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Marc S. Greenberg, Ph.D.
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U.S. EPA - Environmental Response Team
OSWER/OSRTI/TIFSD/ERT

Re: Gowanus Canal Superfund Site: Estimation of PAH Concentrations on Solids from CSO Water Column Data

Dear Dr. Greenberg:

This memorandum summarizes some of the technical issues associated with the data collected and the analyses discussed by EPA at the CSTAG meeting, as they relate to contaminant loads associated with New York City (City) Combined Sewer Outfalls (CSOs). The City is hopeful that this analysis will be helpful to the CSTAG panel in their review process. The City's assessment of EPA's analysis is summarized in the following sections. The City would also like to restate its concerns regarding data gaps in the Draft RI Report and the current Conceptual Site Model ("CSM") for the Gowanus Canal, as presented in the RI. These concerns were previously presented by the City to EPA. These concerns are also summarized in the following sections.

The City has used the data presented in the RI Report for sediments collected in CSOs to conduct an independent evaluation of the potential impact of CSOs on the canal, and to develop a Conceptual Site Model (CSM) for the canal. These results were presented to CSTAG and demonstrate that PAH concentrations in CSO sediments, as presented in the RI Report, are equivalent to background concentrations, and are less than human health risk-based values. The EPA has discussed an alternative analysis in which they characterized PAH loads in CSOs as significantly

greater than the City's analysis. The City has not seen the EPA analysis, as it was not presented in the RI Report. It appears that USEPA is using the whole water data presented in the RI to estimate particulate matter concentrations for PAHs for risk assessment purposes.

This memo presents an analysis of the problems associated with estimating the PAH concentrations in CSO solids using the whole water data presented in the RI. There are several concerns with the methodology used in sampling whole water data and in the laboratory results reported for these data. These include:

- high and variable detection limits were reported for chemical and TSS data;
- poor agreement was observed for field duplicates;
- assumptions made regarding PAH partitioning in estimating particulate concentrations may not be valid: and
- discrete surface water samples used for CSOs are not representative of CSOs.

These uncertainties in the data can result in estimated particulate concentrations that may be more than an order of magnitude greater than actual values. These results have significant implications for load calculations, risk assessment, and remedial action decisions for the Site. Given the concerns with EPA's whole water sample data collection methodology, analysis, and the approach used to derive PAH concentration on the solids, the City believes that EPA's usage of these derived concentrations is problematic. In general, EPA's calculation methods are overly conservative for PAH compounds and the data are very poor for estimating concentrations of the more particle reactive PAH compounds. While the whole water data collected by EPA could be used to develop a preliminary assessment of the risk due to CSO water, it should not be used to derive conclusions on particulate matter. Further, using data presented in the RI for background samples and CSO whole water samples, the City has determined that, using EPA's methodology, the estimated B(a)P concentration on particulates for CSO samples with B(a)P detections are within or below the range of reference area results. This analysis would indicate that CSO and background area solids have essentially the same B(a)P levels. These analyses are discussed in more detail in the following sections.

1. Concerns with Data Collected by EPA for Remedial Investigation (RI) and its Use to Derive Remedial Decisions:

As reported in the RI Report, EPA collected sediment and surface water samples from the 1) reference site (Gowanus Bay and Upper NY Bay), 2) CSOs, and 3) Gowanus Canal. Ten locations in Gowanus Bay were selected by EPA to characterize the reference site. At the reference locations surface water samples were collected during dry weather and one wet weather event. Water samples were collected from ten CSOs during a single dry weather event and three wet weather events in an attempt to characterize CSO water and solids that may enter the Canal during CSO discharge events. Note that not all ten CSOs were sampled during all three wet weather events; however, each of the ten sampled CSOs has at least one wet weather sample.

Sediment samples were collected from the 10 locations representing the reference or background locations. In order to characterize the sediment from the CSOs, EPA sampled seven CSO locations from within sewer pipes and interceptors. An attempt was made to sample 10 CSO locations, but sediment was not found at 3 of the proposed locations.

Twenty-five locations were sampled for sediment and surface water samples from the canal in order to characterize the canal itself. Sediment and surface water samples were analyzed for TAL metals and TCL organics.

