in 2019.

Human Health Exposure

As summarized below, recommended modifications to the human health exposure monitoring media include elimination of mallard duck and snapping turtle monitoring, and the following modifications to adult bass monitoring:

- Elimination of sampling at select locations on the Shenandoah River and SFS River,
- Monitor once each year in the fall at all locations on the South River and select locations on the South Fork of the Shenandoah River, and
- Monitor once every five years in the fall for all remaining locations.

Adult Bass

The current LTM Program specifies biannual adult smallmouth and largemouth bass monitoring, once every spring and fall, at 13 locations from RRM -2.7 to RRM 158; adult bass tissue plugs are analyzed for THg only (Table 1).

Length-normalized THg concentrations in adult largemouth and smallmouth bass are not significantly different between the spring and fall seasons (ANOVA: largemouth bass, $p=0.813$; smallmouth bass, $p=0.504$). Measurable reductions in concentrations of THg in adult bass tissue in response to the IM will likely take several years to manifest.

Monitoring fish tissue concentrations once annually will provide sufficient data to assess remedy effectiveness of the IMs and is will still be conducted at a greater frequency than what is included in the VDEQ 100-year monitoring program which includes fish tissue sampling every five years. *Therefore, the reduction of adult bass tissue monitoring to once annually in the fall is recommended (Table 1).*

It is expected that THg concentrations will respond to remediation on the South River before seeing a measurable response in downstream waterways such as the Shenandoah River. THg concentrations in adult bass tissue downstream of station SF48 are relatively similar to one another, and are significantly lower than fish from the South River ($\alpha=0.05$). *Thus, it is recommended to reduce monitoring frequency at the locations downgradient of SFS48 to once every five years (Table 1).*

The current LTM Program monitoring approach includes three monitoring stations on the South Fork Shenandoah and Shenandoah Rivers that are not included in VDEQ's 100-year monitoring program (Fosters Landing: SF89.4; Karo Landing: SF115; and, Berryville: SH158). These three monitoring stations have also proved to have difficult access and/or limited available habitat that can be safely accessed and sampled during low water conditions in the fall. *Therefore, elimination of these three specific monitoring stations, including from the LTM Program is recommended (Table 1; Figure 1).*

Snapping Turtle

The current LTM Program specifies annual snapping turtle monitoring, once per year in the summer, at 13 locations from RRM -2.7 to RRM 158; snapping turtle toenails are analyzed for THg and MeHg (Table 1)

According to regression models using one-tailed F-tests ($\alpha=0.05$), THg concentrations in snapping turtles are statistically correlated with smallmouth bass ($R^2=0.71$) and largemouth bass ($R^2=0.59$), indicating data redundancy between these two human health exposure monitoring media. Furthermore, snapping turtles have a long life span, and as such, typically have a relatively high mercury body burden that will likely respond more slowly to remediation compared to smallmouth and largemouth bass. *Therefore, it is recommended to eliminate snapping turtle monitoring from the LTM program (Table 1).*

Mallard Duck

The current LTM Program specifies annual mallard duck monitoring, once every winter, at nine locations from RRM -2.7 to RRM 89.4; mallard tissue is analyzed for THg and MeHg (Table 1).

THg and MeHg concentrations in mallard duck tissue are not correlated with other human health exposure medium and display high variability within each monitoring station. This is likely due to the fact that mallard ducks are migratory and the amount of time a mallard duck spends within AOC 4 habitats is uncertain, which makes it difficult to evaluate the proportion of its body burden that is attributable to exposure to AOC 4. Because of these uncertainties related to a mallard duck's migratory habits, mercury concentrations in mallard duck tissue are not a consistently reliable indicator of remedy effectiveness. *Therefore, it is recommended that mallard ducks be eliminated from the LTM program (Table 1).*

Water and Habitat Quality

As summarized below, habitat quality and surface water monitoring were assessed as part of this effort. Recommendations include reduction of benthic community and substrate grain size sampling to every three years (Table 1).

No revisions are recommended for surface water sampling as part of the AOC 4 LTM program; however, this is an opportunity for VDEQ to harmonize or coordinate its' surface water monitoring program with that of the LTM Program to establish a consistent dataset between the two programs. The following changes are recommended for the VDEQ program:

- Omit analysis of ancillary parameters that do not provide usable information to support the AOC 4 remedial decision process; ancillary parameters will be determined collaboratively with VDEQ,
- Add MeHg analysis to maintain consistency with the LTM Program, and
- Add annual monitoring for the month of April, which is not currently included in either program.

Benthic Community

The current LTM Program specifies biannual benthic community monitoring, once every spring and fall, at five locations from RRM -2.7 to RRM 23.5, and a reference location on the Middle River (MR01). The current LTM Program includes sample analysis for benthic community composition (Table 1). Individual metrics are calculated based on macroinvertebrate taxa identified in the benthic community samples; multimetric indices,

such as the Index for Biological Integrity (IBI) are calculated to evaluate overall biological condition based on a compilation of benthic metrics.

