UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
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Memorandum

To: Stephen J. Ells, Chair
Contaminated Sediment Technical Advisory Group (CSTAG)

From: Daniel Keefe, RPM, EPA Region 1

Date: September 10, 2010

Subject: Updated Response to CSTAG Recommendations dated June 7, 2010
Nyanza Chemical Waste Dump, OU4 – Sudbury River

Thank you for your Memorandum dated June 7th, 2010 regarding the Nyanza Chemical Superfund Site in Ashland, Massachusetts. Your memorandum contained numerous comments, questions, and recommendations. The original CSTAG comment is repeated here in *italics* to provide added context to the response. Occasionally, the CSTAG comment was a combination of multiple comments; in these instances, Region 1 broke apart the comment and answered the various questions independently, but sequentially (i.e., Part 1; Part 2, etc…) in the order they were presented.

#4 – Develop and Refine a Conceptual Site Model that Considers Sediment Stability.

The CSTAG reiterates and expands on a couple of the recommendations it made in 2006. The fates of mercury (Hg) and methylmercury (MeHg) are very complex, but understanding the relationship between these is critical to understanding the exposures resulting in uptake of MeHg by fish. The generic figure portraying mercury cycling within the environment is not adequate to explain the relationship between the high total mercury concentrations in the surface sediments in segment 5 of Reach 3 and the concentrations of dissolved MeHg in the surface water and the concentrations of MeHg in fish fillets. The ROD should carefully describe a conceptual site model that explains these relationships at this site.

Response:
The Region agrees that fates of mercury (Hg) and methylmercury (MeHg) are very complex. Region 1 has spent considerable resources developing a Conceptual Site Model (CSM) and computer model calibrated with site-specific data to reflect the Sudbury River system (26 miles in all). The information used in developing the CSM includes the latest developments in the "state" of mercury science as well as information obtained directly from the Sudbury River. In

regard to figures previously shared, we agree that Figure 2-2 is a generic depiction of the fate & transport of mercury; however, Figures 2-3 (A, B, and C) have been updated to more clearly portray the varying ability of each of these different hydrological settings (flowing, standing and wetland reaches) to methylate mercury (Attachment A). To further illustrate the complexity regarding mercury speciation, the schematic in Attachment B regarding the transformation of mercury, although generic, will also be included in the ROD. The Region appreciates and shares CSTAG's desire to know the specific processes which drive methylmercury production. The scientific understanding of these processes is largely variable (e.g., location specific) and is still being elucidated. The following is an excerpt from a 2009 USGS publication:

> The exact mechanism(s) by which mercury enters the food chain remain largely unknown, and probably vary among ecosystems. We do know, however, that certain bacteria play an important early role. Studies have shown that bacteria that process sulfate (SO4=) in the environment take up mercury in its inorganic form, and through metabolic processes convert it to methylmercury. The conversion of inorganic mercury to methylmercury is important for two reasons: (1) methylmercury is much more toxic than inorganic mercury, and (2) organisms require considerably longer to eliminate methylmercury. At this point, the methylmercury-containing bacteria may be consumed by the next higher level in the food chain, or the bacteria may release the methylmercury to the water where it can quickly adsorb to plankton, which are also consumed by the next level in the food chain. (USGS, 2009)

The evaluation of clean-up alternatives in the Feasibility Study (FS) focused on the most-elevated concentrations of mercury (and thus readily attributable to historic Nyanza sources). This mercury represents a continuing source of mercury for methylation at the sediment-water interface. Once methylated, fish become contaminated either 1) through assimilation of mercury dissolved in surface water or 2) from lower trophic level food sources - smaller fish and plankton and/or ingestion of mercury-contaminated benthic organisms. This is further described elsewhere in this response and will also be discussed in the ROD. As described by Mason *et al.* (2005) in Monitoring the Response to Changing Mercury Deposition:

> "Many chemical, biological, and physical factors, such as bacterial community structure, pH, redox status,and nutrient and sulfate concentrations, influence MeHg production, but *mercury supply* is obviously an important variable" (Mason *et al.*, 2005)

#6 – Carefully Evaluate the Assumptions and Uncertainties Associated with Site Characterization Data and Site Models.

Based on the review of the WASP modeling information, the CSTAG believes there is significant uncertainty in the predicted level of risk reduction attributed to placing a 6" layer of sand in the 84 acres of segment 5, one of the alternatives considered for the site. The sensitivity analysis that quantifies the changes in output predictions based on changes in key input parameters should be presented in the ROD. The level of certainty or uncertainty associated with the bioaccumulation factor (BAF) of 7.8 x 10^6 should also be described in the ROD. Since there

is limited empirical data to support the modeling predictions, the CSTAG cautions that there is an over-reliance on the model predictions for remedial decision-making. As stated in Principle #6 of Highlight 2-15 in the 2005 Contaminated Sediment Remediation Guidance for Hazardous Waste Sites: "Modeling results should generally not be relied upon exclusively as the basis for cleanup decisions."

The ROD needs to explain why the model used 2 and 10 ppm Hg in sediments as the basis for the evaluation of remedial alternatives. CSTAG is concerned that none of the alternatives evaluated were shown to achieve the target fish tissue concentrations. The model description in the ROD should also clarify whether the model assumed that contributions of mercury from atmospheric deposition would continue over the life of the alternatives evaluated.

The ROD should more fully describe the locations where the fish, sediment and surface water samples were collected in segment 5 of Reach 3; a map would be helpful.

Response
Part 1:
Region 1 has periodically given updates (July 2009) and coordinated with members of CSTAG (August 2009) as well as provided responses to earlier informal comments received on the model (September 2009) as a means of discussing, understanding and quantifying the degree of uncertainty. Based on CSTAG's recommendation, an Uncertainty Analysis was completed and added to the final version of the Modeling Report (i.e., Volume 1). Further, the Region provided Volume 2 to the CSTAG in January 2010. In summary, and as one might reasonably expect when modeling a dynamic pollutant such as mercury, the analysis revealed disparate degrees of uncertainty. The uncertainty between observed versus predicted values was greatest when predicting total mercury species (in surface water); however, the model performed better when predicting methylmercury species. Research has shown that of all the mercury species in surface water (that is to say total and dissolved mercury and total and dissolved methylmercury) – the strongest correlation to fish tissue concentrations (relative to these four parameters) is with dissolved MeHg in water (Brumbaugh, *et.al*, 2001). On this basis, EPA Region 1 believes the level of uncertainty is acceptable.

Part 2
As requested, EPA ORD recently coordinated with appropriate members of CSTAG to discuss specific parameters to evaluate as part of the Sensitivity Analysis. This analysis was completed and will be shared under separate cover. Conclusions from the Sensitivity Analysis will be presented in the ROD.

Part 3:
In general terms, fish can accumulate mercury by two mechanisms – 1) the uptake of mercury over their gills directly from surface water and 2) from ingestion of lower trophic-level food items (such as smaller fish and benthic organism) and depending on their size (plankton and zooplankton). One of the outputs of the computer model is dissolved methylmercury in surface water. Accordingly, in order to relate this concentration to mercury in fish, a bioaccumulation factor (BAF) is needed and was calculated. This approach may overestimate the contribution of

mercury in fish solely from surface water and pelagic-based food sources as it may underestimate the mercury that fish may accumulate from other sources (namely consumption of plankton and zooplankton and/or benthic organisms such as crayfish).