The City has used the data collected by EPA in the RI Report to conduct an independent evaluation of the CSOs and develop an initial framework for a conceptual site model for the Canal. However, there are many concerns regarding the data collected by EPA. Concerns are as follows:

- a) Whole Water Data Sampling Method for CSOs: To characterize the general level of contamination in the discharge water from a CSO, composite sampling is required. The EPA collected almost exclusively discrete (grab) water samples. A grab sample represents the instantaneous conditions at the time of collection and does not represent or integrate the contaminant concentration variations over the period of discharge during a rainfall event. A single 12-hour composite sample was collected from only one CSO (RH-034) during one wet

weather event. The remaining whole water samples are highly variable and don't characterize average CSO discharges.

b) Total Suspended Solids (TSS) Results from the CSOs and Background: The total suspended solids results from the surface water data for background and CSOs are shown in Table 1a and 1b respectively. For the background site, the average dry weather TSS value is 78 mg/L with a median of 86 mg/l. For wet weather sampling similar values are reported. However, reports in the literature (NYCDEP 2010, Litten 2003, Garvey 1990) conducted in the NY Harbor report the TSS in the harbor to be in the range of 3-20 mg/L. This discrepancy between the EPA's results and those of prior observers raise a major concern for the EPA data set. High TSS values reported by EPA's laboratory could be due to an error in measurement. Measurement of TSS in salt water requires special care in the selection of an appropriate filter pad and proper rinsing of the filter pad. If this is not done correctly, dissolved salts from the salt water sample will remain on the filter pad resulting in a false high TSS reported result.

Table 1a. Total Suspended Solids Results for Background

Sample ID	TSS (mg/L) DRY Weather	TSS (mg/L) Wet Weather Event 1
326	45	63
327	90	97
328	94	77
329	90	83
330	104	62
331	106	94
332	82	80
333	60	79
334	42	91
335	64	63
Average	78	79
Median	86	80

Related to this concern, the City notes that for the CSO results, the average of the reported TSS values is very similar for both dry (149 mg/L) and wet (136 mg/L) weather samples (see Table 1b). Since storm water is expected to contain less suspended matter than municipal wastewater, it is expected that the TSS levels in a CSO flow during a wet weather event should

be lower than dry weather event. Despite the close agreement of the average TSS levels for dry and wet events, the individual TSS values for the three wet weather events ranged from 19 mg/l to 989 mg/L. Notable in the wet weather TSS levels were two apparently extreme values obtained in wet weather event 2, 377 and 989 mg/L. However, evaluation of the rainfall intensity showed that wet weather event 2 had the lowest rainfall intensity of all the rainfall events. If these two values are excluded from the mean wet weather TSS calculation, the average TSS values reduces to 70 mg/L, which is more consistent with the City's measured TSS levels (65-70 mg/L¹) for CSOs during wet weather events. However, the wide variation in the results and the sensitivity of the mean value to just two values is considered symptomatic of poor TSS data in general. The City believes that the discrete sampling method employed by EPA fails to characterize the TSS levels in the CSO discharge during a wet weather event.

Table 1b. Total Suspended Solids Result for CSOs

CSO	TSS (mg/L) Dry Weather	TSS (mg/L) Wet Weather Event 1	TSS (mg/L) Wet Weather Event 2	TSS (mg/L) Wet Weather Event 3
OH-005	171	46		19
OH-006	78			132
OH-007	61			40
RH-031	161		377	56
RH-033	71	24		66
RH-034	123	38	70	
RH-035	220		989	126
RH-036	100	45		18
RH-037	38	102		91
RH-038	467	186		35
Average	149	137		
Median	112	61		

¹ TSS values in sanitary sewage average about 115 mg/L (NYCDEP, 2002) and in stormwater average about 60 mg/L (Hazen and Sawyer, P.C., 1993). Analyses conducted for the *Gowanus Canal WBWS Facility Plan Report, August 2008* indicate that CSOs are roughly 90% stormwater and 10% sanitary sewage, and a typical TSS concentration for CSO is about 65-70 mg/L.

c) CSO Water Sampling Analysis: For the CSO water data, SVOC analysis was conducted on a whole water basis, providing no information on dissolved and suspended matter concentrations, an important consideration in estimating impacts from the CSOs. This is an important analysis because chemicals partition between the dissolved and particulate phases depending on their solubilities, and this can have a significant impact on chemical concentrations in the particulate matter. In contrast to SVOCs, metals were analyzed for dissolved and particulate phases in an attempt to get this type of information but the results are problematic and do not provide precise estimates of suspended matter-borne contaminants. Additional concerns with the results of this analysis include:

d) Variable detection limits: From the results provided by EPA, it is apparent that EPA's laboratory did not achieve consistent reporting limits (RL) in their analysis of contaminants in whole water. For the CSO results, reporting limits of both 1 ug/L and 0.1 ug/L were reported. The value of 1 ug/L was reported for the majority of the results from wet weather event 1. The issue with this RL is that most of the detected values of the subsequent wet weather samples from the CSOs are less than 0.5 ug/L, i.e. less than half the reporting limit for the first event. The high detection limit of 1 ug/L thus renders the wet weather event 1 results unsuitable for further evaluation and substantively reduces the data set.

d) Concerns with field duplicates (for both surface water and sediment sampling): Field duplicates were collected by EPA for surface water and sediment samples. For surface water, field duplicates were analyzed for two CSOs, RH-033 (wet weather event 1) and OH-007 (wet weather event 3). A single field duplicate for CSO sediments was collected for sample RH-035. Results of the field duplicates for some contaminants for RH-033 (wet weather event 1) are shown in Table 2a. For this sample, multiple detection limits were used by EPA's lab to characterize the field duplicates, limiting the usability of the data. In Table 2b, the results for a CSO sediment field duplicate are shown. In this instance, the results show very poor precision with detected levels in one sample more than 2 times higher than the detected values or the detection limits in the second sample.