The benthic communities in AOC 4 are currently healthy and stable (URS, 2012; AECOM, 2017); system-wide changes to substrate distribution and characteristics related to the Phase I IMs will likely take many years to measurably influence the benthic communities in AOC 4. *Therefore, it is recommended to reduce the biannual (spring and fall) benthic community sampling from yearly to every three years (Table 1).*

Substrate Grain Size

The current LTM Program includes annual substrate grain size monitoring, once every fall, at seven locations from RRM -2.7 to RRM 48 and a reference location on the Middle River (MR01) (Table 1). Evaluation of substrate grain size distribution is used to evaluate the potential impacts of Phase I IMs on benthic habitat and the macroinvertebrates that colonize these habitats.

System-wide changes to substrate characteristics and distribution such as reduced embeddedness that are related to the Phase I IMs will likely take many years to become apparent at the LTM stations. *Therefore, it is recommended to reduce substrate grain size sampling from once each year, to once every three years, concurrent with the fall triennial benthic community monitoring (Table 1).*

PATH FORWARD

The current LTM Work Plan will be revised to incorporate recommended program modifications outlined above, with the concurrence of VDEQ. The revisions will be implemented immediately as part of the 2018 field effort.

The LTM Program will be revisited periodically as progress of the IMs continues, consistent with the adaptive management strategy. Similar to the current approach for streamlining the LTM program, elimination or reduction in monitoring frequencies and analyses will occasionally be re-evaluated, specifically if unexpected data trends or fluctuations become apparent. If warranted, additional data collections or modifications to the LTM Program may be considered; concurrence of VDEQ will be sought for any future recommendations as the program matures.

REFERENCES

- AECOM. 2017. Long-Term Monitoring Baseline Report, Former DuPont Waynesboro Site, Area of Concern 4, Waynesboro, Virginia. March 2017; Revised December 2017.
- Anchor QEA and URS. 2013. Remediation Proposal – South River and a Segment of the South Fork Shenandoah River, Virginia. Final Report.
- URS. 2015. Final AOC 4 Long-term Monitoring Plan for the South River and a Segment of the South Fork of the Shenandoah River, Virginia. February 2015.
- URS. 2012. Final Report: Ecological Study of the South River and a Segment of the South Fork Shenandoah River, Virginia. September 2012.
- U.S. District Court. 2005. Consent Decree between E.I. Du Pont de Nemours and & Co. and the Virginia Chapter of the Sierra Club / Natural Resources Defense Council. Civil. Action No. 5:05-cvCV-30013. Harrisonburg Division, U.S. Western Virginia District Court. July 1, 2005.

Table 1

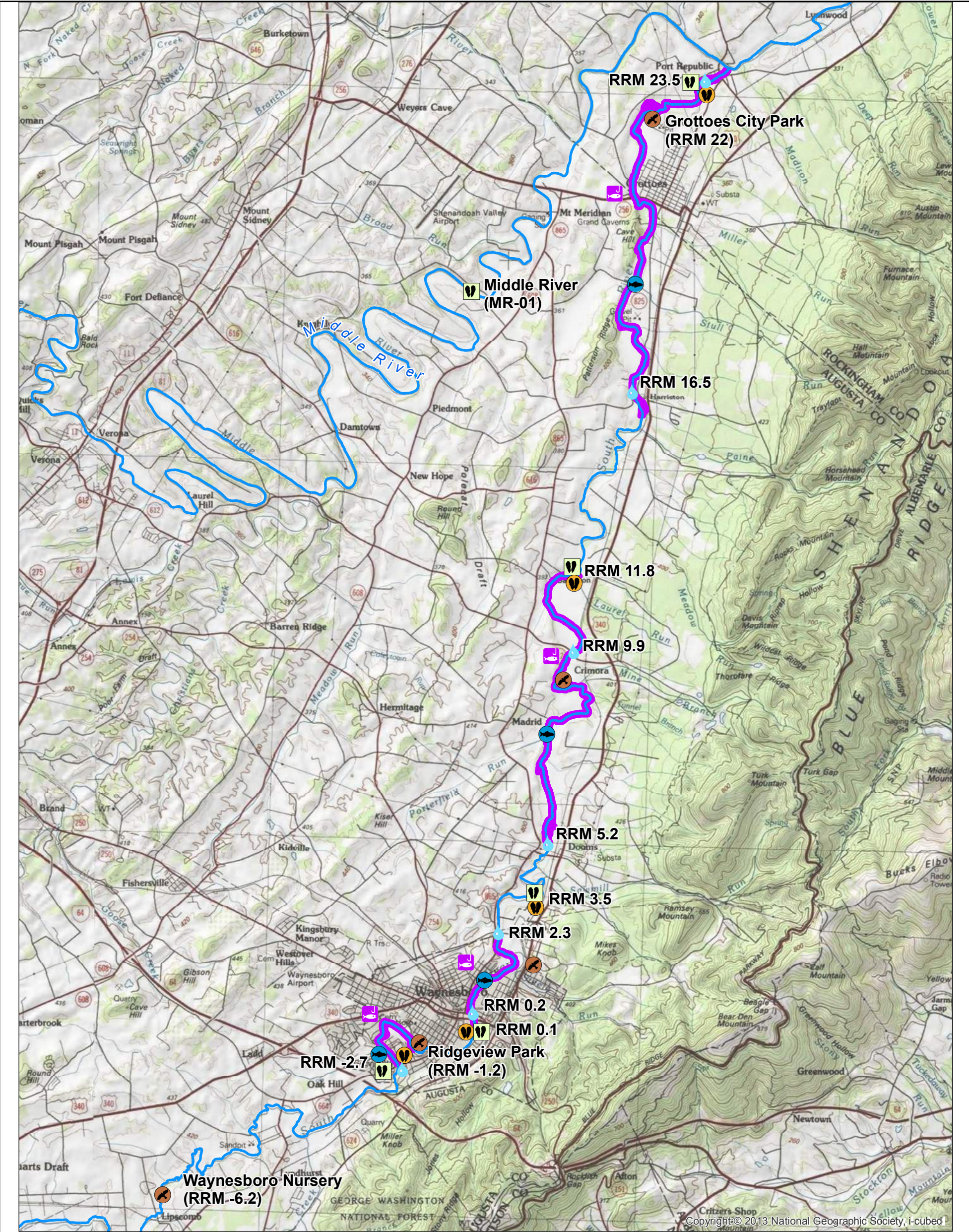
Summary of Recommended Program Modifications

