

# **Use of Benthic Flux Chambers for the Quantification of Filter-passing Mercury and Methylmercury from the Streambed of the South River**

South River Science Team and Expert Panel Meeting – October 2008  
Rich Landis

## **Background:**

The various habitats within the South River have been hypothesized to be potentially important contributors of filtered methylmercury fluxes to surface water. These habitats encompass a diverse environment such as fine-grained channel margin (FGCM) deposits, periphyton attached to main channel cobbles, wetlands or other quiescent areas like mill races that hydraulically connected to the South River and embedded substrates or gravel bars in the high flow portions of the main channel.

Benthic flux chambers (BFC) allow the direct measurement of chemical flux from discrete areas of sub-aqueous habitat in the South River. The use of a BFC allows for the measurement of the flux of filter-passing total mercury (THg), methylmercury (MeHg), iron (Fe) and manganese (Mn) in the South River, as well as measurements of dissolved oxygen in the chambers. The use of an opaque and a clear BFC allows for the testing of the effects of induced diurnal changes in the redox state within the BFC, such as the dissolution of mineral phases or increase in anaerobic microbial activity.

## **Objectives:**

The overall goals of the study are to:

- Provide direct measurements of filtered total mercury (THg), methylmercury (MeHg), iron (Fe) and manganese (Mn) flux from the habitats within the South River;
- Identify habitats and reaches within the South River that are significantly contributing filtered THg and MeHg to the water column.
- Identify the potential for mercury to be released to the surface water by mineral dissolution induced by diurnal changes of the redox state within the South River.

## **Progress:**

Summary of the recent BFC efforts for the South River.

- Methods have been developed to seal the BFCs to the embedded gravel habitat that is the dominant within the South River.
- Two BFC deployments were conducted in May 2008 and August 2008 to support the Ecological studies
- Two BFC deployments were conducted in June 2008 and September 2008 to develop a mercury mass balance for the habitats in the reach from the bridge at Hopeman Parkway (roughly RRM 2.3) to bridge at Doods' (roughly RRM 5.0).

The BFC efforts for 2007 and 2008 built upon the results of the 2006 BFC study and the results of the Phase I System Characterization. A goal of the 2007/2008 study was to seek to extend the utility of the BFCs to the embedded gravel habitat for the South River that is the dominant habitat in the South River.

In 2008, the three dominant habitats were studied: FGCM deposits, embedded substrates, and wetland type habitats to determine their relative differences in filtered THg or MeHg fluxes, and to determine if flux measured from these substrates can account for the flux measured over a given reach based upon surface water sampling.

In the May 2008 BFC study, our focus was to measure flux of specific habitats of interest to support the Ecological study and collect sediment from beneath the BFCs for further study by others. We also attempted to place the BFC flux measurements in context by comparing them to the reach wide surface water flux predicted by surface water concentrations and physical parameters of the South River at the given time. Results from the May 2008 BFC study are in Figures 1 & 2 and were limited to FGCM Deposits and Wetland type habitats due to methods development issues for the embedded gravel habitat.

### May 2008 BFC Data in Support of the Ecological Study

Site Location	Habitat	Date	BFC Type	Flux		Sediment Data		
				(ng*m <sup>-2</sup> *hr <sup>-1</sup> )		THg	MeHg	LOI
				FIHg	FMeHg	ug/g		%
RRM 1.6	FGCM Deposit	5/6/2008	Opaque	-4.29	-11.36	3.96	0.01	13.98
			Clear	17.21	-6.11			
RRM 5.2	FGCM Deposit	5/6/2008	Opaque	70.26	-4.81	45.15	0.06	6.46
			Clear	144.83	-12.64			
RRM 6.2	FGCM Deposit	5/7/2008	Opaque	106.69	15.23	18.90	0.11	23.23
			Clear	112.00	21.34			
RRM 12.8	FGCM Deposit	5/8/2008	Opaque	112.60	37.55	45.20	0.20	12.94
			Clear	-36.26	14.44			

Figure 1: May 2008 BFC and sediment data (Note: RRM 1.6 = Oxbow, RRM 5.2 = Millrace)

