Comment Response Document
Regarding the Total Maximum Daily Load of Polychlorinated Biphenyls in South River Mesohaline Chesapeake Bay Segment, Anne Arundel County, Maryland

The Maryland Department of the Environment (MDE) has conducted a public review of the proposed Total Maximum Daily Load (TMDL) of Polychlorinated Biphenyls (PCBs) in the South River Watershed. The public comment period was open from July 17, 2014 through August 15, 2014. MDE received three sets of written comments from the South River Federation (Capt. Diana Muller, et.al.), Mr. Christopher Phipps, P.E. of Anne Arundel County, Dept. of Public Works, and a number of very similar letters and comments from Ms. Gwenn Azama, Ms. Kincey Potter, Ms. Beverly Marcus and Mr. John Koontz.

Below is a list of commentors, their affiliations, the date comments were submitted, and the number referenced to the comments submitted. In the pages that follow, comments are summarized and listed with MDE's response.

Author	Affiliation	Date	Comment Number
Capt. Diana Muller, et. al.	**South River Federation**	**8/8/2014**	**1-6**
Mr. Christopher Phipps, P.E.	**Anne Arundel County Dept. of Public Works**	**8/11/2014**	**7**
Ms. Gwenn Azama, Ms. Kincey Potter, Ms. Beverly Marcus & Mr. John Koontz	**South River Federation**	**8/12-15/2014**	**8**

Comments and Responses

Comment 1 -- *Executive Summary, the use of a One-Segment Tidal Prism Model*.

The Commentor asserts that the tidal prism model of Kuo has significant limitations in the South River PCB TMDL that casts doubt that the most significant source of PCBs in the South River is the Chesapeake Bay mainstem. The tidal prism model of Kuo et al. (2006) is a modified water quality model that uses a correction factor to calculate flushing times of estuaries based on the concept that the estuary does not fully flush over one tidal cycle. The specific model is relevant only for Chlorophyll *a*, dissolved oxygen, nutrients, and total organic carbon. The model tends to over predict many of the parameters and was only calibrated for Lynnhaven Bay, Virginia. The authors make it a point that their model was specific to Virginian estuaries. Further studies to determine the efficacy of this model to other areas, especially those that do not work like the Virginian estuaries (South River) have not been conducted. The tidal prism model should contain multiple segments, which is the classic way to determine flushing rates. Also, Tidal Prism models are only relevant to water column transport of conservative constituents. PCB's do not transport in the dissolved phase in significant concentrations and usually bind with fine-grained sediments. Since fine-grained sediments are cohesive, one would need to use a cohesive transport model to properly estimate the transport. This model neglects the asymmetrical tidal curve in the South River due to bottom friction and constriction, and fails to incorporate South Rivers Turbidity maximum, which should trap significant concentrations of PCB's. Another important component missing from this simple model is the potential particle-particle interactions and phase state changes due to pH and redox state changes in the water column and sediments. The South River experiences significant pH fluctuations depending on the season and hypoxic state of the water column. As shown in our attachment, the South River Tidal Technical Report and the peer-reviewed publication, "Nodal Point Pollution, Variability, and Sustainability in Mesohaline Tidal Creeks", clearly shows the calculation using the tidal prism method of each tidal creek, and the data clearly shows that South River's sediment and nutrients are NOT coming from the Chesapeake Bay Mainstem.

Response:

As with any model, there are limitations associated with the tidal prism model. For the purposes of this TMDL—the identification of major sources of PCBs and the development of allocations—the tidal prism model is an appropriate choice.

The PCB impairment is a legacy problem and this TMDL report attempts to quantify the overall impact of current sources on the river and potential improvement among these sources. This TMDL report focuses on the overall mean condition rather than on spatial and short-term temporal variations. Although the tidal prism model is limited in distinguishing the spatial variation of the substance, it can provide the mean condition and the potential timescale for the recovery of the watershed. In order to obtain the overall mean condition, we used a volume weighted method to estimate the mean PCB concentration. The spatial variation is implicitly included in the mean concentration. This method is justified since the sediment PCB TMDL endpoint is calculated based on the PCB fish consumption listing threshold and as fish move throughout an estuarine system and will bioaccumulate PCBs as they feed from sediments throughout the entire waterbody. Fish have home ranges between two and ten miles, so the mean PCB sediment concentration is spatially representative of the conditions within an estuarine system and can be compared to the sediment TMDL endpoint in order to meet the TMDL.

This model incorporated sediment processes, including the exchange between the dissolved and particulate phase of the substance and the exchange with bottom sediment. Both settling and deposition are quantified (Please refer to the TMDL report for details). The model indicates that the dominant transport processes are the interaction with sediment through sorption and desorption processes. The model includes all the major processes and interactions of the substance.

We are aware that high concentrations of PCBs can be located in the Estuary Turbidity Maximum (ETM). However, this spatial variation was accounted for using a volume weighting method to estimate mean concentration.

The document referenced in the comment above, "Nodal Point Pollution, Variability, and Sustainability in Mesohaline Tidal Creeks", indicates that the majority of nutrient and sediment loads to the South River do not come from the Chesapeake Bay mainstem, but provides no analysis of PCB loads. Data collected by MDE in 2011 and 2012, during the development of this TMDL, and the subsequent modeling efforts, indicate that PCB loads from the bay are currently the predominant source of PCBs to the South River embayment.