Table 1
Summary of Recommended Program Modifications
LTM Program Assessment and Recommended Modifications
Former DuPont Waynesboro Site, Area of Concern 4

Monitoring Media	Current Monitoring Approach					Baseline LTM Conclusions					Recommended Modifications		
	Sample Frequency	Analytes	Spatial Extent	Expected Improvement Due to Remediation		Significant Variations (NMDS /ANOSIM)		Highly Predictive Relationships		Other	Sample Frequency	Locations	Analytes
				Yes or No	Timeframe	Annual	Seasonal	Other Media (One-tailed F-test)	THg/MeHg (Linear Regression)				
Aquatic Ecological Exposure													
Interstitial Sediment	Spring	THg, MeHg	RRM -2.7 to 48	Yes	Long	Where applicable (sediment and YOY fish only sampled once annually), IHg does not vary annually or seasonally, but MeHg does vary both seasonally and annually		Yes*	No	The aquatic ecological exposure group appear to be more responsive to changing regional climatic conditions more than the other exposure groups	--	--	--
Epilithic Periphyton	Spring & Fall	THg, MeHg	RRM -2.7 to 48	Yes	Short			Yes*	No		Eliminate from LTM Program		
Mayfly	Spring & Fall	THg, MeHg	RRM -2.7 to 48	Yes	Short			Yes*	Slight; R ² = 0.749		Once annually (spring/summer)	--	THg only
Transplanted Asiatic Clam	Spring & Fall	THg, MeHg	RRM -2.7 to 48	Yes	Short			Yes*	Yes; R ² = 0.867		--	--	--
YOY Smallmouth Bass	Fall	THg, MeHg	RRM -2.7 to 48	Yes	Short			Yes*	Yes; R ² = 0.988		--	--	THg only
Terrestrial Ecological Exposure													
Floodplain Soil	Summer	THg, MeHg	RRM -6.2 to 85	No	NA	Where applicable (Carolina only analyzed for THg), both IHg and MeHg do not vary annually	NA	Yes; Earthworm	No	--	Eliminate from LTM Program		
Earthworm	Summer	THg, MeHg	RRM -6.2 to 85	No	NA			Yes; Floodplain Soil	No	--	Eliminate from LTM Program		
Wolf Spider	Summer	THg, MeHg	RRM -6.2 to 85	Yes	Short			Yes; Carolina Wren	Yes; R ² = 0.963	--	--	--	THg only
Carolina Wren	Summer	THg	RRM -6.2 to 85	Yes	Short			Yes; Wolf Spider	NA	--	Reduced frequency to every three years (Spring/Summer)	--	--
Human Health Exposure													
Adult Bass (SMB and LMB)	Spring & Fall	THg	RRM -2.7 to 158	Yes	Long	THg does not vary annually	SMB vary seasonally (fall generally higher); LMB do not; combined bass do not vary seasonally (ANOVA and ANCOVA).	Yes; LMB-SMB, and Snapping Turtle	NA	LMB were not available to collect at all locations due to limited habitat; LMB THg concentrations had a higher degree of variability compared to SMB	Once annually (Fall): SR Locations + SFS26.6 and SFS48	THg	
											Every five years (Fall only): Coincident w/VDEQ 100-year program sample at: SR-2.7, SR2.0, SR11.8, SR23.5, SFS26.6, SFS48, SFS63, SFS72, SFS106, and SH143		
Snapping Turtle	Summer	THg, MeHg	RRM -2.7 to 158	Yes	Very Long		NA	Yes: LMB and SMB	Yes; R ² = 0.951	--	Eliminate from LTM Program		
Mallard Duck	Winter	THg, MeHg	RRM -2.7 to 89.4	No	NA	NA	NA	No	Yes; R ² = 0.993	--	Eliminate from LTM Program		
Water and Habitat Quality													
Surface Water	Quarterly	THg, MeHg, TSS, TOC, DOC, etc.	RRM -2.7 to 94	Yes	Short	NA	NA	NA	NA	--	Coordinate with VDEQ to add monitoring in April	--	Coordinate with VDEQ to reduce analytes
Benthic Community	Spring & Fall	--	RRM -2.7 to 23.5 (and reference location, MR01)	No	NA	No	Yes	NA	NA	Natural variability in baseline (2014-2016) data	Reduced frequency to every three years (Spring and Fall)	--	--
Substrate Grain Size	Fall	--	RRM -2.7 to 48 (and reference location, MR01)	No	NA	No	NA	NA	NA	--	Reduced frequency to once every three years	--	--

