

# New York State Department of Environmental Conservation

## Division of Environmental Remediation

Remedial Bureau D, 12th Floor

625 Broadway, Albany, New York 12233-7013

Phone: (518) 402-9676 • Fax: (518) 402-9020

Website: [www.dec.ny.gov](http://www.dec.ny.gov)



Alexander B. Grannis  
Commissioner

April 26, 2010

Mr. David King  
United States Environmental Protection Agency  
421 Lower Main Street  
Hudson Falls, NY 12839

Dear Mr. King,

This letter contains the comments of New York State on the reports provided to the panel performing the peer review of the Phase 1 dredging work done as part of the remedial action at the Hudson River PCBs Federal Superfund Site. The reports were reviewed by the New York State Department of Environmental Conservation and Department of Health, along with the New York State Canal Corporation. The Canal Corporation will be providing comments in a separate letter.

While preparing the State's "Report on Observations from Phase 1 Dredging Oversight – Recommendations on Changes for Phase 2" ("the State's report", attached as an Appendix to USEPA's Phase 1 Evaluation Report), the State's project team identified a number of recommendations for improving the project operations and allowing the project to better meet the Engineering Performance Standards. These recommendations will not be reiterated at length in this letter, but NYSDEC continues to support the recommendations put forth in the State's report, and believes that the peer review panel should continue to refer to the State's recommendations as the panel completes its deliberations.

At this point in the peer review process, it is clear that there are significant areas of disagreement between the reports that the panel has received from GE and from USEPA. The peer review panel should expect to see a vigorous debate between the regulated entity (GE) which is facing a significant cost in implementing the balance of the remedial work for this site, and the regulatory agency which is responsible for ensuring that the remedial program for this NPL site is implemented in accordance with applicable laws and the Record of Decision for the site. The peer review panel should attempt, where possible, to draw its own conclusions from the data where GE's view is significantly different from USEPA's view on how to interpret the data. In this way, USEPA will receive the most benefit from the peer review process and will be better able to improve project performance and better able to modify (as appropriate) the Engineering Performance Standards.

In reviewing the two reports provided by GE and USEPA, the State has identified areas of disagreement, and specific design issues, where the State has a point of view to offer to the peer review panel. These issues are:

- 1) How to address the uncertainty in the Depth of Contamination (DoC) measurements developed during project design;
- 2) How to modify the project design to reduce resuspension losses

- 3) The impact of the redistribution of resuspended PCBs, including both local redistribution and downstream transport.
- 4) How to resolve the tension between the three engineering performance standards
- 5) Modification of the project design and reducing air emissions
- 6) Increasing the amount of “access dredging” designed in the project to allow for the appropriate sized equipment to be used.
- 7) The unloading operations at the work wharf of the sediment processing facility needs to be addressed to improve productivity and reduce scow unavailability.

The State’s views on these issues are as follows.

**Issue 1: How to address the uncertainty in the Depth of Contamination measurements developed during project design**

In the State’s report, the State project team recommended that an approach be developed which included both additional data gathering and the application of a correction factor to account for the uncertainty in the DoC measurement. The State believes that this approach is still appropriate to address this issue, but has the following observations on the competing approaches proposed by USEPA (inclusion of a planned overcut) and by GE (single pass to DoC in high confidence areas, with dredging to DoC and recharacterization in lower confidence areas) in their reports. The planned overcut approach proposed by USEPA would be relatively straightforward to implement in revising the Phase 2 design, and would not require the time and cost of additional data gathering. Such over-dredge methods are also consistent with the USACE report “The Four R’s of Environmental Dredging: Resuspension, Release, Residuals and Risk ERDC/EL TR-08-4”.

USEPA’s planned overcut approach does not, however, address those areas where the magnitude of the DoC underestimation exceeds the designed overcut. For these areas, there would still be the need to redelineate the new DoC after the first dredge pass in order to complete removal of the contaminated sediment inventory. After this redelineation, the area would then be dredged to meet the ROD targeted cleanup goal.

GE proposes to dredge only one pass in areas where GE has a high confidence in the design DoC estimates, followed by a cap or backfill. In areas where GE has a lower confidence in the design DoC estimates, GE proposes to dredge one pass, followed by redelineation of the DoC with only one additional dredge pass prior to either capping or backfill.

The State does not believe that the GE approach would be in compliance with the selected remedy identified in the ROD for this site. Simply put, the State believes that an error in design (the inaccurate DoC estimates) should not be used as the rationale for modifying the remedy. Rather, the error should be corrected and the project should move forward. USEPA’s approach would likely reduce the impact of the DoC error on the ability of the project work to meet the engineering performance standards, but the degree to which this would occur is directly related to the relationship between the magnitude of the error and the magnitude of the correction (the overcut); the State believes that additional data gathering to quantify the DoC error would likely allow the project designers to most accurately correct this error.

The State also believes that where there are areas of hardpan or bedrock, it is preferable to dredge and then cap the remaining thin layer of material rather than to try to remove the thin remaining layer with a clamshell bucket. However, the use of some type of suction dredging in these locations should also be investigated.

### **Issue 2: How to modify the project design to reduce resuspension losses**

The State's report contained a number of recommendations for changes to project design elements in order to reduce resuspension losses during Phase 2 which will not be reiterated here. It is important to note, however that the State does not believe that the project should be modified between Phase 1 and Phase 2 solely through a change in the standards. The primary basis for having two phases as described in the ROD was a recognition by USEPA that the project design would need to be updated and adjusted as the project progressed. Experience in Phase 1, particularly related to oil/sheen release control and air emissions control, showed that the existing design approach and the specific techniques used to implement the design during Phase 1 will need to be adjusted for Phase 2 in order to better meet the project standards and improve project quality.

It is also important for the peer review panel to recognize that there were limits established in the Consent Decree governing this project. (See Appendix B, in the Introduction to the EPS Scope)

The text of the agreement here states that "GE shall not be required, during a Phase 1 or Phase 2 field season, to make equipment modifications or additions for that season that are not reasonably available from a schedule or cost standpoint, recognizing that substitutions during a field season for major equipment approved in the Phase 1 or 2 Final Design Reports or being used in Phase 1 or Phase 2 may be impractical. (If necessary, more significant changes in equipment, operations, or processes may be required for subsequent seasons, subject to Paragraphs 15 and 20 of the Consent Decree.) However, in the event reasonable changes can be made to address achievement of the performance standards during any dredge season, GE will propose (either on its own initiative or at EPA's request) such changes to equipment or operations for EPA review and approval. The Parties agree that what is considered "reasonable" or "reasonably available" in a given situation, for the purposes of this paragraph, may depend on the circumstances and will need to take account of what is necessary in order for the project to be done in a way that does not jeopardize public health or safety."

Underpinning GE's belief that the quantitative relationship between mass of PCB dredged from the river and mass of PCB resuspended is somehow inviolate is GE's assertion that everything that could reasonably have been done to limit resuspension during Phase 1 was in fact done. Such is not the case. GE points to "Best Management Practices (BMPs)" such as deployment of containment and absorbent booms in response to oil sheens (GE Table 5.8-1), and states: "The numerous best management practices designed into the dredging program as well as those developed and implemented during the program were ineffective in lowering PCB resuspension to levels that would meet the Resuspension Standard." In fact GE's response to oil sheens and other resuspension issues was slow, often after-the-fact, and incomplete or untended.

Containment booms, when deployed, were often left unmonitored and uncollected for days at a time, allowing oils that were initially contained to eventually escape the boom and migrate down river. When oil sheens were discovered GE's response was frequently slow, allowing oil to escape down river for hours before response began. At one point government observers watched a tug boat steaming up-river, dragging a used containment boom behind.

In summary, it should be clear to the peer review panel that the scope of Phase 1 did not include a comprehensive evaluation of potential mitigation measures to address resuspension losses; rather, only a very limited set of alternatives was available for the contractor to use to reduce resuspension losses. It is now, after Phase 1 has been completed, that the entire universe of design alternatives can and should be evaluated to help identify how best to improve project quality.

**Issue 3: The impact of resuspended PCB redistribution, including both local redistribution and downstream transport.**

The State has reviewed the available data, and the presentations made by GE and USEPA related to the impacts of resuspended PCBs both locally in the vicinity of the dredging operations and downstream, including far field transport of PCBs through the upper Hudson downstream into the lower Hudson.

The State does not agree with GE's conclusions concerning the impact of project PCB releases on fish in the Hudson River. Attached to this letter are "Analysis of Fall Fish Data Collected Under the Baseline and Remedial Action Monitoring Programs of the Hudson River PCBs Superfund Site from 2004 through 2009" by NYSDEC – Division of Fish, Wildlife, and Marine Resources (April 2010) which summarizes NYSDEC's interpretation of these data, and a detailed discussion as to why NYSDEC does not agree with GE's interpretation of the fall 2009 fish data. In summary, NYSDEC disagrees with GE's interpretation of the fall 2009 fish data and GE's recommendation that a maximum downstream PCB load standard, which may limit the extent of PCB removal, is needed to protect fish. NYSDEC biologists concluded that the remedy as currently designed poses no long term danger to fish. This conclusion was reinforced by the localized nature of meaningful increases in PCB levels in the 2009 fall fish. To the contrary, scaling back the scope of the remedy as proposed by GE will be detrimental to the recovery of fish from PCB contamination by failing to remove highly contaminated sediments that will continue to release PCBs for uptake by fish.

The State also believes that it is critical for the peer review panel to understand the State's view of the benefits of the remedy, and how the PCB mass load standard element of the resuspension performance standard should not be construed as the overarching measure of achieving the benefits of the remedial program for this site. In order to make a credible assessment of the potential for the project to achieve the anticipated benefits identified in the ROD, an unbiased observer would need to take into account the most significant environmental benefits associated with the removal of hundreds of tons of persistent environmental toxins from the river. These benefits are most significant in the portions of the river which are to be dredged. An analysis which focuses only on the downstream transport of a very small fraction of the PCB

already in the river ignores the most significant benefits of the remedy – a permanent reduction in human health and environmental risk in the areas to be dredged in the upper Hudson River.

The State supports USEPA's approach to managing the downstream transport of PCBs associated with implementation of this remedial project. USEPA's approach is to limit the downstream transport of PCBs such that the amount of PCB mass transported downstream in the long term is reduced over the estimated amount which would have been transported if no remedial action were implemented. The State agrees with USEPA's analysis that the anticipated significant reductions in downstream PCB transport have not occurred, and that as a result comparisons between project-related loadings and loadings under the no action scenario support the modification of this element of the resuspension standard.

#### **Issue 4: How to resolve the tension between the three engineering performance standards**

Both GE and EPA acknowledge that the three Engineering Performance Standards are in tension with one another. "The rub is the antagonistic relationship among the standards. Efforts to re-dredge to recover residual PCB mass retard productivity and exacerbate resuspension. Efforts to reduce resuspension reduce productivity and extend the project. ... Something has to give." (GE page 138) The something that should give is the Productivity Standard. The State recommends that elements of the other engineering and quality of life performance standards intended to protect human health and the environment, should be given priority over compliance with the productivity standard. Extension of the project duration of a few years, resulting in better compliance with the standards established to protect human health and the environment, would be appropriate.

#### **Issue 5: The ability of project designers to modify the project design to reduce air emissions**

The State believes that it is important that changes to project design which arise as a result of the peer review process take into account not only the need to comply with the engineering performance standards, but with the Quality of Life standard for PCB in air as well. This standard was put into place to protect people living in the vicinity of the project work, much as the resuspension standard was put into place to protect downstream water users. The NYSDEC Division of Air Resources has performed a detailed analysis of the available air data (an attachment to this letter) which concludes that the exceedances of the air standard were related to the presence of the PCB oil sheens, and offers specific mitigation strategies to address PCB exposure to people near project operations via the air route.

#### **Issue 6: Increase the amount of "access dredging" designed in the project to allow for the appropriate sized equipment to be used.**

GE and EPA both note that GE's inability in many instances to fully load barges because adequate draft was not available negatively impacted productivity. During Phase 1 very little access dredging was done, and most of what was done occurred after dredging as an aid to back-fill placement. GE notes that access issues will also plague Phase 2: "Dredging on the west side

of Griffin Island will require access from the south end of the channel. Due to the shallow water depths in the channel, equipment (dredges, scows, etc.) working in the area will require shallow drafts, and dredged sediment will need to be transferred to the south end of the channel in mini-hopper barges before being rehandled to transload the sediment to larger scows for transfer to the Sediment Processing Facility." (GE page 129) The clear solution to this problem is pro-active access dredging in the first instance in areas where shallow draft is predicted to impede remedial dredging. EPA proposes such dredging: "Dredging necessary to gain access to a CU should be conducted immediately prior to dredging that CU so that the dredge platforms and scows can operate efficiently." (EPA Intro-25)

It should be noted that EPA's ROD envisioned significant navigational dredging to alleviate this problem. "It is likely that initial dredging work will be focused on improving navigation along the Hudson River/Champlain Canal between Locks 1 and 6. One reason for this is to enable project-related equipment to navigate the Champlain Canal system with minimal interference from in-river obstructions. Another reason is to limit, as much as possible, interference between project generated river traffic and traffic otherwise occurring on the river. One way to reduce such inriver interference is to clear out shoal areas and thereby restore the navigation channel to its designated width." (EPA Record of Decision Responsiveness Summary, January 2002, page 10-2)

**Issue 7: The unloading operations at the work wharf of the sediment processing facility needs to be addressed to improve productivity and reduce scow unavailability.**

The State, in its oversight capacity, observed multiple problems with the unloading operations at the work wharf of the sediment processing facility. Scow offloading was conducted primarily with a Komatsu excavator until reaching the bottom of each scow when a remote-controlled Bobcat skid steer was lowered into the scow to assist in consolidating the remaining sediment for the Komatsu to remove.

There were several occasions that the Komatsu was inoperable, and would take half a day to repair. The Trommel screen was also in need of repair in the second half of the year. There were also problems with the clay in the Trommel screen all of the way through to the gravity thickener. As observed by the State and its contractors, approximately half of the sediment that was offloaded was directly into the Trommel screen. Another third of the time sediment was offloaded directly into the articulated dump trucks. Sediment was off-loaded onto the pavement the remaining amount of the time.

Consideration of the addition of a second Trommel screen or another sediment segregation process should be considered. Expanding operations at the work wharf for the unloading of two barges at a time should be considered to reduce the amount of unavailable scows at any particular time. A second unloading and size separation process would help when mechanical issues, as observed during the dredging, and sediment with a higher clay content are encountered. It is also important to note that the State believes, based upon the available data, that the percentage of dredged material which will be able to be direct loaded into trucks and not processed through the solids handling system will likely decrease in Phase 2 as the project moves away from the debris field in the vicinity of Rogers Island.

**Summary and Conclusion**

The State will continue to work with USEPA and GE to move forward with implementation of the remedy for this site with a goal of maximizing the benefits of the remedy, while minimizing the negative project impacts on human health and the environment. The State believes, as was stated in the State's report, that the overall benefit associated with the removal of PCB from the river greatly outweighs the short-term impacts associated with the work.

Sincerely,



Kevin L. Farrar  
Remedial Bureau D  
Division of Environmental Remediation

Analysis of Fall Fish Data Collected Under the Baseline and  
Remedial Action Monitoring Programs of the Hudson River PCBs  
Superfund Site from 2004 through 2009

Wayne Richter  
Michael W. Kane  
Lawrence C. Skinner

Division of Fish, Wildlife and Marine Resources  
New York State Department of Environmental Conservation

April 2010

**Abstract:** As part of its activities for the Hudson River PCBs Superfund Site, General Electric Company determined PCB levels in fish collected for five years preceding the initiation of dredging and during the first year of dredging to remove PCBs in 2009. Fish were collected in one reference section above the main source of PCBs and from four sections beginning with the most contaminated area of the river and proceeding downstream for approximately 45 miles from Fort Edward to Albany, New York. This report analyzes small pumpkinseed and forage fish collected in the fall of each year and compares contaminant levels in the 2009 fish, exposed for four months to elevated water column PCB concentrations due to dredging, with fish from the previous five years.

PCB levels in fish collected during the five baseline years showed high interannual variability in both forage fish and pumpkinseeds. PCB levels appear to have declined slightly over this baseline period but high variability prevented development of a valid model for any decline. PCB levels were significantly higher after dredging in both groups of fish when compared to the previous five years in the Thompson Island section, where the 2009 dredging occurred, and in the immediately downstream Northumberland – Fort Miller section; means increased by about 2.5 and 1.5 times in these sections, respectively. In contrast, no significant increase occurred in either the Stillwater section or at Albany. Thus, dredging was associated with a moderate, localized increase in PCB levels in small fish, but no discernible effect more than a few miles downstream.

## **Introduction**

General Electric Company discharged PCBs into the Hudson River from its plants in Hudson Falls and Fort Edward, New York, from about 1947 until an agreement with the New York State Department of Environmental Conservation ended intentional releases in 1977. The 1973 removal of the Fort Edward Dam, below GE's operations, led to a downstream release of PCBs and PCB laden sediments, although PCBs were undoubtedly accumulating in downstream sediments even before the dam was taken out. Much of this remobilized PCB was deposited in a 40 mile stretch of the river beginning just below the removed dam and ending at the Federal Dam at Troy, with the bulk in the upper portion of this area. A major unintended release from the abandoned Allen Mill adjacent to GE's Hudson Falls plant site resulted in a further injection of PCBs into the river in 1991. Continuing control efforts have greatly reduced the amount of PCBs entering the river.

These releases of PCBs caused widespread contamination of the river bottom sediments and a chronic elevation of water column PCB concentrations. Among the consequences of high ambient PCB levels in the Hudson are elevated concentrations of PCBs in a wide variety of fish and other biota (Sloan et al. 2002, 2005). Fishing was banned for a period of time and is currently restricted to catch and release on the upper Hudson River, and heightened fish consumption advisories are in effect downstream of the catch and release area for the remaining 153 miles of the river (NYSDOH 2009).

In 2002, the U.S. Environmental Protection Agency issued a Record of Decision to remove PCB contaminated sediments from the upper Hudson River by dredging (US EPA 2002). The portion of the site where dredging will occur is within the 40 miles of river from Fort Edward downstream to the Troy Dam. Subsequent agreements and plans developed by EPA and GE called for an intensive monitoring program, which would build upon long term sampling by the New York State Department of Environmental Conservation, to monitor PCB levels in fish before, during and after dredging. The Baseline Monitoring Program (BMP) was designed to document pre-dredging conditions as a basis for evaluating the effects of PCB removal and took place from 2004 through 2008. The succeeding Remedial Action Monitoring Program (RAMP), which began after the initiation of dredging in 2009, was designed

to detect and evaluate any effects during dredging. The monitoring programs had spring and fall fish sampling components. The spring collections were targeted at larger sportfish in size classes that might be eaten by humans while the fall collections were targeted at smaller fish that might be eaten by predacious fish and wildlife.

The Hudson River is divided by dams into eight pools over the length of the PCB remediation site. PCB removal is expected to proceed from upstream to downstream. Fish collection locations were chosen to include a reference area upstream of General Electric's plants, the three principal sections of the remediation site, and a location downstream of the remediation site. The three sections in the remediation site each had multiple sampling areas as part of an effort to look at spatial variation and determine an average concentration for the river reach.

Dredging began in 2009 in the pool formed by the Thompson Island Dam. Dredging occurred in the two channels around Rogers Island, six miles from the dam, and in the east channel around Griffin Island, about 1.5 miles from the dam. As expected, dredging and associated activities mobilized PCBs and resulted in a rise in water column PCB concentrations (US EPA 2010). While the monitoring programs had spring and fall fish collection protocols, the spring collection in 2009 occurred less than a month after dredging began, probably too soon to expect detectable effects on PCB levels in fish.

This report analyzes the fall fish collections to characterize PCB levels in fish during the baseline monitoring period and to compare fish exposed to higher levels of PCBs during the dredging season to the baseline fish. It reports only on data collected under the Baseline and Remedial Action Monitoring Programs. Although longer time series of data are available for some locations, the BMP and RAMP data form a coherent, spatially intensive body of information collected in a consistent way with few deviations from the designed protocol.

## **Materials and Methods**

Fish sampling was divided into two periods or programs. Baseline or pre-dredging sampling was conducted as part of the Baseline Monitoring Program (BMP) from 2004 through 2008. Sampling in 2009

took place while dredging was underway as part of the Remedial Action Monitoring Program (RAMP). Detailed protocols can be found in the project plans for the monitoring programs (QEA and ESI 2004, Anchor QEA 2009). Sampling protocols under the two programs were as similar as possible; the program designation serves mainly to distinguish the pre-dredging baseline from the samples taken during dredging. Fall fish were typically collected in late August through the middle of September. Collections usually occurred over a generally contiguous three to five day period except in 2007 when sampling was split between the middle of September and early October due to equipment problems.

Fish were sampled in five sections of the Hudson River. The Feeder Dam section is located above the Glens Falls Feeder Dam, upstream of General Electric's Fort Edward and Hudson Falls plant sites, and functioned to provide background levels of PCBs. The Thompson Island section, equivalent to River Section 1 in remediation program documents, extends six miles downstream from the former Fort Edward Dam to the Thompson Island Dam. This section contains many of the most contaminated sediments and was the location where dredging took place in 2009. The Northumberland – Fort Miller section, which corresponds to River Section 2 of the remediation program, extends downstream for five miles from the Thompson Island Dam. It comprises pools formed by the Fort Miller Dam and the Northumberland Dam. The Stillwater section extends about 15 miles downstream from the Northumberland Dam to the Stillwater Dam and forms the upstream part of River Section 3 of the remediation program. The Albany section is below the Federal Dam at Troy, downstream of the confluence of the Mohawk River with the Hudson, in the tidal portion of the Hudson River.

Each section had one or more sampling areas (Figure 1). These were localities within which fish were sought. Although fairly small, these sampling areas were not rigorously bounded or fixed in location. Rather, they would be more or less extensive and might even be in slightly different locations from year to year, depending upon where fish could be obtained. The Feeder Dam section was sampled as a single area covering the entire pool (FD1). The Thompson Island section was sampled in five areas (TD1 – TD5); dredging was most closely associated with TD1 in the west channel of Rogers Island and TD5 in the east channel of Griffin Island. The Northumberland – Fort Miller section was sampled in four

areas (ND1 and ND2 in the pool formed by the Fort Miller Dam, and ND3 and ND5 in the pool formed by the Northumberland Dam). An additional area (ND4) had been planned for the pool formed by the Northumberland Dam. When it failed to yield fish in 2004, it was dropped and its samples were apportioned to ND3 and ND5. Problems with access prevented sampling in areas ND1 and ND2 in the Fort Miller pool from 2006 through 2008. Samples scheduled for those two areas were taken instead from the two other areas in the Northumberland pool, ND3 and ND5. The Stillwater section was sampled in five areas (SW1 – SW5). The Albany section had a single designated area (AT1). The fall location for AT1 was initially established at the south turning basin opposite the Port of Albany, ten miles downstream from the Troy Dam but was later expanded to two other locations due to difficulty in obtaining fish. A second location 2.0 miles upstream was added for 2007 and 2008 while a third location 3.4 miles upstream of the turning basin was needed for pumpkinseeds in 2009. The flexible nature of the sampling areas needs to be kept in mind when considering differences among years and areas.

Sampling targeted small pumpkinseeds (*Lepomis gibbosus*) and medium sized “forage fish.” Sample size goals were 20 pumpkinseeds at the Feeder Dam and at Albany, 30 pumpkinseeds in the Thompson Island and Stillwater sections, 25 pumpkinseeds in the Northumberland – Fort Miller section, and 10 forage fish composites in each section. Pumpkinseeds were targeted by size in an attempt to obtain yearling fish, with 90% of the fish between 77 mm (3 inches) and 127 mm (5 inches) in length. Ages were determined by examination of scales in 2004, 2006 and 2009. Although yearling fish were targeted, in practice somewhat more than half the fish were yearlings. Most of the rest were two years old but a small number of three and four year old fish were also collected. Forage fish comprised a miscellaneous collection of small minnows (Cyprinidae) that depended upon availability. Spottail shiner (*Notropis hudsonius*) was the preferred species and accounted for nearly half the samples. The other species, listed in order of sample numbers, were golden shiner (*Notemigonus crysoleucas*) with about a quarter of the samples, unidentified small minnows, spottail shiner (*Notropis spilopterus*), bluntnose minnow (*Pimephales notatus*), common shiner (*Notropis cornutus*), mimic shiner (*Notropis volucellus*), fallfish (*Semotilus corporalis*), and rosyface shiner (*Notropis rubellus*). Species composition differed among

years (Chi-square = 48.7, df = 10,  $P < 0.0001$ ). Approximately 90% of the forage fish were between 55 mm (2 inches) and 119 mm (4½ inches) in length.

Fish were collected by electroshocking. Forage fish were sought opportunistically without regard to species. Fish were stunned, collected with a net, and placed in a live well. Fish were then sorted on shore. Each pumpkinseed was weighed, measured for length and given an individual identifying number. Forage fish were sorted by species and approximately by size. Forage fish were measured individually for length and weight, and then combined into composites of between 2 and 25 fish (most often 2 to 10 fish) for analysis. Each composite was given an individual identifying number. Fish were placed on ice after processing and shipped within 24 hours to an analytical laboratory for analysis.

PCB results were reported as Aroclor concentrations on a whole body, wet weight basis. Percent lipid was also reported. Total wet weight PCB was obtained by summing the individual Aroclor values. Non-detect results were handled as follows: Aroclors were divided into two groups. The lower group consisted of Aroclors 1016, 1221, 1242 and 1248. The upper group consisted of Aroclors 1254 and 1260. If at least one detection occurred in one Aroclor from each of the lower and upper groups, all detected values were summed and no correction was made for non-detects. If a value was reported for at least one Aroclor in one group but not the other, half a detection limit was added to the sum of the reported values. If all Aroclor results were non-detect in both groups, total wet weight PCB was assigned the value of one detection limit. Lipid adjusted PCB values were derived by dividing the wet weight value by the percent lipid.

Data were collected by contractors to General Electric Company and provided to the New York State Department of Environmental Conservation by General Electric under the terms of agreements with the United States Environmental Protection Agency. Statistical analysis was performed using the R statistical software program (R Development Core Team 2009). Exponential regressions were fit using non-linear least squares after scaling the year of data collection by subtracting 2000.

## Results

Correlations between wet weight PCB levels and lipid adjusted PCB levels were high for both forage fish and pumpkinseeds (Table 1; forage fish:  $r = 0.904$ ; pumpkinseeds:  $r = 0.974$ ; both  $P < 0.001$ ). Consequently, nearly all statistical tests reported below gave equivalent results for both wet weight PCB and lipid adjusted PCB. Due to the lipophilic nature of PCBs, which may allow changes in lipid concentrations to mask or cause spurious changes in PCB trends, most figures show only lipid adjusted PCB levels; patterns were, however, very similar for wet weight and lipid adjusted plots. Correlations among other variables were generally low except for that between weight and length (Table 1, Figure 2). With such generally low correlations, attempts to adjust PCB values to other characteristics of the fish such as size are likely to be counterproductive and were not performed. BMP and RAMP fish generally showed little differences in other measured characteristics. No significant differences were found in either forage fish or pumpkinseeds for length, weight or percent lipid with the exception of pumpkinseed weight in the Thompson Island section (BMP mean = 19.7 g, RAMP mean = 15.95 g;  $P = 0.022$ ).

The BMP fish showed a weak and generally inconsistent trend of declining PCB concentrations over the five year monitoring program (Figure 3). Plausible models for any decline are linear (constant reduction) and exponential (reduction proportional to the amount present). Models were fit to each of the four river sections for wet weight and lipid adjusted PCBs. Of the 32 model fits (2 model types, 2 species, 2 response variables, 4 sections) all were significant ( $P < 0.05$ ) except for the forage fish lipid adjusted linear regression at Stillwater and exponential regression at Thompson Island. An examination of regression residuals (Figure 3) shows, however, that almost none of the models provided a good fit to the data. All linear regressions have at least one, and most have two, annual means that are outside the 95% confidence limits for the regression (Figure 3). Similarly, the individual data values, and hence the residuals from the regression, from one or two years cluster heavily on one side of the fitted regression line in every case (Figure 3). Thus, neither type of model provides an adequate description of the data. Given this inadequacy, it would be inadvisable to adjust BMP levels for any trend when comparing them

to RAMP levels. Comparisons between BMP and RAMP fish were therefore made using unadjusted data from each program.

Feeder Dam PCB levels for both forage fish and pumpkinseeds were consistently low during the BMP period and remained low in 2009, with all lipid adjusted PCB medians below 4 ppm (Table 2); medians are reported because of the substantial number of results below the detection limit. The BMP and RAMP forage fish were significantly different, with higher levels in RAMP fish for wet weight and lipid adjusted PCBs, while pumpkinseeds did not differ on either variable (Table 3).