MDE agrees to review any additional water column or sediment PCBs data from the South River embayment that are submitted for consideration in the future.

Comment 2 -- *Section 3.0, Targeted water column and sediment TMDL Endpoints, The use of a calculated water column equivalent PCB concentration from fish tissue (Hayward and Buchanan)*

The Commentor asserts that although the Hayward and Buchanan method for converting fish tissue concentrations into a water column concentration has been developed and used in the Potomac River, and appears to have been accepted by EPA, this has not been vetted by the scientific community at large by the Peer-Review process. This is not a reasonable assumption given the fact that PCBs most readily travel as particulates within the fine grain sediment population.

Response:

As the commenter noted, the Hayward and Buchanan method for developing TMDL endpoints has been accepted by EPA. More specifically, the Tidal Potomac and Anacostia PCB TMDLs, for which this method was developed, were approved in October, 2007. EPA's approval of a TMDL indicates that the methods developed within the TMDL are scientifically sound and defensible. This method has also been used in several subsequent TMDLs that were approved by EPA (for example, in the Corsica River, Baltimore Harbor, and Back River PCBs TMDLs). While a peer review process is not required for TMDL approval by EPA, an extensive review process was conducted by scientists and engineers at the state and federals level within MDE, MDDNR, MDA and EPA.

Regarding the commenter's concern that PCBs travel most readily as particulates, these processes are addressed in the TMDL. The model accounts for partitioning of PCBs within the dissolved and particulate phases in the water column and sediment and simulates the dynamic processes of sediment deposition, resuspension and diffusion. This means that the TMDL does address the PCB fraction that travels as particulates within the fine grain sediment.

The TMDL has separate endpoints that are developed for both the water column and sediments to ensure that water quality is met and the fishing designated use is supported, since fish will accumulate PCBs from both the water column and from the sediment through respiration, dermal contact, and ingestion. The TMDL is determined only when both the water column and sediment PCB TMDL endpoints are achieved.

Comment 3. -- *Section 4.1 Nonpoint Sources, 1) Chesapeake Bay Mainstem Tidal Influence, "The South River embayment is highly influence by tidal exchange of PCBs from the Chesapeake Bay mainstem.*

The Commentor asserts that the claim that the South River is highly influenced by the tidal exchange of PCBs from the Chesapeake Bay mainstem is largely unsubstantiated given the fact that it this claim is not reference to any peer-reviewed scientific document. Furthermore, in their recent peer-reviewed publication, Muller and Muller, 2014 demonstrate that the South River is NOT significantly influenced by the Chesapeake Bay Main-stem with respect to nutrients, dissolved oxygen, and in particular sediments/particulates. In fact, the study shows that the South River is highly influenced by individual tidal creeks, and these are the main source of all pollutants- including PCB's.

Response:

We have reviewed Muller's paper mentioned above. The paper indicates that the majority of nutrient and sediment loads to the South River do not come from the Chesapeake Bay mainstem, but provides no analysis of PCB loads. Data collected by MDE in 2011 and 2012, during the development of this TMDL, and the subsequent modeling efforts, indicate that PCB loads from the bay are currently the predominant source of PCBs to the South River embayment. The PCB impairment results from the residual substance that remains from legacy use and it is therefore fundamentally different from nutrient and other impairments which result from ongoing land uses. Please refer to comment response 1.

Comment 4. **--** *Section 4.0, Source Assessment, 4.1 Nonpoint Sources,*

The Commentor asserts that not all key [PCB] sources are accounted for**:** According to the EPA PCB TMDL handbook, linking water quality and pollutant source – Point Source loadings, "to the extend data allow, identify specific point sources, **landfills…"** Anne Arundel County and the Maryland Department of the Environment have identified over 100 dumpsites within the South River watershed. Attached is a map of the dumpsites identified by Anne Arundel County and MDE, which includes the largest tire dump in the State of Maryland. In the most recent consent decree of *MDE and South River Federation vs. Boehm* this landfill consisted of over 300,000 tires, is a known site for sewage sludge, and other materials know to contain PCB's. In MDE's own study, Aroclors were found in the sediments at this site. It is also a known fact that the combustion of tires release PCB's into the steam, sediments and air.

Response:

In the development of this TMDL, MDE's Land Restoration Program Geospatial Database was used to provide site specific source information. The database gives information about uncontrolled hazardous waste sites in Maryland and it was reviewed in order to determine whether any contaminated sites within the South River watershed are contaminated with PCBs.

No PCB contaminated sites were identified. Had they been, a contaminated site PCB loading would have been calculated and allocated within this TMDL. A data solicitation was conducted for this TMDL in which Anne Arundel County had the opportunity to provide a list of these dumpsites and any relevant PCB water quality data. While there may be over 100 dumpsites within the South River watershed, without evidence of specific contaminant sources or PCB soil concentration data, it is not possible to calculate loadings for these sites. MDE accounts for all contaminated sites that have been identified and listed in the database. The presence of dumpsites within the watershed does not indicate that there are detectable levels of PCBs present at those sites.