As noted previously (December 2009 Tech Memo from Avatar to Nobis), species-specific BAFs were developed using available pairings of methylmercury concentrations in filtered (dissolved) surface water samples and total mercury in largemouth bass and yellow perch fillets collected from Reach 3. The fish data used to develop the BAFs consisted of 13 bass and 8 yellow perch samples. Surface water data used in the BAF development consisted of surface water grab samples that were collected on separate events between May 2007 and June 2008 (7 sampling events in total across 3 locations within Reach 3). The goal of deriving site-specific methylmercury BAFs is to approximate the "long-term" average bioaccumulation of methylmercury in a target organism, in this case, fish. Because fish, and especially top predators like bass, integrate uptake of methylmercury from trophic transfer and diffusion across gill membranes, it is assumed some degree of bioaccumulation occurs throughout the year. The degree or rate of uptake is a function of the concentration of methylmercury in the water column and in bed sediment for bottom feeding organisms. Concentrations of methylmercury in surface water can show variation both seasonally and diurnally due to a variety of physical, chemical, and biological factors associated with the water column (e.g., spring runoff) and the bordering wetlands (e.g., microbial activity). Refer to figure provided in Attachment C which depicts the temporal variability of dissolved methylmercury in surface water. Having collected surface water samples over a period of time that reflects different seasons helps reduce this variability.

The variability of the site-specific calculated BAF ranged by a factor of ten for the largemouth bass and about 15 for the yellow perch. This variability is less than the variability associated with the national value (of 5.74E+06 L/kg), in which the 5^{th} and 95^{th} percentiles differ by a factor of more than 100, or two orders of magnitude (Water Quality Criterion for the Protection of Human Health: Methylmercury, USEPA, 2009). Further EPA Guidance cautions water quality managers that methylmercury bioaccumulation is generally viewed as a *site-specific process* and that BAFs can vary greatly across ecosystems. The uncertainty in the estimates of the national BAF comes from the uncertainty arising from natural variability, such as size of individual fish, and from uncertainty due to measurement error, such as error in measurements of mercury in water or lack of knowledge of the true variance of a process (e.g., methylation). Based on the data distribution used to estimate the BAF, the 95% upper confidence level of the mean was calculated and used. Consequently the BAFs used reflect the upper range of the possible BAFs. Utilization of a site-specific BAF, in lieu of using the national value, is supported and preferred (U.S. EPA, 2009).

Part 4:

EPA Region 1 disagrees with CSTAG's assessment that Region 1 relied too heavily on the computer model. The computer model was constructed using an immense trove of sampling data and hydrological observations, and it was carefully calibrated until it could predict with reasonable accuracy observed concentrations of *methylmercury* in surface water. Although its predictions about future concentrations under various remedial scenarios are subject to significant uncertainties – uncertainties which will be acknowledged in the ROD -- it is unclear what other means the Region could have employed to evaluate remedial alternatives.

In addition, even if the exact degree of improvement predicted by the model turns out to be inaccurate, it is clear from other sites where thin layer capping has been used that the cap has performed well and significantly reduced the bioavailability of contaminants. Region 1 and our contractor researched and evaluated the performance of thin-layer capping at other sites. For example, EPA Region 10 selected and implemented TLC at several Superfund sites with the most relevant (based on contaminant) being Eagle Harbor in Seattle, Washington. An Enhanced Monitoring Natural Recovery (EMNR) Case Study Review was prepared on behalf of the U.S. Navy, and states in regard to Eagle Harbor "it appears that thin layer capping has been implemented successfully as a component of the larger remedial effort at Eagle Harbor and that the thin layer cap has remained stable during 10 years of monitoring." The report detailed numerous other sites where thin-layer capping has been implemented, but with less time (i.e., less than 10 years) for a comprehensive evaluation; these site were located in Washington DC, Maryland, California, Canada, and New York. The Report concluded EMNR has been implemented with the generally stated goals of reducing the concentration of chemicals in the biologically active zone of sediment in a manner that enhances the potential for benthic recolonization, while not causing widespread disturbance to existing habitat. (May 2009).

In 2007, a report entitled Demonstration of the Aquablock™ Sediment Capping was prepared for a site in Region 3. This report details the application and performance of different capping materials within a part of the Anacostia River. As part of the pilot, a thin layer sand cap was installed (alongside other capping materials) so as to compare Aquablock™'s relative effectiveness. The river was characterized as having (among other things) heavy metals including mercury up to 1.4 parts per million (ppm). Performance was assessed by measurements made at various time intervals up to 30 months. This demonstration indicated that sand can be an effective capping material for metals.

In closing, Region 1 believes based on the type of risk found in the Sudbury River study area (specifically the lack of any contact risk) that TLC is preferred over other more impermeable capping materials and will be effective at reducing the highest level of contamination and risk present in the river (i.e., in Reach 3).

Part 5:
Regarding the selection of Target Sediment Concentrations (i.e., the 2 and the 10 ppm used to evaluate remedial alternatives). Region 1 used an iterative approach based on the range of total mercury in sediment (up to 44 ppm) to assure a robust and disparate array of alternatives were considered in the FS. There are no risk-based sediment clean-up goal based on the absence of risk to this media. The "clean-up goal" is mercury *in fish.* The ROD will explain this.

Part 6:
The description of the Computer Model in the ROD will clarify that mercury from atmospheric deposition was assumed to continue for the lifetime of the alternatives evaluated.

Part 7:
Surface water and sediment samples were collected based on "reach" and in some cases "subreach" (the "subreach" designation was used predominantly in the ecological and human

health risk assessment). This information was provided to CSTAG (refer the Data Summary Memorandum dated March 24th, 2009 previously shared and also in the FS as Appendix A); however, as requested, maps will be included in the ROD. In summary, Reach 3 has three subreaches (note that the computer model divided the same area into 5 "segments"). In 2008, three locations were selected for the collection of surface water samples (S3-SW1 upstream, S3-SW2 just downstream of Fountain Street and within Segment 5, and S3-SW3 at the down stream end of Reach 3 and also within the area referred to as Segment 5). Surface water sample locations are depicted in figures in Attachment D and the data, represented graphically, is presented in Attachment E.

Region 1 believes the slight decrease in surface water concentrations of certain mercury species does not mean that the high levels of mercury in sediment within segment 5 are not a continuing source of mercury. While the outputs of the computer model rely on a BAF (i.e., a value which relates dissolved methylmercury in surface water to fish tissue) there are other processes which are not captured by this simplification. A BAF will quantify the rate of accumulation in fish from surface water and other water-based (pelagic) food sources; however, it may underestimate the accumulation of mercury in fish from benthic-based food webs (such as crayfish). In the 2008 SBERA, crayfish were easily captured and analyzed in the reservoir but were either absent (or difficult to collect) in other downstream wetland reaches. Moreover, it was noted during the collection of bass from Reach 3 (in 2003 - 2005) that the majority of their diet were crayfish.

Also in 2008, fish (largemouth bass and yellow perch) were collected and the age of each determined. Largemouth bass were collected from all three subreaches whereas yellow perch were collected from two (Subreaches 1 and 2). The Table below presents the mercury data for the largemouth bass as well as the laboratory-measured fish age. The table below also normalizes the data with respect to age (in nanograms (ng) per year that a fish in each subreach has accumulated).