PCB levels at the Thompson Island section were considerably higher than at the Feeder Dam, with lipid adjusted PCBs averaging 133.60 ppm for forage fish and 209.57 ppm for pumpkinseeds during the BMP period (Figure 4). Levels decreased downstream from the Thompson Island section to attain lipid adjusted averages for the BMP fish of 29.00 ppm and 30.02 ppm for forage fish and pumpkinseeds, respectively, in the Albany section. Year to year variation was considerable for both species during the BMP (Table 4, Figure 5).

Dredging was associated with a substantial increase in PCB levels in fish from the Thompson Island section, a smaller increase in the Northumberland – Fort Miller section, and little, if any change in the Stillwater and Albany sections (Figure 6). Because PCB levels clearly differed among sections, the effect of dredging was first analyzed as a two way analysis of variance with factors of program (BMP versus RAMP) and section. The interaction term of the ANOVA was significant ( $P < 0.001$ ) in both forage fish and pumpkinseeds for both wet weight and lipid adjusted PCB levels (Figure 7). This significant interaction means that the effect of dredging on PCB levels in fish differs among the sections. Consequently, examination of the effect of dredging over all sections combined (a main effect of program) would be meaningless. Instead, differences between the BMP and RAMP fish were tested for each section.

The ANOVAs for the Thompson Island and Northumberland – Fort Miller sections were significant for both forage fish (all  $P < 0.04$  for wet weight and lipid adjusted PCBs) and pumpkinseeds (all  $P < 0.03$ ) (Table 5). RAMP PCB levels increased about 2.5 times in the Thompson Island section and

about 1.5 times in the Northumberland – Fort Miller section over BMP levels, with the proportionate increase somewhat less for lipid adjusted than for wet weight PCB levels (Table 5). In contrast, no ANOVA was significant for either the Stillwater or Albany sections for forage fish (all  $P > 0.20$ ) or pumpkinseeds (all  $P > 0.15$ ) (Table 5).

PCB levels in the BMP fish appear to differ among the sampling areas within a section and some areas had more change between the BMP and RAMP fish than others (Figure 8). The two-way ANOVA interaction term for sampling area and program was significant ( $P < 0.001$ ) for forage fish and pumpkinseeds for both wet weight and lipid adjusted PCB levels. Given the small numbers of RAMP samples, two for forage fish and five for pumpkinseeds from all but one sampling area, and the large number of sampling areas, an attempt to test for differences between sampling programs for each area is inadvisable as it would be plagued by incorrect rejections and acceptances of the null hypothesis of no difference. Given this limitation, no reliable conclusions can be drawn as to whether the patterns evident in Figure 8 reflect real differences among the sampling areas or are merely the result of a relatively small number of samples.

## **Discussion**

Dredging to remove PCBs was associated with a fairly rapid and substantial, but local, increase in PCB levels in small fish. After about four months of dredging and associated work, three of which were at a high rate of activity, RAMP fish collected from the Thompson Island section, in which dredging occurred, had average wet weight and lipid adjusted PCB levels that increased about 150% over the average of the BMP fish from the previous five years. Levels were elevated by about 50% in the Northumberland – Fort Miller section. This section, comprising two pools formed by dams, extends for five miles immediately downstream from the Thompson Island section.

In contrast, the data do not support a conclusion that PCB levels increased further downstream. Although the average RAMP wet weight PCB levels in the Stillwater section increased by 0.76 ppm and 0.42 ppm for forage fish and pumpkinseeds, respectively, the difference was not significant. In the

Albany section, RAMP averages were actually less than the BMP averages and were again not significantly different. Thus, beyond about eight miles from the downstream limit of dredging, any effect of dredging on PCB levels in young fish is at most questionable and small in magnitude.

PCB levels in these fish reflect both the sharp increase in PCB concentrations in the river water in the vicinity of dredging and the attenuation of concentrations downstream due to loss of PCBs from the water column and dilution from tributaries. Water column PCB levels during the BMP period were similar at all monitoring stations between the Thompson Island Dam and the Troy Dam and typically ranged between 20 and 80 ng/L during the summer months (US EPA 2010). Concentrations at Albany averaged roughly half those in the upper three sections (US EPA 2010), reflecting the influence of the inflow from the Mohawk River. Water column PCB monitoring during dredging showed a considerable increase over baseline just below the Thompson Island Dam, with an average through October 27 of 200 ng/L (US EPA 2010), roughly a five-fold increase. The average at Lock 5, at the head of the Stillwater section, was 155 ng/L (US EPA 2010), a roughly four-fold increase, while the 59 ng/L average at Albany was about double the BMP average (US EPA 2010). The increase in PCB levels in RAMP fish relative to BMP fish was thus considerably smaller than the increase in PCB water concentrations. Whether these fish had attained steady-state levels of PCB concentrations by the time of sampling and how the limited duration of increased water column PCB concentration during and shortly following PCB removal activities will affect fish concentrations over the long term cannot yet be determined.

Over five years, the BMP fish showed considerable interannual variability in PCB levels amidst what is probably a slight decline (Figure 3). This interannual variability is a far more salient feature of the data than any trend. The consequent failure to fit regression models embodying plausible mechanisms of change over time to the BMP data precludes valid projection of temporal trends. Because the decline is too erratic to be modeled reliably, the most that can be concluded is that a slight decline has probably occurred; useful prediction or extrapolation into the future is impossible. Extrapolation based on a purely descriptive model with no causal mechanism would be even less advisable. Such a model would merely

fit the data with no reason to believe that it encapsulates any decay process. Moreover, with only five years of data, model overfitting would be a real danger.

Although a temporal association between dredging PCB laden sediments and higher PCB levels in fish has been demonstrated, the high interannual variability suggests that caution is appropriate before assigning a causal relationship. When, as in the Thompson Island section, the mean in 2009 was well beyond the range of means of the preceding five years (Table 4), a conclusion of dredging induced effects on fish PCB levels is well supported. In the Northumberland – Fort Miller section, the 2009 wet weight PCB means were slightly higher than all of the means for the preceding five years whereas the lipid adjusted means in 2009 were less than the means in 2006 for both forage fish and pumpkinseeds. A causal relationship between dredging and the higher 2009 levels in Northumberland – Fort Miller therefore seems likely but is less certain. The 2009 means at Stillwater and Albany are well within the range of the means of the preceding five years, further reinforcing the conclusion that dredging had little influence on fish PCB levels in these river sections. The significantly higher 2009 PCB levels in forage fish at the Feeder Dam, which could not have been caused by dredging, emphasizes this caution as well as the need to look at magnitude of any difference along with statistical significance when drawing conclusions about the effect of dredging on fish.

Sample sizes at individual areas were too small to determine whether the apparent differences among areas (Figure 8) are meaningful. As remedial dredging progresses, it may be useful to reliably distinguish among these areas, an analysis that will require larger sample sizes.

In conclusion, small fish in the vicinity of dredging showed an increase in PCB levels that was smaller than might be expected given the increase in water concentration. The effect of dredging on PCB levels in fish diminished rapidly with distance. As with past events such as the Allen Mill release of PCBs in 1991 and subsequent control, it is likely that the effect will also diminish with time so that fish sampled within a few years following dredging can be expected to no longer exceed pre-dredging levels. Of great interest will be how rapidly PCB concentrations decline below the pre-dredging levels following the removal of a portion of the PCB laden sediments.

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Table 1. Correlations among measured variables; upper diagonal has the correlation coefficient and the lower diagonal has the P value. WW PCB and L PCB are wet weight and lipid adjusted PCB, respectively.

Forage fish (n = 294)

	WW PCB	L PCB	Length	Weight	Percent Lipid
Wet weight PCB	–	0.90	0.18	0.12	0.40
Lipid adjusted PCB	<0.0001	–	0.19	0.14	0.13
Length (mm)	0.0019	0.0014	–	0.94	0.20
Weight (grams)	0.0466	0.0149	<0.0001	–	0.12
Percent lipid	<0.0001	0.0292	0.0006	0.0434	–

Pumpkinseeds (n = 738)

Wet weight PCB	–	0.97	0.03	0.04	0.20
Lipid adjusted PCB	<0.0001	–	0.01	0.01	0.07
Length (mm)	0.3612	0.7709	–	0.95	0.01
Weight (grams)	0.2811	0.7539	<0.0001	–	0.06
Percent lipid	<0.0001	0.0575	0.6985	0.1059	–

Table 2. Median PCB levels at the Feeder Dam.

	2004	2005	2006	2007	2008	2009
Wet weight (ppm)						
Forage fish	0.06	0.05	0.06	0.03	0.01	0.09
Pumpkinseeds	0.05	0.07	0.06	0.05	0.01	0.05
Lipid adjusted (ppm)						
Forage fish	1.55	2.62	2.60	1.21	0.34	3.71
Pumpkinseeds	1.99	2.72	2.30	2.56	0.41	1.91

Table 3: Comparisons of PCB concentrations between BMP and RAMP fish at the Feeder Dam (K-W is the Kruskal-Wallis test statistic).

	BMP	RAMP	K-W	df	P
	Median				
Wet weight (ppm)					
Forage fish	0.04	0.09	6.7547	1	0.0094
Pumpkinseeds	0.05	0.05	0.0299	1	0.8628
Lipid adjusted (ppm)					
Forage fish	1.40	3.71	10.3321	1	0.0013
Pumpkinseeds	2.16	1.91	0.2643	1	0.6072

Table 4. Mean PCB levels by section and year.

	2004	2005	2006	2007	2008	2009
Wet weight (ppm)						
Forage fish						
Thompson Island	4.72	7.15	7.06	1.52	1.85	10.57
Northumberland – FM	5.75	4.81	6.20	1.81	1.63	6.27
Stillwater	3.68	3.36	3.05	0.98	1.78	3.33
Albany	2.11	0.56	1.21	0.52	0.56	0.90
Pumpkinseeds						
Thompson Island	9.47	5.53	8.61	3.44	2.17	14.80
Northumberland – FM	7.52	5.64	6.82	1.34	3.57	7.83
Stillwater	3.52	3.02	2.71	1.40	1.77	2.90
Albany	1.05	1.12	0.79	0.59	0.55	0.79
Lipid adjusted (ppm)						
Forage fish						
Thompson Island	121.79	242.06	183.84	69.89	50.41	267.08
Northumberland – FM	107.07	106.24	142.37	46.19	53.17	129.84
Stillwater	81.54	75.92	72.56	39.80	69.36	74.97
Albany	33.15	34.21	37.57	26.47	19.58	32.25
Pumpkinseeds						
Thompson Island	305.37	205.87	308.49	130.70	84.64	520.93
Northumberland – FM	208.34	149.30	225.37	64.33	130.20	216.99
Stillwater	119.69	92.83	94.57	55.36	66.49	104.56
Albany	38.25	39.00	37.33	15.78	22.63	26.44

Table 5: Comparisons of PCB concentrations between BMP and RAMP fish at the Thompson Island, Northumberland – Fort Miller, Stillwater and Albany sections.

	BMP		RAMP		F	df	P
	Mean	SE	Mean	SE			
Wet weight (ppm)							
Forage fish							
Thompson Island	4.46	0.53	10.57	2.37	14.98	1, 58	0.0003
Northumberland – FM	4.04	0.43	6.27	0.82	41.54	1, 58	0.0348
Stillwater	2.57	0.24	3.33	0.65	1.61	1, 58	0.2095
Albany	0.96	0.11	0.90	0.17	0.06	1, 51	0.8007
Pumpkinseeds							
Thompson Island	5.94	0.65	14.80	2.41	23.68	1, 182	<0.0001
Northumberland – FM	4.93	0.38	7.83	0.94	9.54	1, 140	0.0024
Stillwater	2.48	0.17	2.90	0.56	0.83	1, 177	0.3639
Albany	0.80	0.03	0.79	0.05	0.02	1, 111	0.8983
Lipid adjusted (ppm)							
Forage fish							
Thompson Island	133.60	17.13	267.08	45.46	9.51	1, 58	0.0031
Northumberland – FM	91.01	7.70	129.84	17.62	4.21	1, 58	0.0448
Stillwater	67.84	4.69	74.97	11.93	0.37	1, 58	0.5457
Albany	29.00	1.52	32.25	2.26	0.95	1, 51	0.3351
Pumpkinseeds							
Thompson Island	209.57	19.69	520.93	82.33	29.48	1, 182	<0.0001
Northumberland – FM	155.93	11.50	216.99	21.96	5.16	1, 140	0.0247
Stillwater	85.56	5.03	104.56	19.98	1.76	1, 177	0.1861
Albany	30.02	1.49	26.44	1.44	1.18	1, 111	0.2789

## Figure Legends

Figure 1: Locator map of fish collection sections and sampling areas. Areas labeled AT1a and AT1b are considered part of AT1 but were added in later years due to insufficient fish at the main AT1 area.

Figure 2: Pairwise scatterplots for forage fish (a) and pumpkinseeds (b). The variables involved in each plot are given by the intersection of the variable names found on the main diagonal.

Figure 3. Linear and exponential regressions of lipid adjusted PCB concentration on year over the five years of the BMP program for each section for forage fish (a) and pumpkinseeds (b). Open circles are individual sample results, large filled circles are annual means, red line is linear fit, blue line is exponential fit, and dotted lines are 95% confidence intervals for the linear fit.

Figure 4. Lipid adjusted PCB levels of BMP fish from 2004 through 2008 by section. Individual observations are offset horizontally to minimize overlap. Violin plots (the symmetric wavy lines) show the approximate density of sample results at the concentration given by the Y axis value. The large dot is the median.

Figure 5. Lipid adjusted PCB levels for each year by section and species; individual observations (small circles) are offset horizontally to minimize overlap.

Figure 6. BMP and RAMP lipid adjusted (a) and wet weight (b) fish PCB concentrations for each section. Individual observations are offset horizontally to minimize overlap. Violin plots (the symmetric wavy lines) show the approximate density of sample results at the concentration given by the Y axis value. The large dot is the median.

Figure 7. Interaction plots showing mean lipid adjusted PCB levels by section and monitoring program for forage fish (left) and pumpkinseeds (right).

Figure 8. Lipid adjusted PCB levels of BMP and RAMP fish by sampling area. Individual observations (small dots) are offset horizontally to minimize overlap. Violin plots (the symmetric wavy lines) show the approximate density of sample results at the concentration given by the Y axis value..

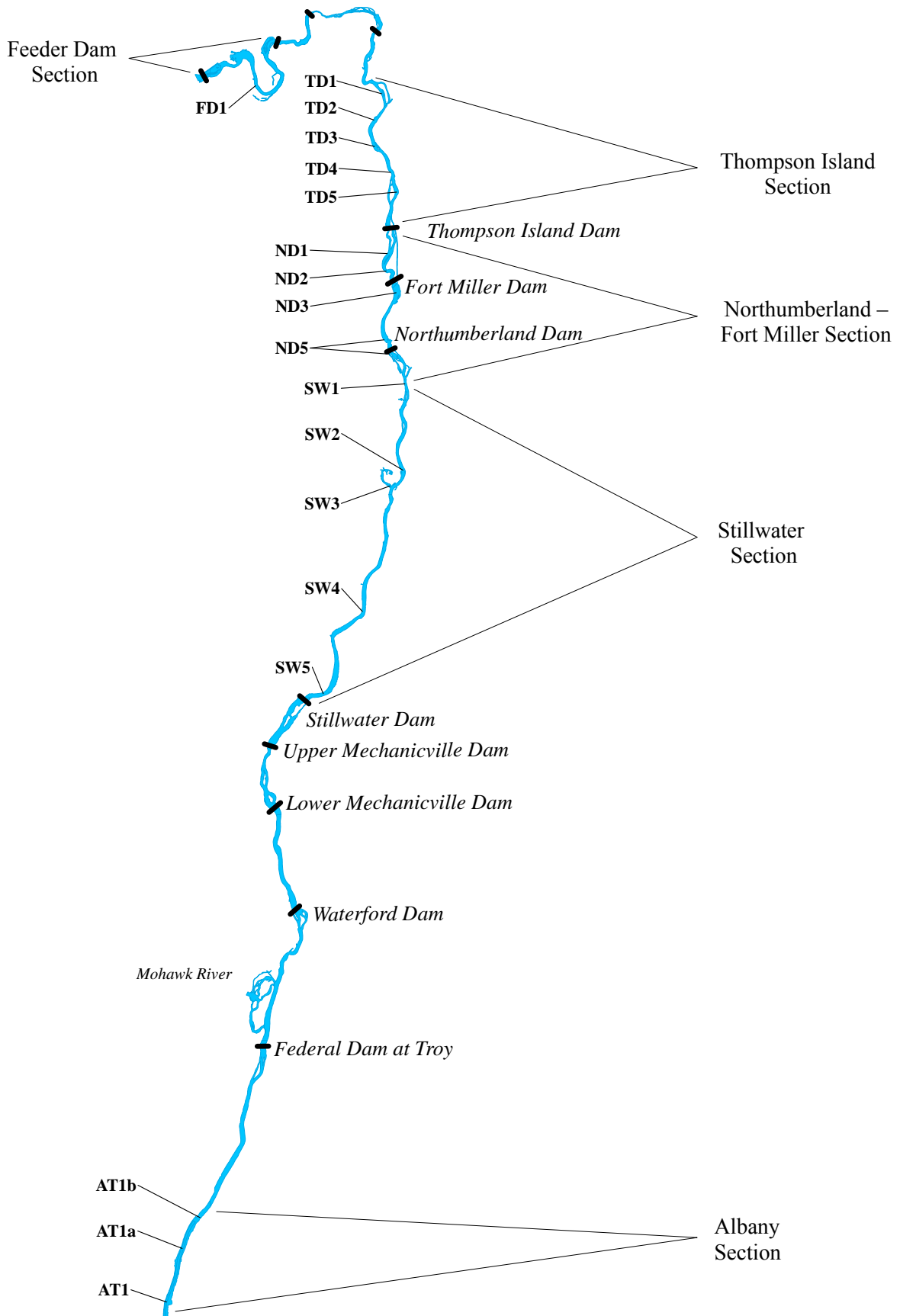


Figure 1: Locator Map.

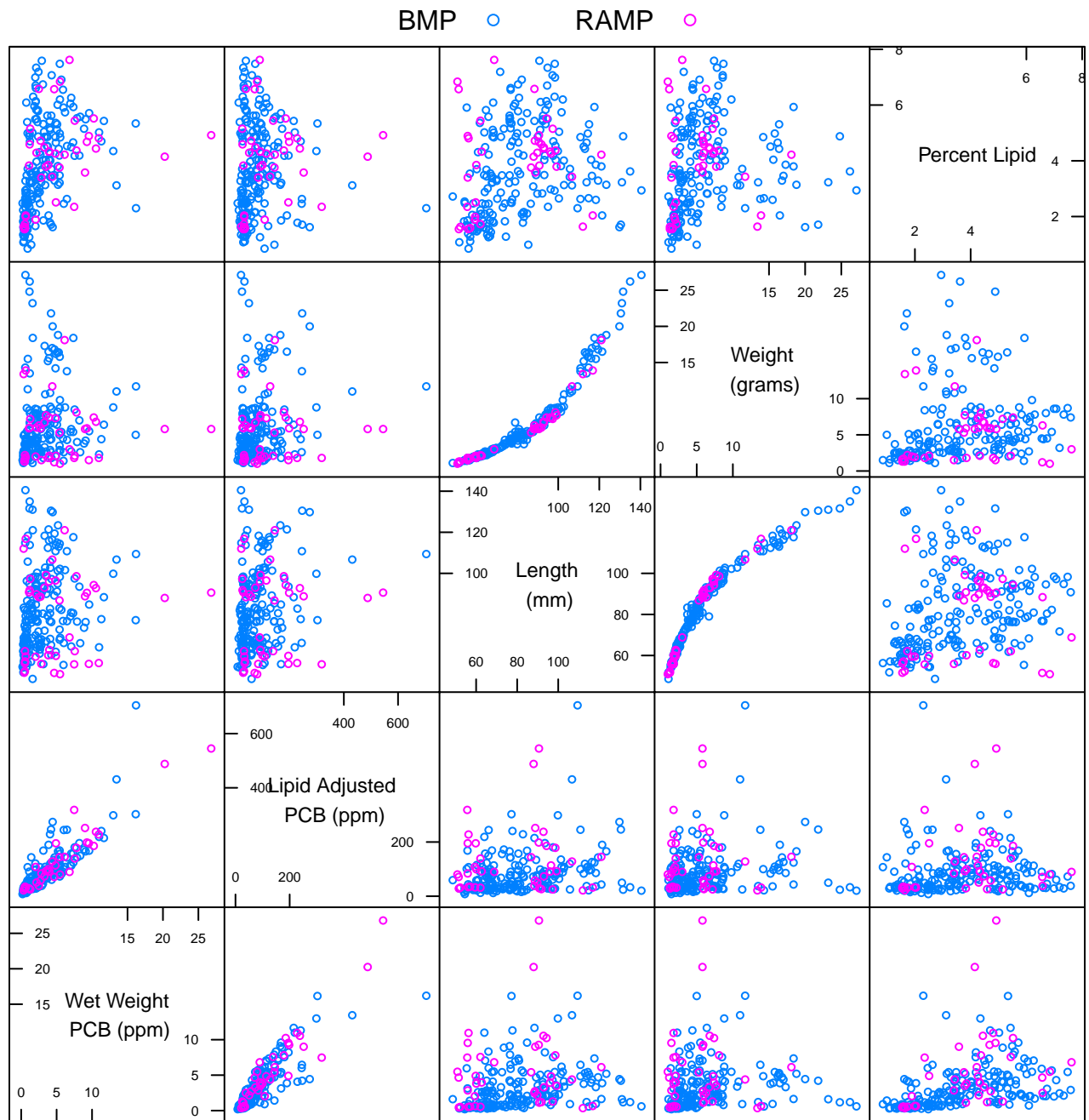


Figure 2a: Pairwise scatterplots for forage fish.

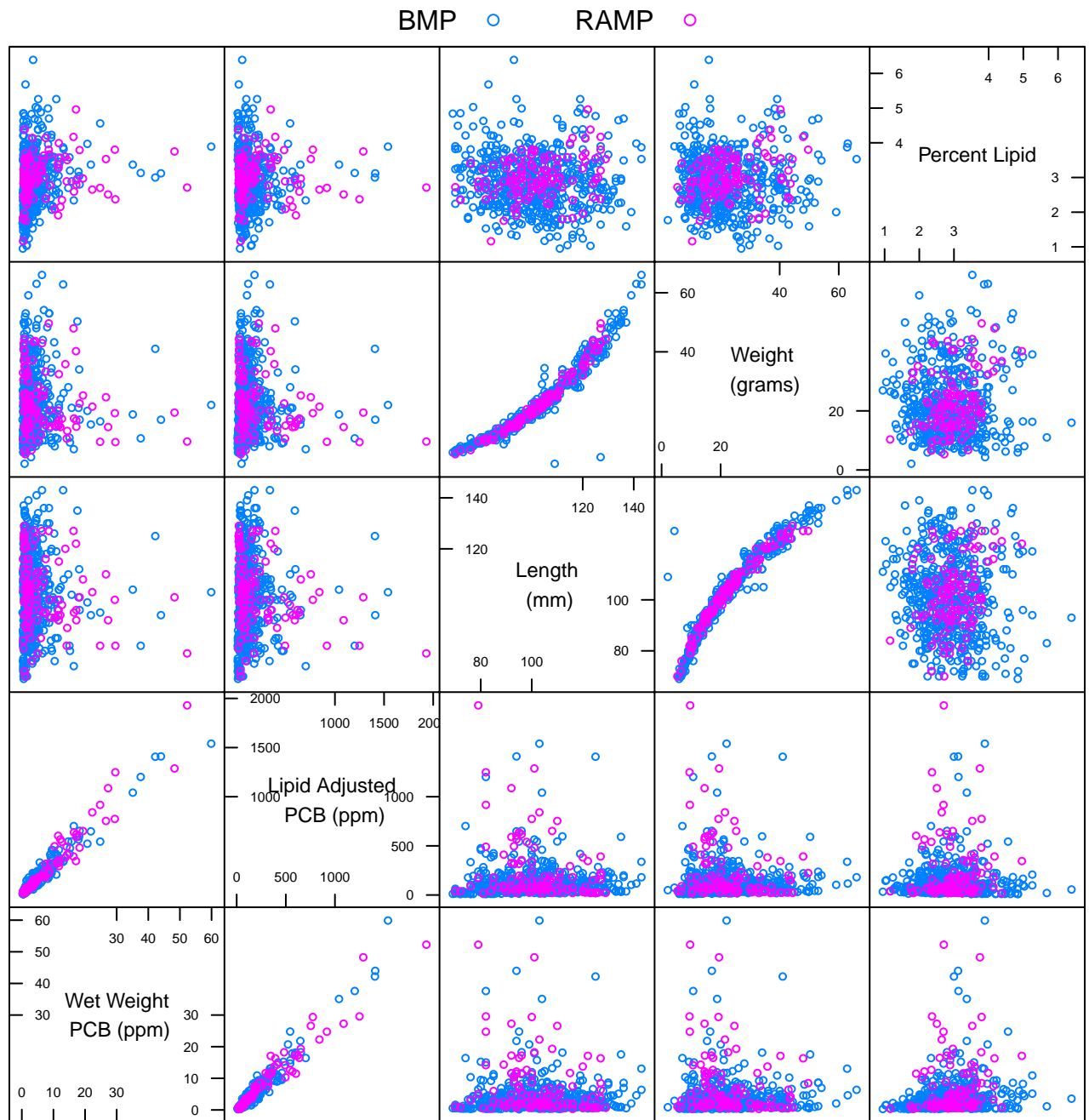
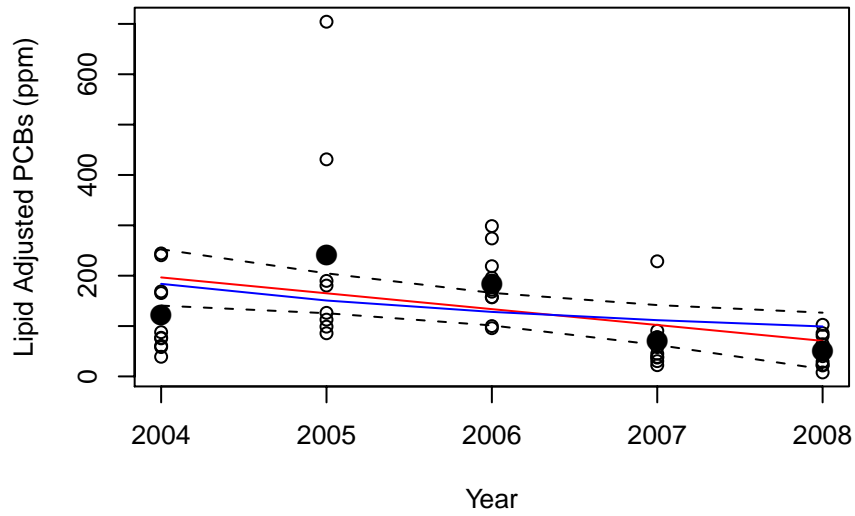
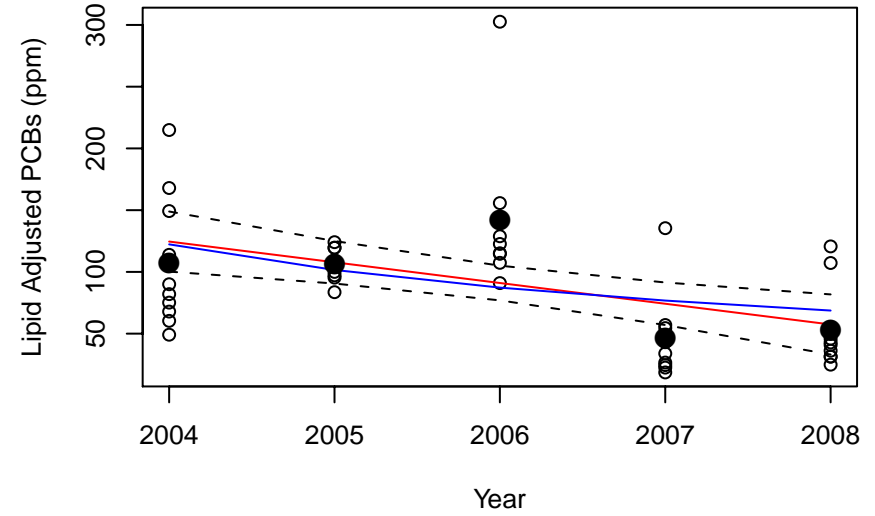


Figure 2b: Pairwise scatterplots for pumpkinseeds.