In addition, the PCB watershed load is calculated based on non-tidal PCB water column concentration data and watershed flow data. PCB loadings from dumpsites located upstream within the direct drainage of the non-tidal monitoring stations will be captured by the water column sampling. Therefore, while a specific PCB loading for each dumpsite may not be explicitly included and calculated within this TMDL, it will be accounted for within the estimated watershed load for the South River.

In the case of the Joy Boehm landfill, while the specific PCB load cannot be calculated, a non-tidal monitoring station (STH-7) downstream of the landfill has been sampled and will capture the load from this landfill in the overall watershed load estimation.

The combustion of scrap tires will release PCBs into the atmosphere. This process is accounted for within the model through atmospheric deposition, which simulates the deposition of PCBs to the water surface of the South River. Any deposition to the land surface is accounted for within the PCB watershed load.

Comment 5. -- *Section 4.0, Source Assessment, 4.1 Non-Point Sources*

The Commentor asserts that the TMDL does not use data from the “2005 Caged Clam Study to Characterize PCB Bioavailability in the Impaired Watersheds throughout the State of Maryland.” Referenced in the EPA PCB TMDL Handbook, (EPA 841-R-11-006) in the section “Identification of Waterbodies, Pollutant Sources, Priority Rating”, states the following: “Identification of other factors within the waterbody or watershed that may affect PCB loadings (e.g., watershed area, land use/ land cover, population, future growth, distribution of sources and loadings, including air deposition, etc.). Maryland and Virginia have recently published a source tracking study and point source guidance, respectively, that may be informative to other states. The “2005 Caged Clam Study to Characterize PCB Bioavailability in the Impaired Watersheds throughout the State of Maryland” aimed to characterize Maryland subwatershed draining into the PCB-impaired tidal waters”. MDE’s own study is referenced in the EPA Handbook, and MDE does not reference or use their study /data.

This study was performed in the Bacon Ridge Branch section of the South River and PCB concentrations were found to be 8 to 9 times higher than the allowable threshold. The North River, South River had PCB concentrations 1 to 2 times higher than the allowable threshold. Interestingly, the Boehm landfill is upstream from the Bacon Ridge Branch location. This data and this study was not put into this TMDL, therefore not all known data was included in this TMDL as required by EPA.

Response:

The objective of the "2005 Caged Clam Study" was to conduct a first level screening effort to identify potential sources of PCB contamination within several watersheds throughout Maryland. At each bio-monitoring station a basket of clams is placed within the water column of a non-tidal stream for a two to four week period to allow the clams to filter feed resulting in bioaccumulation of PCBs. A reference bio-monitoring station was also selected in the non-tidal Choptank River as it is considered devoid of PCB contamination. The PCB clam tissue concentration data from this reference station was selected as a threshold to compare PCB clam tissue concentrations from the other field stations selected in this study. The threshold is not an indication of water quality. If levels in clam tissue from field stations exceed this threshold, it does not necessarily mean that the water is impaired for PCBs. It only demonstrates that PCBs are present within the water column at levels greater than the Choptank River reference watershed. PCB clam tissue concentration data cannot be used to calculate an actual watershed load.

While the PCB clam tissue concentration for the bio-monitoring station in the Bacon Ridge Branch section was 8 – 9 times higher than the threshold, a non-tidal monitoring station (STH-7) sampled in the Bacon Ridge Branch for this TMDL demonstrated that PCB water column concentrations between 0.48 to 1.17 ng/L. This data was used to estimate the overall watershed load and accounts for the PCB contamination indicated by the clam study within this branch including the Joy Boehm landfill.

Comment 6. -- *Section 5.0 Total Maximum Daily Loads and Load Allocation, 5.2 Analysis Framework, 5.4 TMDL Allocations.*

The Commentor asserts that the tPCB water column data shows that the tPCB concentrations are higher in the South River than in the Chesapeake Bay mainstem. "…The Chesapeake Bay mainstem tidal influence and resuspension and diffusion from the bottom sediments are the two primary sources of tPCB baseline loads resulting in the PCB impairment in the South River embayment**.** MDE's own sediment tPCB data shows an increase with tPCB concentration as going from Bay into River- meaning the concentrations at Stations STH5 are higher than the Chesapeake Bay (r2= 0.42)- stations are plotted over distance (See Figure 1). This is consistent with the Muller and Muller, 2014 paper where results show that it is the South River polluting the Bay and not the Bay polluting the South River. Either the data was entered into the MDE model incorrectly or they completely study was flawed. MDE's own data is counter to what they are stating in their comments.

