Data Evaluation Report No. 4:
“Surface Sediment Contamination”

LOWER EIGHT MILES OF THE LOWER PASSAIC RIVER DATA EVALUTION REPORT NO. 4: SURFACE SEDIMENT CONTAMINATION

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1 INTRODUCTION

This document is part of a series of data evaluation reports, which were prepared to support the Remedial Investigation (RI) and Focused Feasibility Study (FFS). Reports in this series describe different aspects of the Lower Passaic River. Where necessary, data evaluation reports are cross-referenced to direct the reader to another report that contains further explanation. Topics discussed in this series include major sediment and water investigations conducted in the river, boundary conditions on the river, historical sediment contamination, surface sediment contamination, contaminant inventory calculations, and biota analysis. The following data evaluation report summarizes the observations of surface sediment contamination within the FFS Study Area and portions of Newark Bay, and describes major sampling programs conducted on the river.

1.1 Overview of the FFS Study Area

The FFS Study Area is located within the Lower Passaic River Study Area (LPRSA), which is the 17-mile, tidal portion of the Passaic River from Dundee Dam [located at River Mile (RM[1]) 17.4] to the confluence with Newark Bay at RM0 and the watershed of this river portion, including the Saddle River (RM15.6), Third River (RM11.3) and Second River (RM8.1) [Figure 1-1]. During a comprehensive study of the Lower Passaic River, the sediments of the lower eight miles were found to be a major source of contamination to the rest of the river and Newark Bay. Therefore, the United States Environmental Protection Agency (USEPA) completed the FFS to evaluate alternatives to address those sediments in the lower eight-mile stretch from RM0 to RM8.3, near the border between the City of Newark and Belleville Township. The entire 17-mile Lower Passaic River is the subject of another Remedial Investigation/Feasibility Study (RI/FS) being implemented by the Cooperating Parties Group (CPG; a group of approximately 70

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[1] The FFS uses the “River Mile” (RM) system developed by the United States Army Corps of Engineers (USACE), which follows the navigation channel of the Lower Passaic River. The Data Evaluation Reports (Appendix A), Empirical Mass Balance (Appendix C) and Lower Passaic River-Newark Bay model (Appendix B) were initially developed at the beginning of the 17-mile Remedial Investigation and Feasibility Study (RI/FS), and thus follow a RM system developed for that RI/FS, which follows the geographic centerline of the river. RM0 is defined by an imaginary line between two marker lighthouses at the confluence of the Lower Passaic River and Newark Bay: one in Essex County just offshore of Newark and the other in Hudson County just offshore of Kearny Point. River miles then continue upriver to the Dundee Dam (RM17.4). The two RM systems are about 0.2 miles apart.

potentially responsible parties who signed an agreement with USEPA in 2007), under USEPA oversight. The Upper Passaic River watershed (the portion of the Passaic River located above the Dundee Dam) contributes solids, water, and contaminants that cross over the head-of-tide, which is represented by the Dundee Dam[2], into the Lower Passaic River.

1.2 Overview of Lower Passaic River Surface Sediment Contamination

Surface sediment data for the FFS Study Area were available from various studies conducted on the river between 1991 and 2012. The list of sampling programs included in this report is presented in Table 1-1. The objective of this data evaluation report is to describe the spatial and temporal characteristics of surface sediment contamination in the Lower Passaic River, while also noting conditions at the two main boundary areas, the Upper Passaic River and Newark Bay. A more detailed discussion of the relationship between Lower Passaic River surface sediment contamination and the various external sources of sediment can be found in Data Evaluation Report No. 2. The compounds considered in this data evaluation report are listed in Table 1-2. While surface sediments in this analysis constitute sediments within the top 6 inches of the sediment bed or less, there are differences in the age of the sediments contained within those samples, depending on the local rate of deposition. Given the broad range of deposition rates observed in the Lower Passaic River, a 6-inch sample may represent any of the following: i) prehistoric sediments (from a non-depositional area), ii) a few months of deposition (in a rapidly accumulating location), or iii) a few decades of deposition (in a slowly or irregularly accumulating location). To distinguish samples containing recently-deposited sediments, beryllium-7 (Be-7) was measured in the top 2 inches of a subset of the 0 to 6 inch samples. In all, four types of surface sediment samples are reviewed in this report:

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[2] The Dundee Dam represents a hydraulic boundary separating the Upper and Lower Passaic River. The head-of-tide actual location is downstream of the dam because the Lower Passaic River rises above sea level close to the dam (refer to Lower Passaic River System Understanding of Sediment Transport [HQI and Sea Engineering Inc, 2011] for further details on the salt front migration).

- Surface sediment samples obtained from 0 to 1 inches with measureable levels of Be-7,
- Surface sediment samples obtained from 0 to 6 inches with measureable levels of Be-7 in the top 2 inches,
- Surface sediment samples obtained from 0 to 6 inches, and
- Surface sediment samples obtained from 0 to 2 inches.