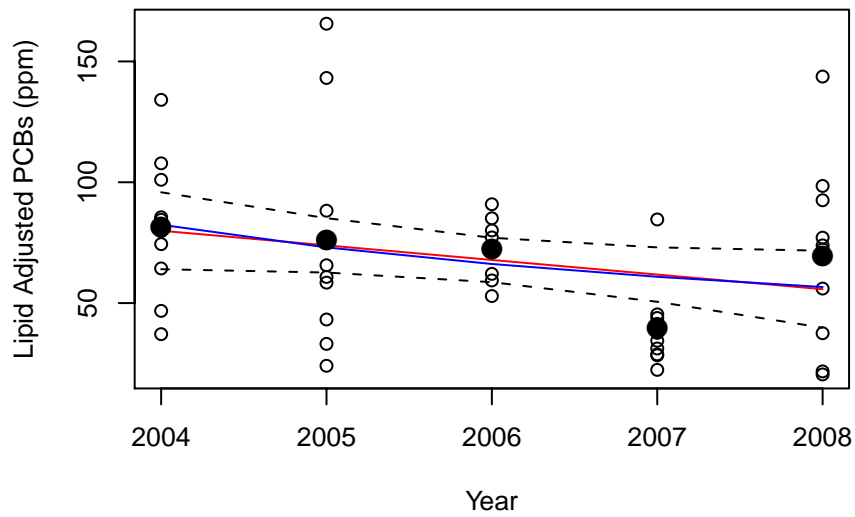
**THOMPSON ISLAND**



**NORTHUMBERLAND – FT MILLER**



**STILLWATER**



**BELOW TROY DAM**

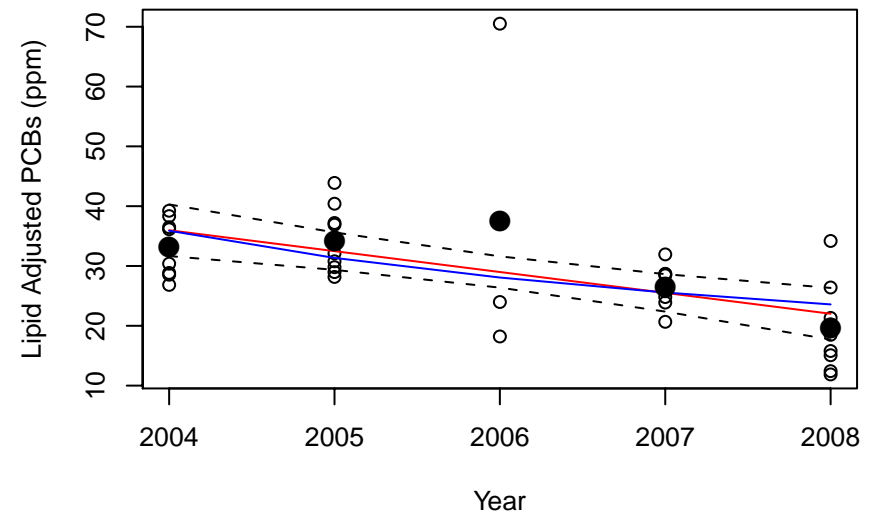
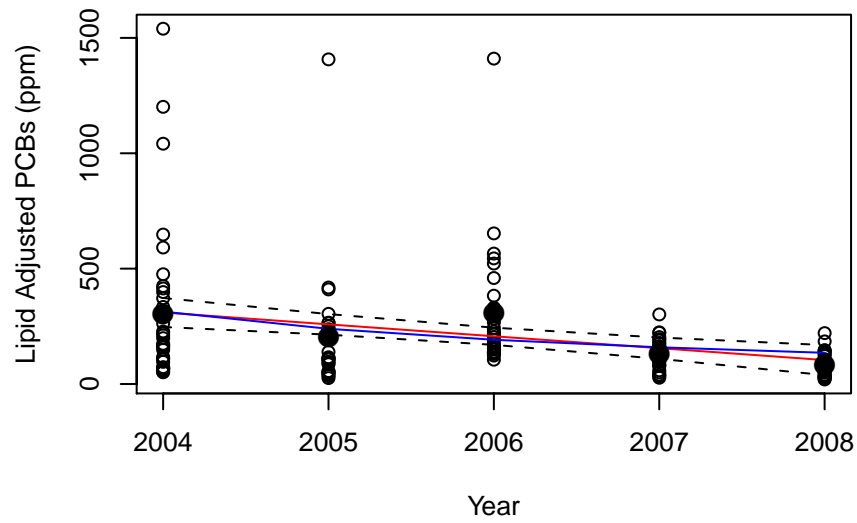
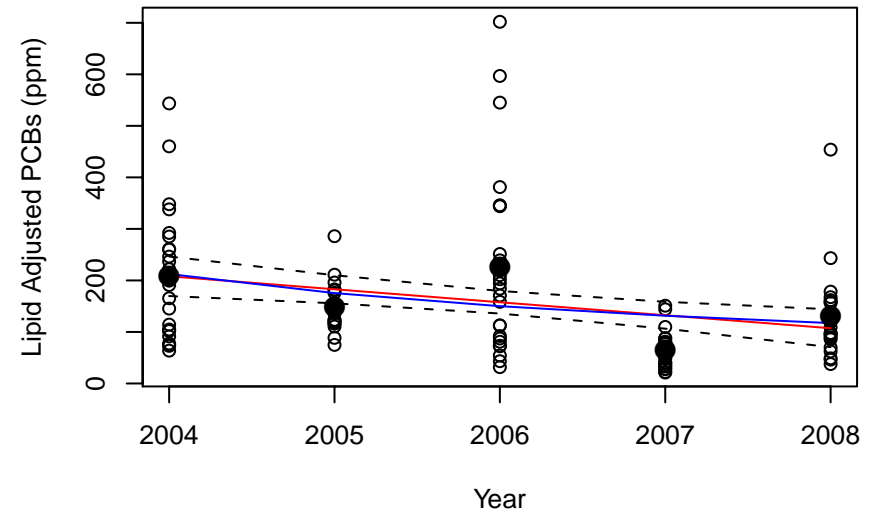


Figure 3a: Forage fish regressions.

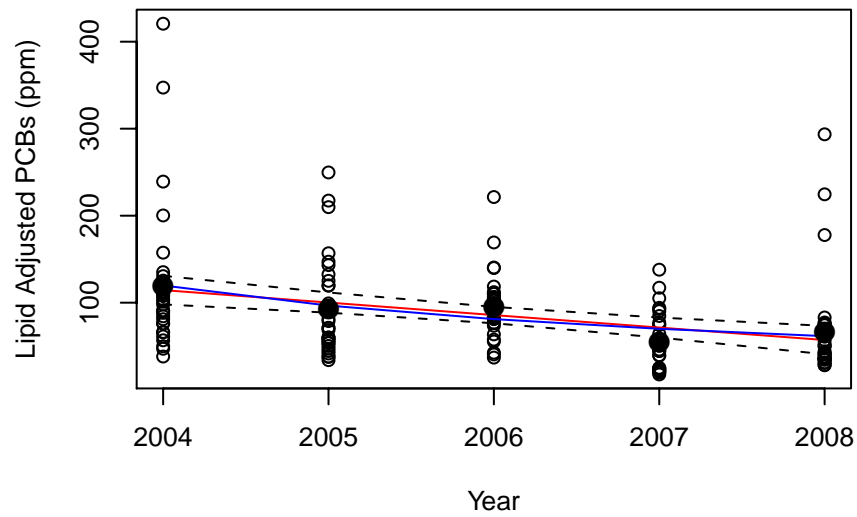
**THOMPSON ISLAND**



**NORTHUMBERLAND – FT MILLER**



**STILLWATER**



**BELOW TROY DAM**

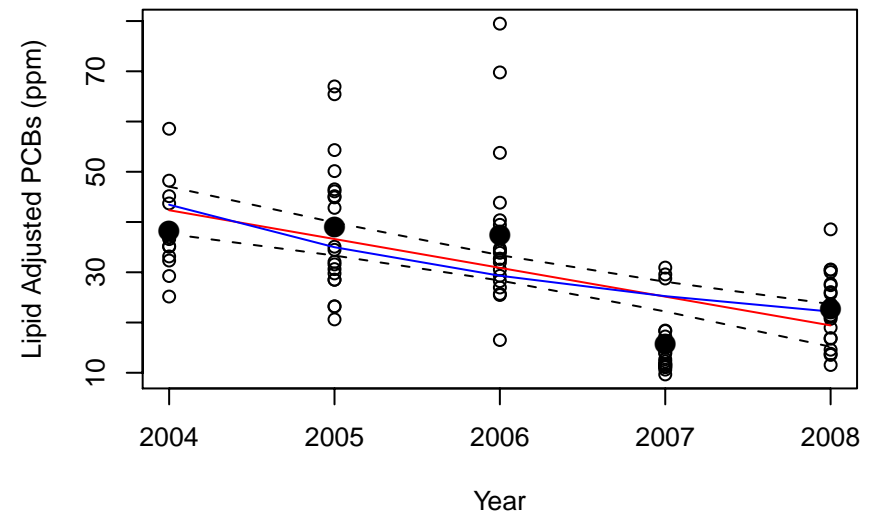


Figure 3b: Pumpkinseed regressions.

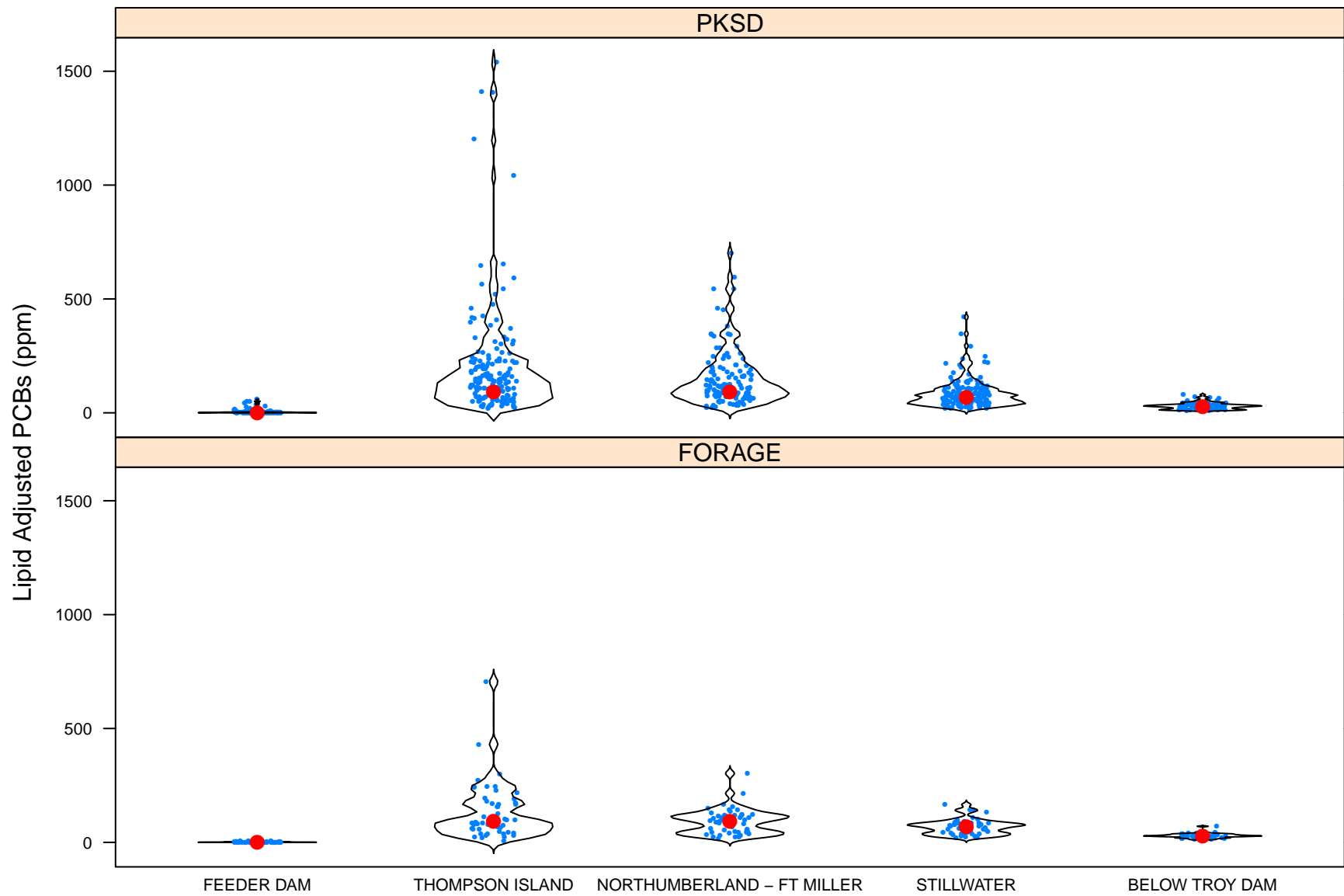


Figure 4: BMP fish PCBs by river section.

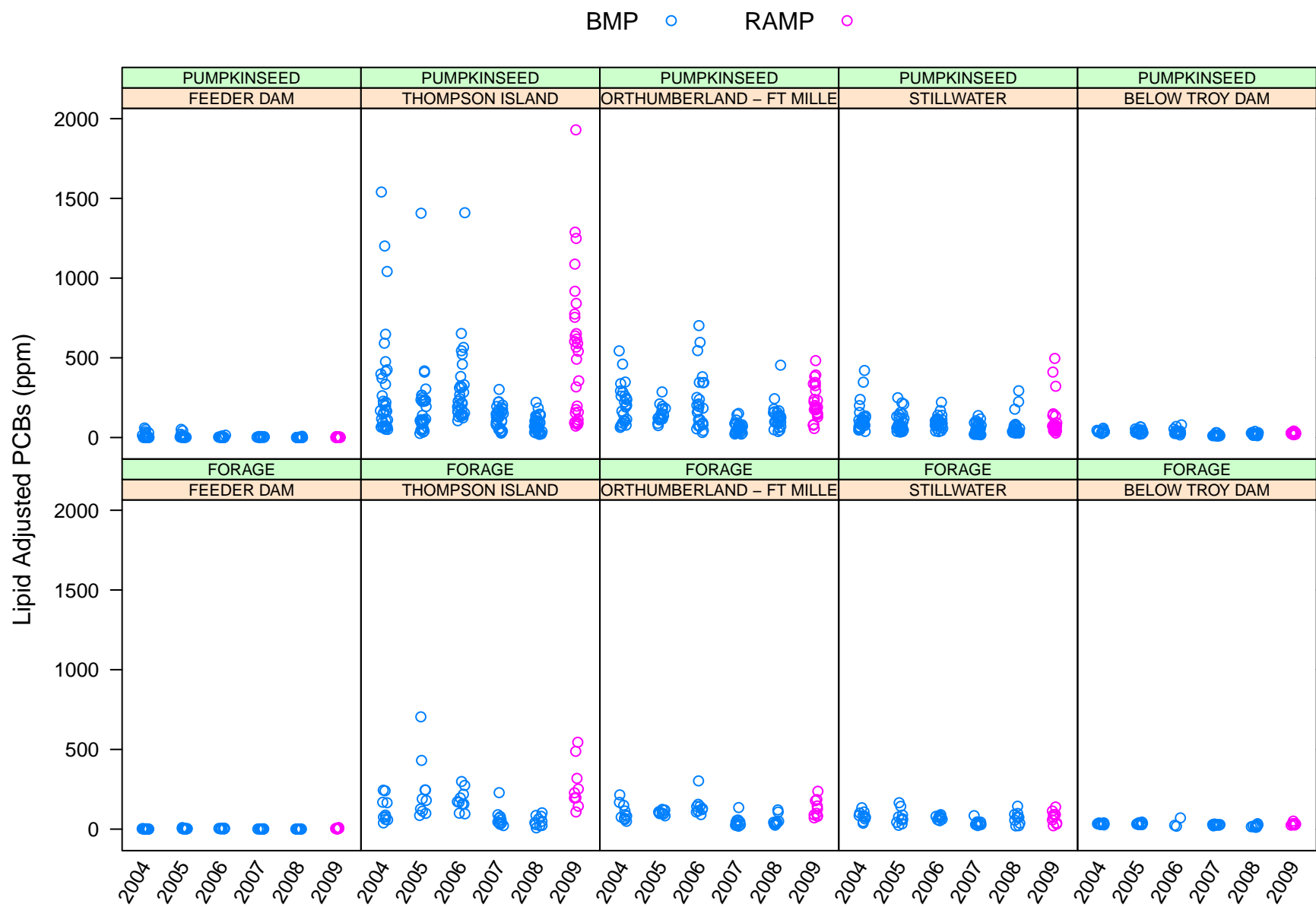


Figure 5: PCBs by river section and year.

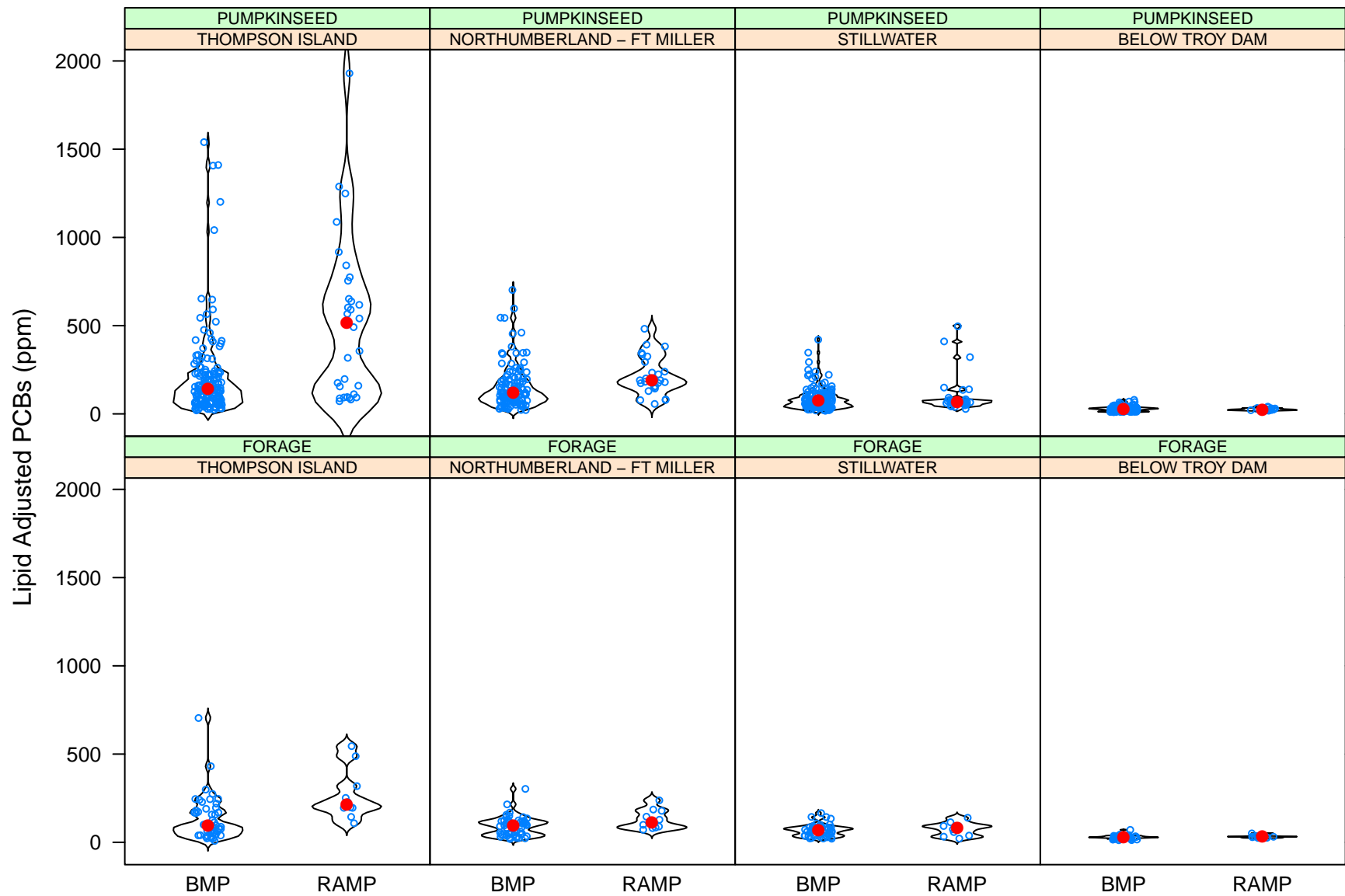


Figure 6a: BMP versus RAMP lipid adjusted fish PCBs by river section.

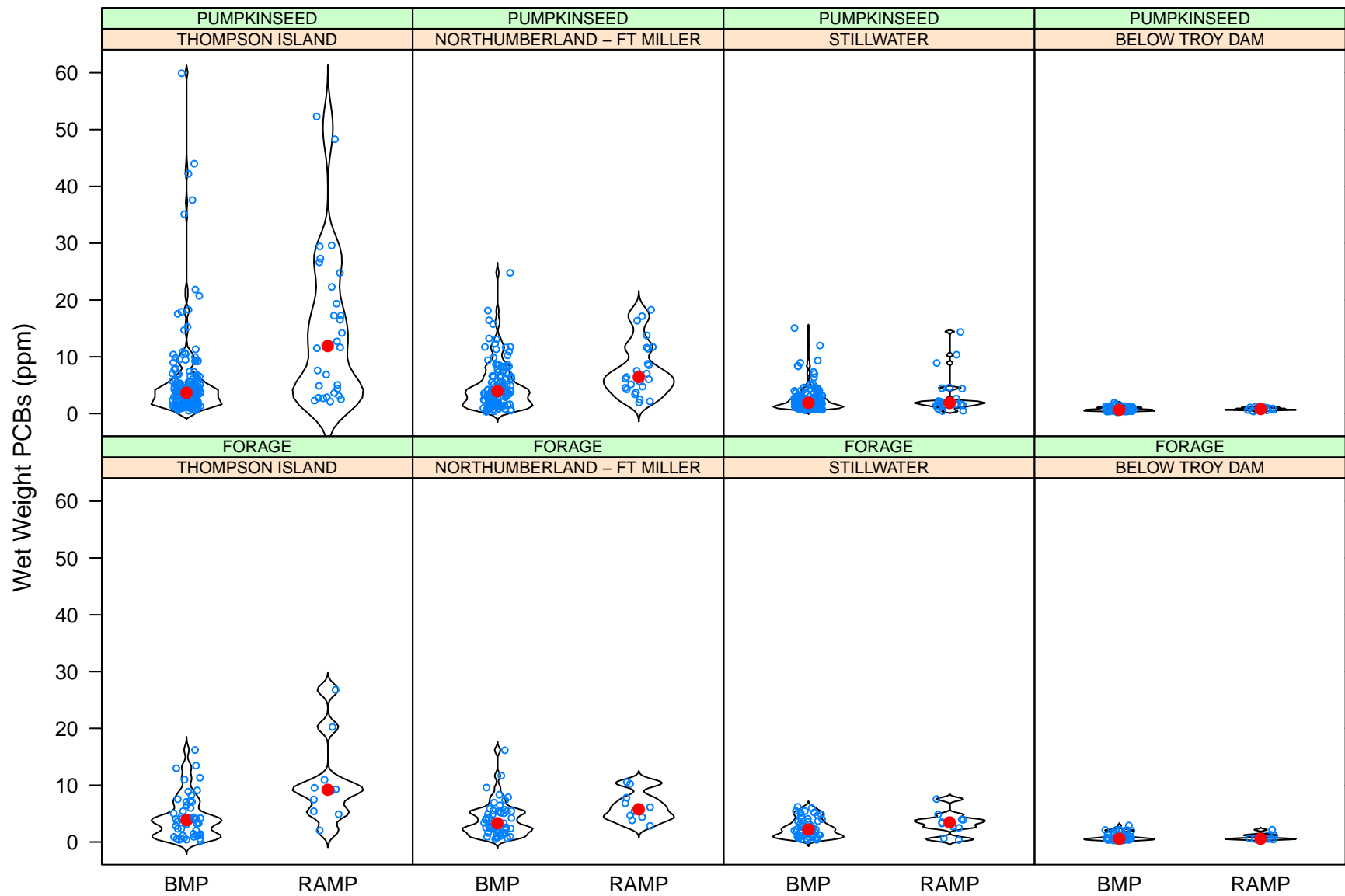


Figure 6b: BMP versus RAM wet weight fish PCBs by river section.

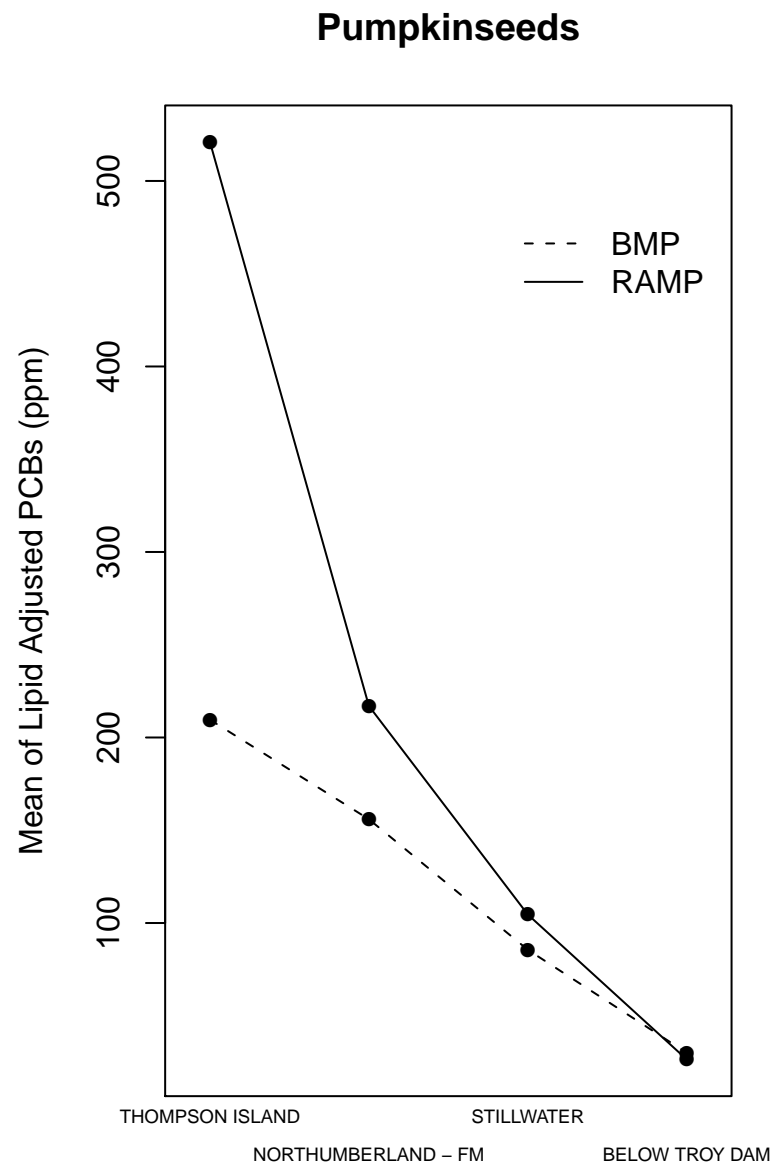
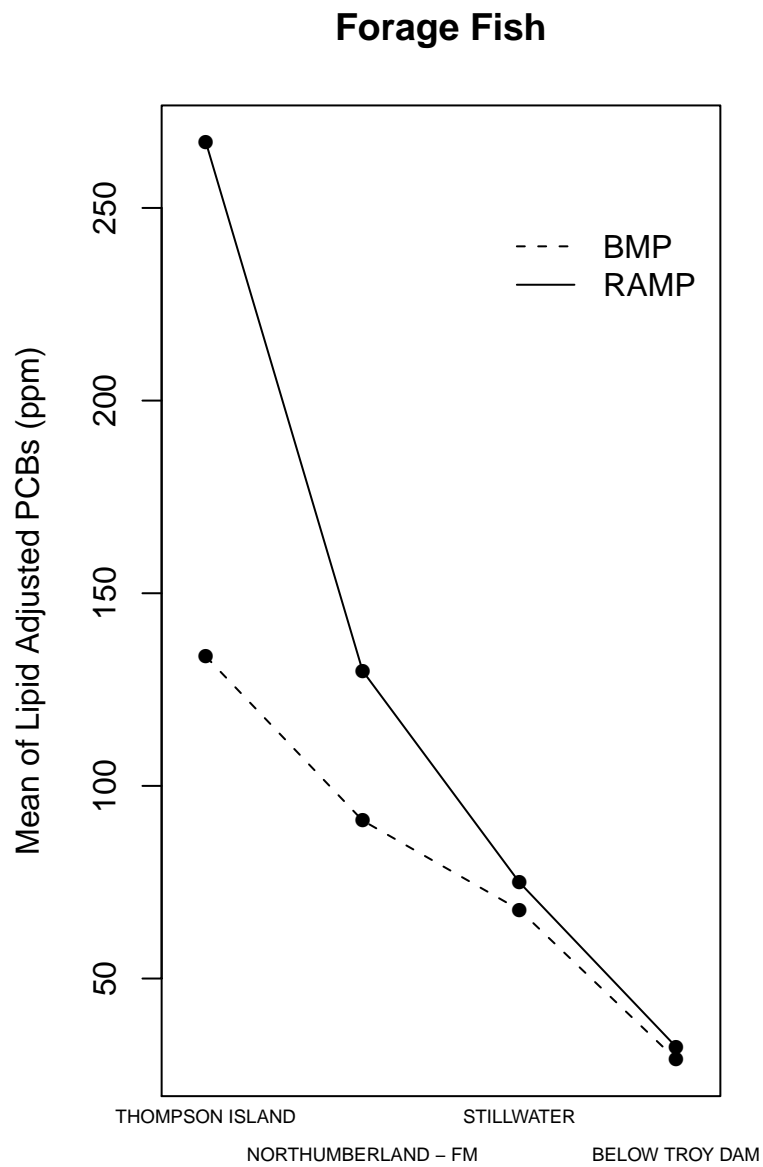


Figure 7: Interaction plots.