Table 2a. Field Duplicate Results for Surface Water

Analyte	RH-033 - Wet Weather Event 1				Notes
	Result (ug/L)	Qualifier	Result - Duplicate (ug/L)	Qualifier	
Acenaphthylene	1	U	0.1	U	A
Benzo(a)pyrene	1	U	0.1	U	A
Naphthalene	1	U	10		B
Benzo(k)fluoranthene	1	U	0.066	J	A
Chrysene	1	U	0.13		A

Notes:

A: Disparate detection limits reduce data usability.

B: Result value is 10 times lower than the corresponding duplicate result.

Table 2b. Field Duplicate Results for CSO Sediment Samples

Analyte	CSO - RH-035			
	Result	Qualifier	Result - Duplicate	Qualifier
Lead (mg/kg)	38		3320	
Benzo(a)anthracene (ug/kg)	270		120	U
Benzo(a)pyrene (ug/kg)	490		140	
Benzo(b)fluoranthene (ug/kg)	440		130	
Benzo(g,h,i)perylene (ug/kg)	340		92	J
Benzo(k)fluoranthene (ug/kg)	400	J	120	U
Chrysene (ug/kg)	260		120	U
Dibenz(a,h)anthracene (ug/kg)	280		120	UJ
Fluoranthene (ug/kg)	600		120	U
Indeno(1,2,3-c,d)pyrene (ug/kg)	460		170	
Phenanthrene (ug/kg)	370		120	U
Pyrene (ug/kg)	560		120	U

Note that result value is more than two times greater than the corresponding duplicate value/ detection limit. This is the only duplicate pair for CSO sediments.

f) Results for Metals: For metals, the surface water data was analyzed for dissolved and whole water. For some metals the whole water results were lower than the dissolved results, a

physically impossible result that reveals the poor precision of the data and the sampling approach. Table 3 shows results for some metals where this is observed.

Table 3. Inconsistency and Poor Characterization of Metals for Dissolved and Particulate Phase Results

CSO	Wet Weather Event	Metal	Total (ug/L)	Qualifier	Dissolved Phase (ug/L)	Qualifier	Notes
RH-036	3	Barium	11.2	J	20	J	A
RH-037	1	Copper	51		217	J	A
RH-033	1	Cadmium	2.7	J	10	U	B
RH-031	2	Cadmium	0.4	J	1.0	U	B
RH-033	3	Zinc	40		52	J	A

Notes:

A: Dissolved concentration is higher than the total concentration so suspended matter concentration is undefined.

B: Non-detected dissolved concentration value is higher than the reported total concentration value.

In conclusion, the City believes that the data used by EPA to characterize the CSOs is inadequate and should be used with caution in assessing the impact of CSOs on the Canal or for making remedial decisions.

2. Estimation of Contaminant Concentration on Particulate Phase using Whole Water

Data:

At the November 3, 2011 CSTAG meeting, EPA Region 2 indicated that it is using whole water data to estimate particulate concentrations for PAHs. The City has yet to be provided with this analysis, and has several questions and concerns regarding the underlying methodology and its conclusions. Based on the description provided by EPA at the November 3 meeting, it seems that EPA's methodology may make conservative assumptions that all the reported PAH concentrations are present on the particulate matter, and that the dissolved phase concentration is zero. Based on the data quality issues discussed above, the City has concerns regarding this approach. For purposes of this discussion, the City is using B(a)P for illustrative purposes, given its importance in the risk analysis and its hydrophobic nature.