Sample I D	Subreach	Age	Mercury (ng/g)	Rate of Accrual/year
S3-1-LB0001	1	4	714	176 ng Hg/year
S3-1-LB0001		4	659	
S3-1-LB0001		6	927	
S3-1-LB0001		3	615	
S3-1-LB0001		4	783	
S3-2-LB0001	2	5	1010	164 ng Hg/year
S3-2-LB0001		6	794	
S3-2-LB0001		3	690	
S3-2-LB0001		6	908	
S3-2-LB0001		4	547	
S3-3-LB0001	3	5	834	182 ng Hg/year
S3-3-LB0001		4	1040	
S3-3-LB0001		5	681	

The highest rate of accrual of mercury in largemoouth bass from Reservoir 2 (i.e. Reach 3) is the downstream subreach (Segment 5) and the location of the proposed thin-layer capping.

Although yellow perch were collected during this sampling event, they were not collected form all of the Reach 3 subreaches.

#7 – Select Site-specific, Project-Specific, and Sediment-Specific Risk Management Approaches That Will Achieve Risk-Based Goals.

Both the modeling results and the trend analyses performed with historical data indicate that after the source control actions were taken at the site, there has been little reduction in fish tissue concentrations. As a result, it is difficult to state that naturally occurring processes will result in significant risk reduction at the site or that MNR is an important component of any proposed alternative.

As recommended in 2006, rates of methylation, especially in Reach 3, should be provided. This is a critical component of understanding the site and expected changes in fish tissue concentrations as a result of any active remediation.

Response
Part 1:
Region 1 and CSTAG disagree on the extent to which the trend analysis suggests MNR is (or has been) occurring. CSTAG has previously conveyed reservations that the reduction may be attributable to other completed remedial activities (namely OU3 – Continuing Source Areas). The removal of mercury and sediment from the "Continuing Source Areas" was initiated in 1999 and completed in 2001. Much of the data used in the trend analysis (our most robust set of data) was collected in 2003 and many of these fish (based on the length/age relationship) existed prior to the initiation of the remedial action and thus are not a good indicator of water quality improvements associated with the completed remediation. All the data used in the trend analysis were collected at different times and with different objectives and thus significant normalizing of the data were required (age, length, sample type). Notwithstanding this, Region 1 believes that, if one includes the oldest data, there is an indication of predominantly decreasing (or a few cases stable) trends of mercury in most reaches and media.

In regard to CSTAG's assessment that Region 1 has characterized the risk reduction as "significant," Region 1 wishes to clarify and/or emphasize that risk from the consumption of mercury-contaminated fish is marginally (factor of 2) above those calculated to represent no risk of adverse health effects, and is marginally above the risk attributable to mercury from other mercury sources (principally atmospheric). As such Region 1 evaluated alternatives that would result in a *modest* reduction of risk (yet to acceptable levels) as this would result in the remediation goal's (0.48) being more quickly attained in some reaches. See also response to Item 8, Part 1.

Part 2:
In regards to CSTAG's question (re: MNR as an important component of any remedial alternative) Region 1 interprets this comment to suggest that given the marginal risk (and perceived conservatism in its calculation) that CSTAG questions if any remedy (either passive - such as MNR, or active) is warranted. Region 1 believes, based on the modeling, the

performance of thin-layer capping elsewhere, and mercury trends, that a Natural Recovery approach, enhanced where mercury sources and risk are highest, is more conservative and will be effective at reducing fish tissue concentrations.

Part 3:
Regarding a measured "rate of [mercury] methylation," there are several published methods for its determination; however, there is not a consensus that a single method is preferred. See list of methods below:

A simplified radiochemical technique for measurements of net mercury methylation rates in aquatic systems near gold mining areas, Amazon, Brazil Jean R.D. Guimaraes, Olaf Malm, and Wolfgang C. Pfeiffer *Science of the Total Environment*, Dec. **1995** 175 (2), 151-162.

- In this method mercury methylation rates were determined using simplified versions of the Furutani and Ruddi (1980) radiochemical method. Rates varied depending on sample type and extraction procedure.

Mercury methylation in estuaries: Insights from using measuring rates using stable mercury isotopes Andrew Heyes, Robert P. Mason, Eun-Hee Kim, Elsie Sunderland *Science Direct, Marine Chemistry*, Sept. **2005** 102, 134-147.

- In this method stable isotopes of mercury and methylmercury were used to determine rates of mercury methylation. The digestate was analyzed using a combination of EPA method 1631 and a method determined by Gill and Fitzgerald (1987) utilizing stannous chloride reduction and 2-phase gold amalgamation with gas phase detection.

Constants of mercury methylation and demethylation rates in sediments and comparison of tracer and ambient mercury availability Holger Hintelmann, Katherine Keppel-Jones, R. Douglas Evans *Environmental Toxicology and Chemistry*, Nov. **2009** 19(9), 2204-2211.

- In this method gas chromatographic separation and isotope-specific detection with inductively coupled plasma mass spectrometry were used to simultaneously measure mercury methylation and demethylation.

Methods for Measuring Specific Rates of Mercury Methylation and Degradation and Their Use in Determining Factors Controlling Net Rates of Mercury Methylation Patricia S. Ramlal, John W. M. Rudd, and Robert E. Hecky *Applied Environmental Microbiology*, Jan. **1986** 51 (1), 110-114.

- In this method specific rates of methylation can be determined by measuring the volatile ^{14}C end products of $^{14}CH3HgI$ demethylation in conjunction with a 203Hg2+ radiometrical method.

Determination of mercury methylation rates using A 203-HG radiotracer technique M. C. Stordal and G. A. Gill *Water, Air, & Soil Pollution*, Feb. **1995** 80 (1), 725-734.

- In this method, Mercury methylation rates are determined using a high specific activity 203-Hg radiotracer. A sediment core and associated water are collected in a core barrel. The water is spiked with 203-Hg radiotracer and the core is then incubated at room temperature. Mercury is extracted from small samples of the water and the activity of the mercury is measured.

To a large degree these are research-oriented determinations and thus are limited in their application and acceptance. Despite disparate methods for determining methylation rates, several factors are generally accepted as affecting the *rate of mercury methylation*; these include seasonal flooding, high dissolved organic carbon (DOC), low pH, and anoxic surface water or sediment, and sulfate-reducing bacteria. Most research on which the foregoing was determined was based on empirical data, that is to say measurements of methylmercury in the environment (surface water, sediment, fish). As described in our CSM we have different hydrological settings along the 26 miles of river, with the implication being that we have high–methylating areas (downstream reaches - notably Reach 8) and lower methylating areas (faster flowing sections). The reservoirs (like lakes and ponds) have been described by others (Krabbenhoft, *et.al*., 1999) as having a moderate ability to methylate mercury greater than faster flowing "rivers" but less than seasonally-flooded wetlands. So while a "rate" is not available per se, Even if one method were selected from the list above and a methylation rate could be accurately calculated, Region 1 disagrees that a specific "rate" (e.g., ng MeHg/cm2/day) is a critical component of the evaluation of remedial alternatives or remedy selection. Methylation processes will occur based on watershed properties (such as frequency of flooding, watershed drainage area, residence time, pH, etc.); these are unlikely to be affected by any active remediation. Our empirical data from the various reaches support literature observation that GMNWR (Reach 8) is an area of very high methylation potential, followed by the reservoirs and lastly fast-flowing section of the river Refer to figures in Attachment F which depicts the percentage of mercury that is methylmercury within each media along the length of the river.

#8 – Ensure That Sediment Cleanup Levels Are Clearly Tied to Risk Management Goals.