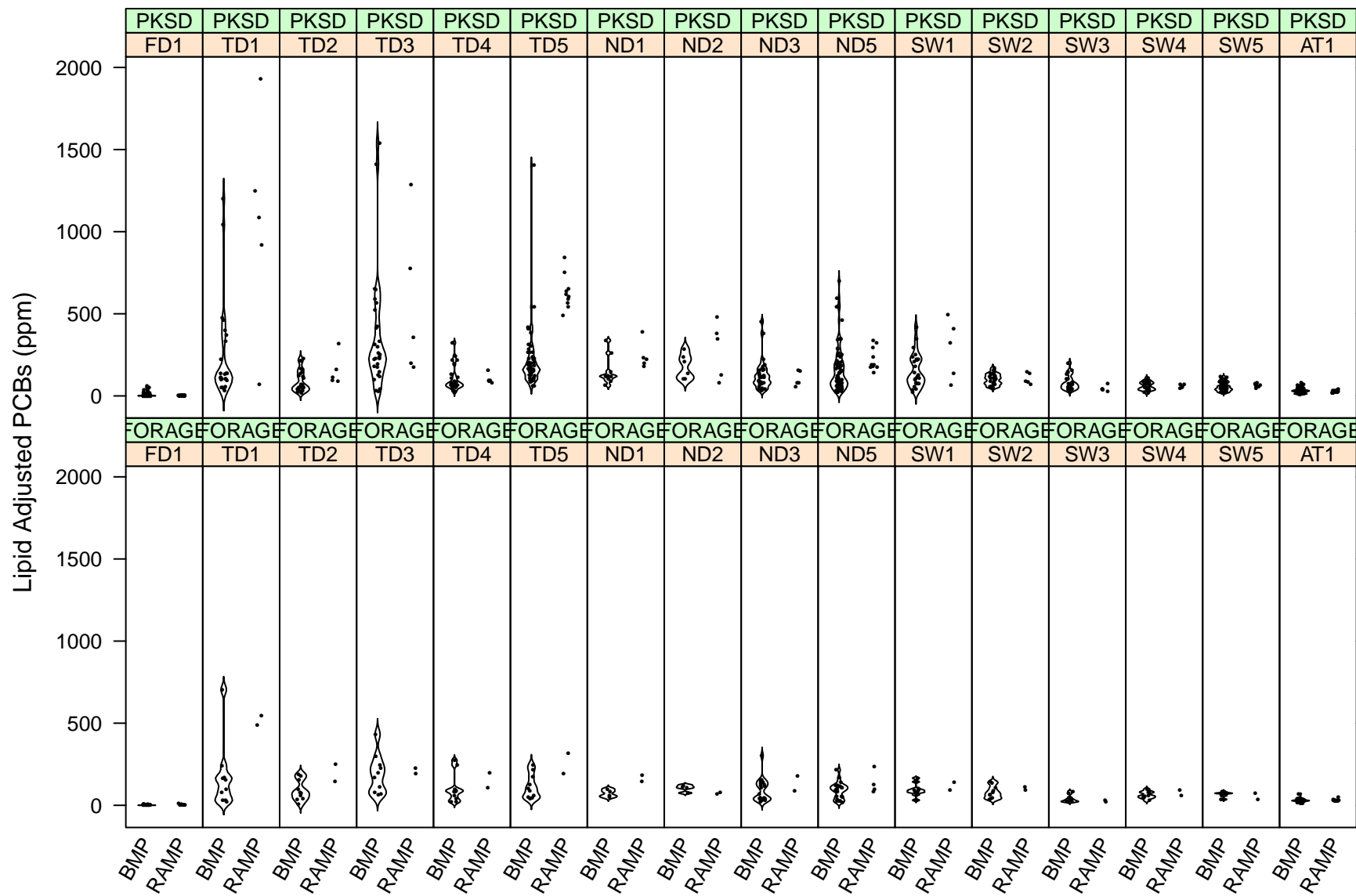


Figure 8: PCBs by sampling area.

Comment to the Peer Review Panel for Phase 1 of the Hudson River PCB Superfund Site  
New York State Department of Environmental Conservation  
Division of Fish, Wildlife and Marine Resources  
Wayne Richter, Research Scientist 3  
26 April 2010

Subject: General Electric's Phase 1 Evaluation Report Analysis of PCB Levels in Fish

Article 11 of the New York State Environmental Conservation Law gives the New York State Department of Environmental Conservation responsibility for "the efficient management of the fish and wildlife resources of the state" including "the maintenance and improvement of such resources as natural resources and the development and administration of measures for making them accessible to the people of the state" (NYS ECL §11-0303.1). Accordingly, restoration of the fisheries resources in the Hudson River has been one of the Department's primary goals during its many years of involvement in the Hudson River PCBs Superfund Site. The following comments on General Electric's analysis of PCB contaminant levels of fish are provided to support this aspect of the Department's mission.

General Electric's discussion of PCB levels in fish contains statistical analyses, conclusions, and implications for Phase 2. NYSDEC takes issue with all three aspects of GE's discussion, finding that statistics are often inappropriate, conclusions are selective and overly negative, and implications are not supported by the data. NYSDEC has conducted its own analysis of the fall fish PCB data, which it is providing to the Peer Review Panel as a separate submission. The following comments pertain directly to GE's analysis.

The most important statistical error was to compare the fall Remedial Action Monitoring Program (RAMP) fish from 2009 with only the fish from the preceding two years, while ignoring the Baseline Monitoring Program (BMP) data from 2004 through 2006. In its report, GE made frequent reference to a five-fold increase in PCB levels in some fish. This difference, like nearly all comparisons, was based on 2007 and 2008 fish versus the 2009 fish. GE justified its selective use of data with the claim that "the downward trends make earlier data not representative of conditions in the river just prior to dredging" (page 69).

GE, in fact, failed to properly demonstrate or quantify downward trends in the data. It merely asserted a downward trend on the basis of the difference between the first and last components of a five member sequence. Such a claim fails to conform with even elementary statistical practice. The proper way to determine the existence and strength of a trend is with regression analysis. Even basic treatments of regression contain cautions about extrapolating a regression beyond the range of the data used to construct the data.

The figures in EPA's Phase 1 Evaluation Report (Appendix I-C Figures 1 - 17) show proper application of regression analysis to extrapolation by including confidence and prediction limits; these are the 95% confidence limits for the regression line and predicted values, respectively. The figures typically show that both types of intervals are quite wide even when the regression trend is extrapolated by only one year to 2009. When the temporal pattern of all BMP data, including the considerable interannual variability, is properly accounted for, the range of plausible values for 2009 is considerably greater than indicated by the mean of the results from only 2007 and 2008.

An important aspect of trend development and extrapolation is analysis of the regression residuals, the difference between actual and predicted values. NYSDEC's analysis of residuals indicated that neither linear nor exponential decay models could adequately describe temporal trends because interannual

variability was so much more important than any temporal trend. Within the BMP period, one or more of the five annual means in every data series fell outside the 95% confidence limits of a linear regression. With this much variability among years, it would be unsurprising if the 2009 PCB levels were outside the confidence limits of a regression even had no dredging taken place, further demonstrating the inappropriateness of comparing the 2009 PCB fish levels to only a subset of the BMP data.

Another way to look at GE's claim that only the last two years of the BMP data should be used for comparison is in the context of model overfitting. Model overfitting occurs when too many parameters are fit to a model, enabling a close fit to the data because the model is fitting the noise in the system rather than the causal relationship. By saying that only the last two years of BMP data need be used, GE is effectively claiming that the trend of the data passes through the mean of these two years, something that can only be accomplished through overfitting. Overfitting is bad statistical practice that should be avoided because it leads to inappropriate conclusions.

GE's claim of a decline between 2004 and 2008 also needs to be evaluated in the context of the available longer term data series. These show (Figure 1) only weak indications of a long term trend since about 1999 but considerable fluctuation from year to year with some tendency to a cyclical pattern.

All of these considerations led NYSDEC to conclude that GE's use of only the last two years of BMP data in their comparison to post-dredging PCB levels in fall fish is more confusing than illuminating. NYSDEC's analysis using all five years of BMP data found a modest rise of about 2.5 times in the Thompson Island section and 1.5 times in the Northumberland – Fort Miller section. We found no significant difference at either Stillwater or Albany.

GE's report also has several overly broad and misleading generalizations. For example, the statement (page 68), "Pumpkinseed and forage fish PCB levels had dropped by about a factor of two over the five years prior to dredging (2004 to 2008) at all the monitored reaches (Figures 3.3-22 and 3.3-23)" implies a steady decrease but ignores interannual variability. As examples of the variability and lack of strong trend, mean lipid adjusted PCB levels in forage fish in the Thompson Island pool doubled from 2004 to 2005 (121.79 to 242.06 ppm) and nearly doubled (39.80 to 69.36 ppm) between 2007 and 2008 in the Stillwater pool. Mean lipid adjusted levels in pumpkinseeds doubled (64.33 to 130.20 ppm) in the Northumberland – Fort Miller pool between 2007 and 2008. Year to year increases exceeding 50% were common.

GE compared the maximum RAMP fish levels to mean BMP levels (page 68): "The maximum Total PCB concentration in pumpkinseed (52.30 mg/kg wet weight) and forage fish (26.81 mg/kg wet) was recorded from TD1 (near Rogers Island), which is almost 10 and 4 times higher, respectively, than the baseline mean in this area." The comparison of the maximum from one distribution to the mean from another distribution is highly unusual. It is also pointless unless the goal is to create an exaggerated perception of the difference between the two distributions. A more consistent, though still not particularly useful, comparison would be to compare maxima of the two distributions. The maximum for BMP pumpkinseeds was 59.90 ppm, higher than the RAMP maximum. The maximum for BMP forage fish was 16.20 ppm, lower than the RAMP maximum. Of the top twelve values (twice the number of years), six came from BMP fish among the pumpkinseeds and seven came from BMP fish from among the forage fish. The incidence of the most contaminated fish is indeed somewhat higher among the RAMP fish but is consistent with the modest elevation in PCB levels in fish near the dredging demonstrated by other analyses by NYSDEC and EPA.

GE over-dramatized the claimed increase in PCB levels at Albany and confused statistical significance with biological importance using statements such as "Statistically significant increases of 40% to 60% were found as far downstream as the Albany/Troy area ..." (page ES-4) and "Although increases were

lower further downstream, elevated PCB concentrations in these fish species were found as far downstream as Albany at statistically significant levels” (page ES-20). What GE failed to mention was that the difference in means at Albany from 2007 and 2008 to 2009 was a trivial 0.36 ppm in forage fish and 0.22 ppm in pumpkinseeds.

GE also committed the error of attributing cause to a correlation in its conclusion that dredging caused the rise in PCB levels in the 2009 fall fish. The 2009 results are within the range of values from the preceding five years at Stillwater and Albany, and perhaps at Northumberland (e.g., GE figures 3.3-23a and 3.3-23b and Figure 1 of these comments). The Stillwater and Albany data series show no indication that anything different happened in 2009, in contrast to the time series from the Thompson Island section where 2009 PCB levels were clearly outside the norms of the previous few years.

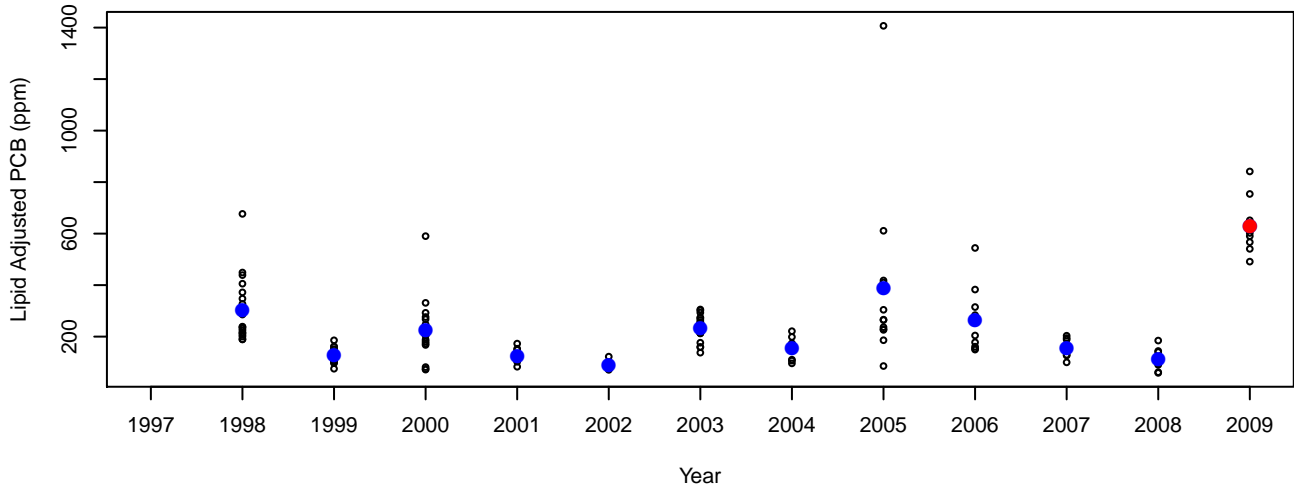
Also instructive is a comparison with the results from the Feeder Dam pool, the reference site on the Hudson River upstream of General Electric’s Hudson Falls and Fort Edward plants. The dominant temporal pattern in all four sections at or downstream from dredging was three years of relatively high PCB levels, followed by two lower years, followed by an increase in 2009 (GE figures 3.3-23a and 3.3-23b). This pattern was closely followed by the median (medians are used because many fish were reported as below the detection limit) PCB levels in forage fish at the Feeder Dam, although at considerably lower levels (Figure 2). Although this pattern was not seen in Feeder Dam pumpkinseeds, its presence in even one of the two reference species groups suggests that some of the 2009 rise in PCB levels in fish downstream of the dredging may be due to phenomena other than dredging such as regional hydrological or weather patterns. It is further worth noting that the median lipid adjusted PCB in pumpkinseeds at the Feeder Dam increased over fourfold between 2008 and 2009 from 0.41 ppm to 1.91 ppm.

NYSDEC’s conclusions from analysis of the fall fish data differ considerably from GE’s firm claims of excessively harmful effects to fish. We found clear evidence of a moderate but highly local effect of dredging on PCB levels in fall fish. Conclusions to be drawn from fish sampled more than a few miles downstream of the dredging are less definitive. The 1.5 times increase observed in the immediately downstream Northumberland – Fort Miller section suggests a likely effect of dredging on PCB levels in fish, although EPA’s analysis, which differed somewhat in methods from NYSDEC’s, failed to find a statistically significant effect for forage fish. Further downstream, both NYSDEC and EPA found no significant increase in PCB levels. More important, whatever arguments might be made about statistical significance at the Stillwater and Albany sections from selective use of the available data, the biological effect was small: Even with GE’s comparison of 2009 to only 2007 and 2008, the mean increase in fish PCB levels was less than 2 ppm at Stillwater and less than 0.4 ppm at Albany. Furthermore, PCB levels at both locations in 2009 remained less than the levels found only three to four years previously. The similar pattern of changes in forage fish at the upstream Feeder Dam location, where the PCB median was significantly greater than the BMP median, further suggests caution. Overall, while a downstream impact of dredging on fish PCB levels is plausible, even a small effect is not conclusively demonstrated.

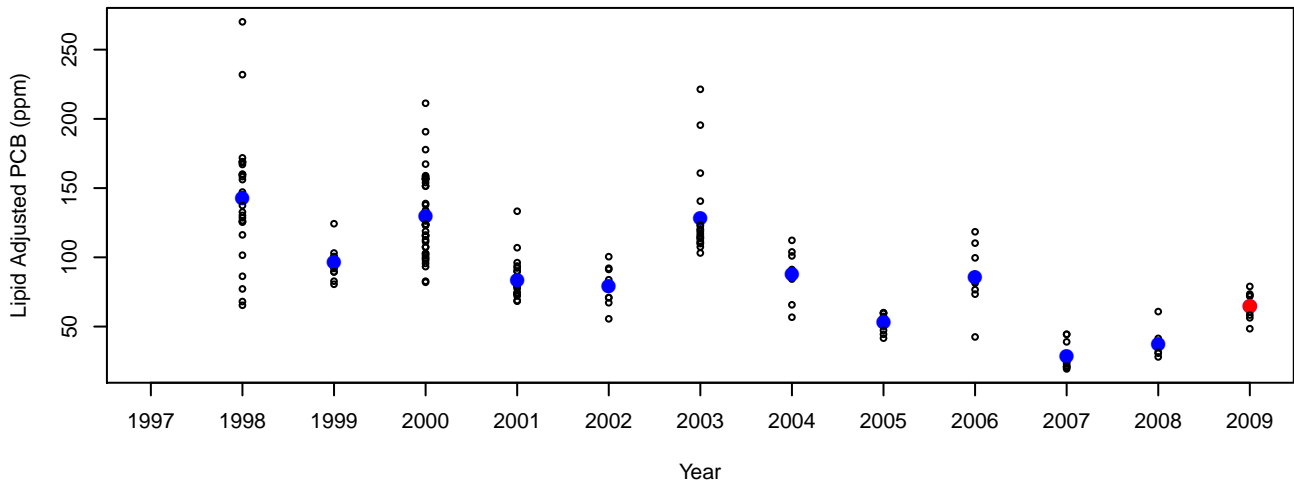
Of perhaps greatest concern is GE’s implication that continuation of the remedy as implemented in Phase 1 will irretrievably compromise the fish and that appreciable modifications to the scope of Phase 2 are needed to preserve the ROD’s (misquoted) objective to “Reduce PCB concentrations in fish.” For example, page ES-2 states, “We believe that common sense adjustments can be made so that Phase 2 will ensure that the project reduces PCB levels in fish and reduces PCB transport downstream.” GE further stated, “Without a hard cap [on downstream PCB load], it is likely that the remedy will increase and prolong PCB levels in fish in the upper Hudson River and possibly also in the upper parts of the lower Hudson River” (pages ES-10 and 178).

NYSDEC disagrees with these statements and GE's recommendation that a maximum downstream PCB load standard, which may limit the extent of PCB removal, is needed to protect fish. NYSDEC biologists concluded that the remedy as currently designed poses no long term danger to fish. This conclusion was reinforced by the localized nature of meaningful increases in PCB levels in the 2009 fall fish. To the contrary, scaling back the scope of the remedy as proposed by GE will be detrimental to the recovery of fish from PCB contamination by failing to remove highly contaminated sediments that will continue to release PCBs for uptake by fish.

### THOMPSON ISLAND



### STILLWATER



### ALBANY

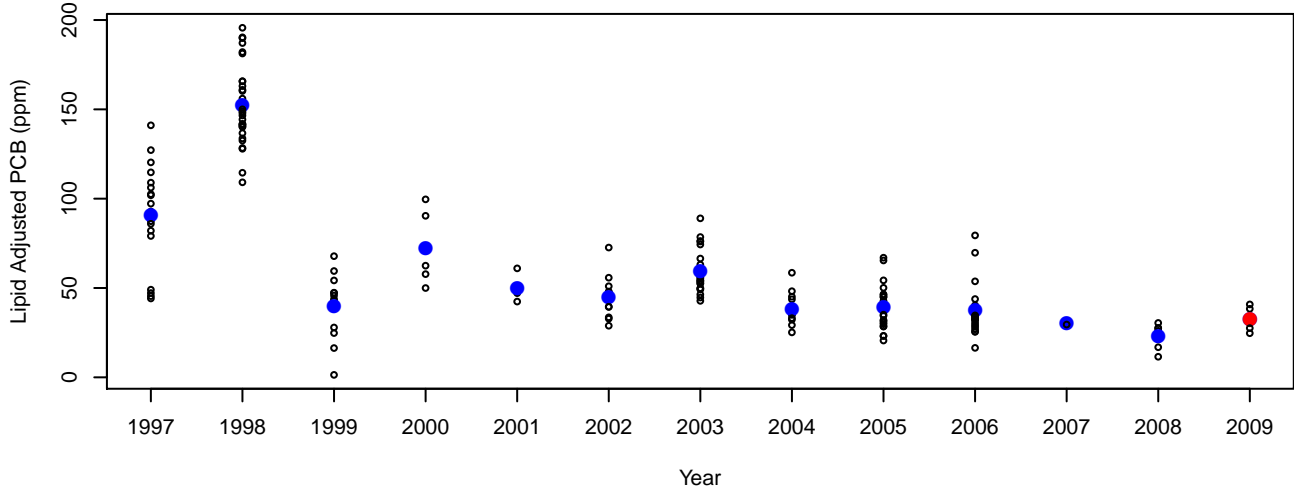
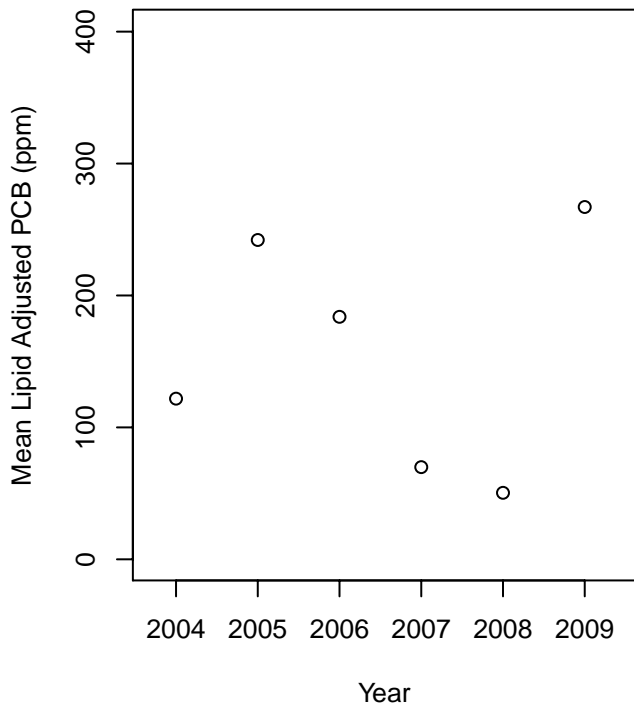
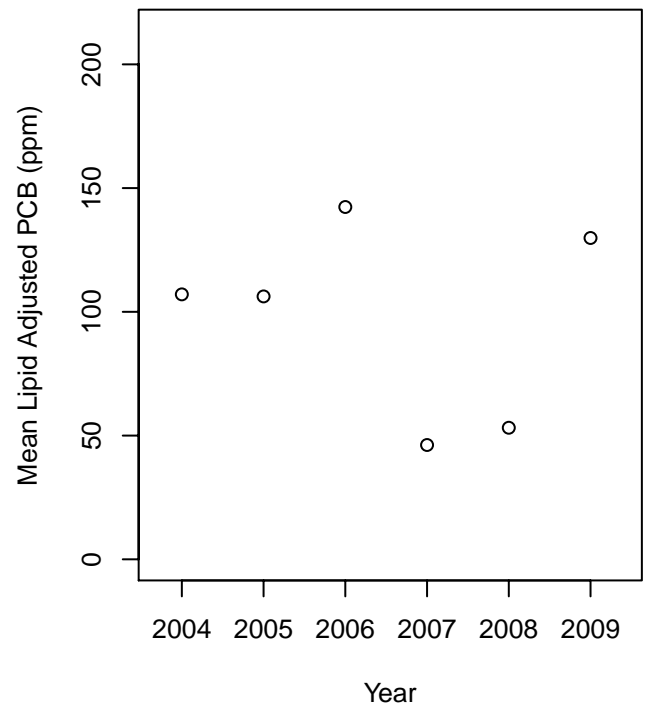


Figure 1: Pumpkinseed long term series, lipid adjusted PCB. Large dots are annual means, small circles are individual values.

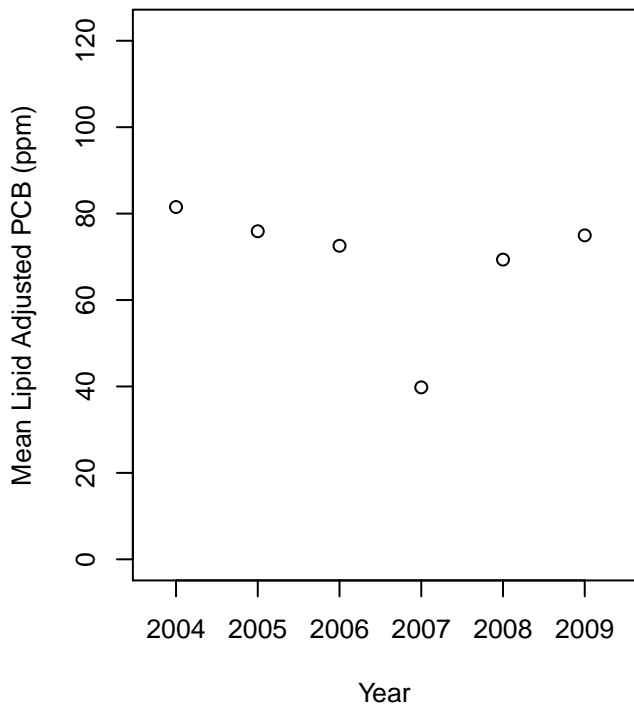
THOMPSON ISLAND FORAGE FISH



NORTHUMBERLAND - FT MILLER FORAGE FISH



STILLWATER FORAGE FISH



BELOW TROY DAM FORAGE FISH

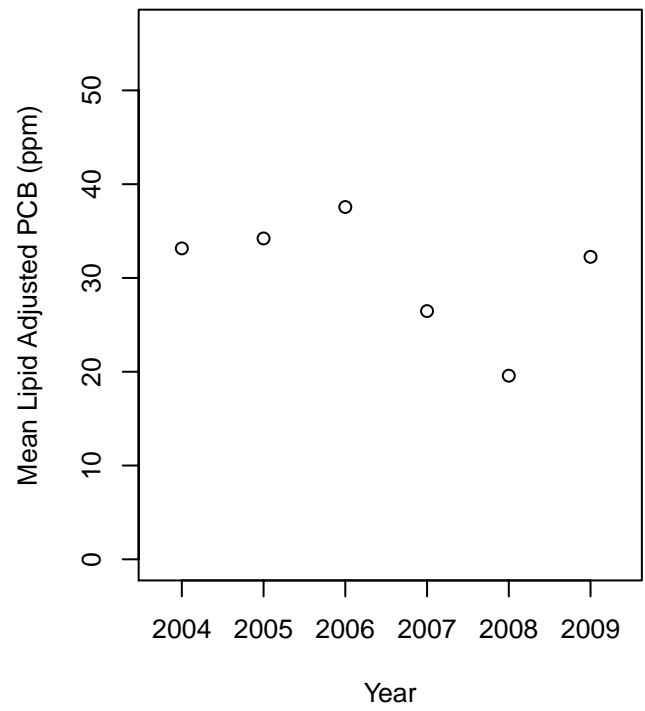


Figure 2a: Mean forage fish lipid adjusted PCB in each pool at or downstream of dredging.