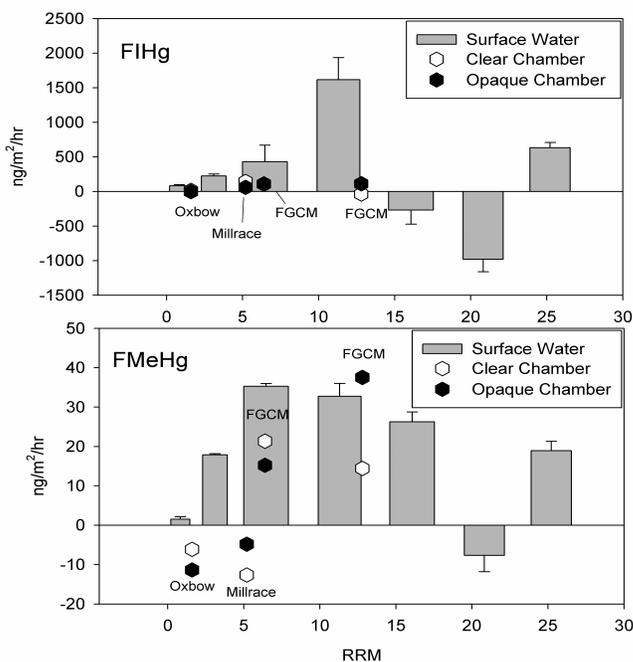


Figure 2: May 2008 BFC and Surface water flux data for the South River

Summary of the results from the May 2008 BFC study are:

- The filtered inorganic mercury and methylmercury fluxes are uniformly low compared to surface water for the areas studied.
- The Oxbow and the mill race at Dooms' dam do not appear to be a significant source of filtered methylmercury to the South River.
- Fine grain channel margin deposits do not appear to be a significant source of filtered inorganic mercury and methylmercury to surface water due to their limited areal extents.

In the June BFC study, this was our first attempt at a mercury mass balance of the dominant habitats within the study reach. The chosen study reach was between the bridge at Hopeman Parkway (roughly RRM 2.3) and the bridge at Dooms (roughly RRM 5.0). Within this study reach six locations were selected to deploy paired BFCs based upon information from the Ecological study. Results from the June 2008 BFC study are in Figure 3.

### June 2008 BFC Reach Study Data

Site Location	Habitat	Date	Whole River Flux (ng/hr/m <sup>2</sup> )				BFC Type	Flux		Sediment Data			
			IHg		MeHg			(ng*m <sup>-2</sup> *hr <sup>-1</sup> )		THg	MeHg	%Fines	LOI
			AM	PM	AM	PM		FIHg	FMeHg				
RRM 2.8	FGCM Deposit	6/17/2008	490	651	52.5	61	Opaque	-9.82	28.30	18.4	0.03	38	3.1
							Clear	3.43	30.07				
RRM 4.0	FGCM Deposit	6/17/2008	490	651	52.5	61	Opaque	-30.42	109.98	24.3	0.09	56	2.5
							Clear	-48.77	160.42				
RRM 4.6	Embedded Gravel	6/18/2008	456	618	36.3	32.9	Opaque	-64.00	31.66	21.3	0.06	41	3.5
							Clear	25.01	41.72				
RRM 4.0	Rock Plate	6/18/2008	456	618	36.3	32.9	Opaque	-43.01	12.72	56.4	0.12		1.4
							Clear	-31.81	1.01				
RRM 4.0	Embedded Gravel	6/19/2008	498	661	31.2	40.2	Opaque	65.68	4.90	69.0	0.07		1.1
							Clear	75.03	5.18				
RRM 4.5	FGCM Deposit	6/19/2008	498	661	31.2	40.2	Opaque	42.57	9.41	38.3	0.04		1.6
							Clear	82.56	11.13				

Figure 3: June 2008 BFC Flux, Sediment, and Whole River Flux data for the South River

Summary of the results from the June BFC study are:

- Though the filtered MeHg BFC flux measured at RRM 4.0 was elevated its areal extent is quite limited and does not appear to be a significant source to surface water on reach wide basis.
- The June 2008 data also indicate that overall the FGCM deposits continue to appear to be a limited source of filtered inorganic and methylmercury to surface water due to their limited areal extent.
- The June 2008 data indicate that the embedded gravel deposits could be a significant source of filtered methylmercury due to their much larger areal extent versus FGCM deposits.

In the August BFC study, (as in the May 2008 BFC study) our focus was measure flux of specific habitats of interest to support the Ecological study and collect sediment from beneath the BFCs for further study by others. As in the May 2008 study, we attempted to place the BFC flux measurements in context by comparing them to the reach wide surface water flux predicted by

surface water concentrations and physical parameters of the South River at the given time. Results from the August 2008 BFC study are in Figures 4 & 5.