Table 4 lists the B(a)P and TSS concentrations in water obtained from the sampled CSOs. Of the 21 samples (including field duplicates) that were collected by EPA, fifteen had non-detect values for B(a)P concentrations reported by the laboratory. Additionally two different RLs (1 ug/L and 0.1 ug/L) were reported by EPA's laboratory for B(a)P in Events 1 and 3. Use of ½ RL as an estimate of the sample concentration when compiling statistics on mean or median concentration is a common practice. Use of ½ RL for the majority of the data set for B(a)P estimates would be problematic. The non-detect values with an RL of 1 ug/L (30 percent of these samples) should not be included in the evaluation because five of the six detected results are well below half the RL. Thus the RL for these samples is sufficiently high so as to lie outside the range of the detections. These data are effectively useless in trying to estimate B(a)P concentrations since they provide only a crude upper bound to the actual sample concentration. Loss of these sample results substantively reduces the amount of data that is available for CSO characterization. In total, of 21 measurements of B(a)P, 6 were nondetect at a RL of 1 ug/L, 9 were nondetect at a RL of 0.1 ug/L and six were detections in the range of 0.15 ug/L to 0.59 ug/L. These values are not particularly different from water column concentrations reported in the Gowanus Bay reference area (0.17 ug/L to 1.4 ug/L). Table 4 also demonstrates that the B(a)P concentrations calculated using EPA's assumed method results in very low concentrations when actual detected values are used. For example in event #2 the 2 detected values result in B(a)P concentrations of 150 ug/kg and 425 ug/kg. In contrast, when assigning a value of 0.5 ug/L as ½RL for the ND samples in event #1, the B(a)P concentrations are much greater, as high as 20,800 ug/kg.

Table 4. Benzo(a)pyrene and TSS Concentration in Sampled CSO Data

Wet Weather Event	CSO	B(A)P (ug/L)	Qualifier	TSS (mg/L)	Qualifier	Estimated B(a)P Concentration on Solids (ug/kg) (1)	B(a)P Solids Concentration assuming Equilibrium Partitioning(ug/kg) (2)
Event 1	OH-005	1	U	46		10,900	10,800
Event 1	RH-033	1	U			20,800	20,400
		0.1	U	24	J	2,100	2,000
Event 1	RH-034	1	U	38		13,200	13,000
Event 1	RH-036	1	U	45		11,100	11,000
Event 1	RH-037	1	U	102		4,900	4,900
Event 1	RH-038	0.1	U	186		270	270
Event 2	RH-031	0.16	J	377		425	425
Event 2	RH-034	0.1	UJ	70		700	700
Event 2	RH-035	0.15	J	989		150	150
Event 3	OH-005	0.28		19		15,000	14,000
Event 3	OH-006	1	U	132		3,800	3,800
Event 3	OH-007	0.1	U			1,250	1,234
		0.1	U	40			
Event 3	RH-031	0.59		56		10,500	10,400
Event 3	RH-033	0.1	U	66		760	750
Event 3	RH-034	0.1	U			930	920
Event 3	RH-035	0.16		126		1,300	1,300
Event 3	RH-036	0.1	U	18		2,800	2,700
Event 3	RH-037	0.29		91		3,200	3,200
Event 3	RH-038	0.1	U	35		1,430	1,400

(1) Assumes EPA's method for estimating values consists of dividing the whole water concentration by the TSS value. ND values were assumed to be substituted as 1/2RL.

(2) Note: For the equilibrium partitioning methodology, equilibrium partitioning coefficients for individual PAHs were derived using K_{oc} values from the Agency for Toxic Substances and Disease Registry (ATSDR) and the maximum organic carbon concentration on the CSOs. B(a)P concentrations on solids for nondetect samples were estimated using 1/2 the detection limit value and are considered highly uncertain.

An additional concern arises from B(a)P solubility. B(a)P has a low solubility in water and is highly particle reactive (high K_{oc}). As a result, samples with the highest TSS are expected to have among the highest B(a)P concentrations since so little of the B(a)P is dissolved.

However, EPA's whole water data do not support this. From the table it can be seen that the sample with the highest TSS of 989 mg/L has the lowest detected B(a)P concentrations (0.15 ug/L) while the highest detected B(a)P concentration (0.56 ug/L) is associated with a TSS concentration that is 18 times lower (56 mg/L). Figure 1a shows a plot of B(a)P whole water values vs. corresponding TSS results and Figure 1b shows the estimated B(a)P concentrations on particulates derived from whole water result and TSS. From the plots it can be seen that the B(a)P concentrations vary inversely with TSS, *i.e.*, B(a)P concentrations decrease as the TSS values increase.