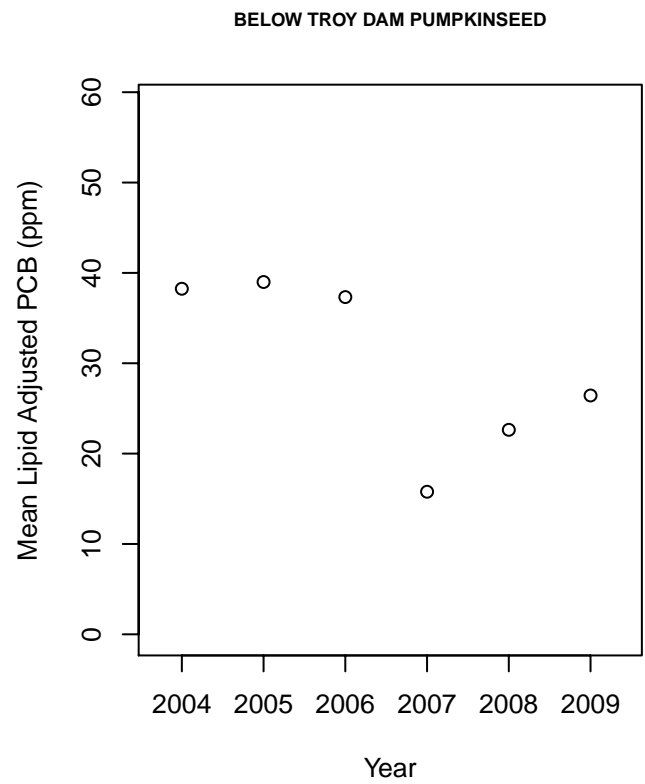
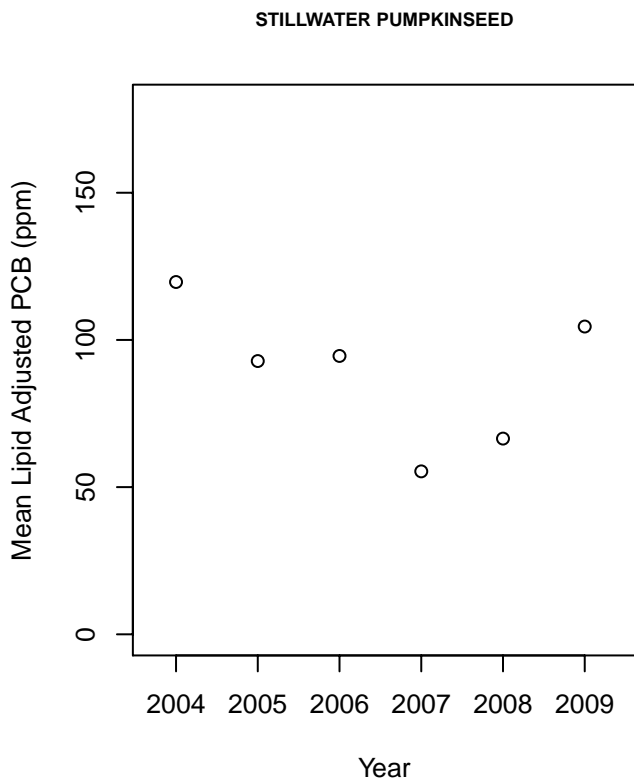
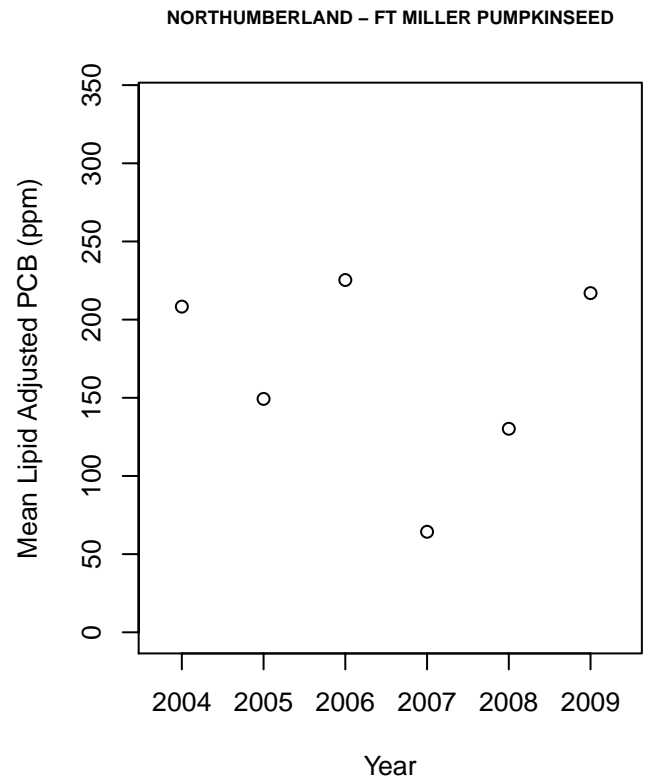
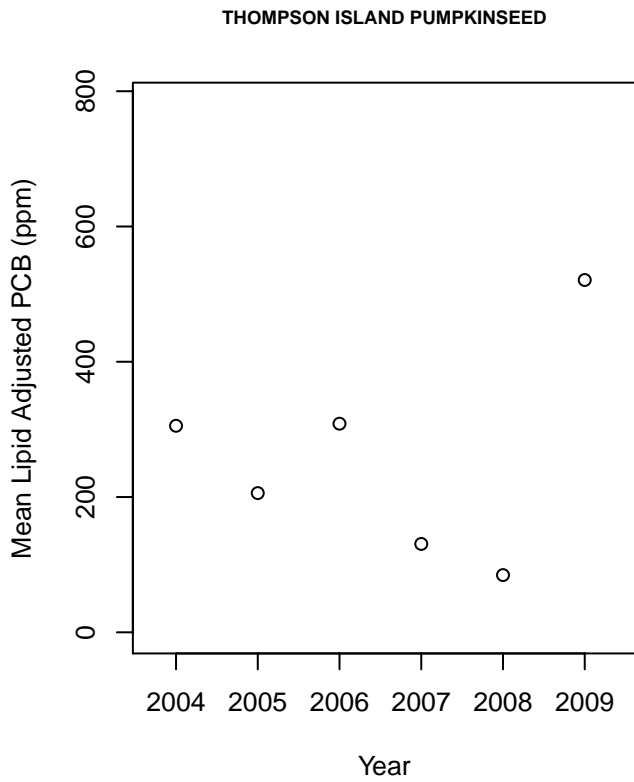


Figure 2b: Mean pumpkinseed lipid adjusted PCB in each pool at or downstream of dredging.

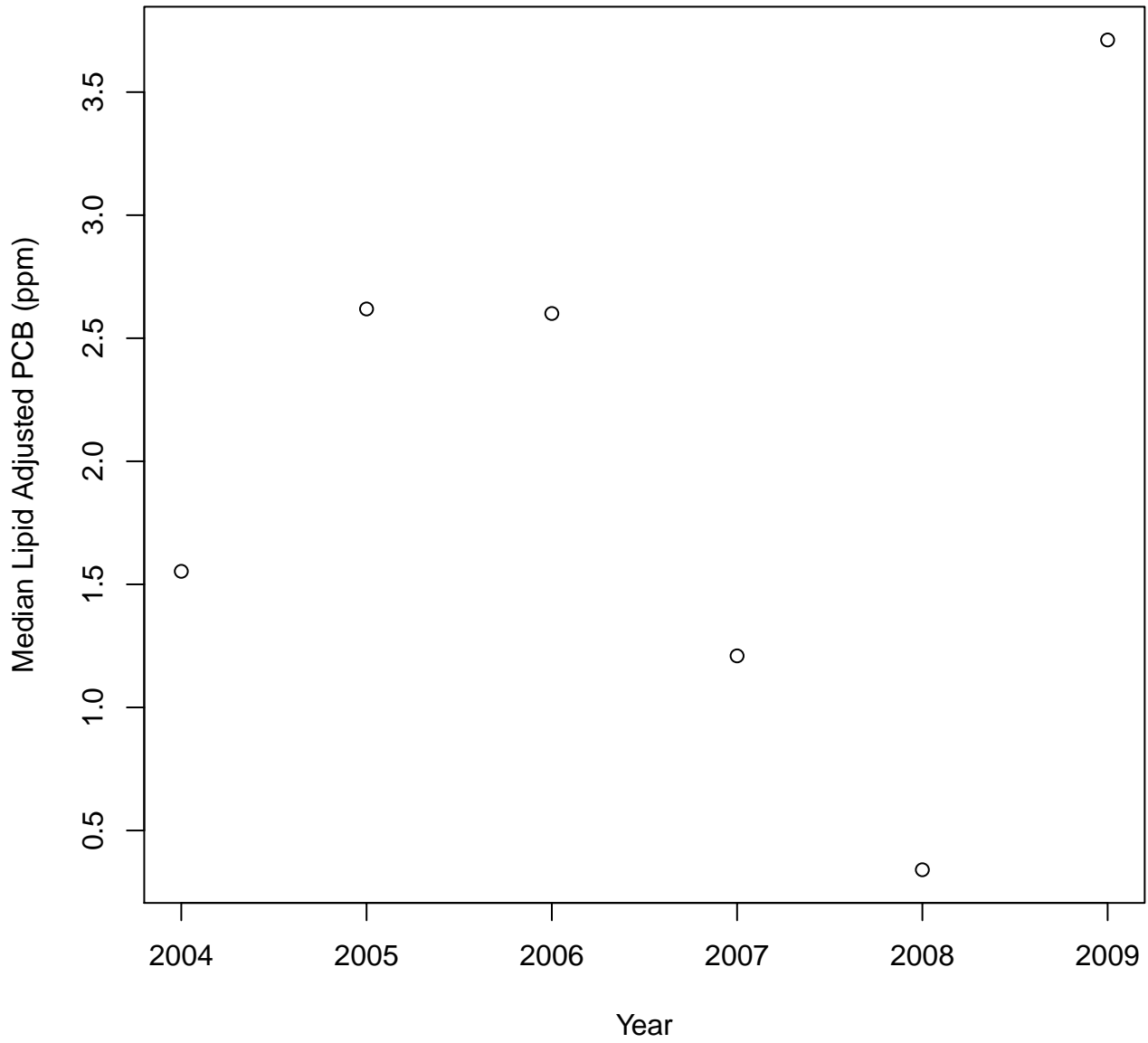


Figure 3: Feeder Dam forage fish lipid adjusted PCB (annual median).

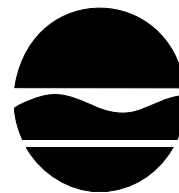
**New York State Department of Environmental Conservation  
Division of Air Resources**

**Bureau of Air Quality Analysis and Research, 2<sup>nd</sup> Floor**

625 Broadway, Albany, New York 12233-3259

**Phone:** (518) 402-8402 • **FAX:** (518) 402-9035

**Website:** www.dec.ny.gov



Alexander B. Grannis  
Commissioner

**MEMORANDUM**

**TO:** William Daigle and Kevin Farrar  
Hudson River Unit  
Division of Environmental Remediation

**FROM:** Tom Gentile and Randi Walker  
Bureau of Air Quality Analysis and Research  
Division of Air Resources

**SUBJECT:** Evaluation of Total Polychlorinated Biphenyls Ambient Air Concentrations for Phase 1 Hudson River Dredging Project

**DATE:** April 26, 2010

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**Introduction**

General Electric (GE) was required to establish an ambient air monitoring network to measure total polychlorinated biphenyls (PCBs) as Aroclor patterns. The network was designed to assess ambient impacts related to the dredging and processing of PCB contaminated sediments. An air monitoring plan was developed to ensure that the dredging project would comply with ambient air Quality of Life Performance Standards (QoLPS) for total PCBs. These air quality standards were developed for the project by the United States Environmental Protection Agency (USEPA) for the protection of public health during remedial activities.<sup>1</sup> Daily QoLPS of 0.11µg/m<sup>3</sup> for residential areas, and 0.26µg/m<sup>3</sup> for commercial/industrial areas were developed as action levels that should not be exceeded. In addition, concern levels which were within 20% of the QoLPS were developed to trigger actions to mitigate potential exceedances of the QoLPS. These values were compared to 24-hour ambient air measurements that were collected at locations at the processing facility and along the dredge corridor by GE during the course of the Phase 1 dredging project (May - October 2009).

Numerous exceedances of the residential and commercial/industrial QoLPS were observed during the course of the Phase 1 project. GE has reported 82 exceedances of the residential concern level (0.08 µg/m<sup>3</sup>), 78 exceedances of the residential QoLPS (0.11 µg/m<sup>3</sup>), 8 exceedances of the commercial/industrial concern level (0.21 µg/m<sup>3</sup>) and 26 exceedances of the

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<sup>1</sup>Ecology and Environment Inc. May 2004. Hudson River PCBs Superfund Site: Quality of Life Performance Standards. Prepared for United States Environmental Protection Agency (USEPA) Region 2. Available online: [http://www.epa.gov/hudson/quality\\_life.htm](http://www.epa.gov/hudson/quality_life.htm) [accessed 4/1/2010]

commercial/industrial QoLPS ( $0.26 \mu\text{g}/\text{m}^3$ ).<sup>2</sup> In summary, during the course of the Phase 1 dredging project there were 104 exceedances at air monitoring stations sited in residential or commercial/industrial areas.

This memorandum represents a preliminary analysis of the ambient air data collected during the Phase 1 project and the corrective action reports (CAR)<sup>3</sup> generated by GE. Our evaluation also included other information collected by the New York State Department of Environmental Conservation (NYSDEC) Division of Air Resources. This memorandum was developed to support NYSDEC's Hudson River PCBs Federal Superfund Site Report<sup>4</sup> by providing an analysis of the potential causes of the ambient air exceedances and a discussion of some of the mitigation measures that were undertaken by GE. We recommend independent evaluations of the ambient air data be conducted by the USEPA.

## **Background Air Concentrations of PCBs Prior to Phase 1 Dredging Project Activity**

Background measurements of ambient concentrations of PCBs were independently assessed prior to Phase 1 dredging by GE, NYSDEC and New York State Department of Health (NYSDOH). Many of the measurements were obtained in areas, impacted by project activities.

In the late summer of 2005, GE collected six ambient air measurements. The average 24-hour total PCB concentration reported was  $2.41 \text{ ng}/\text{m}^3$  (range  $0.82 - 3.73 \text{ ng}/\text{m}^3$ ). In the spring of 2009, prior to any dredging activities, GE conducted daily background sampling at eight locations over two days. Total PCB 24-hour average concentrations ranged from non-detect to  $47.8 \text{ ng}/\text{m}^3$ , at the eight locations.<sup>5</sup> A high and unexpected concentration was measured on the west bank of Certification Unit (CU) 9 ( $92.3 \text{ ng}/\text{m}^3$ ) on May 11<sup>th</sup>, followed by a non-detect measurement at the same location on the following day. No explanation was provided as to why this value was elevated (above residential concern level) and no laboratory errors were noted. The only activity reported was tree trimming in CU8.

During the summer months in 2000, 2001 and 2002, NYSDOH collected numerous 24-hour composite air samples in Fort Edward as part of the *PCBs and Health: The Hudson River Communities Project* and analyzed the samples for PCB congeners.<sup>6</sup> The results suggested that background PCB levels in the area were below  $4.1 \text{ ng}/\text{m}^3$ . Total daily PCB concentrations ranged from  $0.102$  to  $4.01 \text{ ng}/\text{m}^3$ .

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<sup>2</sup> Anchor QEA LLC & Arcadias. March 2010. Phase 1 Evaluation Report Hudson River PCBs Superfund Site. Prepared for General Electric Company. Albany, New York.

<sup>3</sup> Corrective action reports were prepared for each exceedance of the concern level and QoLPS. These reports provided information on meteorological conditions during exceedances and an assessment of activities potentially contributing to the exceedance.

<sup>4</sup> NYSDEC 2010. Hudson River PCBs Federal Superfund Site Report on Observations from Phase 1 Dredging Oversight Recommendations on Changes for Phase 2. Division of Environmental Remediation February 2010.

<sup>5</sup> Anchor QEA LLC. November 2009. Phase 1 Data Compilation Hudson River Superfund Site. Prepared for General Electric Corporation, Albany, New York.

<sup>6</sup> Palmer P. et al. 2008. Outdoor Air PCB Concentrations in Three Communities Along the Hudson River, New York. Archives of Environmental Contamination and Toxicology. 54:3. pp363-371.

In 2005 to 2006, as part of the Hudson River Baseline PCB study, NYSDEC collected numerous 24-hour composite air samples at two monitoring stations along the dredge corridor (Locks 6 and 7) and at the site of the processing facility prior to its construction.<sup>7</sup> Across the three monitoring sites, the average total PCB concentration was 0.6 ng/m<sup>3</sup>. The total daily PCB values ranged from non-detect to 2.8 ng/m<sup>3</sup>.

## **Analysis of Ambient Air Concentrations of PCBs During Phase 1**

We conducted a monthly review of the exceedances of the QoLPS during Phase 1 and reviewed dredging activities to assess the likely contributing factors for these exceedances. Additionally, an evaluation of the corrective actions was conducted to understand the effectiveness of mitigation efforts. The two dredging areas (Northern Thompson Island Pool (NTIP<sup>8</sup>) and Eastern Griffin Island (EGI<sup>9</sup>)) were reviewed separately since the monitors in the NTIP area also were subject to the confounding influence PCB volatilization from the transport of contaminated material. Additionally, the EGI area was dredged in Phase 1 to evaluate an area representative of the types of areas planned for dredging in Phase 2. Therefore, those mitigation measures identified as successful in the EGI area would likely be considered for Phase 2. Finally, the processing unit was evaluated separately since the activities at that location contributing to an exceedance of the QoLPS would be different than activities in the dredge corridor. Also, those mitigation measures deemed successful in Phase 1 would continue in Phase 2, since the processing facility will be utilized in Phase 2.

Ambient air samples were collected at 56 locations in the NTIP area, six locations in EGI area, and nine locations at the processing facility. A community monitor was installed in Village of Fort Edward to collect air samples representative of background concentrations.

Attachment 1 summarizes the monthly total PCB concentration for each ambient air monitor. None of the residential monitors report a monthly average above the QoLPS. At one residential monitor (DRC-E1901-RR-00036) operating continuously, two monthly averages (July and August) were greater than the residential concern level. One commercial/industrial monitor (DRC-E1939-CI-00034) reported a monthly average (July) greater than the commercial/industrial QoLPS. This commercial/industrial monitor recorded the highest ambient concentrations during Phase 1 dredging with the following levels reported in July<sup>10</sup>: 2,459 ng/m<sup>3</sup> (July 15), 4,237 ng/m<sup>3</sup> (July 16), and 2,316 ng/m<sup>3</sup> (July 17). Monitor DRC-E1939-CI-00034 was removed from consideration as a compliance monitor and was designated as an engineering monitor through an agreement between GE and USEPA in July. This monitor was placed in a

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<sup>7</sup> New York State Department of Environmental Conservation. 2007. Hudson River Baseline PCB Air Monitoring Study. Presented at the Hudson River Community Advisory Meeting, May 2007. Available On-Line: <http://www.hudsoncag.ene.com/documents.htm> [Accessed 4/5/2010].

<sup>8</sup> The northern portion of the Thompson Island Pool (TIP) from the northern end of Rogers Island to the southern end of Rogers Island on the east side of the island and to approximately River Mile (RM) 194.1 on the west side of the island.

<sup>9</sup> The area of the river in the vicinity of Griffin Island, between RM 190.4 and RM 189.9.

<sup>10</sup> The PCB measurements were collected over a 24-hour period, generally starting at 8:00 am in the morning and ending at 8:00 am the following day. The convention of reporting the ending date for the 24-hour monitoring period has been used in this memo.

fairly large commercial area with no nearby residences. Air monitors were sited at the two residential locations closest to DRC-E1939-CI-00034.

## **May 2009**

### *Dredge Corridor*

In the NTIP dredging area, the first exceedance of the residential QoLPS (158.1 ng/m<sup>3</sup>) was reported along CU9 (West Bank) for the 24-hr period ending on the morning of May 28. During this time period two dredge vessels were conducting inventory dredging in CU9 and loading mini-hoppers which were subsequently off-loaded to a larger barge in CU10. A tug also was operating in shallow water during this exceedance event and a local visible plume was reported in the wheel wash of the tug in CU9. The CAR for this date did not indicate the presence of a presence of non-aqueous phase liquid (NAPL)<sup>11</sup> associated with the plume. Sediment concentrations prior to dredging in CU9 were an average of 50.3 mg/kg (0 – 730 mg/kg).

The next round of exceedances occurred on May 29, at the monitoring stations near CU3. One monitor recorded an exceedance of the concern level (104 ng/m<sup>3</sup>) and the other recorded a significant exceedance of the QoLPS (1,145 ng/m<sup>3</sup>). During this time period debris removal activities were taking place in CU2 and CU3 and the debris was loaded into a mini-hopper then off-loaded into a large barge. A visible sheen also was observed in CU2. The sediment concentrations in CU2 prior to dredging were an average of 98.7 mg/kg (0 – 5,900 mg/kg).

Another exceedance occurred on May 30 (195 ng/m<sup>3</sup>), during similar activities that included debris removal in CU4. A heavy sheen was reported in CU4. It was also noted that the barge contained contaminated sediment and debris from CU3, CU17 and CU18 and archeological artifacts that were exposed to the wind on the flat barge deck. A number of possible causes of the exceedances were noted in the CARs, but a single cause was not identified. Sediment concentrations prior to dredging for these two CUs were the highest among all CUs. In CU3 the average PCB concentration in sediment was 277 mg/kg (0 – 18,000 mg/kg) and for CU4, the average was 337 mg/kg (0 – 14,600 mg/kg).

The limited near-field PCB water monitoring, downstream of dredge operations, revealed a maximum concentration of PCBs in river water in the west channel of Roger's Island of 1,620 ng/L (May 28) but with levels generally below 100 ng/L. In the east channel near CU2 and CU3, PCB levels in the near-field were generally higher over 100 ng/L with a maximum of 5,098 ng/L (May 28).

In the last week of May, two monitors were installed in the EGI dredging area in CU17 and CU18. No exceedances of the QoLPS occurred in this month at this location although one monitor (DRC-E1902-RR-00009) recorded a total PCB air concentration above the residential level of concern (89.85 ng/m<sup>3</sup>) in CU17. Two dredge vessels removing debris were active in CU17 during this sampling event. The other monitor in operation in CU18 recorded a concentration close to the residential level of concern (75.4 ng/m<sup>3</sup>) while two dredge vessels

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<sup>11</sup> Also identified as oil sheen in the field notes.

were active in CU18. The sediment concentrations prior to dredging were 150 mg/kg (0.018 – 1,620 mg/kg) and 127 mg/kg (0 – 1,500 mg/kg) for CU17 and CU18, respectively.

In May, the background air monitor located in Fort Edward reported an average of 3.4 ng/m<sup>3</sup> and a range of 0.4 – 15.38 ng/m<sup>3</sup>. The maximum value was measured on May 30. The second maximum value 12.19 ng/m<sup>3</sup> was measured on May 29. Although these values are within the average of the background measurements obtained prior to dredging, the two highest days correspond with the exceedances measured in CU3. The location of this sampler is approximately 1600 feet from the river (near CU1) and 3700 feet from the sediment processing site. In May, no exceedances were reported at the processing facility monitors.

Two mitigation measures were implemented in May. The first was the use of oil booms to collect surface oil sheen. Since the oil booms were not removed after saturation,<sup>12</sup> they effectively served to concentrate the sheens rather than limiting volatilization of PCB-laden oil. The second implementation measure was the use of 5 feet of interior freeboard on barges during mooring and transport. The increase in freeboard provided a wind screen for contaminated debris, sediment and artifacts.

### *Processing Facility*

There were no exceedances of the QoLPS or concern levels at the monitors located around the processing facility and loading wharf.

## **June 2009**

### *Dredge Corridor*

Exceedances of the concern level and QoLPS occurred within the NTIP dredge corridor during this month. The dredge corridor exceedances occurred in the east channel of Roger Island at monitoring locations near CU2. On June 14, the residential level of concern (104.7 ng/m<sup>3</sup>) was exceeded. During this time period two dredging vessels were in operation in CU2 and debris removal was occurring in CU4. No further details about sediment loading or concentrations were available.

In CU2 during the time period of June 20 - June 24, many monitor measurements above the residential level of concern (80 ng/m<sup>3</sup>) were observed, however, there were only three exceedances of the QoLPS, one commercial/industrial (271.6 ng/m<sup>3</sup>) and two residential (113.1 and 138.9 ng/m<sup>3</sup>). During this time two dredging vessels were conducting inventory dredging in CU2. Dredge material was loaded directly into a large barge moored in CU2 and material was also loaded in mini-hoppers which were transported to CU13 for loading into the larger barges. A heavy sheen was reported in CU2 on June 20. Also on June 22 and 23, a heavy sheen was observed in CU13, an area with no active dredging. It was not clear if this was related to dredging activities in CU2 or the loading of material from CU2 from the mini-hoppers to the large barges. The highest concentration at the monitoring location near CU13 (62 ng/m<sup>3</sup>) was

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<sup>12</sup> NYSDEC 2010. Hudson River PCBs Federal Superfund Site Report on Observations from Phase 1 Dredging Oversight Recommendations on Changes for Phase 2. Division of Environmental Remediation February 2010.

reported during this time period. It was noted that the mini-hoppers were operating without wind screens during this time and the sediment and debris were exposed to the wind during transport to CU13. Oil booms also were deployed to contain the sheens in CU2, but the oil booms were routinely not collected. Additionally, one of the monitors (DRC-C1940-RR-00069) was moved further from the river when it registered elevated PCBs during this episode. The movement of monitors makes it difficult to assess if the mitigation measures implemented by GE were effective in reducing ambient air levels of PCBs.

GE implemented a number of mitigation measures to address the exceedances. In the dredge corridor, GE used wind-screens on the mini-hoppers operating in CU2. Mitigation measures proposed by GE in response to the exceedances at the processing facility included priority unloading of sediment from barges containing sediment that were required to have wind screens based on modeled exceedances and making sure the hopper barges loaded with sediment from CU2 had at least 5 feet of interior freeboard. Additionally, the monitor across from the loading dock was moved away from the activities that caused the exceedances and closer to a receptor. This monitor (PFX-E1943-RR-01269) was not moved until September and a new residential monitoring site (PFX-E1943-RR-01324) was established next to the Wedgewood Golf Course clubhouse.

In the EGI area, limited dredging activities were conducted and there were no exceedances of the QoLPS or residential level of concern for the month of June.

In June, the background air monitor located in Fort Edward reported an average of 3.3 ng/m<sup>3</sup> and a range of 1.11 – 10.7 ng/m<sup>3</sup>. The maximum value was measured on June 27. There were no exceedances or elevated concentrations measured along the dredge corridor, but concentrations at the monitors by the processing facility ranged from 20.7 to 32.1 ng/m<sup>3</sup> during this time period. The second maximum value 6.8 ng/m<sup>3</sup> was measured on June 24. On this date, an exceedance of the commercial/industrial standard in CU2 also occurred. The location of this sampler is approximately 1600 feet from the river (near CU1) and 3700 feet from the sediment processing site. The prevailing winds were from the north northeast, and the wind speed was high during this period. Although this monitor recorded concentrations within the background levels reported prior to dredging, it does appear to be impacted by activities both in the dredge corridor and at the processing facility.

### *Processing Facility*

One exceedance of the residential level of concern (104 ng/m<sup>3</sup>) and residential QoLPS (148 ng/m<sup>3</sup>) occurred at the monitor (PFX-E1943-RR-01269) located across the canal from the loading wharf. These exceedances occurred on June 21 and June 24, respectively. The CAR indicated that these exceedances were associated with the unloading of two barges containing sediment with high PCB concentrations (sediment concentrations not provided) from CU2. During these dates, a number of exceedances in CU2 also were observed. Samples collected at monitor (PFX-E1943-RR-01269) were not evaluated for two days in the middle of this episode (June 21 and 22) since it was determined that the monitor was not in the predominant wind direction. When sample analysis resumed, this monitor recorded an exceedance on June 24, followed by another elevated measurement (77 ng/m<sup>3</sup>) on June 25. An evaluation of the cause of

the exceedances concluded that the probable source of the PCB emissions producing the exceedance was the unloading of barges that were loaded with dredged material from CU2. The PCB concentrations in air decreased at the monitor over the subsequent days which also corresponded to decreasing levels measured in CU2. Selecting to analyze samples based on wind direction also makes it difficult to assess the effectiveness of mitigation measures.

## **July 2009**

### *Dredge Corridor*

Multiple exceedances of the concern level and QoLPS occurred within the NTIP dredge area during this month. Elevated concentrations were observed in CU3 at monitoring location DRC-E1939-CI-00034. This monitor was removed from consideration as a compliance monitor and was designated as an engineering monitor through an agreement between GE and USEPA. This monitor remained in place in an attempt to evaluate the implemented mitigation measures. The monitoring at this location as a non-compliance monitor began on July 8, and ambient levels of total PCBs were recorded at this monitor above the residential QoLPS for the remainder of the month, with the exception of three days. The monthly average for this monitoring location was  $706 \text{ ng/m}^3$  (range  $85.3 - 4,237 \text{ ng/m}^3$ ).

In response to these exceedances, a wind-screen test was begun on the mini-hoppers operating in CU2 and CU3 and water was added to the barges to mitigate directly exposed sediment. On July 10, mini-hoppers in CU3 were equipped with wind screens and on July 11, mini-hoppers in CU2 were equipped with wind screens. Dredge bucket cycle times also were reduced in CU3. These mitigation measures were put into place in response to elevated measurement in CU3 that ranged from  $110$  to  $927 \text{ ng/m}^3$  for these two dates. The average concentration at three monitoring locations in CU2 and CU3 were  $224 \text{ ng/m}^3$ . Total PCB concentration rose as the total daily dredging time increased in CU2 and CU3 during this time period. These mitigation activities in the east channel of Rogers Island had a minimal effect on the ambient concentrations during the week of July 12.