One alternative considered is the placement of 6" of sand in segment 5 of reach 3. The hypothesis is that significant fish tissue reductions will occur as a direct result of this active remediation alternative. The ROD should justify this hypothesis and provide supporting information on the relationship between total mercury in sediment, MeHg in water, and MeHg in fish. The Region should not rely solely on a surface water and sediment transport model with unquantified levels of uncertainty, and a BAF based on one set of fish tissue samples to support a high-cost remedy decision.

The ROD should include a table listing the predicted final sediment cleanup level, the final fish tissue concentrations, the risk-based protective fish tissue remediation goal, and the corresponding risk levels for Hg and MeHg.

Response
Part 1:
Risks in the river from contaminated fish tissue are only somewhat above risk-based values and only somewhat above the risk attributable to background concentrations of mercury. This makes it difficult to achieve fish tissue concentrations that might be considered "significant" in an absolute sense (e.g., a 50% reduction in fish contamination). However, we evaluated alternatives to the extent they are expected to result in the risk reduction mandated by CERCLA. The Region believes any reduction that converts an unacceptable risk to an acceptable risk in a reasonable period of time is significant in this sense.

The remainder of this response also relies on details provided previously (re: the conceptual site model). Simply - fish absorb methylmercury from their food and from water as it passes over their gills. Methylmercury in the water and sediment is taken up by tiny animals and plants known as plankton and zooplankton. Small fishes eat large quantities of plankton. Larger predatory fish consume many smaller fish, accumulating methylmercury in their tissues. The older and larger the fish, the greater the potential for higher levels of mercury. There is no method of removing mercury from fish. As shown previously, within Reach 3, the greatest rate of accumulation (measured in fish) appears to be from that portion of the reservoir in which active alternative (thin-layer capping) is proposed.

Finally, we are confused by CSTAG's assessment that this is a high-cost remedy. The remedy is expected to cost less than $8.5M. It is our understanding in the Region that this is the first sediment remedy that did not require National Remedy Review Board approval (i.e. less than $25M). This proposal is also one of the least costly "active" remedies put forward by the Region in many years.

Part 2
As explained previously (see response to # 5) there is not a sediment-based clean-up level, per se, and some mixing of clean sand with contaminated sediment due to the activities of benthic organisms is anticipated to occur. The contaminated media is fish tissue. In setting the National Recommended Water Quality Criterion, EPA acknowledged that mercury in sediment is not particularly well correlated to the concentration of mercury in fish; hence the fish tissue criterion. The risk-based protective fish tissue remediation goal is 0.48 mg/kg; this is the concentration that (based on other human health risk assumptions) the HI would equal 1.0. The model projects that the concentration of mercury in fish from Reach 3 (post-construction) to be 0.47 mg/kg. These details will be included in the ROD.

Finally, to clarify, risk from mercury and methylmercury were not calculated independently. Prior Human Health risk assessments (Weston, 1999) evaluate the risk of contact and ingestion of total mercury; these did not trigger a risk of adverse health affects. However, in aquatic species, it is well document that mercury exists almost exclusively as methylmercury (Watras and Bloom, 1992).

9. Maximize the Effectiveness of Institutional Controls and Recognize their Limitations.

The ROD should include a comparison of the input parameters used by EPA in the Human Health Risk Assessment (HHRA) with the information used by the Massachusetts Department of Health to establish the State-wide fish advisory for mercury in fish. It should also clearly explain whether maternal exposures were evaluated in each, or if the exposures are based on direct ingestion of fish by children.

In addressing this question, Region 1 solicited feedback from the Massachusetts Department of Public Health (DPH). EPA was informed by DPH that, in their evaluation and subsequent

determination of fishing advisories for mercury, DPH utilizes one-half the FDA limit of 1 ppm. In other words, if the mean level in largemouth bass from a water body is 0.5 ppm or greater, it will get some type of advisory. DPH acknowledges that this strategy does not specifically take into account parameters like weight, ingestion rate, etc; however, DPH believes this to be conservative knowing that the FDA took those into account when setting their limit.

In regard to maternal exposure, Region 1 did not specifically evaluate maternal exposures in the risk assessment; however, a review of EPA's IRIS value and associated toxicological assessment for methylmercury on which it is based, revealed the following: IRIS evaluated three available epidemiological studies in the mid-1990s. Overall, data from these studies showed that a strong correlation exists between maternal-blood mercury concentrations and fetal-blood mercury concentrations, as shown by cord-blood and also indicate that cord-blood mercury is higher than maternal-blood mercury. However, EPA chose not to make a numerical adjustment between cord-blood and maternal-blood mercury. At this time, the relationship between cord-blood and maternal-blood mercury is considered subject to variability and uncertainty, and is to be included in the determination of the uncertainty factor (UF). In calculating the methylmercury RfD (1E-4 mg/kg-day), a composite UF of 10 was used. This choice was made to account for the following factors: 1) Pharmacokinetic variability and uncertainty in estimating an ingested mercury dose from cord-blood mercury concentration: a factor of 3 was applied; and 2) Pharmacodynamic variability and uncertainty: a factor of 3 was applied. The assessment also shows that the overall confidence in this RfD assessment is considered high. Region 1 believes that by using this toxicity value, we have taken into consideration the maternal exposure to mercury.

The ROD will include a discussion of these issues.

#11 – Monitor During and After Sediment Remediation to Assess and Document Remedy Effectiveness.

Based on the CSTAG's understanding of the limited number of fish samples used to calculate baseline fish tissue concentrations, and the apparent large variation among individual fish, the CSTAG believes it may not be possible to collect after remediation a sufficient number of similar sized bass in segment 5 of Reach 3 to determine whether the 15% reduction in risk predicted by the model occurred. More fish should be sampled to decrease the variance in baseline concentrations and increase the likelihood that future small reductions can be discerned in post-remediation sampling.

The site team stated that post-remediation monitoring will be conducted and will likely consist of the collection of a single species (bass) every five years and three species (bass, perch and catfish) every 10 years to allow for the reassessment of human health risk. The first round of monitoring activities (excluding any pre-design studies) would be performed five years after the ROD is issued. As discussed in the Sediment Assessment and Monitoring Sheets (SAMS #1): Using Fish Tissue Data to Monitor Remedy Effectiveness, at least two species should be collected, and a small non-game fish with high site fidelity should also be considered. Fish should be collected in late summer or early fall, as this is typically the time of most active Hg methylation. The CSTAG recommends that if an active remedy is chosen for this site, a more

aggressive monitoring program for fish should be established initially and modified based on the evaluation of the results. It is recommended that at least two rounds of fish tissue data be collected and evaluated before the preparation of the second five-year review.

Response
Part 1:
Region 1 believes that given the overarching desire to maintain healthy fish communities, and the disparate size and habitat from which fish are collected, that the most recent comprehensive sample collection (in 2003) is not limited, but rather a robust set of fish data. Specifically, in support of the Human Health Risk assessment, over 300 fish samples were collected (10 each of three species assumed to be likely food source = 30 fish per reach x 10 reaches). More recently, and in support of the computer modeling, in 2008 additional fish samples were collected from certain reaches; these included yellow perch and largemouth bass from Reaches 3, 8 and 9. While risks were apportioned at the "reach" level, in the past, sub-reaches were used. The 2008 largemouth bass data, divided by subreach, are presented previously (see response above). The remainder of the data is presented as appendix in the FS and as letter Report entitled "*Report summarizing data collected for the Nyanza mercury Modeling Effort*" dated March 24, 2009.

The Region generally agrees with the observation by CSTAG that it may be difficult to quantify a 15% decrease in fish tissue samples if the number of samples remains similar. To that end, non-lethal methods of sample collection (tissue core) will be evaluated in the Remedial Design, thus preserving some ability to collect both more samples more frequently without detriment to fish communities.