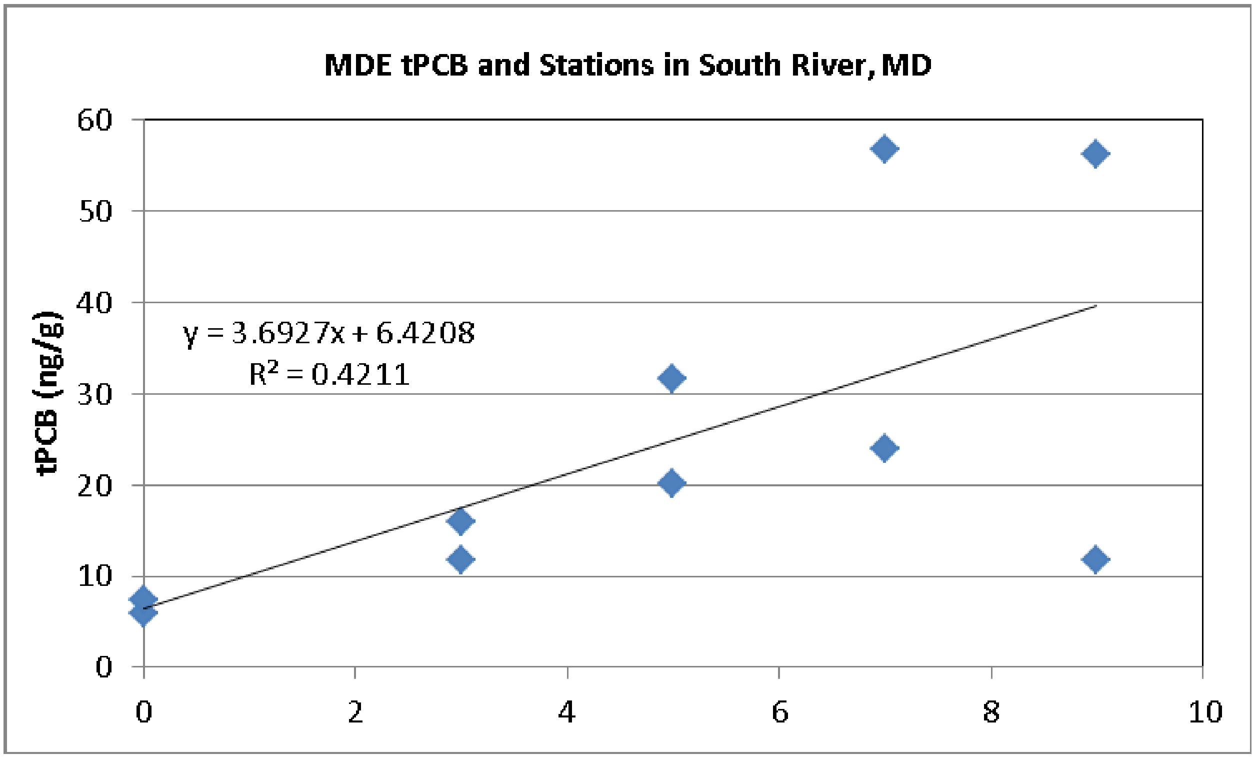

Figure 1: MDE tPCB and Stations in South River, MD (Provided by Commentors)

Response

MDE disagrees with the commenter's conclusion that the data and results presented in this TMDL report show that sources from within the South River watershed are polluting the Chesapeake Bay with PCBs. While the Muller study provides a detailed analysis of monitoring data for temperature, dissolved oxygen, pH, water clarity and nutrients, it does not present any PCB data. MDE believes that the conclusions from this paper cannot be broadly applied to PCBs. The following response will detail three separate analyses that substantiate this statement.

First, MDE has developed a mass balance for the uppermost portions of the tidal South River showing that current PCB loads from the watershed are significantly smaller than what would be required to cause the bottom sediment conditions seen in the South River today. Second, this response will present water column data which show that the majority of current water column loads into the tidal waters of the South River are coming from the boundary with the Chesapeake Bay mainstem rather than from the non-tidal boundary. Finally, this response will describe an evaluation of PCB congener data showing that the sediment pattern highlighted by the commenter—with higher bottom sediment PCB concentrations closer to the head of tide and lower concentrations at the bay boundary—can exist in situations where there is no major ongoing load from the watershed. The results of these analyses support the conclusion reached in the TMDL report that the fish tissue impairment in the South River is being primarily caused by both ongoing water column inputs from the Chesapeake Bay and legacy contamination of the bottom sediment in the South River.

Analysis 1: Mass balance

For portions of the South River upstream of tidal station STH-4 and the corresponding drainage area (see Figure 2), the mass of PCBs contained in the active layer of sediment was compared to the annual loading of PCBs from the watershed. This area was selected since it is the furthest upstream, where any watershed loadings would be expected to deposit, and because the highest bottom sediment PCB concentrations were seen at these two stations. Furthermore, the subwatershed that drains to this area contains most (84%) of the South River watershed meaning that the majority of the freshwater inputs to the South River occur here. The delineations of the subwatershed and tidal segmentation are depicted as Zone 1 in Figure 2.