As discussed above, extremely elevated concentrations were observed between July 15 -17, ( $2,459 \text{ ng/m}^3$ ,  $4,237 \text{ ng/m}^3$ , and  $2,316 \text{ ng/m}^3$ ) at the non-compliance monitor location DRC-E1939-CI-00034. These were the highest ambient air measurements recorded during Phase 1. The impact on the background air monitor in Fort Edward during this episode was clearly evident. A maximum concentration of  $30.4 \text{ ng/m}^3$  was observed at the background monitor on July 15, which corresponds to the  $4,237 \text{ ng/m}^3$  and  $485 \text{ ng/m}^3$  measurements made at different locations along CU3. During this time period exceedances of the QoLPS also were occurring in CU2 at a residential sampling location ( $152.4 \text{ ng/m}^3$ ) and at a commercial/industrial sampling location ( $288.6 \text{ ng/m}^3$ ). The average concentration of all the Rogers Island dredge corridor monitors collected on July 15, was  $480 \text{ ng/m}^3$ . If the highest monitoring location (DRC-E1939-CI-00034) collected from the shoreline is removed from the calculation, the average of the samples was  $138.6 \text{ ng/m}^3$ . This value indicates that the entire air shed within the east Roger Island dredge corridor and the surrounding area contained elevated levels of PCBs on July 15.

On July 15, there was active dredging occurring in CU1, CU3, CU5, and CU6. Two dredge vessels were operating in CU3. Hopper barges loaded with sediment from CU3 were moored in CU13, where a monitor recorded a QoLPS exceedance of 191.6 ng/m<sup>3</sup> on a residential property. On July 14, active dredging was occurring in CU2, CU3, CU6 and CU7. Sheens were noted in CU2 on July 14 and 16. There was no discussion of the absence or presence of sheens in CU3, however, the contractor was instructed to install an oil containment boom north of the dredging operations in CU3 and at the stern of each dredge working in CU3 on July 15, which indicates the presence of sheen in this CU. This event also corresponded to an increase in the number of hours of active dredging in CU2 and CU3 (21.4 -29.7 hours). Average PCB sediment concentrations removed in CU2 and CU3 ranged from 48 to 323 mg/kg and 44 to 684 mg/kg, respectively.

On July 19, in addition to the mitigation measures already in place, the USEPA directed GE to cease dredging in CU4 and add additional water to hopper barges loading in CU3 such that the majority of sediment would be covered with water. The mitigation measures and activity restrictions on dredging resulted in a decrease of ambient air total PCB concentrations at monitoring site DRC-E1939-CI-00034, even though the daily mean temperatures were higher for the period after mid-July. The average total PCB concentrations, during the time period (July 8 - 18) these different mitigation measures were being phased in, was 1,175.6 ng/m<sup>3</sup>. After all of these mitigation measures were implemented in the dredge corridor, the average total PCB concentration at monitoring site DRC-E1939-CI-00034 was 305 ng/m<sup>3</sup> between July 19 and August 1. The restriction of limiting dredging to only one CU in the east channel of Rogers Island appeared to play a major role in reducing the extremely high ambient air concentrations (greater than 1µg/m<sup>3</sup>) of PCBs at this monitoring location. For the remainder of July, dredging was restricted to only one CU in the east channel of Rogers Island at any given time. There was only one exceedance of the commercial/industrial QoLPS in CU3 measured after implementation of this work restriction. The single exceedance occurred on a day when the effective dredging time in CU3 was 27.75 hours. However, the ambient concentrations measured at monitoring site DRC-E1939-CI-00034 remained elevated (106 – 852.6 ng/m<sup>3</sup>) for the remainder of the month. Overall, it is difficult to attribute a specific activity as the contributing factor for any particular exceedances. However, as is the case in CU3 for this month, the increased dredging time contributed to increased presence of sheen and the decanting of water from the dredge buckets aerosolized PCBs from the contaminated water.

In July, the background air monitor in Fort Edward reported an average of 7.4 ng/m<sup>3</sup> and a range of 1.2 – 30.4 ng/m<sup>3</sup> for total PCBs. The maximum value was measured on July 16, concurrent with the extremely elevated air concentrations in the east channel of Rogers Island.

In the EGI area, six exceedances of the residential QoLPS and two exceedances of the residential level of concern occurred at the end of the month when inventory dredging activities increased in CU18. The two monitors with the exceedances (DRC-E1901-RR-00036 and DRC-E1901-RR-00057) were located on the east side of the river near CU18, closest to the sheet-pile wall. The sheet-pile wall was installed in CU18 to limit movement of suspended material downstream. Active dredging was being performed inside the sheet-pile wall during the first exceedance on July 21. A mini-hopper barge was used to transport material from inside the sheet-pile wall to a regular hopper barge outside the sheet-pile wall. Intermittent sheens were observed in CU17 and

CU18 and containment booms were deployed to address the sheens. Although the same type of inventory dredging activities were occurring in CU17, the monitors in that area did not exceed the QoLPS. The sediment concentrations prior to dredging were similar for these two CUs, averaging 150 mg/kg (0.018 – 1,620 mg/kg) and 127 mg/kg (0 – 1,500 mg/kg) for CU17 and CU18, respectively. GE concluded that the dredging activities inside the sheet-pile wall and the proximity of the monitor (within 100 ft) may have lead to the exceedances of the standard. GE also installed a meteorological station adjacent to the sheet-pile wall to better understand wind patterns at the sheet-pile area.

On July 28 and 29, exceedances (range of 111 - 149 ng/m<sup>3</sup>) of the residential QoLPS occurred at monitors DRC-E1901-RR-00036 and DRC-E1901-RR-00057. The final QoLPS exceedance in this month for the EGI area occurred at DRC-E1901-RR-00036 (131 ng/m<sup>3</sup>). Although 5 feet of interior freeboard was maintained on the hopper barges and wind screens were in place on the mini-hopper, it was concluded that the use of a mini-hopper inside the sheet-pile wall, the presence of sheens, and the higher PCB concentrations in sediment within the sheet-pile wall, likely contributed to the exceedances. GE also began to use a variety of products to contain and collect oil sheens within the sheet-pile wall. GE also discontinued the use of the mini-hopper barge inside the sheet-pile area.

#### *Processing Facility*

There were six exceedances of the residential QoLPS and five exceedances of residential level of concern at the monitors around the processing facility. The QoLPS exceedances occurred on July 15, 18, 22, 24 and 31. There were many exceedances at the monitors located opposite the loading wharf (PFX-E1943-RR-01269 and PFX-E1943-RR-01324 near the golf course clubhouse). Two exceedances of the residential level occurred at PFX-E1943-RR-01269 and three were observed at monitoring location PFF-PERI-RR-01491 on July 15, 17 and 19, which is located northeast of the loading wharf. These exceedances at the processing facility ranged from 83.3 to 154 ng/m<sup>3</sup> and were not as elevated as the exceedances observed in the dredge corridor. The CAR indicated that the exceedances for this month were associated with the unloading of two barges containing material with high levels of PCBs (concentrations greater than 200 mg/kg) from CU3 and CU17, areas associated with the exceedances observed in the dredge corridor. In response to these exceedances, GE implemented a priority system for unloading barges with high average PCB concentrations before other barges at the loading dock. A marking system using yellow flags to identify barges containing high PCB sediment concentrations was established.

The majority of the perimeter monitors were operating every day. However, monitor PFF-PERI-RR-01018 located southeast of the loading wharf operated only one day and monitor PFF-PERI-RR-01380 located northwest by the rail yard was not in operation at all during the month of July.

It is not clear if these monitors were operational and the samples were collected but not analyzed since it was determined they were not in the predominant wind direction.

#### **August 2009**

##### *Dredge Corridor*

Multiple exceedances of the residential and commercial/industrial concern level and QoLPS occurred within the dredge corridor. Elevated concentrations (greater than the residential QoLPS) were observed within CU3 at the engineering monitoring location (DRC-E1939-CI-00034) on 21 days during the month of August. Samples were collected during the entire month and the monthly average for this site was 70.9 ng/m<sup>3</sup> (range 31 – 845 ng/m<sup>3</sup>). From August 8 - 12, a temporary halt to all dredging activities in the east channel of Rogers Island (CU2, CU3 and CU4) was implemented and the PCB air concentrations decreased at the engineering monitor (average concentration 42 ng/m<sup>3</sup>).

The commercial/industrial QoLPS were exceeded three times at monitoring location DRC-E1939-CI-00067 in CU3 and twice at monitoring location DRC-E1940-CI-00043 in CU2. The residential QoLPS and residential concern level were exceeded four and two times, respectively at monitoring location DRC-E1940-RR-00101 in CU2. In addition, the residential QoLPS and concern level were exceeded five and four times, respectively at monitoring location DRC-E1941-UR-00040 near CU2. Seven of these exceedances occurred from August 3 - 5. The other exceedances occurred from August 16 – 22. In addition, there was one exceedance of the residential concern level near CU1 on August 20.

During August 3 - 5, two dredge vessels were operating in CU3 and heavy sheens were observed on two days, followed by a light sheen observation on the third day. The PCB ambient air concentrations were higher at the monitoring locations when the presence of the heavy sheen was noted. Booms were deployed to contain the sheens around the dredge vessels and sorbent materials were tested to evaluate their ability to capture the sheens. In addition, previous mitigation measures that were implemented in July, were still in place in August. During this time period, dredged sediment concentration averages ranged from 62 to 684 mg/kg and total effective daily dredging activity times ranged from 21.62 to 25.42 hours. The PCB ambient air concentrations at the commercial/industrial monitors in CU2 and CU3 ranged from 94.9 to 363.7 ng/m<sup>3</sup>. The PCB ambient air concentrations at the residential monitoring locations ranged from 45.3 to 188 ng/m<sup>3</sup>. The average concentration at the background monitoring location during these events was 13.3 ng/m<sup>3</sup>.

On August 16, 18 – 22, there were five exceedances of the QoLPS at monitoring location DRC-E1941-UR-00040 in CU2. On August 18, exceedances were reported for four monitoring locations (in CU2 and CU3) and elevated concentrations persisted at monitoring location DRC-E1940-CI-00043 until August 21. Two dredging vessels were operating and moderate to heavy sheens were reported in CU2 during this time period. On August 21, there was an exceedance of the residential concern level at monitoring location DRC-E1940-RR-00101 and residential QoLPS at monitoring location DRC-E1941-UR-00040 in CU2. The exceedances persisted for two more days at monitoring location DRC-E1941-UR-00040. During the week of August 16 – August 22, sediment concentration dredged ranged from 0.021 to 365 mg/kg (average 39.2 mg/kg) total effective daily dredging activity times ranged from 11.74 to 27.25 hours. The PCB ambient air concentrations at the commercial/industrial monitoring locations in CU2 and CU3 ranged from 68.2 to 772.2 ng/m<sup>3</sup>. The PCB ambient air concentrations at the residential monitoring locations ranged from 67.0 to 453.7 ng/m<sup>3</sup>. The average PCB concentration at the background monitoring location during these events was 16.1 ng/m<sup>3</sup>.

On August 21, the USEPA directed GE to use only one dredge vessel in CU2, CU3 and CU4 and to dredge only one area of elevated PCB concentrations at anytime in the east channel of Rogers Island. For the remainder of August, there was only one exceedance of the residential concern level at the monitoring locations in the east channel of Rogers Island in the vicinity of these three CUs.

In the west channel of Rogers Island there was one exceedance of the residential QoLPS (126.4 ng/m<sup>3</sup>), which occurred on August 20, at monitor DRC-C1943-UR-00087 in CU6. Two dredge vessels were in operation and mini-hoppers with windscreens were in use. The average PCB sediment concentration dredged was reported to be 804 mg/kg. There was only one exceedance of the residential concern level near CU1 on August 20.

In August, the Fort Edward background air monitor had an average PCB air concentration of 10.0 ng/m<sup>3</sup> and a range of 1.1 – 42.1 ng/m<sup>3</sup>. The maximum value was measured on August 20. This is the time period when elevated air concentrations were measured in the dredge corridor along the east channel of Rogers Island.

In August, 11 exceedances of the residential QoLPS occurred (range 111 – 146 ng/m<sup>3</sup>) and 12 exceedances of the residential level of concern occurred in the EGI region. These exceedances primarily occurred at two monitors, DRC-E1901-RR-00036 and DRC-E1901-RR-00057 on the east side of the river. The mini-hopper was in use for the first day in August but was removed from the sheet-pile enclosure and no longer used in this area. Although many of the mitigation measures implemented in July were in place in August, GE's corrective action report suggests that oil sheens and turbid water were contained by the sheet-pile walls along with concentrations of PCB in sediment being dredged may have contributed to the exceedances. Most of the exceedances occurred in the beginning of August. After removal of the sheet-pile wall on August 19, only one exceedance of the residential QoLPS occurred (in September).

It was concluded in the USEPA Phase I Evaluation Report, that the high PCB concentrations in the water within the sheet pile area contributed to the exceedances of the PCB QoLPS. In the EGI area, water sampling conducted within the sheet pile enclosure found total PCB concentrations that ranged from 21,000 to over 32,000 ng/L, or approximately two orders of magnitude higher than those found within the adjacent river during transect sampling. Additionally, PCBs within the sheet-pile area were predominantly in the dissolved phase.<sup>13</sup>

Finally, during the month of August, GE experimented with different products to contain and collect the oil sheens within the sheet-pile wall.

### *Processing Facility*

There were four exceedances of the residential QoLPS and seven exceedances of residential level of concern at the monitors around the processing facility. The majority of these

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<sup>13</sup> The Louis Berger Group, Inc. March 2010. Hudson River PCBs Site USEPA Phase I Evaluation Report. Prepared for: US Environmental Protection Agency, Region 2 and US Army Corps of Engineers, Kansas City District.

exceedances occurred at the monitor located across the canal from the loading wharf (PFX-E1943-RR-01269) and at monitoring location PFF-PERI-RR-01491 which is located to the northeast of the loading wharf. The QoLPS exceedances occurred on August 8, 19, and 23. Exceedances of the residential concern level also occurred around these dates. An exceedance of the residential QoLPS (187 ng/m<sup>3</sup>) occurred on August 8, at monitor location PFX-E1943-RR-01324 near the golf course clubhouse. The exceedances at the processing facility ranged from 80.9 to 259 ng/m<sup>3</sup> and were not as elevated as the exceedances observed in the dredge corridor. The CAR indicated that these exceedances were associated with the unloading of barges containing sediment of high PCB concentration (greater than 200 mg/kg) from CU3, CU17 and CU18. Exceedances also were observed in these CUs in August. In response to the exceedances at the processing facility, GE covered the debris piles with tarps and removed solids that accumulated in the on-site storm water basin.

The majority of the processing facility monitors were operating every day. Two perimeter monitors operated for only a few days or less. Monitor PFF-PERI-RR-01018 located to the southeast of the loading wharf collected samples only two days and monitor PFF-PERI-RR-01380 located to the northwest by the rail yard collected samples for only one day.

## **September 2009**

### *Dredge Corridor*

Fewer exceedances of the concern levels and QoLPS occurred within the dredge corridor than previous months. Elevated concentrations (greater than residential QoLPS) were observed in CU3 at the engineering monitoring location (DRC-E1939-CI-00034) for 20 days. The monitor was operational for the entire month. The monthly average for this site was 204 ng/m<sup>3</sup> (range 32.8 – 500 ng/m<sup>3</sup>).

The commercial/industrial QoLPS was exceeded two times at monitor DRC-E1939-CI-00067 in CU3, and once at monitor DRC-E1940-CI-00043 in CU2. The residential concern level and QoLPS were exceeded one and two times respectively, at monitoring location DRC-E1938-RR-00149 in CU3. The residential QoLPS and concern level were each exceeded three times at monitoring location DRC-E1940-RR-00101 in CU2. The residential concern level and QoLPS were exceeded one and four times, respectively at monitoring location DRC-E1941-UR-00040 by CU 2. In addition, the residential concern level and QoLPS were exceeded three and six times, respectively at monitoring location DRC-E1937-RR-00035 by CU4 near Lock 7.

The majority of the exceedances in the east Channel of Rogers Island primarily were observed during two time periods. One dredge vessel was operating in CU3 and CU4 on each day during September 8 – 10. The average sediment concentration for samples collected in the first half of the month was 34.9 mg/kg (range 0.003 to 700 mg/kg) and total effective dredging times ranged from 12.83 to 25.75 hours. Moderate to heavy sheens were reported in CU3 and CU4. Over these three dates in September, the ambient air PCB concentrations at the commercial/industrial monitors in CU2 and CU3 ranged from 8.6 to 359.2 ng/m<sup>3</sup> and at the residential monitoring locations in CU2, CU3 and CU4 ranged from 10.9 to 326.3 ng/m<sup>3</sup>. The average PCB concentration at the background monitor during these events was 12.7 ng/m<sup>3</sup>. In response to

these exceedances, USEPA asked GE to cover high PCB concentration sediments (greater than 200 mg/kg) with low concentration sediment on the barges, to use sorbent material to collect the sheens and to use sorbent materials as covers on the barges loaded with sediment with high PCB concentrations.

During September 21 – 25, one to two dredge vessels were operating in CU2 and CU4 per day. The average sediment concentrations ranged from 6 to 283 mg/kg and the effective dredging time ranged from 21.57 to 29.53 hours. Sheens described as light, moderate, heavy and severe were present in both CUs during this time period. The ambient air PCB concentrations at the commercial/industrial monitor in CU2 ranged from 43.1 to 398.7 ng/m<sup>3</sup>. The ambient air PCB concentrations at the residential monitors in CU2 and CU4 ranged from 30.7 to 234.2 ng/m<sup>3</sup>. The average concentration at the background monitor during these events was 17.9 ng/m<sup>3</sup>.

In September, the background air monitor located in Fort Edward had an average PCB air concentration of 12.7 ng/m<sup>3</sup> and a range of 1.8 to 34.0 ng/m<sup>3</sup>. The maximum value was measured on September 10. This is the time period when elevated air PCB concentrations were measured in the dredge corridor along the east channel of Rogers Island.

Only one exceedance of the QoLPS occurred in the EGI area on September 3, at monitor DRC-E1901-RR-00036 (119 ng/m<sup>3</sup>). Several mitigation measures were in place when this exceedance occurred such as loading the barges more evenly, adding water to cover the sediment and maintenance of 5 feet interior freeboard in the barges. Although these measures were in place, the exceedance occurred and the GE corrective action report acknowledges that a heavy sheen was present and contained within an oil boom and Mycelex absorbent boom.

### *Processing Facility*

There were thirteen exceedances of the residential QoLPS and ten exceedances of residential level of concern at the monitor locations around the processing facility. The majority of these exceedances occurred at the monitor located across the canal from the loading wharf by the Wedgewood Golf Course clubhouse (PFX-E1943-RR-01324) and at monitoring location PFF-PERI-RR-01491 which is located to the northeast of the loading wharf. Monitoring location PFX-E1943-RR-01269 was shut down at the end of August and it is likely that this monitor also would have recorded a number of exceedances in September. For this month the highest number of exceedances occurred for the processing facility area even with a smaller network of monitors in operation. For many of the monitoring locations the highest concentration was recorded for this month as well. Some of these exceedances were as high as what was observed in the dredge corridor and ranged from 80.7 to 328.3 ng/m<sup>3</sup>. The majority of these perimeter monitors were operating every day. However, monitor PFF-PERI-RR-01018 located to the southeast of the loading wharf ran only one day and monitor PFF-PERI-RR-01380 located to the northwest by the rail yard ran only one day.

The CAR indicated that these exceedances were associated with the unloading of barges containing sediment of high PCB concentration (greater than 200 mg/kg) from CU3, CU17 and CU18 and the siting of a new auxiliary material staging stockpile at the northeast corner of the wharf. These locations were associated with the exceedances observed in the dredge corridor.

In response, as directed by USEPA, the stock piles of coarse material awaiting transport by railcar were to be covered with tarps. It was later found that these piles were too big to tarp and GE experimented with the application of a cellulose-based material on the southernmost coarse pile. The monitor closest to this pile (PFF-PERI-RR-00943) did show a decrease in PCB concentration for the end of September. In summary it was found that the unloading and staging of dredged materials at the wharf and uncovered stockpiles of coarse material contributed to the exceedances at the processing facility monitors.

## **October 2009**

### *Dredge Corridor*

There were fewer exceedances of the QoLPSs observed during the month of October in the NTIP area. Elevated PCB concentrations (greater than residential QoLPS) were observed within CU3 at the engineering monitoring location (DRC-E1939-CI-00034) on seven days. This monitor was operational for the entire month. The monthly average for this site was 72.8 ng/m<sup>3</sup> (range 8.0 – 250 ng/m<sup>3</sup>). No exceedances were observed at any of the commercial/industrial and residential monitors near CU1, CU2, CU3, CU7, CU8, and CU10. There were three exceedances of the residential concern level and two exceedances of the QoLPSs at monitor DRC-E1937-RR-00035 near CU4. There was one exceedance of the residential concern level at the monitor near CU13.

The exceedances near CU4 occurred during a four-day period from October 13 -16. One dredge vessel was operating in CU4 on the 13<sup>th</sup> and 14<sup>th</sup> and two dredge vessels were operating on the 15<sup>th</sup>. The average sediment concentration was 11.7 mg/kg (range 0.099 – 105 mg/kg) and total effective dredging times ranged from 11.33 to 20.41 hours. Moderate to heavy sheens were observed in CU4 during this period. The ambient PCB concentrations at the residential monitor ranged from 97.8 to 146.1 ng/m<sup>3</sup>. The PCB concentrations in the dredged sediment were not very high but the presence of sheen may have contributed to the monitoring exceedance. The dredging activity ceased on October 15, and the ambient PCB concentrations decreased. The exceedance of the concern level occurred near CU13 on October 16, which may have been due to the mooring of the barges by CU13.

No exceedances of the residential QoLPS or level of concern occurred in EGI dredging area. The highest PCB concentration measured was 49.9 ng/m<sup>3</sup> on October 21, and monitoring in the EGI area stopped on October 26.

### *Processing Facility*

For this month, there were three exceedances of the residential level of concern and two exceedances of the QoLPS. Most of the exceedances occurred October 17, 18 and 21 at the northeast and southeast perimeter monitors. There was no information in the CAR for these exceedances, but it is likely that the activities in September that contributed to the exceedances also contributed to the exceedances October.

## **Corrective Measures**

A number of different corrective measures were used and sometimes the application of individual measures was not always consistent, nor comprehensive; making an evaluation of the effectiveness of each individual measure difficult. Additionally, we found better reporting of potential activities leading to exceedances (e.g., presence of sheen and resuspension events) than the reporting of corrective measures. Our analysis of the ambient air concentrations of PCBs identified specific time periods with consecutive exceedances and identified some corrective measures which appeared to mitigate the ambient levels.

### *Summary of Corrective Measures Implemented by General Electric*

Some of the corrective measures implemented during periods of exceedances include the following:

- the use of wind screens on min-hopper barges and curtailing the use of mini-hopper barges
- utilization of sorbent material to remove non-aqueous phase liquid (NAPL) on the water surface
- loading of regular hopper barges with an interior freeboard of 5 feet and adding water to cover the sediment
- prioritization of barges loaded in dredge areas with elevated PCB concentrations for unloading at the wharf
- installation of a containment boom immediately downstream of all dredges;
- cease dredging in certification units when consecutive exceedances occur
- limiting the number of dredges and associated barges in certain portions of the river (e.g., East Channel of Rogers Island)
- loading the bottom of a hopper barge in a high PCB concentration area, then moving to a low PCB concentration area to load the remainder of the barge, so as to minimize the amount of high concentration sediment dredged during each day
- covering the processed material in the staging areas at the sediment processing facility with tarps, to the extent practical or cellulose-based material

### **Evaluation of Sheen and Wind Direction**

The role of specific factors contributing to exceedances of the QoLPS for total PCBs was evaluated. The factors were presence of non-aqueous phase liquid (NAPL) and wind direction. The presence of NAPL (or sheen as identified by field notes) was identified in GE's Phase 1 Evaluation Report<sup>14</sup> as a potential contributor to the PCB-air exceedances. Based on our review of the exceedances of the QoLPS for the EGI dredging area, the presence of sheen appears to contribute to monitored concentrations and therefore warranted further review. Of significance is the fact that the sheens were sampled by GE and shown to have high PCB concentrations.<sup>15</sup> The evaluation of wind was done to assess monitor placement with respect to exceedances.

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<sup>14</sup> Anchor QEA LLC & Arcadias. March 2010. Phase 1 Evaluation Report Hudson River PCBs Superfund Site. Prepared for General Electric Company. Albany, New York.

<sup>15</sup> Anchor QEA, LLC, November 2009. Phase 1 Data Compilation Hudson River PCBs Superfund Site. Prepared for General Electric Company. Albany, New York.

These two evaluations were conducted as a preliminary assessment and were not intended to be an exhaustive evaluation of all factors influencing total PCB air ambient concentrations.

*Presence of Sheen*

The GE Daily Reports were used to obtain information on the daily presence of sheen. This information was augmented with information from NYSDEC's Oversight Summary Reports prepared by Camp, Dresser, and McKee. For most CUs, GE's Daily Reports provided greater number of days of sheen observance. Although both reports provide qualifier information (e.g., sheen heavy, moderate, light) for daily presence of sheen, the variable was reduced to presence or absence of sheen.

A comparison of means, testing statistical significance (Wilcoxon test) was performed between the presence of sheen and daily total PCB concentrations. Although approximately 62 CU monitors were in operation in Phase 1, only 19 continuously operated for more than 60 days. This analysis was restricted to the 19 monitors. All monitors used in this analysis are listed in Table 1 along with their period of operation. The outcome from the evaluation with the presence of sheen also is shown in Table 1. Each monitor was compared with the presence of sheen in the nearest CU. For 13 (68%) of the 19 monitors, the mean test scores were statistically significant ( $p < 0.05$ ) for the presence of sheen as compared to absence.

**Table 1.** Monitors operating for more than 60 days

Location	Monitor Identification Code	Sheen Statistically Significant	Monitoring Start Date	Monitoring End Date
CU1 North East Rogers Island	DRC-C1944-UR-00065	yes	6/5/2009	10/27/2009
CU1 North East Rogers Island	DRC-E1943-UR-00038	yes	6/5/2009	10/27/2009
CU2 East Bank	DRC-E1941-UR-00040	yes	6/2/2009	10/12/2009
CU2 Rogers Island	DRC-E1940-CI-00043	yes	6/6/2009	10/12/2009
CU2 SEWAGE NE	DRC-E1940-RR-00101	no	7/24/2009	10/12/2009
CU3 EAST	DRC-E1939-CI-00067	yes	7/14/2009	10/27/2009
CU3 East Bank	DRC-E1939-CI-00034	yes	5/27/2009	11/4/2009
CU3 EAST RTE 4	DRC-E1938-RR-00149	no	7/24/2009	10/27/2009
CU4 Lock 7	DRC-E1937-RR-00035	yes	6/6/2009	11/3/2009
CU5 Rogers Island	DRC-C1944-RR-00106	yes	5/21/2009	8/28/2009
CU6 Rogers Island	DRC-C1943-UR-00087	no	6/1/2009	9/26/2009
CU7 West Bank	DRC-W1942-RR-00051	yes	6/6/2009	10/12/2009
CU8 GP SITE	DRC-W1941-CI-00028*	no	7/20/2009	10/24/2009
CU10 Rogers Island	DRC-C1939-RR-00109	no	6/29/2009	10/28/2009
CU13 South Rogers Island	DRC-E1935-RR-00007	no	6/8/2009	11/2/2009
CU17 East Griffin Island	DRC-E1901-RR-00057*	yes	6/25/2009	10/1/2009
CU17 Griffin Island	DRC-C1902-RR-00068	yes	6/14/2009	8/28/2009
CU18 GRIFFIN ISLAND	DRC-C1901-RR-00066	yes	6/20/2009	10/26/2009
CU18 MCDONALD FUEL	DRC-E1901-RR-00036	yes	6/20/2009	10/26/2009

\* DRC-W1941-CI-00028 was compared to sheen presence in the nearest certification unit (CU9).

\* DRC-E1901-RR-00057 was compared to sheen presence in nearest certification unit (CU18).

The remaining, six monitors were not significant for this comparison. For four of these monitors, the presence of sheen in the nearby CU was reported infrequently, less than six days during Phase 1. The remaining two monitors are approximately 500 and 690 feet east of the active dredging area and may be sufficiently far from the river that the presence of sheen did not significantly affect the monitor concentrations.

Figure 1, presents a map of the NTIP dredging area for Phase 1. The map illustrates those monitors (in red) where the presence of sheen was statistically significant. The monitors in green were not significant for the presence of sheen. Additionally, the number of days where sheen was reported for each CU is displayed. Figure 2, presents the same information for the EGI dredging area for Phase 1.