Part 2:
The draft monitoring plan (previously shared and included as an attachment to the FS) attempts to balance the need for data against the negative effect that over-sampling might cause to otherwise healthy fish communities; this is a concern in some, but not all reaches. Non-lethal fish tissue sampling methods will be evaluated and thus would not preclude more frequent monitoring of edible-size species of bass, catfish and perch. Based on the period of time anticipated for fish tissue (in edible-size fish) to attenuate, a recalculation of human health risks every 10 years through more comprehensive sampling (3 species) remains proposed; this allows the 2003 data (used in the 2006 HHRA) to serve as a "baseline" to which other data can be compared. The suggestion of a small non-game fish will be investigated and could be used in lieu of or in addition to the proposed "bass-only" sample collection at intervening 5 years – however, as a warm water fishery of limited size [in some reaches] and natural abundance, it is not certain such species exist (e.g. fat head minnow). If identified, these potentially could be collected more frequently (possibly every 1 - 2 years) and Region 1 agrees their younger age would be a better indicator of remedy effectiveness. It should be noted, however, that these data would have no bearing on risk levels, as these species would be too small to eat and thus represent lower trophic levels than most targeted game fish. This will be further considered in the Remedial Design phase and further discussed with CSTAG.

If you have any questions or would like need further information regarding the Nyanza Chemical, OU4 – Sudbury River project, please do not hesitate to contact me at (617) 918-1327.

cc: James Owens, Region 1
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Attachment A

Spatial Variation in Flux Magnitude
Due to Local Environmental Factors & Setting For Major Mercury Species

Figure 2-3A
Reservoirs/Impoundments
(Reach 3. 4 and 6)

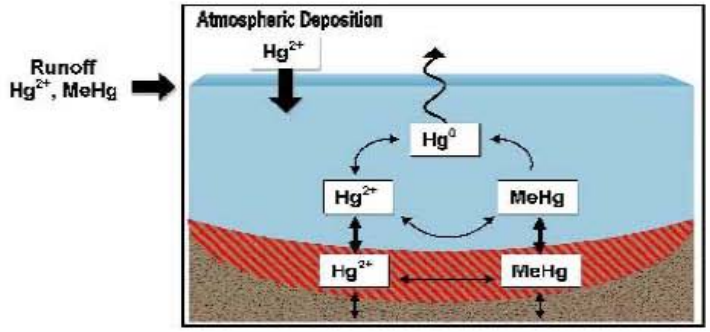


Figure 2-3B
Flowing (Lotic) Reaches
Reach 2, 5 and Portions of 7)

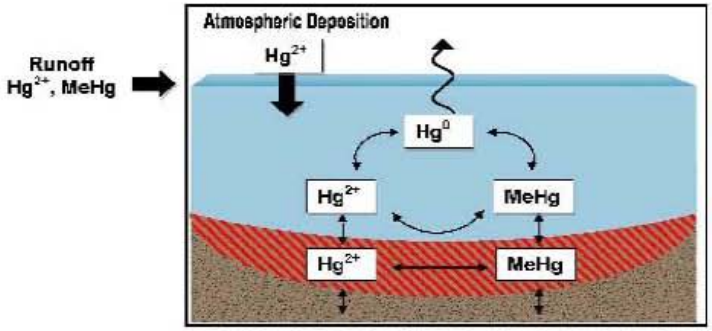
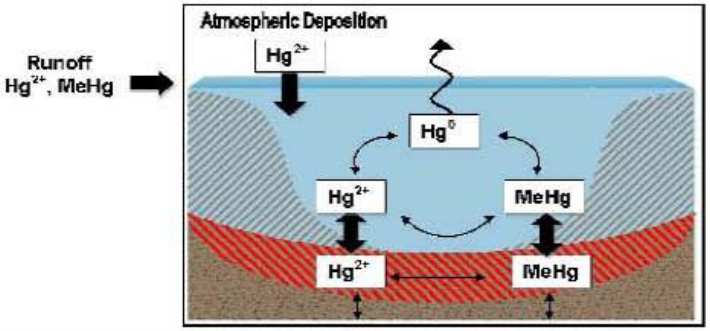
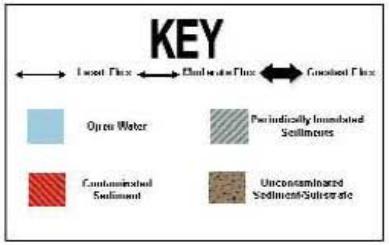


Figure 2-3C
Wetlands
(Reach 8, 9, 10 and Portions of 7)





Nobis Engineering, Inc.
Tel (603) 224-4182
Fax (603) 224-8007
www.nobisengineering.com

FIGURE 2-3A,B,C

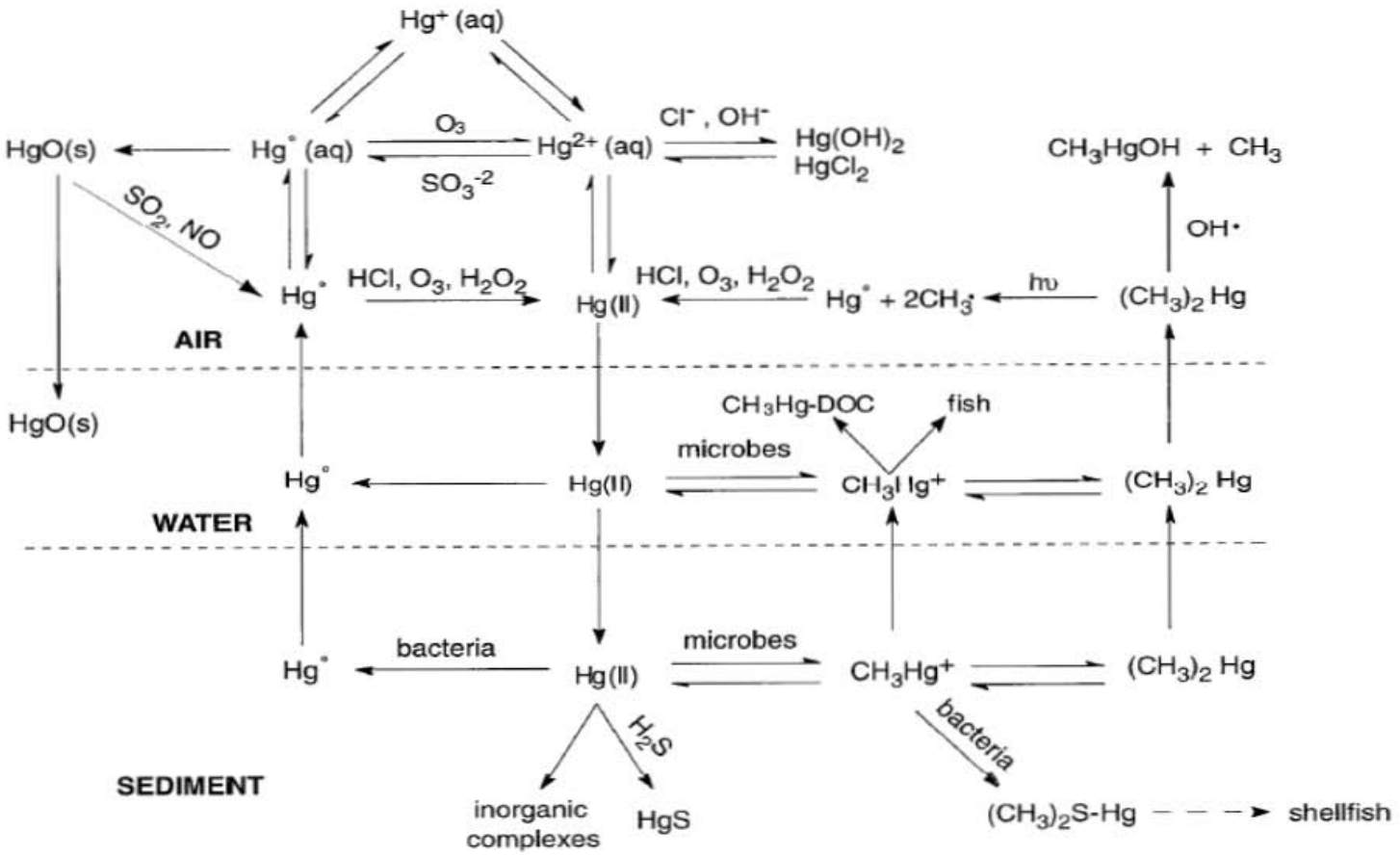
SPATIAL VARIATION IN MERCURY DUE TO ENVIRONMENTAL FACTORS
NYANZA CHEMICAL WASTE DUMP SUPERFUND SITE
OU 4 - SUDBURY RIVER
ASHLAND MASSACHUSETTS