Figure 1a. Whole Water Benzo(a)Pyrene Concentration vs. TSS for Detected Results

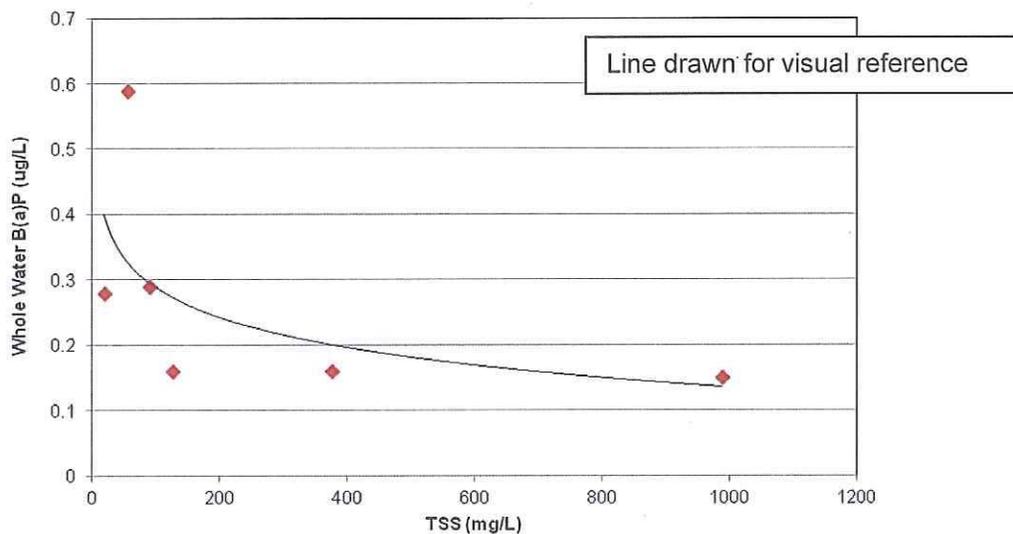
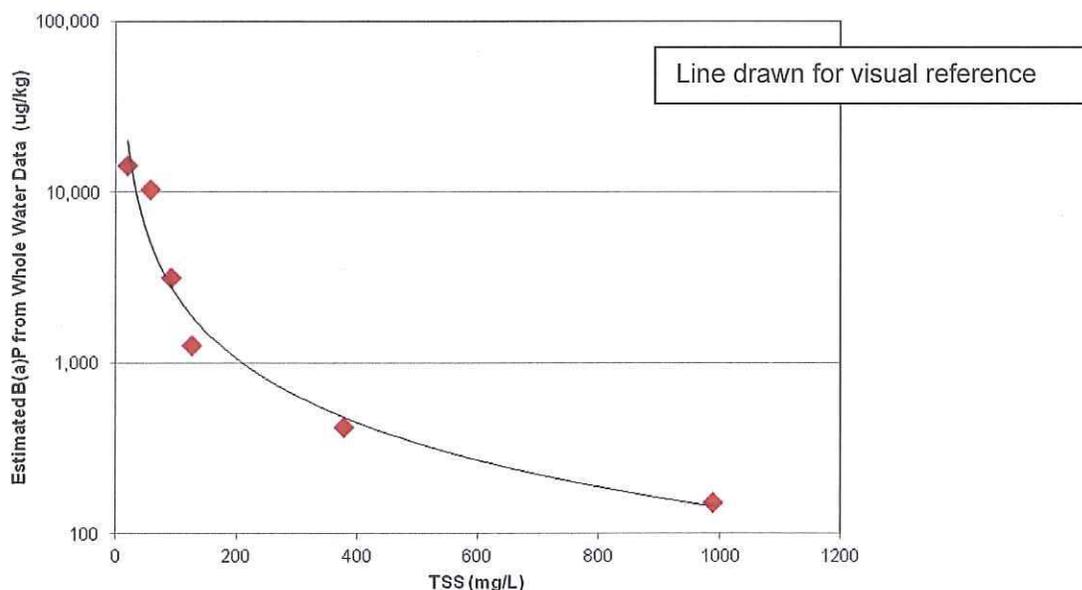


Figure 1b. Estimated Benzo(a)Pyrene Concentration on Particulates vs. TSS for Detected Results



These results indicate that B(a)P concentrations in CSO water correlate inversely with the solids content. While some of the variability may be due to the fact that separate samples were collected for PAH and TSS, this variability is not sufficient to yield the observed trend. Rather this trend indicates that when CSOs deliver large quantities of suspended matter (*i.e.*, high TSS concentrations), the B(a)P concentrations on those solids will be quite low. Given this relationship, a volume weighted average concentration for B(a)P will be substantially lower than the simple arithmetic mean of the samples. As a minimum, these results indicate that B(a)P concentration in CSO discharges are not well understood.

TSS and B(a)P whole water concentrations were used to calculate the B(a)P concentration on the solids to replicate EPA's verbally described method. This approach assumes that the dissolved phase concentration is zero and all B(a)P mass is particle bound. A second approach was conducted to account for dissolved phase using equilibrium partitioning. The particulate concentrations from both approaches are not significantly different, indicating that for B(a)P, EPA's approach produces reasonable upper bound concentrations, given the assumption of equilibrium in the samples. However, this may not be the case, given the short residence time of CSO water within the sewer lines during rainfall driven discharge. Additionally, both of

these approaches ignore the potential impacts of oil phases that may be present in CSO discharges on the B(a)P distribution, a concern that cannot be addressed without sampling of dissolved, suspended and oil (if present) phases. Thus the B(a)P results are still subject to much uncertainty. While the B(a)P results suggest that much of this compound may be particle-bound, this is not the case for low molecular weight PAHs with high solubility, as discussed below. The average B(a)P concentrations on the solids calculated using EPA's methodology and conservative assumptions for detected results range from 150 ug/kg to 14,700 ug/kg with a median concentration of 2200 ug/kg. Using similar methodology, the concentration on particulates was estimated for background. During dry and wet weather events the estimated B(a)P concentrations for the detected results range from 2700 mg/kg to 18,000 mg/kg with a median concentration of 3,800 mg/kg. Estimated B(a)P concentration on particulates for CSO samples with B(a)P detections (150 to 15,000 mg/kg) are within or below the range of reference area results (2,700 to 18,000 mg/kg). This analysis would indicate that CSO and background area solids have essentially the same B(a)P levels.