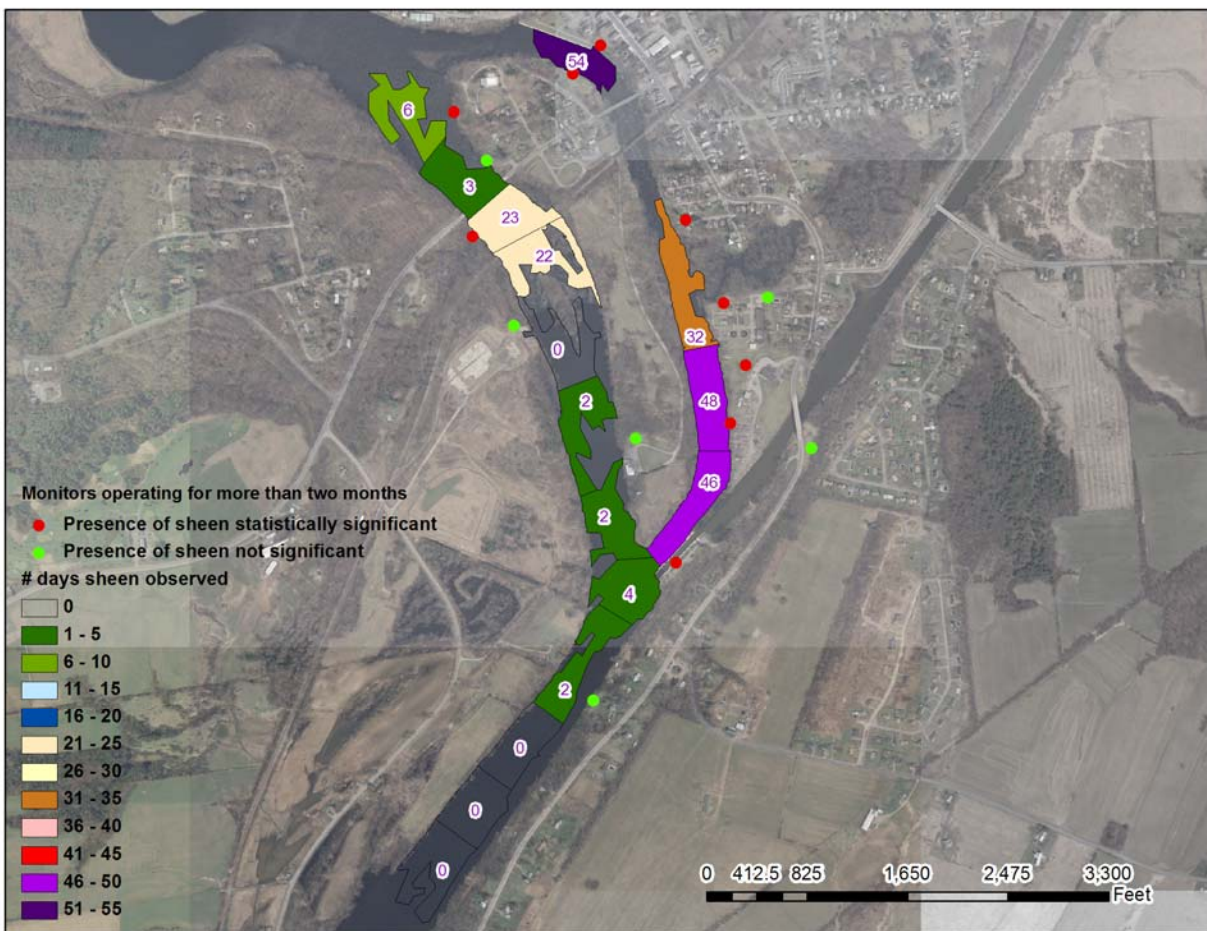


Figure 1. Northern Thompson Island Pool (NTIP) - Phase 1 Dredging Area.

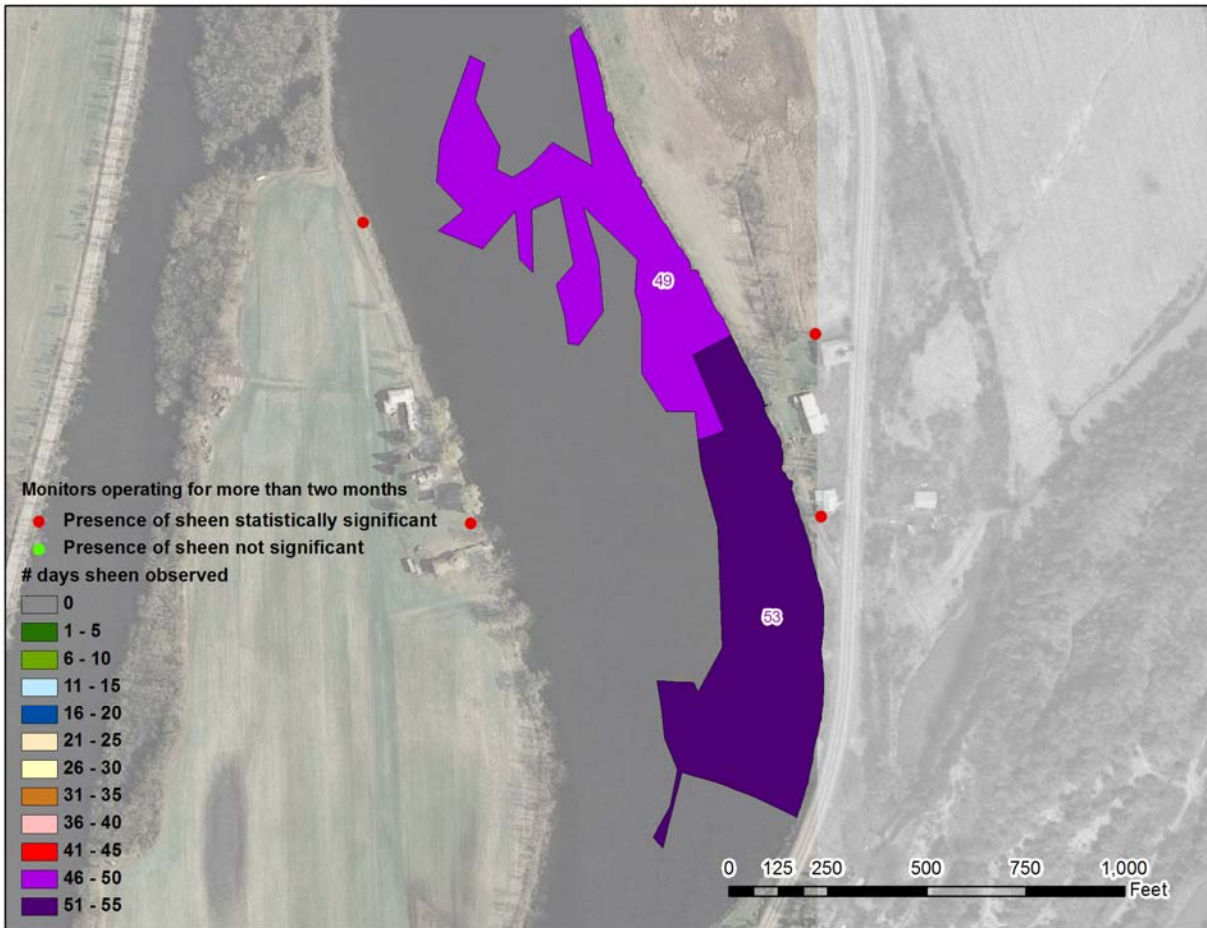


Figure 2. Eastern Griffin Island (EGI) - Phase 1 Dredging Area.

Box plots for all nineteen sites comparing presence and absence of sheen are displayed in Attachment 2. As shown, the highest concentrations were recorded in CU3. The average for both comparisons for monitor DRC-E1939-CI-00034 was above  $180 \text{ ng/m}^3$  and some of the highest monitoring concentrations obtained during Phase 1 were recorded at this monitor. The monitoring concentrations in CU2 also were relatively high. Although the concentrations across the observations for sheen presence are higher than sheen absence, this comparison is not statistically significant for monitor DRC-E1940-RR-00101. The observations for sheen presence in CU17 and CU18 were statistically significant for all monitoring sites. These two certification units also recorded fairly high ambient air PCB concentrations.

Since the recording of the presence of sheen was qualitative, the depth or the areal coverage of sheen plumes is unknown. Therefore, our analysis was limited to a qualitative evaluation. Additionally, the recording of sheen presence may not have been consistent throughout the dredging period. Although observations of sheen presence associated with vessel oil were removed from analysis there may be some occurrences of sheen attributed to vessel release. Finally, dredging was a 24-hour operation and documentation of sheen presence was generally noted during daylight hours.

Although some uncertainties and limitations in this analysis have been identified, a statistically significant relationship between the presence of sheen and ambient air total PCB concentrations for monitors closest to dredging activities was found. Our results are further supported by the conclusions of the study conducted by GE to evaluate application of absorbents to water-sediment mixtures.<sup>16</sup> The study concluded that the emission rate of PCBs appears to be directly proportional to the concentration of PCBs in the aqueous phase and that the presence of contaminated sediments below the water surface does not appear to greatly affect emission rates of PCBs.

### *Wind direction*

An evaluation of the influence of wind on ambient air PCB concentrations was conducted. Two meteorological stations were installed along the Hudson River during Phase 1. The monitors in CU17 and CU18 were evaluated with the meteorological station on Griffin Island and all other monitors were compared to the data from the station on Roger’s Island. The meteorological data were collected every 15 minutes, while the PCB concentrations were collected on a 24-hr basis. The wind data were assigned to one of four, 90 degree arcs (centered on north, east, south and west). A daily cumulative total of 15-minute increments for each of the four directions was obtained and the correlation (Spearman Rank Correlation Coefficient) between total PCB concentration and wind direction was determined. The correlation coefficients are displayed in Table 2. Values in bold are significant ( $p < 0.05$ ). A positive correlation coefficient indicates winds from that quadrant are associated with an increase in ambient air PCB concentration. Whereas, a negative coefficient indicates winds from that quadrant are associated with a decrease in PCB concentration.

**Table 2.** Spearman Rank Correlation Coefficients for comparisons between wind direction and total PCB concentration

Monitor Identification Code	(Southwest to Northwest)	(Southeast to Southwest)	(Northeast to Southeast)	(Northwest to Northeast)
DRC-C1944-UR-00065	-0.18	-0.085	<b>0.21</b>	0.0093
DRC-E1943-UR-00038	-0.0063	<b>0.32</b>	0.15	<b>-0.39</b>
DRC-E1940-CI-00043	0.095	<b>0.23</b>	-0.056	<b>-0.23</b>
DRC-E1940-RR-00101	0.12	<b>0.28</b>	-0.028	<b>-0.25</b>
DRC-E1941-UR-00040	0.042	0.35	0.061	-0.35
DRC-E1938-RR-00149	-0.12	-0.17	0.16	0.17
DRC-E1939-CI-00034	<b>0.28</b>	<b>0.50</b>	-0.17	<b>-0.45</b>
DRC-E1939-CI-00067	<b>0.24</b>	<b>0.44</b>	-0.089	<b>-0.43</b>
DRC-E1937-RR-00035	<b>-0.24</b>	<b>-0.19</b>	0.10	<b>0.29</b>
DRC-C1944-RR-00106	-0.27	<b>0.34</b>	0.077	-0.27
DRC-C1943-UR-00087	-0.10	0.17	0.17	<b>-0.22</b>

<sup>16</sup> General Electric Global Research Center Environmental Technology Lab September 29, 2009. Laboratory Study of Absorbents for Barge Contents PCB Emission Control Hudson River PCBs Superfund Site.

Monitor Identification Code	(Southwest to Northwest)	(Southeast to Southwest)	(Northeast to Southeast)	(Northwest to Northeast)
DRC-W1942-RR-00051	<b>-0.34</b>	-0.023	0.057	0.15
DRC-W1941-CI-00028	<b>-0.46</b>	-0.21	0.19	0.24
DRC-C1939-RR-00109	-0.17	0.073	0.14	-0.011
DRC-E1935-RR-00007	-0.092	0.042	-0.0040	0.033
DRC-C1902-RR-00068	-0.70	-0.30	<b>0.90</b>	0.50
DRC-E1901-RR-00057	0.037	<b>0.41</b>	-0.20	<b>-0.34</b>
DRC-C1901-RR-00066	<b>-0.32</b>	<b>-0.46</b>	<b>0.33</b>	<b>0.39</b>
DRC-E1901-RR-00036	0.036	<b>0.39</b>	0.0082	<b>-0.35</b>

In general, winds from the southeast to southwest direction were associated with an increase in total PCB air concentrations and winds from the northwest and northeast direction were associated with a decrease in concentration. A map of the statistically significant results is displayed in Figure 3. A limitation of this analysis is that it did not account for the influence of wind speed and relative humidity on total PCB air concentrations. Additionally, this exercise suggests that other factors not accounted for in this analysis influence PCB ambient air concentration. For example, monitor DRC-C1939-RR-00109 was statistically significant for the presence of sheen as shown in Figure 1, but PCB concentrations at this monitor were not correlated with wind direction. These results suggest that regardless of wind direction, for monitors located close to the river in certification units with frequent sheen sightings, that the relationship between sheen presence and ambient PCB concentrations is significant.



Figure 3. Wind directions correlated with PCB air concentrations.

## Conclusions and Recommendations

Because of the complexity of the project it was difficult during our review to isolate a single factor for some of the exceedance events. Additionally, the movement of monitors and the selecting to evaluate air monitoring samples based on wind direction made it difficult to assess the effectiveness of mitigation measures. However, our evaluation has revealed some reoccurring factors which should be addressed with more diligence in Phase 2. Below is a general summary of our findings and recommendations. In the subsequent sections, more detailed information is provided.

A statistically significant relationship was found between the presence of sheen and higher monitoring concentrations. We recommend the active removal of surface sheen using either absorbent materials which would be removed frequently or mechanical methods such as vacuuming into a closed container or tank.

Another significant finding was that the modeling of PCB releases to air conducted prior to Phase 1 dredging did not predict the high concentrations that were observed during Phase 1. Although a conservative model was utilized, other factors were not accounted for in the model and the results significantly underestimated the ambient levels for total PCBs measured in Phase 1. Going forward in Phase 2, a redesign of the monitoring network should be considered. The network should include monitors at the following locations: in areas where material is transferred from smaller vessels to larger vessels, Fort Edward community (background monitor), at the processing facility near stockpiles of coarse material, surrounding activities involving loading and unloading of material, and in areas located near residential and commercial receptors. An example of monitors meeting these criteria that were utilized in Phase 1 would be DRC-E-1939-CI-00034, PFX-E1943-RR-01269 and PFX-E1943-UR-00357. The monitoring network for Phase 2 should include monitors in close proximity of the operations to measure source signal and to properly assess if the mitigation measures implemented are achieving reductions. In locations where these activities are continuous and ongoing these monitors should be permanent and active.

Although, we found statistically significant correlations with wind direction, the correlations were not very strong which indicates that factors other than wind direction also contributed to the exceedances. Therefore, we do not recommend the continuing practice of selecting to analyze samples based on wind direction.

Some mitigation measures implemented in the NTIP dredging area appeared to be effective. One was the addition of water to hopper barges such that the majority of the sediment was covered with water. Another measure appears to be the reduction in the number of CUs under active dredging. If Phase 2, involves dredging in multiple CUs adjacent to each other, consideration should be given to implementing all of these mitigation measures before dredging begins. This recommendation is a result of the cumulative effect related to intense dredging in the CUs and dredging of multiple CUs on the air shed as observed during Phase 1 in July 2009.

Since the dredging activities in Phase 2 are more similar to the activities that took place in EGI dredging area a discussion of those measures that were successful is warranted. The EGI area differed from the NTIP because a sheet pile wall was used and the PCB concentrations in the sediment were not as high as the NTIP dredge area. In the early months, a mini-hopper barge was used for dredging within the sheet pile wall but was discontinued after July when it was concluded that the mini-hopper contributed to the exceedances of the QoLPS. A comparison between the monthly averages at the two monitors most often exceeding the QoLPS (see Attachment 1, DRC-E1901-RR-00036 and DRC-E1901-RR-00057), indicates that even in August high ambient PCB concentrations were present. Throughout the months the presence of sheen was observed inside the sheet pile wall. Therefore, active removal of surface sheen should be implemented if sheet pile walls are to be used in Phase 2.

At the processing facility most of the exceedances were attributed to the unloading of barges at the wharf. Even by September, exceedances were still being attributed to this activity which suggests that mitigation strategies were not all that effective. We recommend further evaluation into other mitigation strategies for the unloading of barges at the wharf be considered for Phase 2. Additionally, we know that GE experimented with the use of spray-on cellulose-based material for the exposed coarse material piles. We suggest an evaluation of the effectiveness of this material be conducted. In addition, the stock piling of contaminated material in large piles at the waterfront area should be minimized or avoided.

Finally, we recognize that some of the mitigation strategies while effectively reducing ambient air PCB levels may have lead to longer exposure periods of lower concentrations for nearby residents, such as reducing the number of active dredging vessels in CUs with high sediment concentrations and reducing the number of CUs under dredging. Additionally, the use of the sheet pile wall, while reducing movement of suspended sediment down river, contained NAPL releases contributing to exceedances at nearby monitors. We believe that successful mitigation of NAPL releases (surface sheen oil) should address the problem of ambient air exceedances caused by the aforementioned mitigation strategies.

### **Fort Edward Background Community Monitor**

Although many of the monitor concentrations were within the levels reported prior to dredging, this monitor does appear to be impacted by activities both in the dredge corridor and at the processing facility. On a number of occasions, the highest recorded concentration at the background monitor coincided with elevations at NTIP dredge corridor monitors. Of significance is the fact that the PCB concentrations at the background monitor (which was not a compliance monitoring location) was low compared to the standards but elevated compared to previously recorded background measurements. The second highest recorded value of 30.4 ng/m<sup>3</sup> was recorded during mid-July which coincided with the highest concentrations obtained during Phase 1 dredging.

Although Phase 2 activities are generally focused on areas below the NTIP, because the background monitor was influenced by the activities at the processing facility coupled with the fact that exceedances at the facility monitors seemed to be related to the accumulation of material, it is recommended that the background monitor remain in place for Phase 2 operations.

## **Surface Sheen**

Our analysis of the ambient air concentrations of PCBs identified the presence of sheen during many exceedance events in the dredge corridor. Additionally, we found a statistical significance for the presence of sheen and higher PCB concentrations. Although mitigation of sheen was conducted by the deployment of absorbent material, on many occasions the absorbent material was not collected after saturation. We believe removal of surface sheen when present will reduce the exceedances of the QoLPS and potentially will reduce dredging delays associated with exceedances of the QoLPS which occurred during Phase I.<sup>17</sup> We recommend that the active collection of surface sheen be an integral part of Phase 2.

## **Exposed Dredge Material**

A number of exceedances occurred in areas without active dredging but were locations of exposed dredged material. For example, a number of exceedances occurred in CU13, where full barges were moored waiting for transfer through Lock 7. Exceedances also occurred at the processing facility where sediments were staged awaiting rail transport. Some of the mitigation measures implemented to cover material or reduce exposure included the use of an interior freeboard, the addition of water to cover the sediment on barges, the use of spray-on material, and covering coarse material at the processing facility. It was apparent that the use of a large freeboard did not effectively reduce PCB volatilization since this was implemented early in the dredging process (May) and exceedances occurred as a result of transport after implementation. Since Phase 2 involves dredging in the lower region of the Hudson River, material will be transported over a longer distance increasing exposure time. We recommend the covering of dredged material either with tarps or spray-on material to reduce volatilization at the processing facility and during transport of material.

## **Use of sheet pile wall**

A sheet pile wall was installed in CU18 to test measures to contain sediment during dredging. The wall was effective at reducing the transport of PCBs down the river as water sampling showed total PCBs outside the wall were approximately two orders of magnitude lower than PCB water measurements inside the enclosure. But the containment of the sediment and sheens released inside the wall lead to exceedances of the residential QoLPS. When the sheet pile wall was removed in August, only one exceedance of the residential QoLPS occurred (in September).

Utilization of the sheet pile wall in Phase 2, in addition to reducing transport of sediment would contain liberated sheen oils. The containment of these oils should then be removed more readily with absorbent material or vacuuming. If sheet pile walls are used in Phase 2, we recommend the active collection and removal of sheens when present.

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<sup>17</sup> Anchor QEA LLC & Arcadias. March 2010. Phase 1 Evaluation Report Hudson River PCBs Superfund Site. Prepared for General Electric Company. Albany, New York.

**Attachment 1 - Total PCB Concentration for each Monitor by Month**

Monitor Location Identification Code	Month	Total PCB Concentration (ng/m <sup>3</sup> )		Type
		Average	Range	
DRC-C1901-RR-00066	June	10.6	( 10.4 - 10.8 )	Residential
	July	25.7	( 6.24 - 73.2 )	
	August	18.1	( 3.48 - 84.1 )	
	September	25.5	( 3.47 - 55.6 )	
	October	7.84	( 3.44 - 18.0 )	
DRC-C1902-RR-00068	June	11.7	( 5.61 - 28.8 )	Residential
	July	14.2	( 3.44 - 31.8 )	
	August	12.8	( 3.44 - 37.7 )	
DRC-C1937-RR-00100	May	3.45	( 3.45 - 3.45 )	Residential
	June	19.8	( 10.1 - 31.5 )	
DRC-C1938-RR-00094	May	28.6	( 28.4 - 28.7 )	Residential
	June	53.1	( 37.8 - 68.3 )	
DRC-C1939-RR-00047	May*	150	( 104 - 195 )	Residential
	June	48.2	( 45.2 - 51.1 )	
DRC-C1939-RR-00088	May	8.97	( 3.44 - 14.5 )	Residential
	June	15.2	( 13.8 - 16.6 )	
DRC-C1939-RR-00109	June	14.4	( 14.4 - 14.4 )	Residential
	July	36.4	( 3.46 - 106 )	
	August	37.3	( 12.8 - 88.4 )	
	September	76.9	( 10.8 - 256 )	
	October	24.7	( 3.47 - 59.1 )	
DRC-C1940-RR-00050	May	16.6	( 16.6 - 16.6 )	Residential
	June	20.9	( 11.4 - 30.4 )	
DRC-C1940-RR-00056	May	8.90	( 8.90 - 8.90 )	Residential
DRC-C1940-RR-00069	June	41.9	( 3.44 - 139 )	Residential
DRC-C1940-RR-00146	June	5.32	( 3.44 - 9.07 )	Residential
DRC-C1941-RR-00064	May	6.06	( 3.44 - 8.68 )	Residential
	June	6.72	( 3.44 - 10.6 )	
DRC-C1941-RR-00080	May	3.44	( 3.44 - 3.44 )	Residential
DRC-C1941-RR-00084	June	4.33	( 3.44 - 7.86 )	Residential
DRC-C1941-RR-00129	May	18.6	( 3.44 - 72.1 )	Residential
	June	11.5	( 3.44 - 18.6 )	
DRC-C1942-RR-00122	June	8.02	( 3.44 - 12.6 )	Residential
DRC-C1942-RR-00126	June	6.09	( 3.44 - 11.6 )	Residential
DRC-C1943-UR-00087	June	6.17	( 3.44 - 17.9 )	Residential
	July	25.3	( 3.45 - 125 )	
	August	25.5	( 3.49 - 126 )	
	September	27.6	( 11.0 - 62.0 )	
DRC-C1944-RR-00106	May	7.63	( 3.44 - 11.8 )	Residential
	June	6.81	( 3.44 - 17.7 )	
	July	10.6	( 3.44 - 40.9 )	
	August	19.6	( 3.44 - 86.9 )	

Monitor Location Identification Code	Month	Total PCB Concentration (ng/m <sup>3</sup> )		Type
		Average	Range	
DRC-C1944-UR-00040	May	13.6	( 13.6 - 13.6 )	Residential
	June	6.12	( 3.44 - 18.2 )	
DRC-C1944-UR-00065	June	9.57	( 3.44 - 40.6 )	Residential
	July	16.9	( 3.45 - 39.9 )	
	August	24.0	( 3.44 - 69.0 )	
	September	28.8	( 3.44 - 84.2 )	
	October	18.0	( 3.44 - 50.6 )	
DRC-E1900-RR-00033	May	42.0	( 8.69 - 75.4 )	Residential
DRC-E1901-RR-00036	June	5.86	( 3.44 - 8.28 )	Residential
	July	84.5	( 16.2 - 149 )	
	August	88.0	( 3.46 - 346 )	
	September	27.9	( 3.44 - 119 )	
	October	12.4	( 3.44 - 49.9 )	
DRC-E1901-RR-00057	June	6.63	( 3.44 - 10.0 )	Residential
	July	42.8	( 3.44 - 112 )	
	August	58.8	( 3.44 - 218 )	
	September	18.5	( 3.44 - 107 )	
	October	3.45	( 3.45 - 3.45 )	
DRC-E1902-RR-00009	May	55.3	( 20.7 - 89.9 )	Residential
	June	3.48	( 3.44 - 3.51 )	
DRC-E1932-RR-00037	July	13.9	( 3.44 - 24.4 )	Residential
DRC-E1933-RR-00022	June	3.50	( 3.50 - 3.50 )	Residential
DRC-E1933-RR-00022	July	10.2	( 3.44 - 17.0 )	Residential
DRC-E1934-RR-00049	June	3.56	( 3.56 - 3.56 )	Residential
	July	10.8	( 10.8 - 10.8 )	
DRC-E1935-RR-00007	June	18.7	( 3.44 - 62.0 )	Residential
	July	56.1	( 3.48 - 192 )	
	August	37.8	( 3.46 - 98.9 )	
	September	64.5	( 10.2 - 163 )	
	October	33.9	( 8.10 - 82.2 )	
	November	7.78	( 3.45 - 12.1 )	
DRC-E1937-RR-00042	July	7.72	( 3.44 - 12.0 )	Residential
DRC-E1938-RR-00149	July	22.9	( 3.44 - 34.5 )	Residential
	August	20.6	( 3.44 - 67.5 )	
	September	40.7	( 3.44 - 190 )	
	October	16.6	( 3.44 - 48.6 )	
DRC-E1940-RR-00101	July	63.2	( 16.7 - 109 )	Residential
	August	60.7	( 3.44 - 454 )	
	September	57.0	( 11.5 - 234 )	
	October	20.2	( 10.2 - 33.9 )	
DRC-E1941-UR-00036	May	15.0	( 15.0 - 15.0 )	Residential
	June	7.24	( 3.44 - 13.1 )	

Monitor Location Identification Code	Month	Total PCB Concentration (ng/m <sup>3</sup> )		Type
		Average	Range	
DRC-E1941-UR-00040	June	9.67	( 3.44 - 18.4 )	Residential
	July	50.1	( 3.49 - 152 )	
	August	70.5	( 3.44 - 424 )	
	September	58.1	( 10.3 - 196 )	
	October	13.3	( 3.47 - 29.7 )	
DRC-E1943-UR-00038	June	13.4	( 3.44 - 55.7 )	Residential
	July	24.3	( 3.48 - 57.6 )	
	August	25.1	( 3.44 - 83.1 )	
	September	29.9	( 3.44 - 64.5 )	
	October	15.6	( 3.44 - 62.6 )	
DRC-E1944-UR-00023	May	4.98	( 3.44 - 8.05 )	Residential
	June	11.3	( 3.44 - 38.2 )	
DRC-E1944-UR-00040	May	3.46	( 3.44 - 3.48 )	Residential
DRC-W1931-RR-00051	July	5.28	( 3.51 - 7.05 )	Residential
DRC-W1932-RR-00052	July	9.58	( 3.47 - 15.7 )	Residential
DRC-W1938-RR-00043	May	5.60	( 3.44 - 7.76 )	Residential
	June	17.1	( 9.77 - 24.4 )	Residential
DRC-W1939-RR-00010	May	6.30	( 3.44 - 9.15 )	Residential
	June	11.8	( 10.7 - 12.9 )	
DRC-W1940-RR-00021	May	79.0	( 79.0 - 79.0 )	Residential
DRC-W1940-RR-00049	May	47.9	( 3.45 - 92.3 )	Residential
DRC-W1940-RR-00058	June	9.49	( 3.44 - 22.0 )	Residential
DRC-W1940-RR-00067	May	41.9	( 9.00 - 158 )	Residential
	June	21.5	( 3.44 - 56.2 )	
DRC-W1940-RR-00114	May	8.32	( 3.44 - 13.2 )	Residential
DRC-W1942-RR-00041	June	4.89	( 3.44 - 9.22 )	Residential
DRC-W1942-RR-00051	June	3.44	( 3.44 - 3.44 )	Residential
	July	16.5	( 3.47 - 86.6 )	
	August	16.0	( 3.45 - 32.8 )	
	September	28.1	( 3.44 - 67.6 )	
	October	8.06	( 3.44 - 31.0 )	
DRC-W1943-RR-00011	June	6.35	( 3.44 - 9.64 )	Residential
	July	8.01	( 3.44 - 19.3 )	
DRC-W1943-RR-00027	June	3.98	( 3.44 - 8.25 )	Residential
DRC-W1944-RR-00008	May	3.44	( 3.44 - 3.44 )	Residential
	June	4.95	( 3.44 - 11.3 )	
PFF-PERI-RR-00943	May	1.31	( 0.40 - 2.29 )	Residential
	June	15.8	( 1.72 - 44.0 )	
	July	26.4	( 1.33 - 74.4 )	
	August	25.4	( 2.02 - 81.1 )	
	September	54.4	( 3.94 - 148 )	
	October	33.1	( 3.24 - 116 )	
	November	21.1	( 3.02 - 56.4 )	
	December	8.54	( 2.88 - 20.8 )	