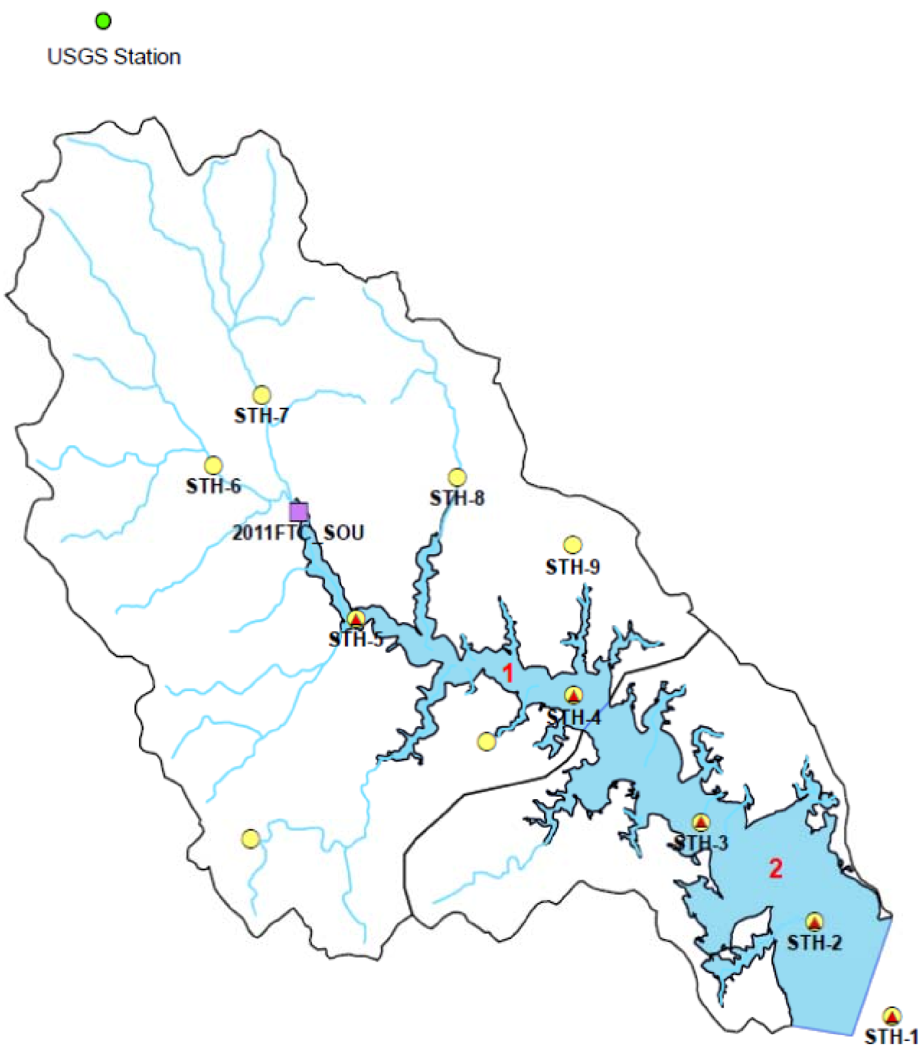

Figure 2 – Subwatershed and tidal segmentation (Zone 1) for the Analysis 1 mass balance

Table 1 shows the inputs and assumptions used for the calculation of current loadings from the watershed.

Table 1 – Watershed loading calculations

USGS mean flow	0.858	cfs	*from TMDL report*
USGS drainage area	1.00	mi^2	*from TMDL report (2.59 km^2)*
Average flow per area	0.858	cfs/mi^2	
Subwatershed area	47.5	mi^2	
Subwatershed flow	40.7	cfs	
Subwatershed flow	3.64E+10	L/year	
Max watershed PCB concentration	1.173	ng/L	*maximum observed non-tidal PCB concentration (station STH-7)*
Max watershed PCB load	42.7	g/year	

Table 2 shows the inputs and assumptions used to estimate the total mass of PCBs in the bottom sediment upstream of station STH-4.

Table 2 – Mass of PCBs in sediment

Tidal water area	2.54	km^2	
Active sediment layer thickness	0.1	m	
Volume of active layer	657,000	m^3	
Sediment density	2.5.E+06	g/m^3	
Porosity	0.8		*from TMDL report*
Mass of active dry sediment	3.29E+11	g	
tPCB concentration in dry sediment	37.19	ng/g	*Average bottom sediment PCB concentration data within subwatershed (stations STH-4 & 5)*
Mass of PCB in active sediment	12,217	g	

Given a current annual loading of 42.7 g/year from the watershed and a mass of 12,217 grams in the active layer of sediment in the South River, it would take 280 years to accumulate enough PCBs to see the mass that is currently present in the sediment. As a conservative assumption, this estimate incorporates the maximum observed non-tidal water column concentration (1.173 ng/L station STH-7). It also assumes that all of the suspended and dissolved PCBs will deposit in the upper reaches of the South River. Lastly, this analysis excludes any potential loads from the Chesapeake Bay or air deposition to tidal waters.

As an extension of this analysis, it is possible to compare the length time calculated above—280 years—with the time span it would take for 0.1 m of sediment to accumulate here. The South River PCB TMDL uses a sediment deposition rate of 3.935×10^{-6} m/day. The derivation of this parameter is described in Appendix E of the TMDL report. At this rate, it would take 70 years for 0.1 m of sediment to deposit, meaning that the observed watershed PCB loads are too dilute to result in the PCB concentrations seen in the bottom sediment.

Analysis 2: Tidal water column trends

The figure provided in Comment 6, shows PCB concentrations in the bottom sediments of the South River. Because of the complexity of environmental processes involved in the transport and deposition of PCBs sorbed to sediment in tidal waters, it is difficult to use these spatial trends to draw any reliable conclusion about the current sources of PCBs to the embayment.

MDE's tPCB water column data, those used to calculate the TMDL, are plotted in Figure 3. They show that tPCB concentrations are higher at stations closer to the bay mainstem rather than those further up the embayment or those in the non-tidal tributaries of the South River. This indicates, that in the current condition, the bay mainstem is a significantly larger source of PCBs into the South River than the South River watershed. The station map and data plot are shown below (Figures 3 and 4).