In conclusion, the City does not agree with EPA's assertions that the CSO data are sufficient to accurately estimate the loads of B(a)P to the Gowanus Canal and that B(a)P levels on CSO solids will of themselves represent concentrations substantively above baseline. The City asserts that the EPA methods will likely overestimate the CSO loads.

Estimating the Total PAH Concentration on Particulates:

The above calculations showed that both EPA's and the City's methods estimate similar B(a)P concentrations for suspended solids in CSO discharges assuming equilibrium. However, this is not the case for lighter PAHs or Total PAH concentrations. Estimating the Total PAH particulate concentrations by assuming no dissolved phase will result in much higher estimates of solids concentration. This is because the whole water data for CSOs shows a high fraction of low molecular weight (LMW) PAHs especially naphthalene, which are much more soluble and less particle reactive. Table 5 lists the Naphthalene, LMW PAH and Total PAH concentrations for CSOs.

Table 5. Whole Water Concentration for Naphthalene, LMW PAH and Total PAH

Event	CSO	Naphthalene (ug/L)	LMW PAH (ug/L)	Percentage of Naphthalene in LMW PAH (Naphthalene/LMW PAH)	Total PAH (ug/L)	Percentage of LMW PAH in Total PAHs (LMW PAH/Total PAH)
vent 1	H-005		ND		ND	
vent 1	RH-033	ND	1.1		1.1	100%
		10	13.1	76%	15.5	84%
vent 1	H-034	0.6	0.6	100%	3.7	15%
vent 1	H-036	ND	ND		ND	
vent 1	H-037	29	31.2	93%	31.2	100%
vent 1	H-038	22	26.5	83%	28.1	95%
vent 2	H-031	3.3	5.2	63%	6.8	77%
vent 2	H-034	1.4	1.9	75%	2.3	80%
vent 2	H-035	1.7	2.7	62%	3.6	77%
vent 3	H-005	0.12	0.4	29%	2.6	16%
vent 3	H-006	ND	ND		1.6	0%
vent 3	OH-007	0.23	0.9	27%	1.8	46%
		0.35	1.3	28%	2.3	55%
vent 3	H-031	3.4	5.5	61%	10.1	55%
vent 3	H-033	0.56	1.5	37%	2.2	69%
vent 3	H-034	0.098	0.6	15%	1.7	38%
vent 3	H-035	0.57	0.9	61%	2.5	37%
vent 3	H-036	ND	ND		0.7	0%
vent 3	H-037	ND	1.5		4.7	32%
vent 3	H-038	4.7	6.2	76%	7.5	82%

Notes:

- 1) Total PAH concentration was calculated using detected results of 16 PAHs, viz, acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, naphthalene, phenanthrene, and Pyrene.
- 2) ND: Non Detect.
- 3) Samples highlighted in blue are field duplicate pairs. Field duplicates for RH-033 shows particularly poor agreement, differing by more than an order of magnitude.

From the table it can be seen that the LMW PAHs represent a significant portion of the Total PAH concentration for majority of the samples, especially when the TPAH concentration is greater than 5ug/L. Across all samples, LMW PAH averages about 56 percent of Total PAH. Given the high solubility of this fraction, the dissolved phase must be considered in developing

an accurate estimate of the concentration of contaminants on solids. This can be approximated using equilibrium partitioning, which describes steady state conditions but may not fully characterize the short-term non-equilibrium conditions that may occur during a storm event, as noted above. Table 6 lists the estimated particulate concentrations for the entire set of CSO samples using two approaches, one where the dissolved phase is assumed to be zero and another using equilibrium partitioning.