Notes:
THg, Total mercury
MeHg, Methyl mercury
IHg, Inorganic mercury
RRM, Relative river mile
YOY, Young-of-year
SMB, Smallmouth bass
LMB, Largemouth bass
TSS, Total suspended solids
TOC, Total organic carbon
DOC, Dissolved organic carbon
NA, Not applicable
*, Predictive relationships exist, but not for both IHg and MeHg per paired media
Green highlight, Significant relationship
--, No recommended modifications
Orange highlight, Recommended monitoring reduction
Yellow highlight, Recommended monitoring removal

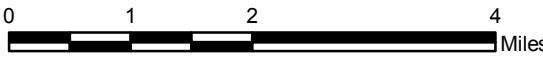
Figure 1
Long-Term Monitoring Program Stations



Legend

- Water Quality - Surface Water
- Ecological Exposure (Aquatic) - Sediment; Benthic Invertebrates; Asiatic Clam
- Ecological Exposure (Aquatic) - YOY Fish
- Ecological Exposure (Terrestrial) - Carolina Wren; Wolf Spider
- Benthic Community
- Human Exposure - Largemouth Bass; Smallmouth Bass

NAD 1983 StatePlane Virginia North
Projection: Transverse Mercator
Linear Unit: Foot US



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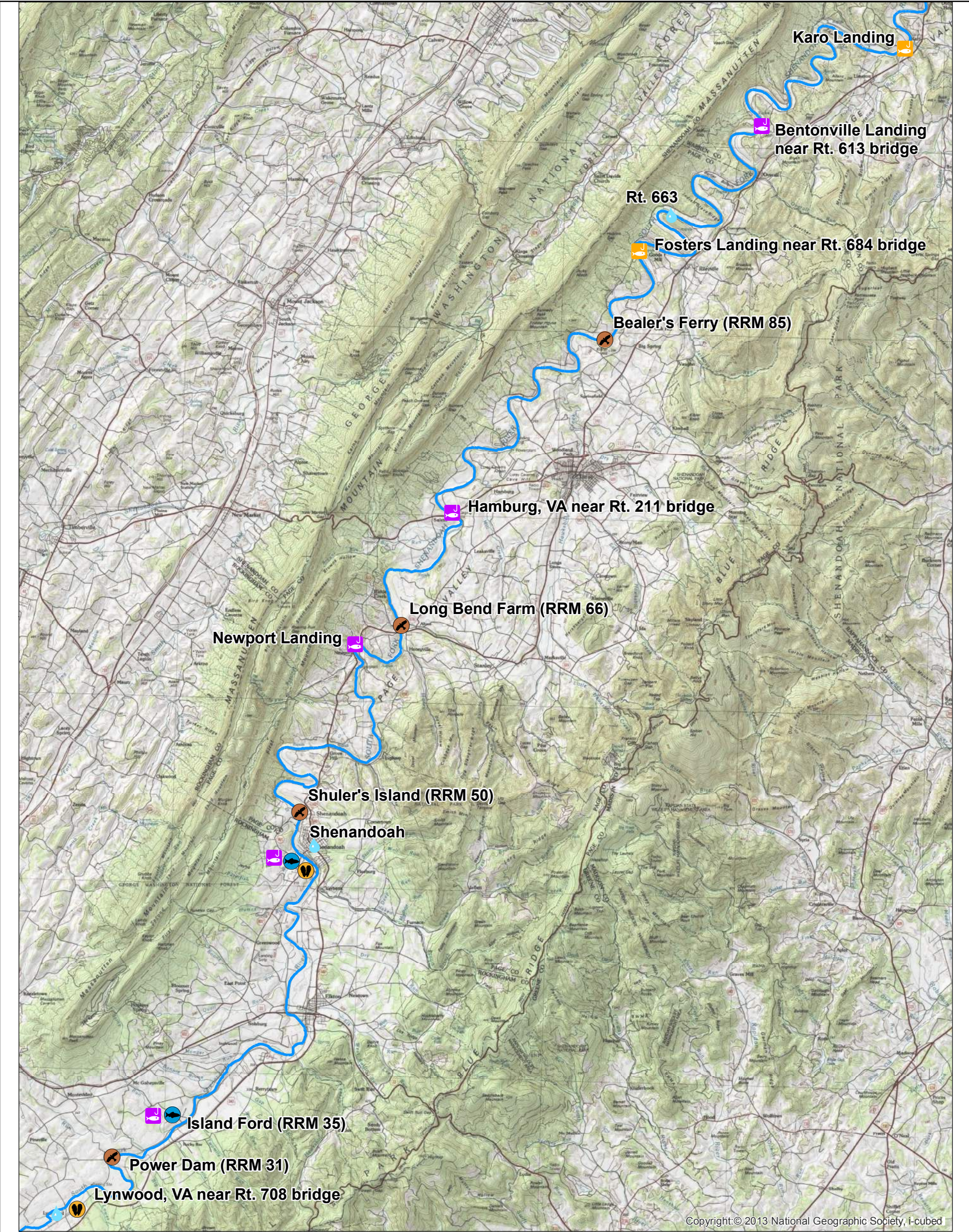
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Prepared by: AM