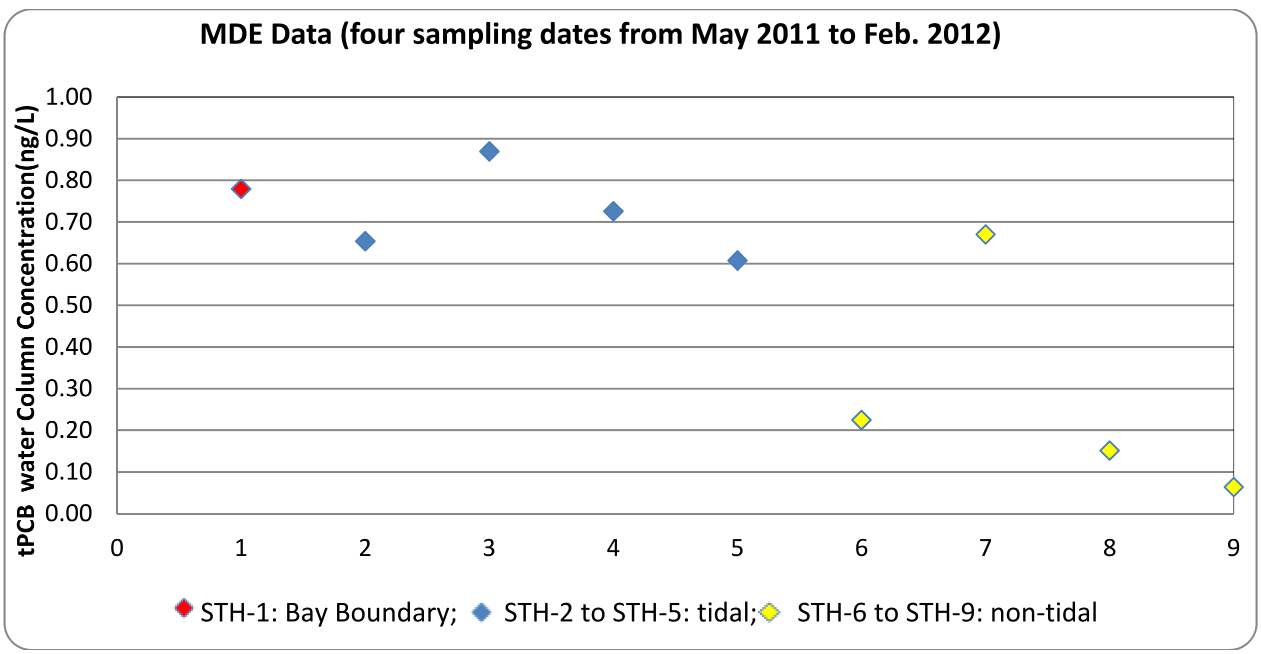

Figure 3 – South River water column tPCB concentrations

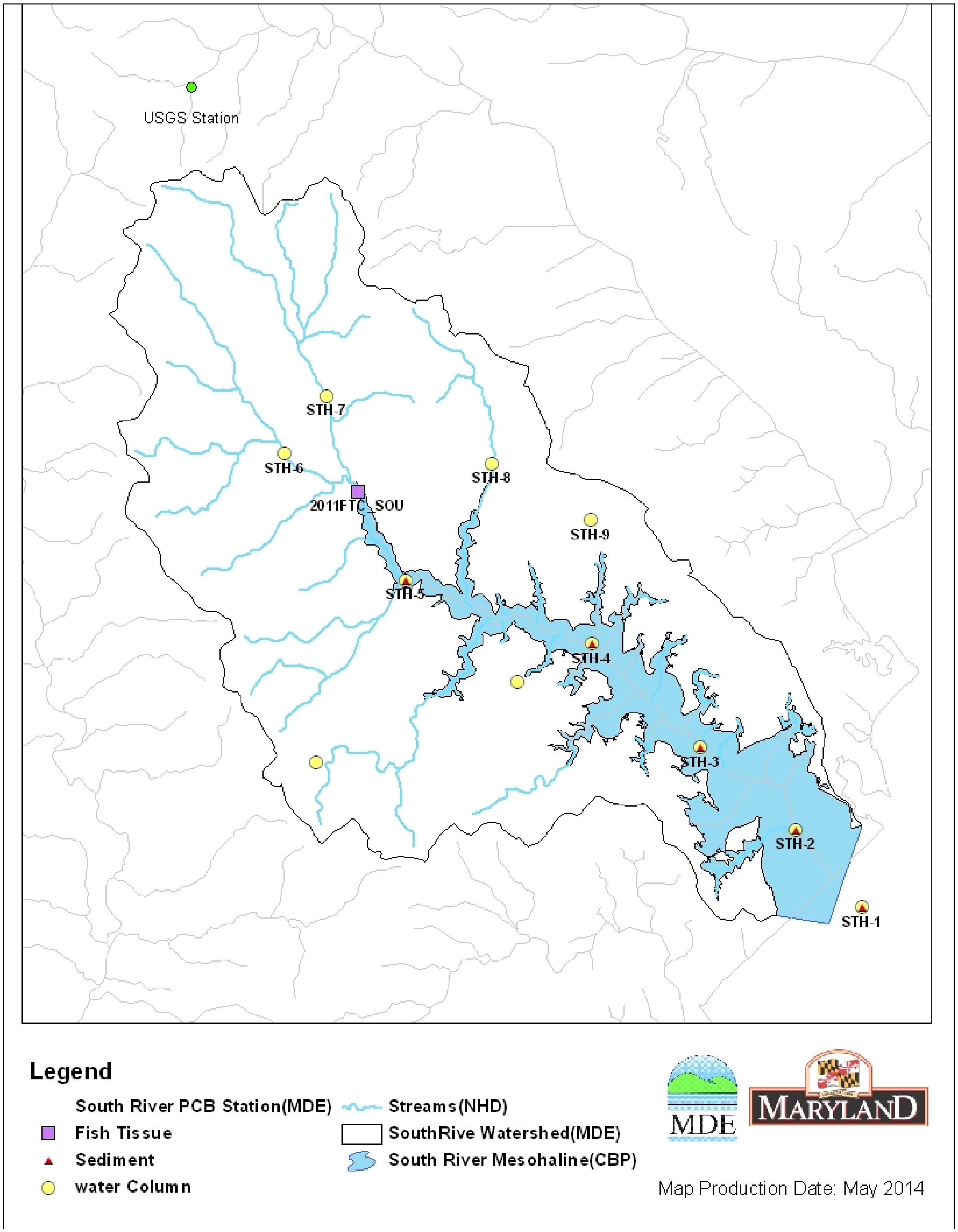

Figure 4 – South River Monitoring Station Map

Analysis 3: PCB congener source tracking

An analysis of the PCB congeners in the bottom sediment, the tidal water and the non-tidal water indicates that a significant portion of the congeners found in the bottom sediment are not the result of current watershed loadings. The congeners in the sediment not coming from the watershed were typically higher-weight congeners from the heptachlorobiphenyl, octachlorobiphenyl, nonachlorobiphenyl and decachlorobiphenyl homolog categories. Congeners 171, 172, 176, 177, 189, 202, 206 and 208, as well as co-eluting congeners 170 and 190 were found in detectable quantities in the bottom sediment of the South River, but were not detected in any of the four non-tidal monitoring stations. Furthermore, decachlorobiphenyl (congener 209) was found in significant concentrations at all of the sediment monitoring stations, but was only found in very low concentrations at one of the non-tidal water column monitoring stations, STH-7.

Figure 5 shows concentrations of select high-weight congeners (170/190, 206, 208 & 209) in the bottom sediment and the water column. Of the eleven congeners listed above, these five were observed in higher concentrations than the others. These results mirror the trends identified in Analysis 2, with higher PCB sediment concentrations closer to the non-tidal boundary of the South River, and higher water column concentrations closer to the tidal boundary.