The technical basis for the use of Be-7 in identifying recently-deposited sediments is discussed below in addition to a brief description of the sediment sample types listed above. This discussion is followed by a description of the use of Total Organic Carbon (TOC) and iron as normalizing factors in the examination of the surface sediment samples. In addition to the introduction, the remainder of this report describes the distribution of contaminants in the surface sediments of the Lower Passaic River and is organized around compound classes as follows:

- *Section 2.0,Temporal and Spatial Trends of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) and Total Tetrachlorodibenzo-p-dioxin (Total TCDD)*: The section describes the concentrations of 2,3,7,8-TCDD and Total TCDD in surface sediment from the various historical studies from 1991 to 2012 and outlines the framework of the conceptual site model that explains the observations of dioxin contamination.
- *Section 3.0, Temporal and Spatial Trends for Other Contaminants*: provides temporal and spatial trends of concentrations of polychlorinated biphenyls (PCBs), pesticides, polycyclic aromatic hydrocarbons (PAHs) and metals in surface sediment from various historical studies from 1991 to 2012. This section focuses on differences in the spatial distribution of the other contaminants of potential concern (COPCs) and contaminants of potential ecological concern (COPECs) relative to that for 2,3,7,8-TCDD.
- *Section 4.0, Summary:* provides a summary of the surface sediment analyses.
- *Section 5.0, Acronyms*: defines the acronyms used in this report.
- *Section 6.0, References*: lists the references used in this report.

For each of the COPCs and COPECs, results are presented as follows:

- Maps of contaminant concentrations for 1991 to 2012 to present spatial and temporal distributions,
- Statistical comparisons of contaminant concentrations across sampling programs to examine temporal variation in concentrations,
- Plots of contaminant concentrations by river mile for 0 to 6 inch samples, 0 to 2 inch samples, and Be-7 bearing samples to further examine spatial trends, and
- Maps of contaminant concentrations by river mile, sediment texture, and location relative to the navigation channel to further explore the spatial variation of contamination.

1.2.1 Use of Beryllium-7 to Identify Recently-Deposited Sediments

Recently-deposited sediments can be distinguished from other surface sediments by the presence of Be-7 in the sediments. Be-7 is a naturally occurring radionuclide with a half-life of 53.4 days. This radionuclide is detectable in sediments within approximately 4 to 5 half-lives of deposition, or about 200 to 250 days (6-12 months). It is produced by the impact of cosmic rays on nitrogen and oxygen in the earth's atmosphere. Once produced, particle-reactive Be-7 rapidly becomes associated with aerosols in the atmosphere, and then deposited on the earth's surface, continuously and practically uniformly, primarily as a result of washout by precipitation. A thorough review of the geochemical application of Be-7 in evaluating sediment dynamics is provided by Kaste *et al.* (2002).

Once deposited in a river’s watershed, the Be-7 partitions strongly to surface soils. Studies by Hawley *et al.* (1986) and You *et al.* (1989) calculate a soil/water partitioning coefficient, K_d, of 10^4 to 10^6. Other field and laboratory evidence has shown that on land, Be-7 is found solely within the first few millimeters of surface soil, and is not transported deeper into soils by infiltrating rainwater (Walling and Woodward, 1992; Blake *et al.*, 1999; Schuller *et al.*, 2006). The hydrophobic nature of Be-7 thus makes this radionuclide a useful tracer of short-term sediment dynamics (Kaste *et al.*, 2002).

As surface soils are eroded during rain storms, particles bearing Be-7 are washed from the watershed into the river, mixing with the suspended sediments in the water column (Kim *et al.*, 1999; Wallbrink and Murray, 1996). Given the much larger surface area of the watershed versus the surface area of the river, the vast majority of Be-7 that is in the water column has its genesis in watershed surface deposition and runoff, rather than in direct deposition of Be-7 from the atmosphere onto the river surface. With a high K_d, Be-7 remains sorbed to particles in the water column and does not readily partition to the dissolved phase. The presence of Be-7 in sediment can therefore be used to track sedimentation and resuspension regimes in aquatic environments such as lakes, lagoons, and estuaries (Fitzgerald, *et al*., 2001; Canuel *et al*., 1990; DeMaster *et al*., 1985).

Be-7 is determined by gamma spectroscopy, with the concentration of the isotope determined by the number of unique decays detected in a given mass of sediment over a standard counting time, typically 8 to 24 hours. For the purposes of the FFS, Be-7 is considered to be present when the detected level based on counting statistics exceeds zero by more than two standard deviations. With the sample sizes available, minimum Be-7 levels of 0.5 pCi/g were generally necessary to obtain positive detections and interpretable and consistent results. These levels were identified based on the sensitivity of the analytical method and prior work conducted in the New York metropolitan area (*e.g.*, USEPA, 1997).