Checked by: BR

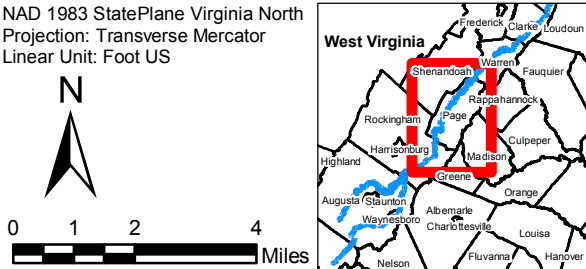
Date: 3/15/2018

Figure 1a
Long-Term Monitoring Program Stations
LTM Recommended Modifications Memo
Former DuPont Waynesboro Site,
Area of Concern 4



Legend

- Water Quality - Surface Water
- Ecological Exposure (Aquatic) - Sediment; Benthic Invertebrates; Asiatic Clam
- Ecological Exposure (Aquatic) - YOY Fish
- Ecological Exposure (Terrestrial) - Carolina Wren; Wolf Spider
- Human Exposure - Largemouth Bass; Smallmouth Bass
- Recommend Removal from LTM Program, Human Exposure - Largemouth Bass; Smallmouth Bass



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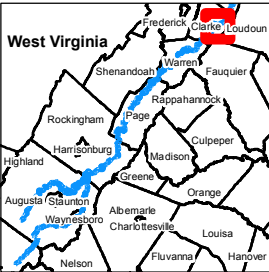
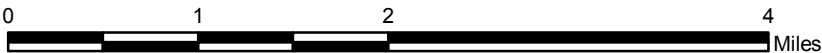
Figure 1b
Long-Term Monitoring Program Stations
LTM Recommended Modifications Memo
Former DuPont Waynesboro Site,
Area of Concern 4



Legend

-  Human Exposure - Largemouth Bass; Smallmouth Bass
-  Recommend Removal from LTM Program, Human Exposure - Largemouth Bass; Smallmouth Bass

NAD 1983 StatePlane Virginia North
Projection: Transverse Mercator
Linear Unit: Foot US



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Figure 1c
Long-Term Monitoring Program Stations
LTM Recommended Modifications Memo
Former DuPont Waynesboro Site,
Area of Concern 4

Attachment A

Revision to Long-term Monitoring Plan-
Fish Tissue Sampling and Analyses



COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

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September 18, 2015

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

**Re: AOC#4 - Proposed Revision of LTM Plan
Former DuPont Waynesboro Plant, Waynesboro, Virginia
EPA ID# VAD003114832**

Dear Mr. Liberati:

The Department of Environmental Quality, Office of Remediation Programs (DEQ) received the proposed revision to the AOC#4 Long Term Monitoring (LTM) Plan dated September 3, 2015. The proposal is considered part of RCRA Site-Wide Correction Action associated with the Former DuPont Waynesboro Plant (Facility) located in Waynesboro, Virginia, and the Corrective Action requirements of the Hazardous Waste Management Permit for the Facility.

DEQ has reviewed this proposal and conditionally approves the transition from the current lethal fish tissue sampling techniques to a non-lethal tissue plug sampling and the request that fish tissue plug samples are analyzed for total mercury (THg) only. The Department's statistician is currently in the process of reviewing the statistical package submitted to support this request. This approval will become final once the statistics have been reviewed and confirmed. The facility may proceed with implementation of this proposal immediately.

Please note that DEQ has not formally approved the LTM plan to date. It is anticipated that this plan will be incorporated in to the Corrective Measures Study and/or Corrective Action Implementation phases of the project. A comprehensive regulatory review will be conducted at that time.

EPA ID# VAD003114832, DuPont Waynesboro
AOC#4 Proposed Revision of LTM Plan
September 17, 2015

If you have any questions, you may contact me at 804-698-4064 or by email at Vincent.Maiden@deq.virginia.gov.