DRAWN BY:	ML	APPROVED BY:	SH
PROJECT:	80026		JUNE 2010

R:\80026 Task Orders\80026 Nyanza DUA\Technical Data (TD)\CAD\dwg\80026.12--FIGURE2.dwg

Attachment B
Mercury Transformations

Figure 5-6. Transformation of Mercury in Air, Water, and Sediment



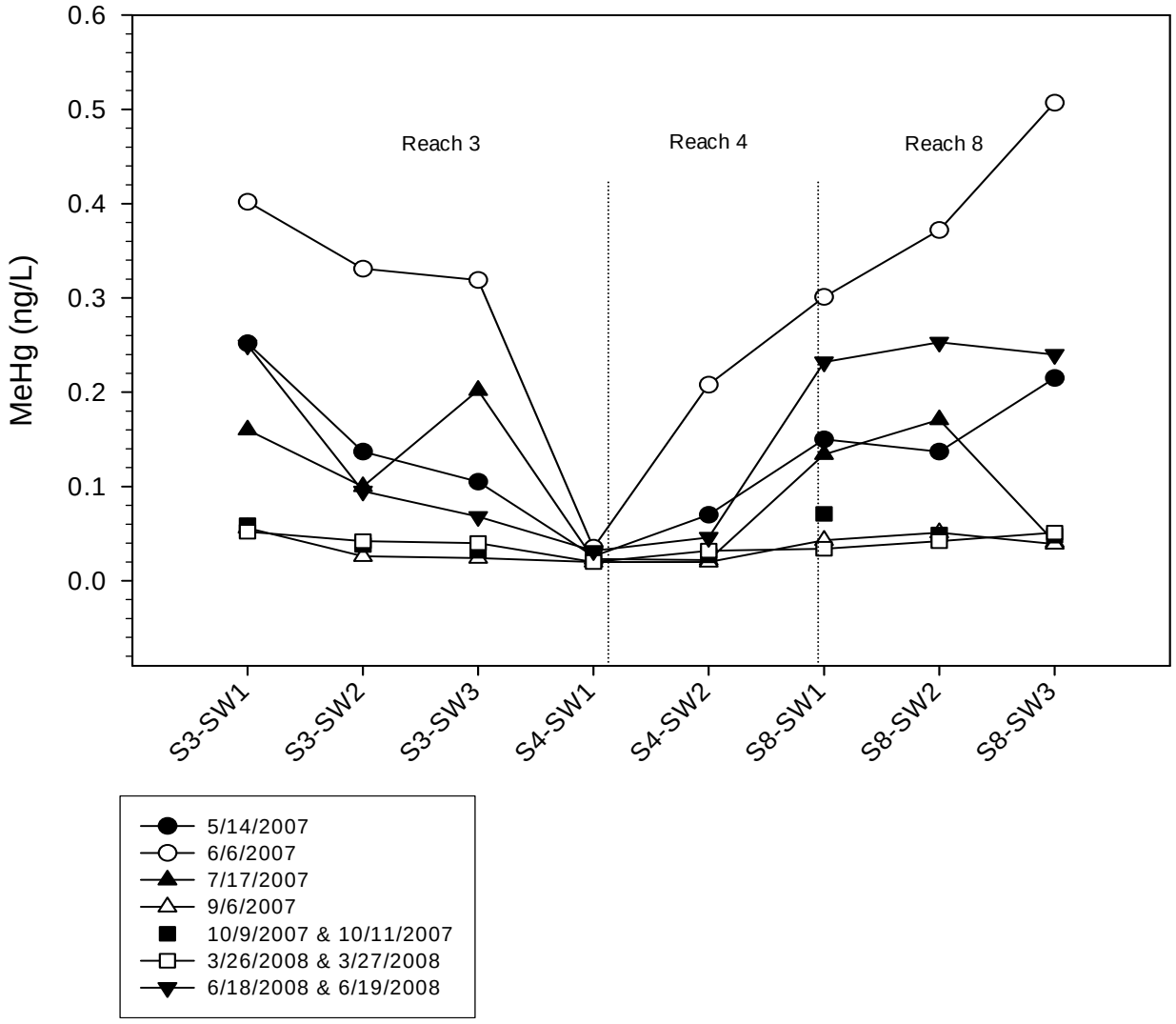
Dashed lines represent the boundary between environmental compartments.