Monitor Location Identification Code	Month	Total PCB Concentration (ng/m <sup>3</sup> )		Type
		Average	Range	
PFF-PERI-RR-01491	May	9.49	( 0.51 - 41.8 )	Residential
	June	6.96	( 0.77 - 32.1 )	
	July	35.0	( 1.62 - 100.0 )	
	August	42.4	( 2.96 - 141 )	
	September	71.9	( 4.82 - 328 )	
	October	41.9	( 8.22 - 165 )	
	November	17.7	( 2.22 - 56.4 )	
	December	21.6	( 7.98 - 38.8 )	
PFX-E1943-RR-01269	June	55.8	( 9.60 - 148 )	Residential
	July	52.7	( 3.48 - 154 )	
	August	51.1	( 11.1 - 259 )	
PFX-E1943-RR-01324	July	28.2	( 3.44 - 134 )	Residential
	August	32.8	( 3.44 - 187 )	
	September	61.5	( 3.44 - 289 )	
	October	28.3	( 3.44 - 81.7 )	
	November	8.08	( 3.44 - 24.0 )	
DRC-E1943-RR-01306	May	3.44	( 3.44 - 3.44 )	Residential
DRC-W1935-RR-00024	July	4.33	( 3.44 - 5.21 )	Residential
PFF-PERI-RR-01018	May	1.26	( 0.95 - 1.47 )	Residential
	June	7.38	( 2.13 - 16.6 )	
	July	8.19	( 7.29 - 9.09 )	
	August	45.1	( 24.1 - 66.1 )	
	September	28.0	( 20.5 - 35.6 )	
	November	14.3	( 14.3 - 14.3 )	
PFF-PERI-RR-01380	May	1.83	( 0.65 - 3.93 )	Residential
	June	4.62	( 1.51 - 15.7 )	
	July	2.23	( 2.23 - 2.23 )	
	August	18.1	( 18.1 - 18.1 )	
	September	18.4	( 13.4 - 23.4 )	
	November	10.4	( 8.55 - 12.2 )	
PFX-E1943-RR-01306	May	6.12	( 3.44 - 10.0 )	Residential
	June	8.16	( 3.44 - 29.6 )	
PFX-E1943-UR-00357	May	3.44	( 0.40 - 15.4 )	Background
	June	3.33	( 1.11 - 10.7 )	
	July	7.30	( 1.16 - 30.4 )	
	August	9.55	( 1.54 - 41.7 )	
	September	12.7	( 1.81 - 34.0 )	
	October	6.34	( 1.74 - 12.7 )	
DRC-W1934-CI-00022	June	11.2	( 11.2 - 11.2 )	Commercial
	July	15.9	( 15.9 - 15.9 )	
BAC-E1937-RR-00035**	May	18.4	( 3.44 - 83.0 )	Commercial
	June	26.4	( 3.44 - 77.4 )	
	June	20.1	( 3.44 - 56.7 )	
	July	42.8	( 3.48 - 111 )	

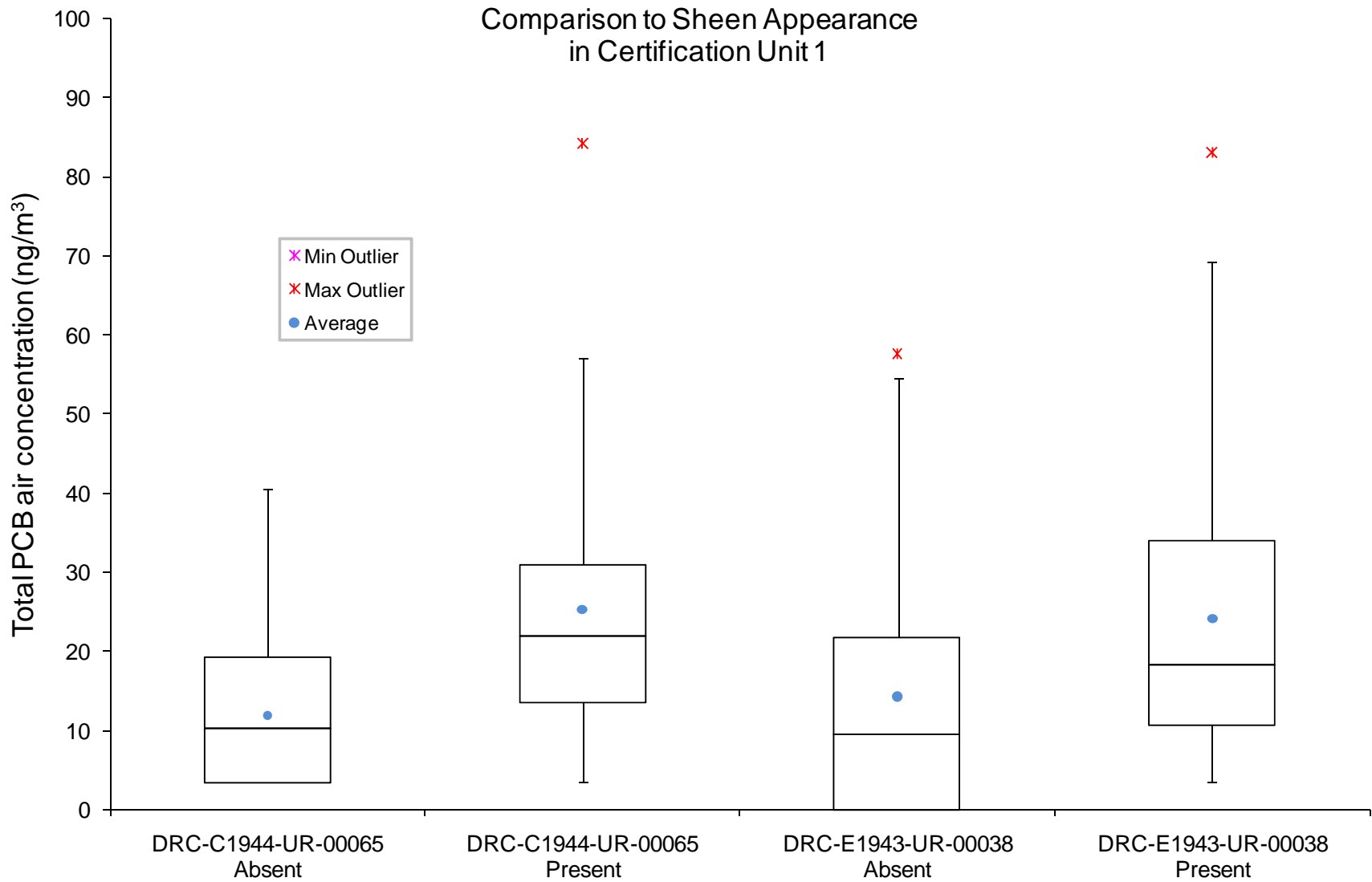
Monitor Location Identification Code	Month	Total PCB Concentration (ng/m <sup>3</sup> )		Type
		Average	Range	
	August	36.6	( 9.51 - 109 )	
	September	75.5	( 9.65 - 326 )	
	October	37.1	( 3.44 - 146 )	
	November	3.46	( 3.45 - 3.47 )	
DRC-E1938-CI-00038	June	30.7	( 28.2 - 33.2 )	Commercial
DRC-E1939-CI-00067	July	139	( 11.9 - 485 )	Commercial
	August	92.1	( 3.44 - 389 )	
	September	97.0	( 13.0 - 295 )	
	October	28.5	( 3.45 - 67.8 )	
DRC-E1940-CI-00024	May	18.0	( 10.7 - 25.2 )	Commercial
	June	9.12	( 3.44 - 14.8 )	
DRC-W1937-CI-00039	June	7.52	( 3.44 - 11.6 )	Commercial
	July	3.48	( 3.45 - 3.52 )	
DRC-W1941-CI-00028	July	18.6	( 3.47 - 58.9 )	Commercial
	August	15.4	( 3.44 - 50.3 )	
	September	19.7	( 3.44 - 48.5 )	
	October	7.35	( 3.44 - 30.4 )	
PFX-E1943-CI-01705	October	23.4	( 10.0 - 52.7 )	Commercial
DRC-E1939-CI-00034	May*	402	( 9.36 - 1.15E+03 )	Commercial
	June	43.3	( 28.8 - 57.7 )	
	July	690	( 87.4 - 4.24E+03 )	
	August	235	( 31.0 - 845 )	
	September	204	( 32.8 - 500 )	
	October	72.8	( 8.03 - 250 )	
	November	7.17	( 3.44 - 11.0 )	
DRC-E1940-CI-00043	June	49.5	( 3.44 - 272 )	Commercial
	July	77.2	( 3.51 - 289 )	
	August	91.3	( 13.5 - 772 )	
	September	76.7	( 8.60 - 399 )	
	October	23.1	( 12.2 - 43.9 )	

Footnote: Half the detection limit, as reported in the data, was used for non-detects.

\* Monitor operated less than 30 days for that month

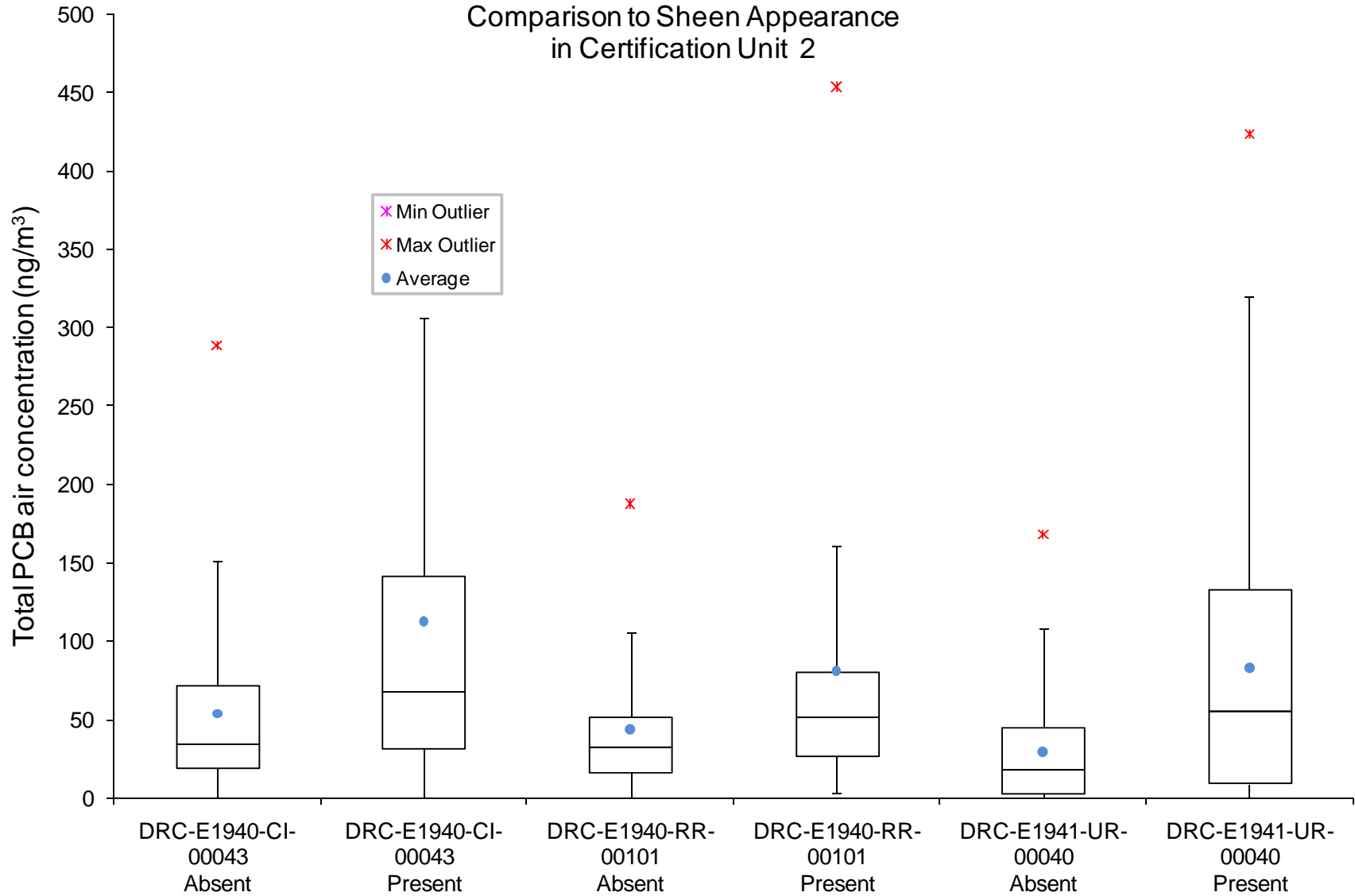
\*\* This monitor does not follow type assignment based on zoning. The monitor identification code indicates it should be a residential monitor since it is located in rural residential zoning. GE assigned it to be a commercial monitor. See Table 3.1-2 in GE's Phase I Data Compilation Report, November 2009.

**Attachment 2 – Box Plots of concentrations in reference to presence of surface sheen**



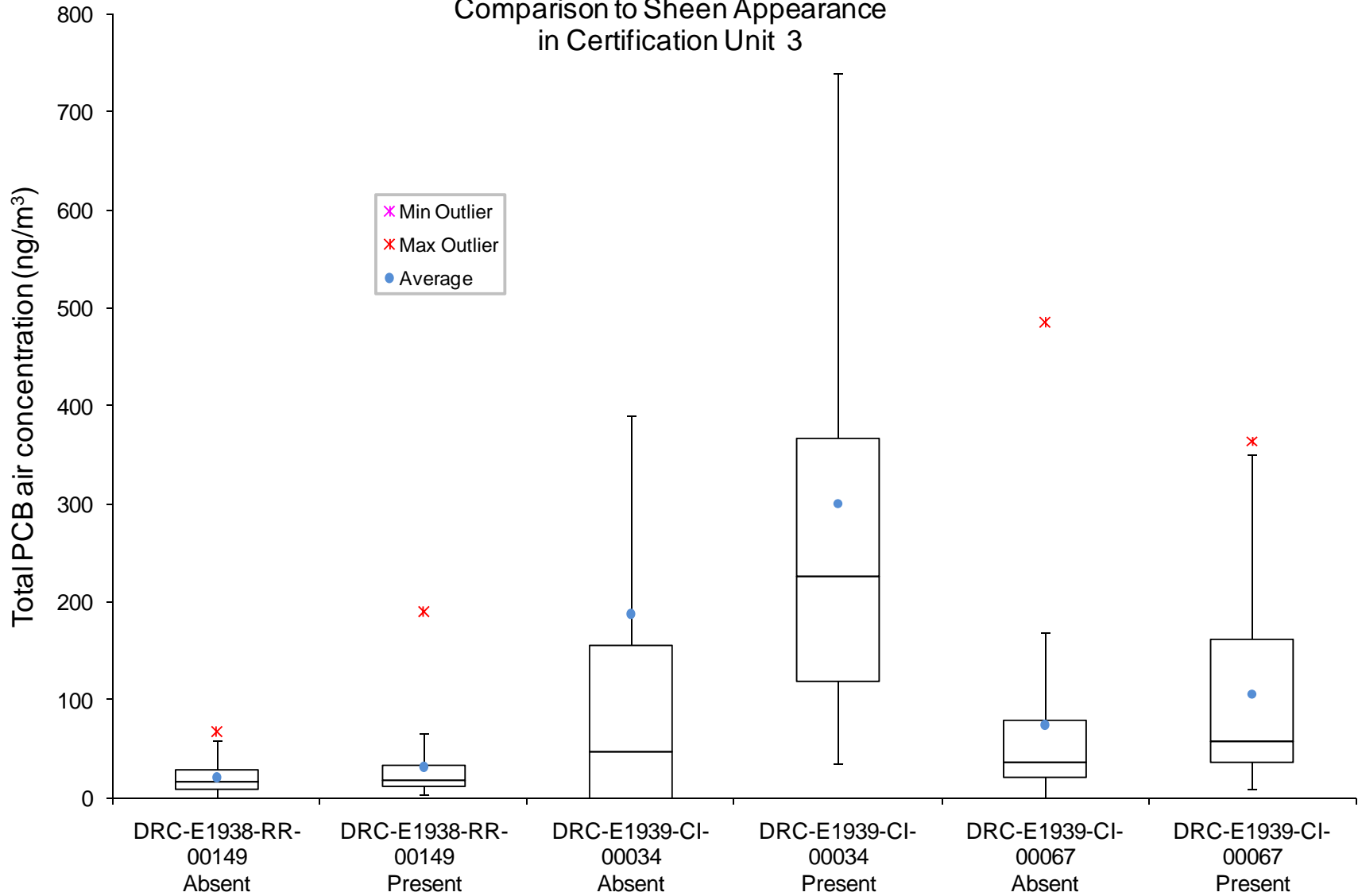
To minimize Y-axis scale - some maximum outliers may not be displayed

### Comparison to Sheen Appearance in Certification Unit 2



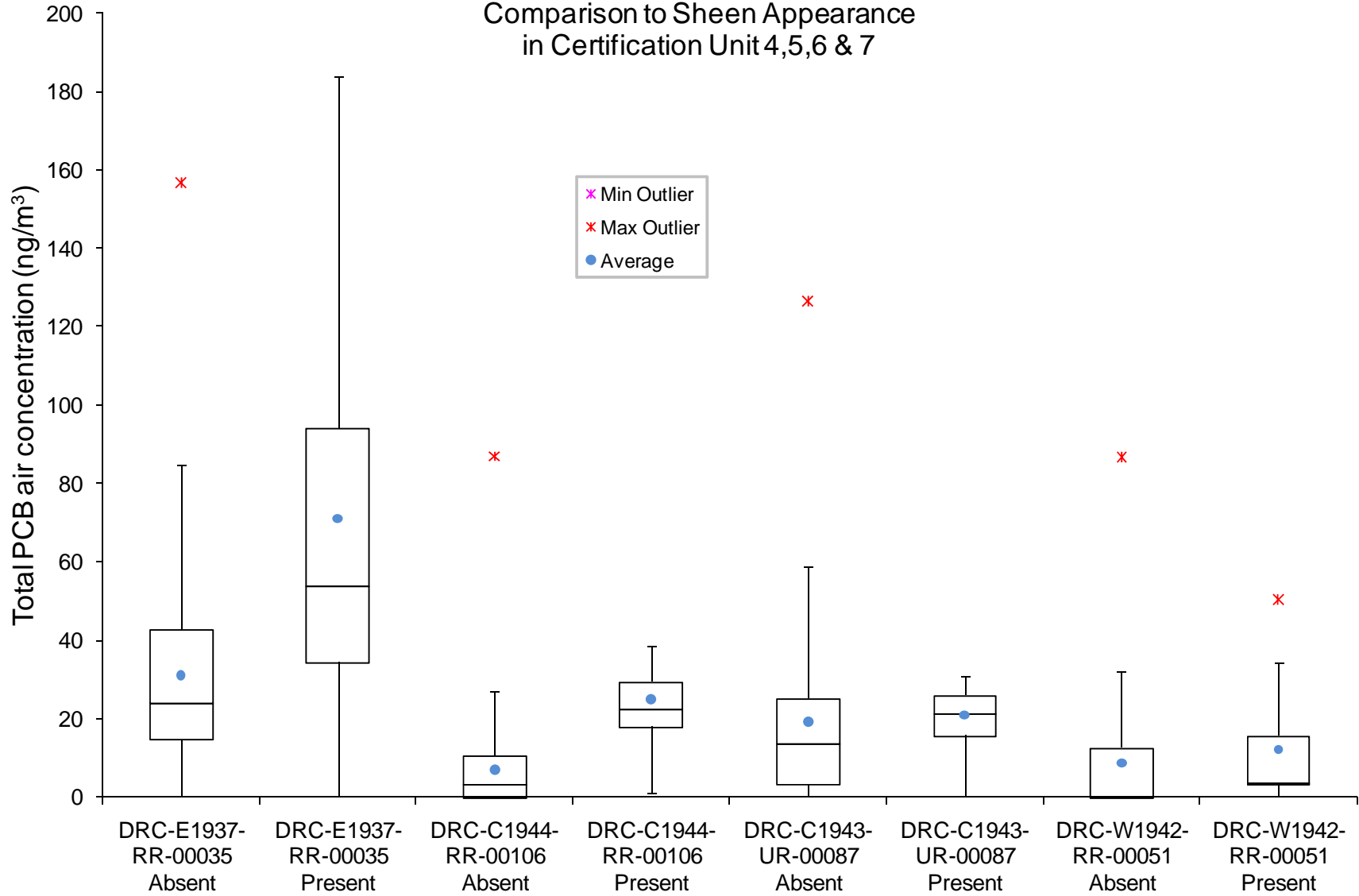
To minimize Y-axis scale - some maximum outliers may not be displayed

### Comparison to Sheen Appearance in Certification Unit 3



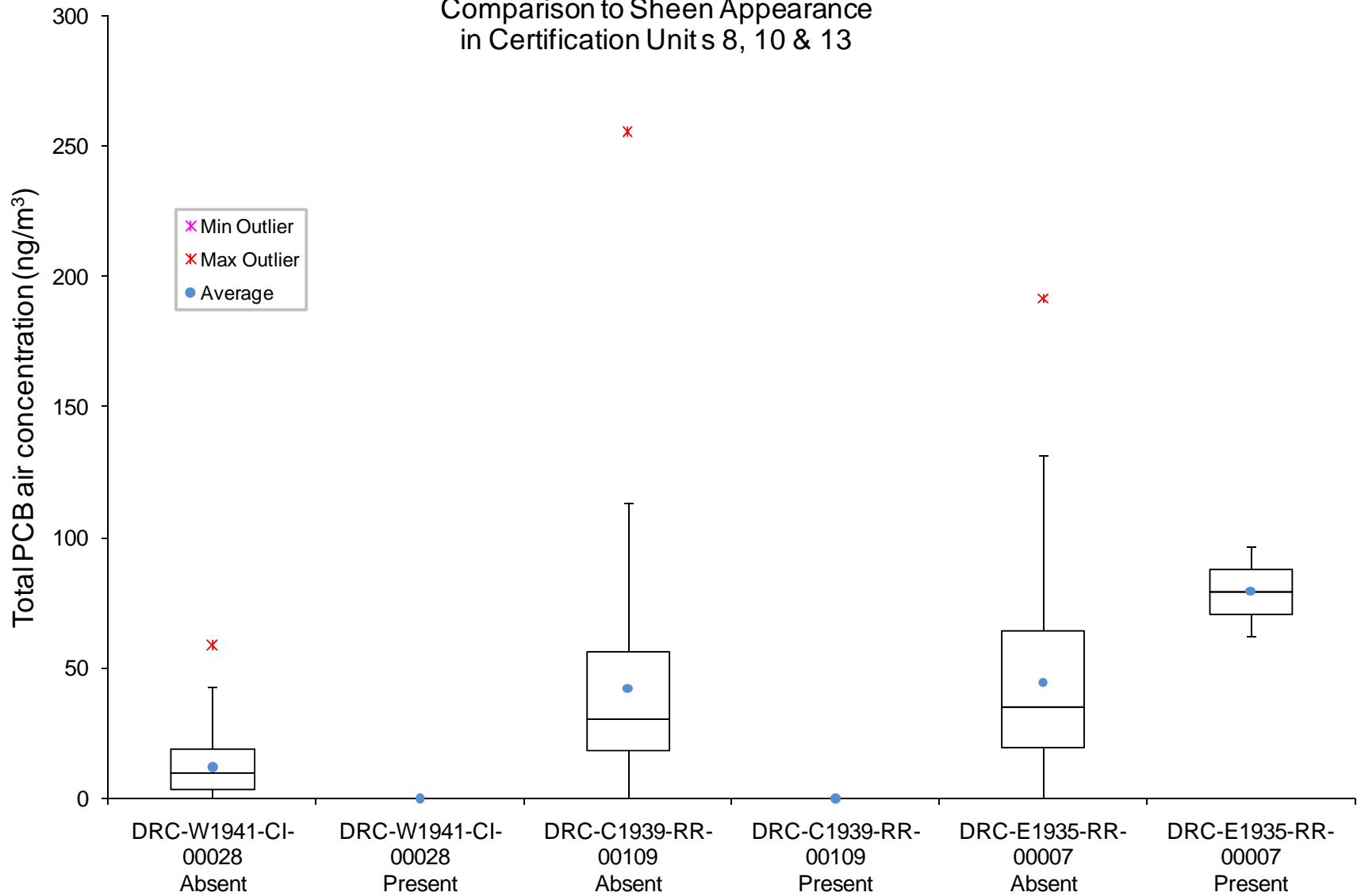
To minimize Y-axis scale - some maximum outliers may not be displayed

### Comparison to Sheen Appearance in Certification Unit 4,5,6 & 7



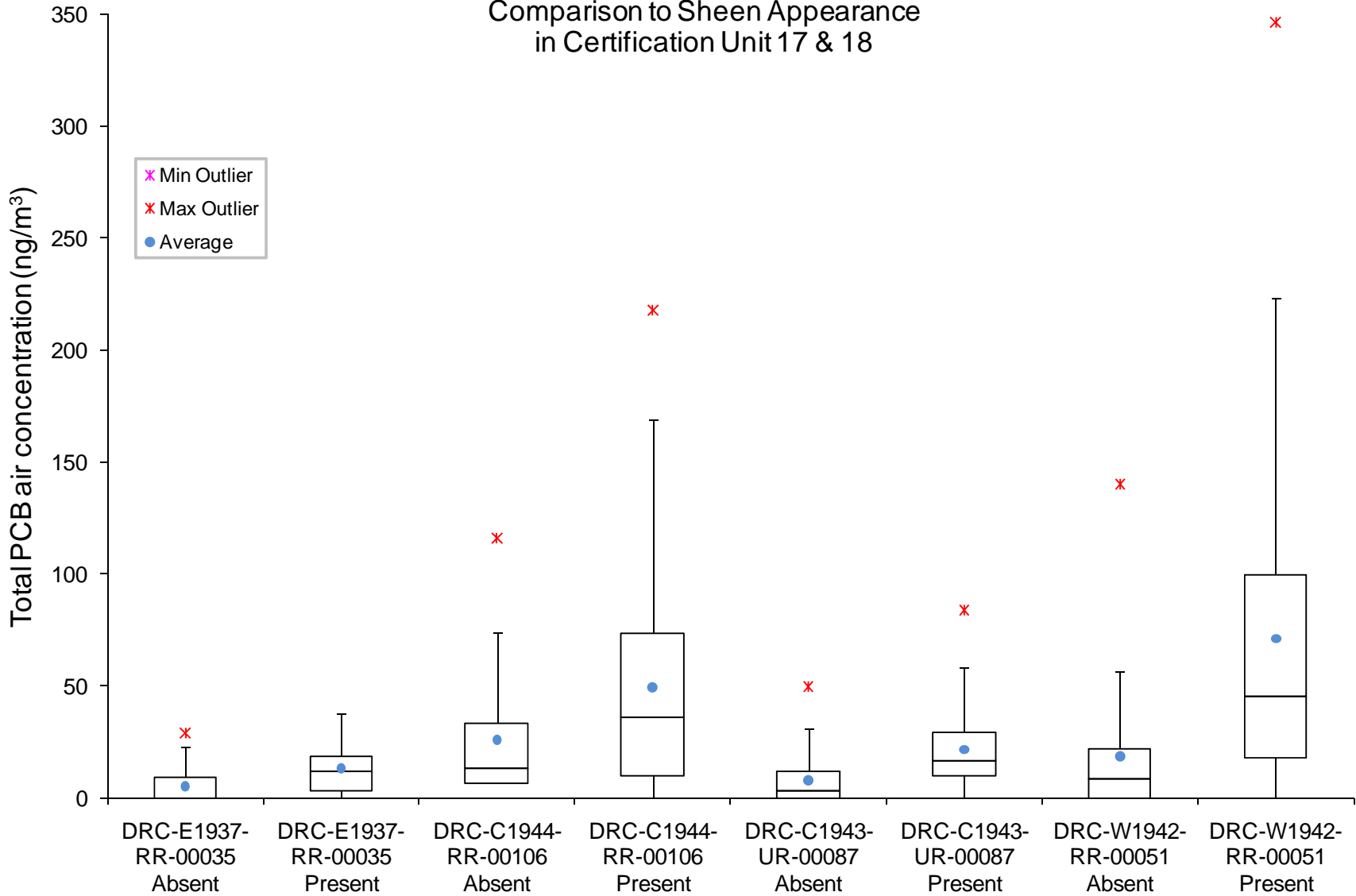
To minimize Y-axis scale - some maximum outliers may not be displayed

### Comparison to Sheen Appearance in Certification Units 8, 10 & 13



To minimize Y-axis scale - some maximum outliers may not be displayed

### Comparison to Sheen Appearance in Certification Unit 17 & 18



To minimize Y-axis scale - some maximum outliers may not be displayed