Sincerely,



Vincent A. Maiden
Office of Remediation Programs

cc: Brett Fisher, File – DEQ CO
Andrea Barbieri, EPA Region III (3LC50)
Graham Simmerman, Don Kain – DEQ VRO
Ralph Stahl, DuPont
Josh Collins, AECOM
Paul Bugas, DGIF

M

TO: Vince Maiden

E

FROM: Hasan Keceli *H.K.*

M

DATE: October 6, 2015

O

SUBJECT: Statistical Review of Fish Tissue Sampling
And Analyses for DuPont

Per your request, I have reviewed the fish tissue sampling and analyses report dated September 3, 2015 for the Dupont Former Waynesboro Site.

Based on the information provided in the report, the Department agrees with the facility that mercury concentrations in plug vs fillet are strongly correlated. Since the data provided in the report shows that the mean of mercury concretions in plugs is statistically different than the mean of mercury concentrations in fillets, then mercury concentration in plugs may not to be used as an estimate for mercury concentrations in fillets. If the facility has any questions regarding for this memorandum, I can be reached at (804) 968-4246.



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MEMORANDUM

TO: Michael Liberati, DuPont
Ralph Stahl, DuPont
CC: Cecilia Mancini, AECOM
FROM: Joshua Collins, AECOM

DATE: September 3, 2015

SUBJECT: PROPOSED REVISION TO LONG-TERM MONITORING PLAN –
FISH TISSUE SAMPLING AND ANALYSES
DUPONT FORMER WAYNESBORO SITE, AREA OF CONCERN 4, VIRGINIA

This memorandum provides the basis for revision to two components of the Long-term Monitoring (LTM) Program for the Former DuPont Waynesboro Site, Area of Concern 4 (AOC 4) (URS, 2015). Based on fish tissue data collected to date, it is proposed that:

- Current lethal fish tissue sampling techniques be replaced with non-lethal tissue plug sampling to collect fish tissue mercury data; and
- Fish tissue plug samples are analyzed for total mercury (THg) only.

Attachments to this memorandum include:

- Attachment A - Spreadsheet of Plug & Fillet Analytical Data

FISH TISSUE SAMPLING

A summary of the approach and results of statistical analysis are provided to demonstrate that dermal biopsy plugs are reliable predictors of total mercury (THg) and methylmercury (MeHg) concentrations in bass tissue, while minimizing lethal impacts to local fish populations.

Approach

Paired biopsy plug and fillet samples ($n=548$) were collected from smallmouth bass (*Micropterus dolomieu*) and largemouth bass (*Micropterus salmoides*) to develop correlations among concentrations of THg and MeHg and tissue types in biopsy plugs and fillets (URS, 2015). Fish tissue samples were collected according to the procedures in the LTM Plan and submitted to CEBAM Analytical; the samples were frozen and packed on dry ice for shipping. The tissues were analyzed for THg and MeHg by EPA Methods 1631 and 1630, respectively. Summary statistics were calculated and the correlations were evaluated individually for each species/sex combination, as well as for all bass combined.

Results

Mean THg and MeHg concentrations (wet weight basis) were comparable between biopsy plug and fillet samples for all groups; however, mercury concentrations were consistently and slightly higher in biopsy plug than fillet samples in paired comparisons (Table 1, Figure 1). This difference may be attributable to lower moisture content in smaller sample volume biopsy plugs (75.3% moisture) compared to fillets (78.8% moisture); it results in tissue plug concentrations being a more conservative estimate relative to fillet data.

Strong correlations were observed between mercury concentrations measured in biopsy plug vs. fillet samples. Linear regression performed for each data grouping resulted in correlation coefficient (R^2) values ranging from 0.89 to 0.93 indicating that 89 to 93% of the variability in the

datasets were explained by the correlations (Table 1, Figure 2). A Spearman Rank Order test was also performed for each grouping as confirmation of the linear regression results due to the non-normal data distribution. Spearman's correlation coefficient (ρ) values ranged from 0.94 to 0.97, which confirms a strong correlation between biopsy plug and fillet data (Table 1).

FISH TISSUE ANALYSES

Almost all mercury (> 95%) in fish tissues was comprised of MeHg, consistent with the well-established bio-magnification of MeHg by piscivorous fish like smallmouth and largemouth bass (Bloom, 1992). A Spearman Rank Order test for THg vs. MeHg in biopsy plugs and fillets also resulted in Spearman's correlation coefficient values of 0.99 indicating a very strong correlation between THg and MeHg.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

These results demonstrate that:

- 1) Mercury concentrations in plug vs. fillet are strongly correlated
- 2) Mercury concentration in plugs is likely to be a conservative estimate for mercury concentrations in fillets; and
- 3) Almost all mercury bioaccumulated in fish tissues is MeHg.

Based on these findings, it is recommended that lethal sampling techniques be replaced by non-lethal plug sampling in the AOC 4 LTM tissue monitoring program for adult smallmouth and largemouth bass. It is also recommended that tissue samples be analyzed for THg only. This analytical approach is consistent with the Virginia Department of Environmental Quality (VDEQ) 100-year Monitoring Program for the South River and South Fork Shenandoah River.