Table 6. PAH Concentration on Particulates

Event	CSO	TSS (mg/L)	Solids Concentration assuming no Dissolved Phase		Solids Concentration assuming Equilibrium Partitioning	
			LMW PAH (mg/kg)	TPAH (mg/kg)	LMW PAH (mg/kg)	TPAH (mg/kg)
Event 1	OH-005	46	ND			
Event 1	RH-033		46	46	2	2
		24	545	647	11	75
Event 1	RH-034	38	14	98	0	59
Event 1	RH-036	45	ND			
Event 1	RH-037	102	306	306	12	12
Event 1	RH-038	186	143	151	14	22
Event 2	RH-031	377	14	18	3	7
Event 2	RH-034	70	27	33	2	8
Event 2	RH-035	989	3	4	1	2
Event 3	OH-005	19	22	135	1	66
Event 3	OH-006	132	ND	12	ND	11
Event 3	OH-007		21	46	2	19
		40	31	57	3	25
Event 3	RH-031	56	99	180	8	67
Event 3	RH-033	66	23	33	3	9
Event 3	RH-034	54	12	31	1	16
Event 3	RH-035	126	7	20	1	11
Event 3	RH-036	18	ND	38	ND	13
Event 3	RH-037	91	17	52	2	34
Event 3	RH-038	35	177	215	5	27
Average			89	112	4	26

Note: For the equilibrium partitioning methodology, equilibrium partitioning coefficients for individual PAHs were derived using Koc values from the Agency for Toxic Substances and Disease Registry (ATSDR) and the maximum organic carbon concentration on the CSOs

From the table it can be seen that the Total and LMW PAH particle concentrations estimated by the EPA method are consistently higher than the more realistic equilibrium-based estimates.

On average, the EPA method overestimates the LMW PAH particle concentrations by 16 fold and the Total PAH concentration by more than 5 fold. From this analysis, it is clear that the EPA estimate basis is very uncertain and likely to be overly conservative. Relative to equilibrium-based estimates, EPA's methodology would significantly overestimate any risks presented by these compounds

Summary of PAH Analysis:

Given the issues with EPA's whole water sample data collection methodology, analysis, and approach to derive PAH concentration on the solids, the City believes that EPA's usage of these derived concentrations is problematic. In general, EPA's calculation methods are overly conservative for lighter PAH compounds whereas the data themselves are very poor for estimating concentrations of the more particle reactive PAH compounds. While the whole water data collected by EPA could be used to develop a preliminary assessment of the risk due to CSO water, it should not be used to derive conclusions on particulate matter.

Estimated B(a)P concentration on particulates for CSO samples with B(a)P detections are within or below the range of reference area results. This analysis would indicate that CSO and background area solids have essentially the same B(a)P levels.

In conclusion, the City does not agree with EPA's assertions that the CSO data are sufficient to accurately estimate the loads of B(a)P to the Gowanus Canal and that B(a)P levels on CSO solids will of themselves represent concentrations substantively above baseline. The City asserts that the EPA methods will likely overestimate the CSO loads.

3. Conceptual Site Model Discussion

The City would like to restate concerns which were previously presented to EPA regarding data gaps in the Draft RI and with the CSM for the Gowanus Canal, as it is presented in the RI. As stated in the City's May 25, 2011 letter report to EPA, the CSM (and attendant underlying data) need to be expanded and refined in the following areas:

- **More Specific Characterization of Key Upland Sites and Groundwater-Surface Water Interaction:** The Draft RI contains a limited discussion of the potential contamination present on the upland sites, and whether soil or groundwater contamination at these sites could be current or future sources of contamination to the Canal. The City is particularly concerned about the progress of the on- and off-site investigations at the former Fulton and Metropolitan manufactured gas plants (MGPs), as a full characterization of the location, magnitude, and extent of all coal tar emanating from these sites is an essential component of the investigation of the Canal. The same type of investigation is also merited at other key upland sites. The lack of information on these upland sites is compounded by the Draft RI's incomplete assessment of the groundwater-surface water interaction, as it does not identify specific locations of contaminant seeps or significant tidal interactions. Unless and until significant sources of upland contamination are identified (including all coal tar contamination), and the contaminant fate and transport dynamics are fully understood, there remains a high possibility that such contamination will continue and interfere with the ultimate remedy for the Canal.

- **Further Assessment of Non-CSO Point Sources:** The Draft RI contains only a limited analysis of the contaminant contribution during wet weather from the over 200 unpermitted discharge pipes located within the Canal, most of which drain from industrial properties. Additionally, the Draft RI does not adequately analyze contaminant/sediment loads associated with overland stormwater flow. Without any characterization or quantification of the contamination from these uncontrolled ongoing sources, it is unclear how contaminant loads from these sources will be addressed in the FS.

- **Lack of Mechanistic Model of Contaminant Fate and Transport:** Mechanistic models capable of quantifying the fate and transport of contamination from a variety of sources and in a variety of environmental media are essential for quantifying the contaminant loads associated with ongoing sources and evaluating phenomena unique to sediment sites such as the re-suspension and transport of surface sediments due to tidal or anthropogenic influences. For instance, it is essential to understand the movement of sediments from Gowanus Bay and the Upper New York Harbor into the Gowanus Canal before a remedial action can be appropriately selected and designed. Yet, the Draft RI does not rely upon, or even contain a

plan to develop, a mechanistic model to assist in selecting and designing remedial strategies for the Gowanus Canal, for performing sensitivity analyses to refine remedial efforts, or for evaluating the potential for recontamination after the remedy is complete. Indeed, the Draft RI does not contain enough information to develop a mechanistic model at this time. Development of such a model is especially essential for Gowanus, as the hydrodynamics analyzed in the Draft RI will be modified when the City re-activates the flushing tunnel to improve current water quality. Considering the complexity, overall cost and importance of the remedial action on Gowanus Canal, we recommend that the FS process not be completed without first developing a mechanistic model.