aq = associated with aqueous; DOC = dissolved organic carbon; s = solid

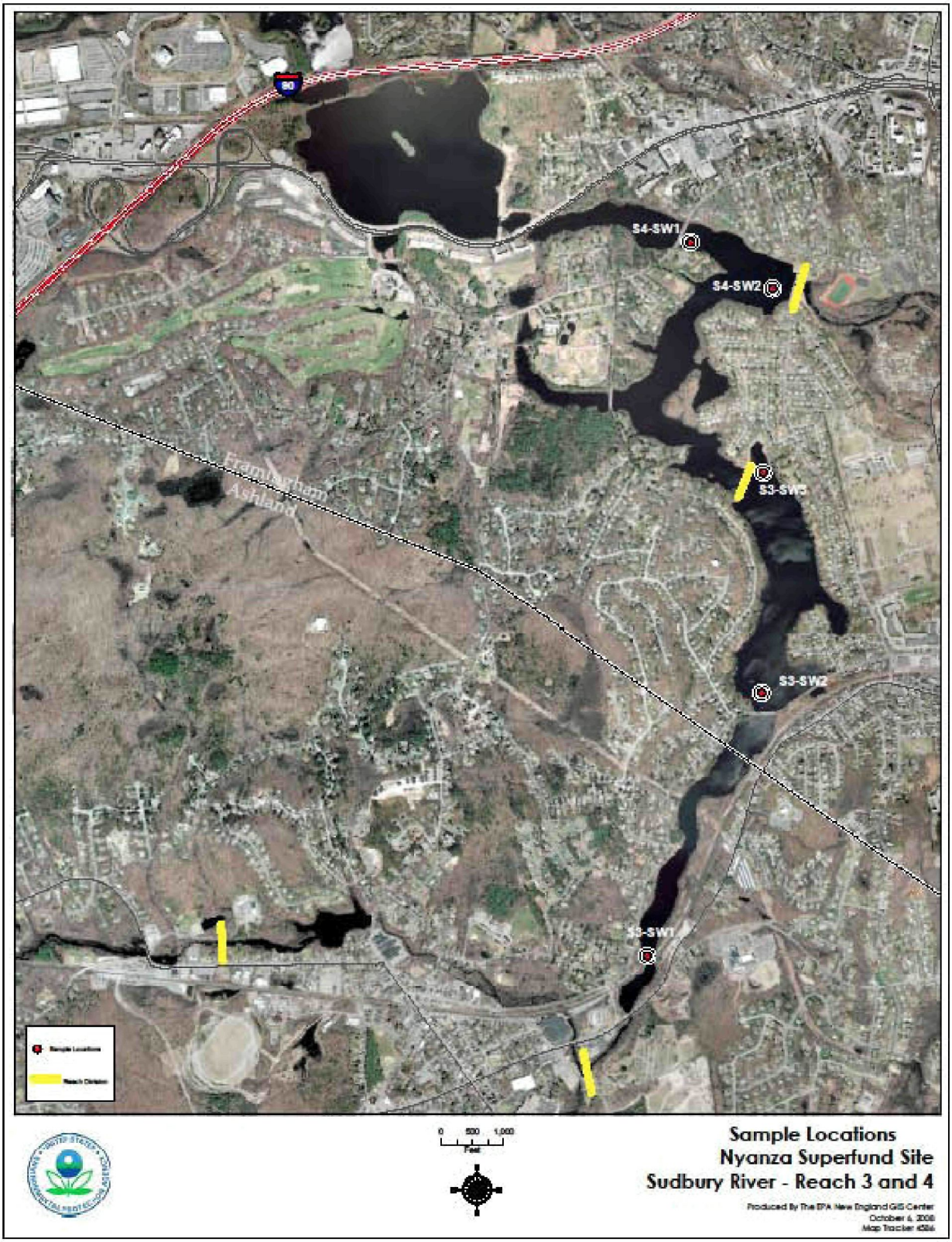
Source: Stem et al. 1996

Attachment C
Temporal variability of dissolved
Methylmercury in surface water

MeHg in Surface Water (Filtered, 2007-2008)

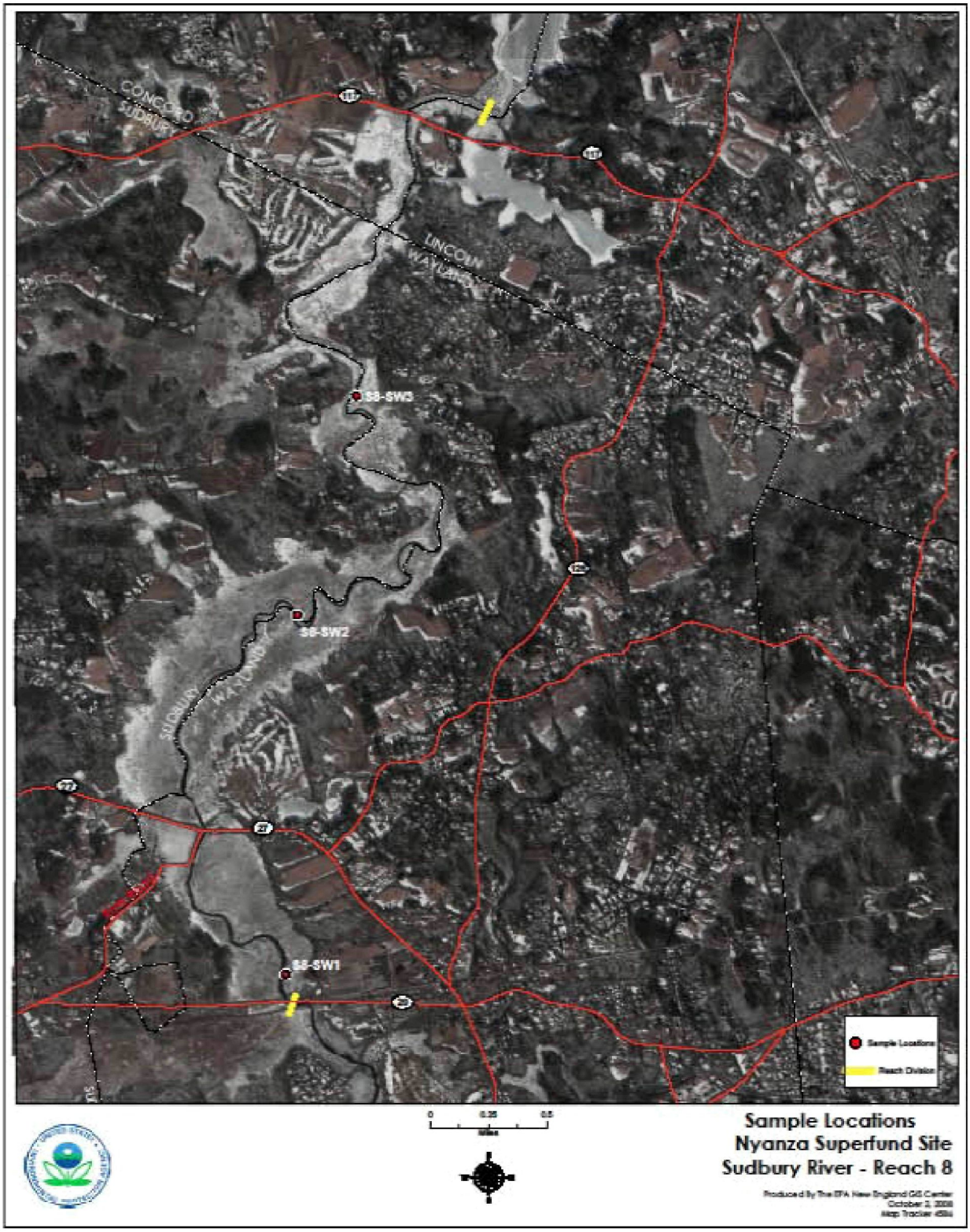


Attachment D
2008 Surface Water Sample Locations
Reach 3, Reach 4, and Reach 8



Sample Locations
Nyanza Superfund Site
Sudbury River - Reach 3 and 4

Produced By The EPA New England GIS Center
October 6, 2008
Map Tracker #586

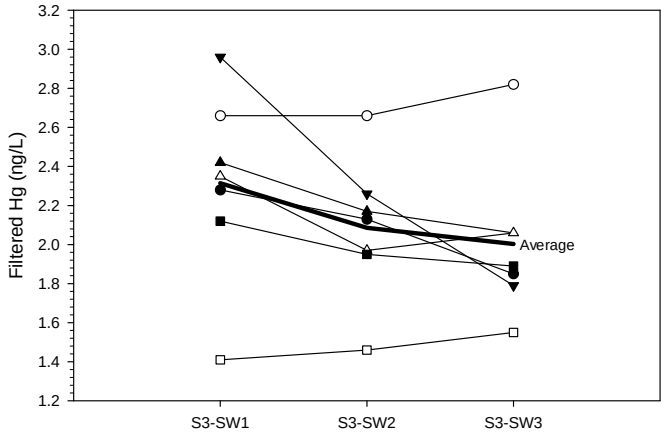


Sample Locations
Nyanza Superfund Site
Sudbury River - Reach 8

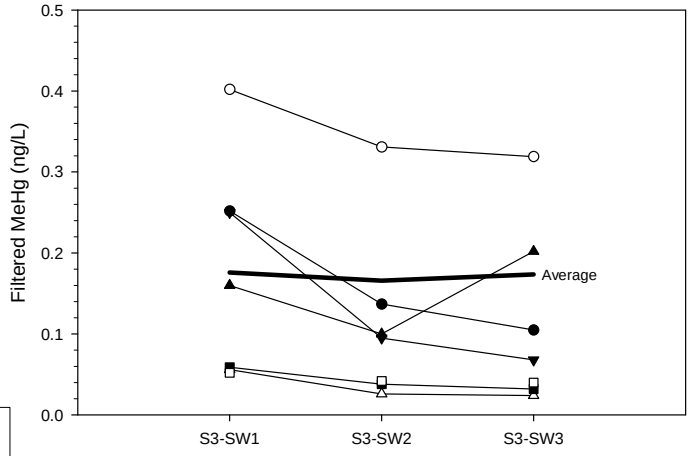
Produced by The EPA New England GIS Center
October 2, 2008
Map Tracker #884