Upon VDEQ's approval, the above monitoring modifications will be initiated beginning with the fall 2015 monitoring event. Paired biopsy plug and fillet samples will be collected in years when VDEQ conducts sampling as part of the 100-year Monitoring Program to monitor for potential changes to the correlations established in the current evaluation.

REFERENCES

- Bloom, N.S. 1992. On the chemical form of mercury in edible fish and marine invertebrate tissue. *Can. J. Fish Aquat. Sci.* 55: 453-457.
- URS Corporation. 2015. AOC 4 Long Term Monitoring Plan; South River and a Segment of the South Fork of the Shenandoah River, Virginia. Final Document February, 2015.

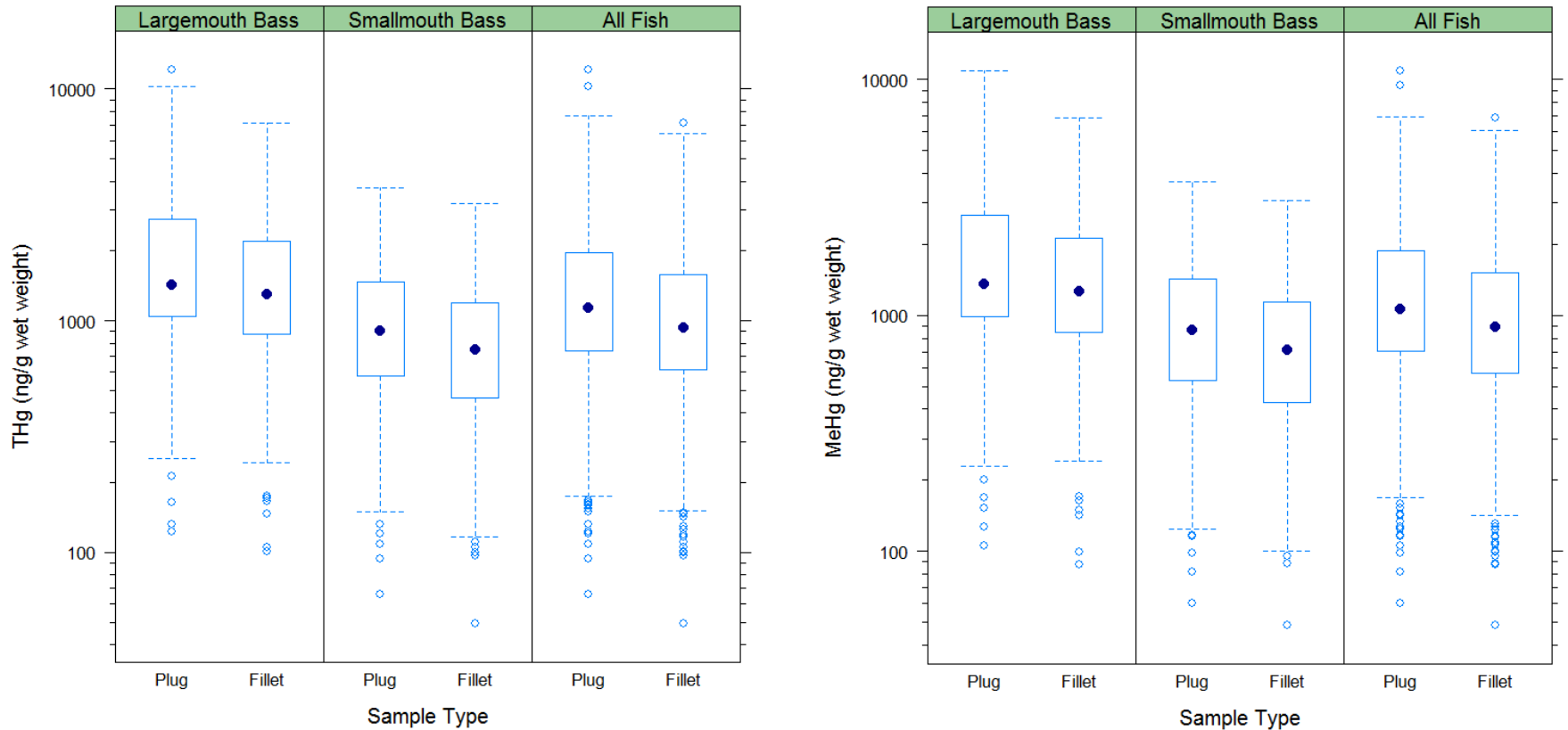
Table 1
Summary of Linear Regression and Spearman Rank Order for
Paired Biopsy Plugs and Fillets
AOC 4 Long-Term Monitoring Program
South River and a Segment of the Shenandoah River