4. Remedial Investigation/Feasibility Study Data Gaps Discussion

The Gowanus Canal was referred for listing by the State of New York due to the presence of area-wide contamination by coal tar in Canal sediments caused by significant discharges of this hazardous substance from three historic MGP facilities in the immediate vicinity of the Canal. Discharges of hazardous coal tar from these facilities have resulted in massive contamination of soil and groundwater in the watershed adjacent to Gowanus Canal and it is this contamination that continues, and will continue, to be released to the Canal if adequate source identification and remedial action is not implemented. We have reviewed existing data and observe that the distribution of MGP-derived hazardous coal tar and its derivatives have not been adequately investigated nor fully characterized in soil and groundwater around and under the Gowanus Canal.

Existing data is sufficient to demonstrate that widespread coal tar contamination is present at multiple depths throughout the length of the Canal. These data also clearly demonstrate past and ongoing discharges of coal tar to the Canal and its sediments. However, there are extensive data gaps and voids in our current understanding of the distribution of coal tar in soil and groundwater emanating from these facilities, and in the current knowledge of the fate and transport of these hazardous substances, and their pathways for discharge into the Canal. EPA has determined that the Remedial Investigation (RI) for the Gowanus Canal is complete. However, under the RI for Gowanus Canal, no direct investigation was performed on these

three MGP sites to fully characterize the coal tar source areas and to delineate the pathways for continued transport of these hazardous substances into the Canal under current conditions, and more importantly, after the remedial action is completed.

We also observe that there is very little known about other potential upland contaminant source areas from former industrial operations on both sides of the Canal. A Phase 1 investigation of groundwater and soil was performed but included relatively widely spaced placement of wells around the perimeter of the Canal. However, this work was very limited in scope and there remain several dozen large historical industrial facilities immediately adjacent to the Canal with known or strongly suspected storage, transport and disposal of hazardous materials and hazardous wastes that were not subject to groundwater or soil investigation during the RI. Currently nothing is known about their potential ongoing and post-remedial discharges to the Canal.

At present, EPA has determined that the RI is complete and the Feasibility Study (FS) is being performed. The eleven principles governing the remedial action for complex urban waterways like the Gowanus Canal require early identification of contaminant source areas and require that sources for future recontamination be established during the RI to assure that the FS considers measures to prevent recontamination of sediments after the remedial action is complete. Given the essential mandate to protect public health and the environment, and the high cost and long time that will be required for the remedial action, it is imperative that the remedial action decision established in the Record of Decision (ROD) 'get it right.' To do this, the RI must be reopened to fully characterize all ongoing upland sources, including coal tar from MGP sites, so that the Feasibility Study can adequately evaluate and address all future discharges of hazardous materials to the Canal.

We propose that CSTAG recommend the performance of additional remedial investigation to fully characterize all ongoing upland sources of hazardous substances to the Gowanus Canal under current and future conditions, and that this work be completed prior to the completion of the Feasibility Study, establishment of the proposed remedial action plan and recording of the ROD. We urge CSTAG to recommend the following:

- The use of TRIAD and other advanced methods established and promoted by EPA for expeditious field screening of subsurface contamination caused by MGP facilities and upland industrial properties (MIP, etc.) and that EPA utilize its extensive network of internal technical support for TRIAD investigations within the watershed. TRIAD, MIP and associated field screening should be used to identify data gaps and the most valuable locations to take additional soil samples and place additional groundwater monitoring wells to fully characterize upland sources including coal tar.
- The use of advanced 3-D visualization and analysis of existing and newly acquired data on soil and groundwater contamination including coal tar and industrial upland site contamination throughout the Gowanus Canal area.
- The establishment of a 3-D groundwater model to assess the current impact of contaminant discharge and use of existing and newly acquired data to build, calibrate and validate this model. The model should be designed to quantify the discharges of hazardous substances into the canal and to model the impact of current and future (post-remedial) conditions.
- The establishment of a sediment transport model for Gowanus Canal that can be used: (1) to model the impact of inputs of the groundwater model to assess future outcomes of ongoing upland discharge sources to determine if remedial actions are warranted, and (2) to evaluate the impact of contaminated sediment transport from New York Harbor after the completion of the remedial action under an EPA ROD.

Sincerely,



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