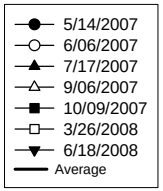
Attachment E
Reach 3 – 2007/2008 Surface Water Data

Reach 3 - Total Hg in Surface Water (Filtered, 2007-2008)

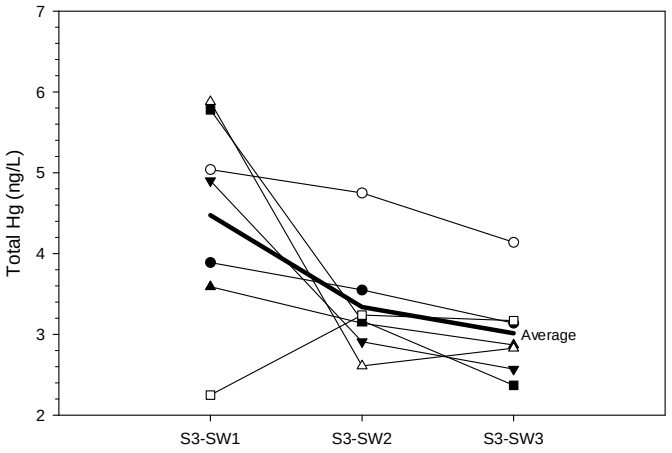


Reach 3 - MeHg in Surface Water (Filtered, 2007-2008)

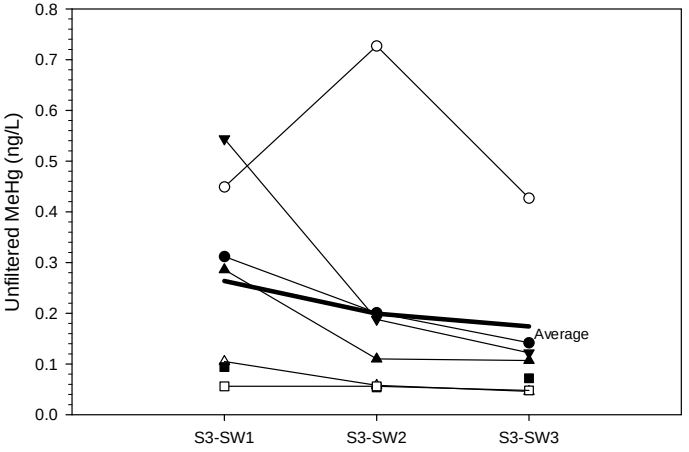




Reach 3 - Total Hg in Surface Water (Unfiltered, 2007-2008)

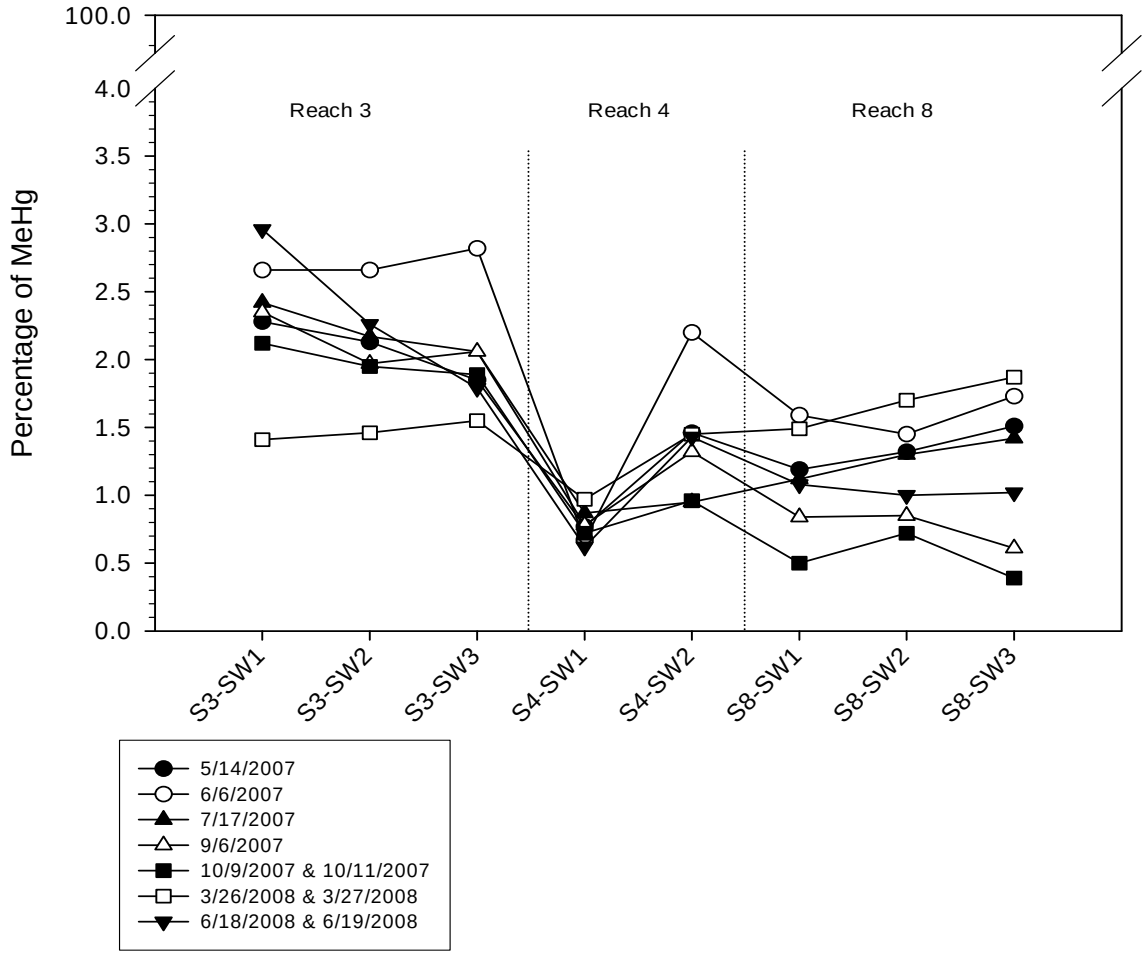


Reach 3 - MeHg in Surface Water (Unfiltered, 2007-2008)



Attachment F
Methyl Mercury as a Percent of Total Mercury

MeHg as a Percentage of Total Hg (Filtered, 2007-2008)



MeHg as a Percentage of Total Hg (Unfiltered, 2007-2008)