As documented in several studies, the spatial and temporal distributions of Be-7 in sediments are commonly used to investigate particle cycling (Olsen *et al.*, 1986; Baskaran and Santschi, 1993; Feng, 1997), sediment deposition rates (Dibb and Rice, 1989; Canuel *et al.*, 1990), and biological mixing intensity (Krishnaswami *et al.*, 1980). Because fine particle deposition is the most important factor affecting the accumulation pattern and vertical distribution of Be-7 in estuarine systems (Olsen *et al.*, 1986), fine-grained sediment locations were targeted for sampling in the Lower Passaic River. These same particles are expected to carry many hydrophobic contaminants; thus the occurrence of both Be-7 and various hydrophobic contaminants in a sediment sample indicates that both were recently in the water column as suspended matter. In the Lower Passaic River conceptual site model, the Be-7 bearing sediments are considered representative of recently deposited materials, allowing them to be compared with recent inputs from the watershed and Newark Bay to complete a solids and contaminant mass balance for the Lower Passaic River.

The level of Be-7 activities in the recently-deposited sediments collected in the Lower Passaic River is comparable to Be-7 activities in settling solids captured in sediment traps or recently-deposited sediments obtained by surface coring in the various tributaries to the Lower Passaic River. This is illustrated in Figure 1.2-1, which shows the Be-7 distribution in samples targeted for Be-7 in Lower Passaic River sediments and tributaries by river mile. Surface sediments and tributary solids all show Be-7 levels on the order of 10 pCi/g. Given the short half-life of this radionuclide, these observations suggest a close link between these solids. As will be illustrated later in this data evaluation report, the patterns of contamination can be used to link Be-7 bearing surface sediments and suspended matter of the Lower Passaic River.

1.2.2 Recently-Deposited Surface Sediments (0 to 1 inch)

Samples from Be-7 bearing locations represent the chemical characteristics of suspended sediments as they settle out of the water column, generally integrating the prior 6 to 12 months of deposition. Recently-deposited sediments used in sediment characterization include: 0 to 1 inch 2007-2008 Be-7 bearing sediments collected in the Lower Passaic River, tributaries and Upper Passaic River, and the 2005-2007 high resolution core tops in the Lower Passaic and Upper Passaic River. Tributary samples are discussed in Data Evaluation Report No. 2.

1.2.3 Surface Sediments (0 to 6 inches) at Depositional Locations

Tierra Solutions, Inc. (TSI) sampling programs for the Passaic River in 1995 and for Newark Bay in 2005 involved the collection of surface sediments in the top 6 inches of the sediment bed. At every location, a sample of the top 2 inches of sediment was tested for Be-7 activity. A separate core was obtained close to this location whose 0 to 6 inch interval was analyzed for chemical parameters. Depending on the sedimentation rate at these locations, the 0 to 6 inch segment may integrate several years of deposited sediments. For example, if the sample was collected at a location with a constant sedimentation rate of 0.5 inch per year, then the top 6 inches will contain an average of 12 years of sediment contamination. If deposition has been interspersed with erosion at the location, this interval may include sediments that are decades old.

1.2.4 Surface Sediments (0 to 6 inches) at Non-Depositional Locations

Surface sediment samples where Be-7 was not detected are older than 6 months, either because they have been re-exposed through the erosion of overlying sediments or because they are from a location that is slowly (or not) depositional. Like the surface sediments at depositional locations, these samples may integrate sediments over multiple years or even decades, depending upon the deposition rate and the frequency and extent of erosion at the location.

In addition to the TSI and CPG samples where Be-7 was analyzed for but not detected, samples collected in 1999 and 2000 were obtained from 0 to 6 inches but without analysis of Be-7. These locations cannot be characterized concerning their time of deposition.

1.2.5 Surface Sediments (0 to 2 inches)

A subset of sediment samples was obtained from 0 to 2 inches but without any measurement of Be-7. As such, the age of the sediments in these samples cannot be surmised. These samples were primarily collected prior to 1995.

1.2.6 Comparison of Recently-Deposited Sediment to Suspended Solids

Daily tides mix, resuspend, and redeposit sediments, thereby reducing the variability in chemical concentrations in the recently-deposited surface sediments across the Lower Passaic River. Accordingly, suspended solids should possess the same contaminant pattern as the recently-deposited surface sediments. Suspended solids data from the

Infiltrex and Trace Organics Platform Sampler (TOPS) samples collected during the large volume water column sampling event in 2005 were converted from mass of contaminant per liter of water to mass of contaminant per mass of suspended solids by dividing the contaminant concentrations by the TSS concentration of the whole water sample. The United States Geological Survey (USGS) Water Monitoring Program data were used as reported to the New Jersey Department of Transportation as part of the Environmental Dredging Pilot Study. To compare the chemical concentrations of suspended solids to the corresponding value in recently-deposited sediments, the following evaluations were completed: 1) comparison of the PCB congener patterns, 2) comparison of the 2,3,7,8-TCDD/Total TCDD ratio, and 3) principal components analysis (PCA) of both sets of data. The results of these evaluations are discussed below.