Decachlorobiphenyl (congener 209) is of particular importance here, since it comprises such a large portion of the tPCB mass found in bottom sediment: 30.3% at station STH-1, 33.4% at STH-2, 24.6% at STH-3, 21.9% at STH-4 and 8.4% at STH-5. The prevalence of this congener in sediments is to be expected due to its environmental persistence and strong tendency to sorb to organic materials. The lack of any large source of decachlorobiphenyl from within the watershed, however, shows that a significant portion of the tPCB concentrations seen in the sediment are not being caused by current sources from within the basin. While the sediment dynamics of higher weight PCB congeners might not match those for lower weight congeners, this analysis demonstrates that it is possible to have the spatial variation of PCBs that was observed in the South River without an active source in the watershed.

Conclusions

While it is difficult to fully explain the spatial trends seen in the bottom sediments of the South River based on the information presented here, these analyses support the conclusion of the TMDL report that current watershed loadings are not a large factor in causing the tidal South River fish tissue impairment. In regards to the spatial bottom sediment PCB trends, there are several environmental processes that could contribute to what is observed. Given the long-term nature of PCB transport and bioaccumulation, and the geographically widespread nature of PCB pollution, answering this question is outside the scope of this TMDL report. It should be noted that similar concentration gradients are seen in the bottom sediment of nearby tidal embayments, which may mean that the phenomenon seen in the South River is not specific to that waterbody.