Species	Sex	Analyte	N	Linear Regression			Spearman Coefficient
				Slope	Intercept	R ²	ρ
Largemouth Bass	M	THg	104	0.64	370.1	0.89	0.95
		MeHg	104	0.67	305.8	0.90	0.96
	F	THg	125	0.84	56.1	0.91	0.97
		MeHg	125	0.86	52.1	0.91	0.97
	All	THg	229	0.75	210.9	0.88	0.96
		MeHg	229	0.78	172.5	0.89	0.96
Smallmouth Bass	M	THg	160	0.75	64.5	0.92	0.94
		MeHg	160	0.77	44.8	0.92	0.94
	F	THg	153	0.74	62.5	0.92	0.97
		MeHg	153	0.75	56.6	0.93	0.97
	All	THg	313	0.75	64.3	0.92	0.96
		MeHg	313	0.76	51.4	0.93	0.96
All Bass	All	THg	548	0.77	95.6	0.90	0.97
		MeHg	548	0.79	68.7	0.91	0.97

Notes:

THg = Total mercury, MeHg = Methylmercury, ρ = Spearman correlation coefficient, M = Male, F = Female

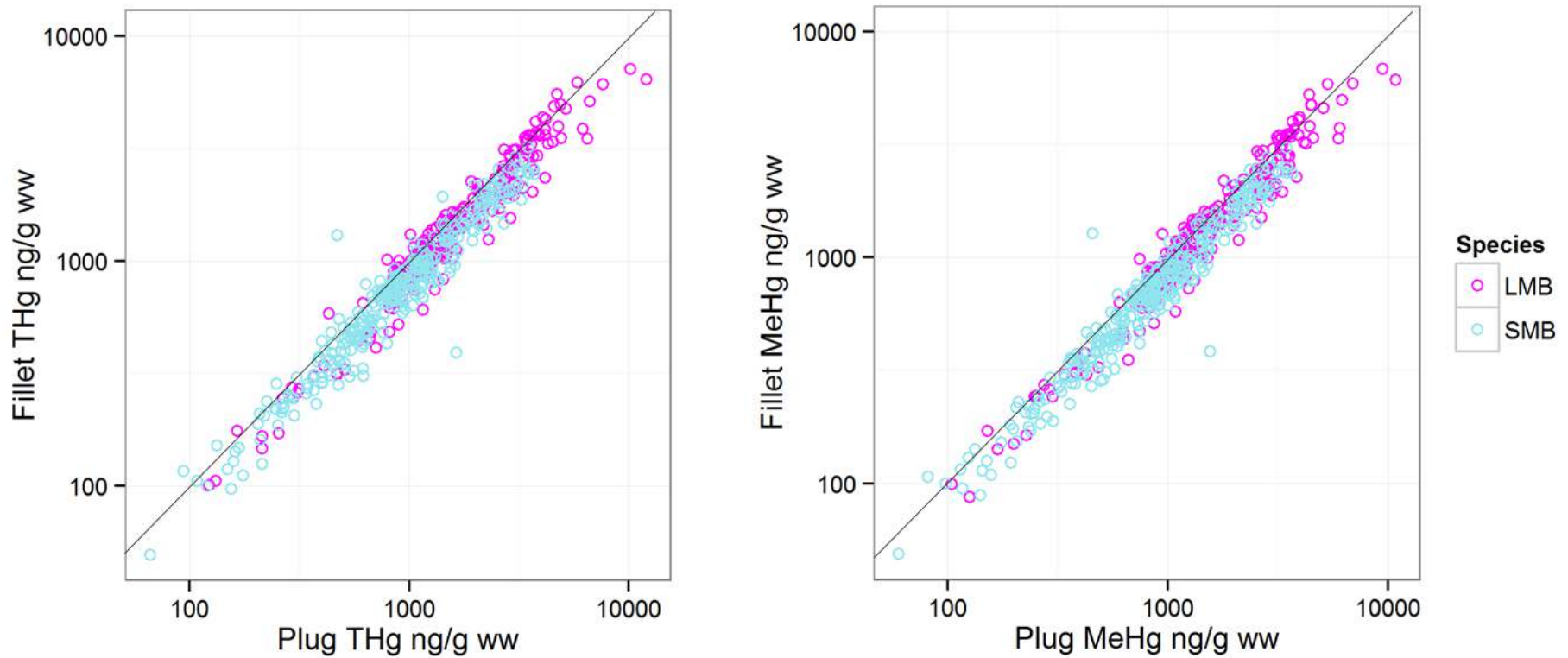
Figure 1
Summary of Mean Mercury Concentrations
In Biopsy Plugs and Fillets
AOC 4 Long-Term Monitoring Program
South River and a Segment of the Shenandoah River



Notes:

THg = Total mercury, MeHg = Methylmercury. The filled circle is the median value, and the box surrounding the filled circle depicts the 25th and 75th quartiles. The range of values is given by the dotted lines outside of each box, and possible outliers are given by the open circles outside the dotted line.

Figure 2
Summary of Mercury Concentrations
In Paired Biopsy Plugs and Fillets
AOC 4 Long-Term Monitoring Program
South River and a Segment of the Shenandoah River



Notes:

THg = Total mercury, MeHg = Methylmercury, ww = wet weight, SMB = Smallmouth bass, LMB = Largemouth Bass. Diagonal black line represents a 1:1 slope.