### August 2008 BFC Data in Support of the Ecological Study

Site Location	Habitat	Date	BFC Type	Flux		Sediment Data			
				(ng*m <sup>-2</sup> *hr <sup>-1</sup> )		THg	MeHg	%Fines	LOI
				IHg	MeHg	ug/g		%	
RRM 3.0	FGCM Deposit	8/19/2008	Opaque	144.65	5.18				
			Clear	84.89	-0.64				
RRM 4.6	Embedded Gravel	8/20/2008	Opaque	124.78	1.24				
			Clear	222.27	7.45				
RRM 6.2	FGCM Deposit	8/19/2008	Opaque	51.28	1.33				
			Clear	97.66	11.42				
RRM 7.4	Embedded Gravel	8/21/2008	Opaque	-31.13	9.32				
			Clear	50.90	4.29				
RRM 8.7	Embedded Gravel	8/20/2008	Opaque	-27.27	4.16				
			Clear	-3.42	-1.71				
RRM 12.8	FGCM Deposit	8/21/2008	Opaque	12.89	2.90				
			Clear	9.54	13.90				

Figure 4: August 2008 BFC data (Note: Sediment data is pending analysis)

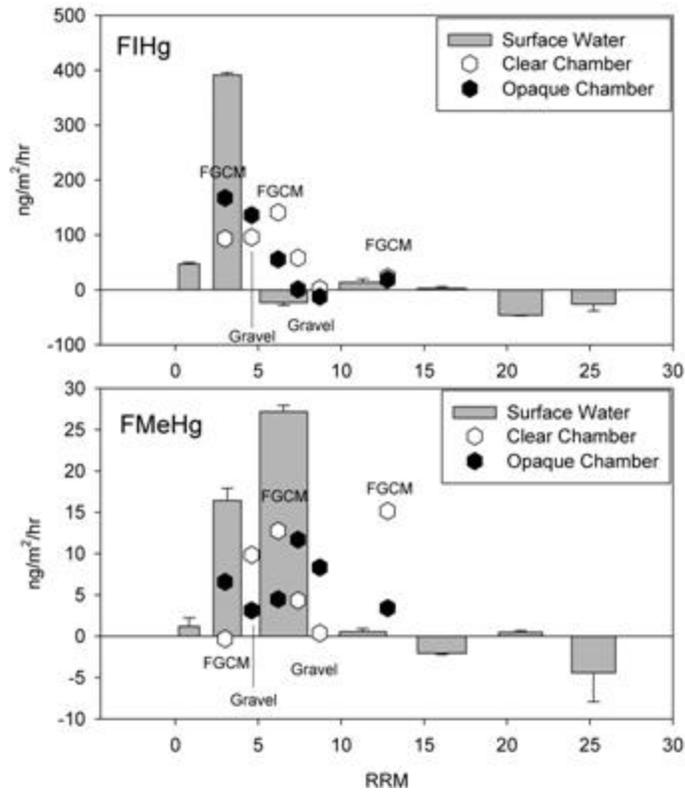


Figure 5: August 2008 BFC flux and surface water flux data for the South River

Summary of the results from the August 2008 BFC study are:

- As in May, the filtered inorganic mercury and methylmercury fluxes are uniformly low compared to surface water flux for the areas studied.
- As in May, fine grain channel margin deposits do not appear to be a significant source of filtered inorganic mercury and methylmercury to surface water due to their limited areal extents.
- As in June, the August data indicate that the embedded gravel deposits could be a significant source of filtered methylmercury due to their much larger areal extent versus FGCM deposits.

In the September BFC study, our focus was another mercury mass balance reach study similar to the June effort, but with a emphasis on the dominant embedded gravel habitat within the study reach. The chosen study reach was the same as in June (between the bridge at Hopeman Parkway and the bridge at Dooms. Within this study reach five embedded gravel locations were selected to deploy paired BFCs in order to collect more flux data on this dominant and potential more habitat type. Results from the September 2008 BFC study are pending analysis.

**Going Forward:**

- 1) Complete the analysis of the August and September data.
- 2) Implement a BFC study using pressure transducers to measure porewater pressures in the embedded gravel, BFC, surface water, and ambient air prior to deployment and during deployment of the BFCs to help determine if the BFCs are impacting advective flow into the BFCs.
- 3) Run enhanced BFC stirring rate tests in the embedded gravel habitat to determine if enhanced stirring can better simulate the flow over the embedded gravel habitat and better account for more filtered inorganic and methylmercury on a reach wide basis.
- 4) Continue the BFC deployments in 2009 to develop larger database of BFC data.