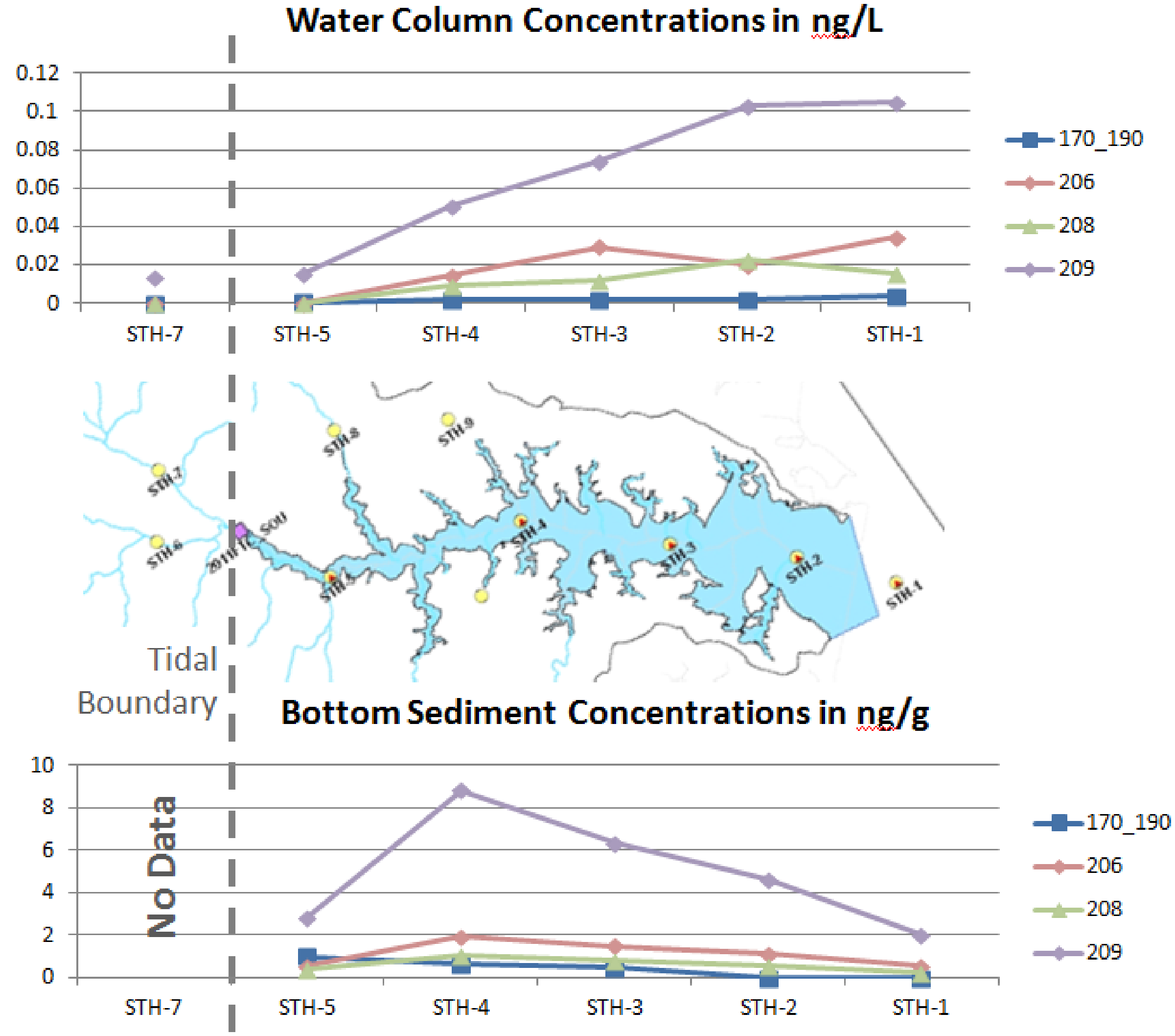

Figure 5 – Concentrations of select high-weight PCBs in the South River water column and bottom sediment

Comment 7: The Commentor asserts that the proposed TMDL appears to misattribute the major source of PCBs to the waterway to "the transport of PCBs…from the Chesapeake Bay Mainstem and from bottom sediment via resuspension and diffusion." This conclusion seems to be contrary to Maryland Department of the Environment's data collected as part of a 2005 caged corbicula study[1] which found elevated PCB levels in both of the major non-tidal tributaries to the South River.

The report found that clams collected in the North River system had PCB levels between 1 and 2 times the allowable threshold and clams collected in the Bacon Ridge Branch system had PCB levels between 8 and 9 times the allowable threshold. Each of these sites is a significant distance above tidal influence and their elevated PCB levels would appear to suggest that an endogenous source (or sources) somewhere in the upper South River. It should be noted that this finding of non-tidal PCB sources in the South River headwaters is consistent with the sampled sediment PCB concentrations in this draft TMDL found on page J-1 which show far lowers levels at the mouth of the River, where it meets the Bay, than further upriver.

The PCB levels in the Bacon Ridge Branch system in the 2005 study approximated those found in the Upper Elk tributaries, Anacostia River tributaries, and tributaries to the Lower Patapsco River, all systems with heavy industrial uses in their watersheds.

Any strategy to reduce PCBs to the South River that does not account for load sources may fail to result in improvements to the waterway.

Response:

That there are PCB sources in the South River watershed is undeniable, as described in the report. But under current average conditions, shown in the TMDL report, the magnitude of the PCB load emanating from the South River watershed is much smaller than that from the Chesapeake Bay mainstem. As mentioned in the above comments, the sediment PCB results from legacy uses. Please refer to all of the above comment responses – particularly number 5 – for details.

Comment 8: MDE received very similar letters from four commentors, three of whom were South River Federation Board of Directors members, all of which supported the South River Federation comments in general and all of which made the specific assertion that the TMDL results were contrary to the Caged Clam Study which showed PCB levels 1 to 2 and 8 to 9 times higher than the allowable threshold.

Response:

Please refer to all of the above comment responses, particularly number 5.

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[1] Poukish, C., et al (2009). *2005 Caged Clam Study to Characterize PCB Bioavailability in the Impaired Watersheds throughout the State of Maryland*. Maryland Department of the Environment.