To determine if the PCB congener patterns in suspended solids and recently-deposited sediments are similar, PCB congeners in both data sets were normalized to the PCB congener BZ52 (Ballschmiter and Zell, 1980) [3] and plotted with the lighter weight PCB compounds on the left and the heavier PCB compounds on the right. Figure 1.2-2 presents the normalized PCB congener pattern for suspended solids measured during the USGS monitoring program. This figure indicates similar PCB congener patterns in all water column samples from the different water column sample collections in December 5, 2005, December 6, 2005, and December 10, 2005. Comparison of average normalized PCB concentrations from the USGS data to normalized PCB concentrations collected by different techniques during the Lower Passaic Large Volume Filtration program also indicate a close agreement in the PCB congener pattern amongst the different programs/sampling techniques. These water column normalized PCB congener profiles (Figure 1.2-3) show that the same dominant PCB congeners (BZ20+28, BZ44+47+65, BZ61+70+74+76, BZ66, BZ90+101+113, BZ110+115, BZ129+138+160+163,

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[3] Ballschmiter and Zell (1980) arranged the 209 PCB congeners in ascending numeric order and assigned what are commonly termed BZ number. The numbering system has been adopted by the International Union of Pure and Applied Chemists (IUPAC).

BZ147+149, and BZ153+168) were identified in the recently-deposited surface sediments of the Lower Passaic River (Figure 1.2-4).

The concentrations and ratio of 2,3,7,8-TCDD/Total TCDD in the suspended solids and the surface sediments were also examined. Similar to the PCB congener pattern, the same ratio observed in the surface sediments was reported in the suspended solids in two independent programs (Table 1-3). The average concentrations agreed within measurement error. Together, these results support the hypothesis that recently-deposited surface sediment and suspended solids are derived from the same pool of solids, tidally mixed, and distributed throughout the Lower Passaic River.

A PCA was performed to further examine the contaminant patterns of the recently-deposited sediment and the suspended solids. The recently collected Be-7 bearing surface sediment and suspended solids data (2007-2008) along with the USGS TOPS and 2005 high resolution core surface sediment data were used in the analysis. All classes of contaminants were included in the PCA analysis, and the analytes were as follows: chromium, copper, lead, mercury, 2,3,7,8-TCDD, Total-TCDD, PCB 24+27, PCB 31, PCB 50+53, PCB 52+69, PCB 61+70+74+76+66, PCB 90+101+113, PCB 180+193, PCB 196+203 and 4,4’-Dichlorodiphenyldichloroethylene (4,4'-DDE). Three principal components (PCs) that explain about 86 percent of the total variance were extracted. The first principal component (PC1) represented 54 percent, the second principal component (PC2) represented 21 percent, and the third principal component (PC3) contained about 11 percent of the total variance in the dataset.

A three-dimensional orthogonal plot of these three principal components (Figure 1.2-5) shows the sample points displayed by the principal components. Sample points are symbolized by different colors for different sources. The PCA result confirmed the hypothesis that the suspended solids possess the same contaminant pattern as the recently-deposited surface sediments (Figure 1.2-5), where the USGS TOPS suspended solids clustered together with the main stem of the Passaic River recently-deposited surface sediment. Another important observation from the PCA analysis is that the suspended solids and recently-deposited surface sediments in the Lower Passaic River are different from the boundary conditions including: Newark Bay, the Upper Passaic River, and all the tributaries and combined sewer overflows / stormwater outfalls (CSOs/SWOs).

1.3 Consideration of TOC and Iron in Normalizing Surface Sediment Concentrations

Sediment concentrations are often normalized to TOC and iron in order to minimize differences between samples whose only real difference is the amount of coarser grained or non-absorbing sediment present in the samples. That is, within two samples, the fine-grained sediments may have the same chemical properties but the samples may vary in the fraction of sand and gravel, causing proportionate changes in overall sample concentration. Iron is used as a normalizing factor for metals contamination since it is generally associated with the binding sites on fine-grained particles that will absorb other metal species. TOC is used as a normalizing factor for organic contaminants since it expected to be present in proportion to the binding sites for organic contaminants such as pesticides and PCBs.

Prior to their use in normalizing, it is important to first examine the spatial distribution of these parameters themselves, since they may be influenced by factors other than fine-grained sediment content. This examination is presented below.

Total Organic Carbon

TOC is most useful as a normalizing factor when the sources of TOC are limited or are well known. In the Lower Passaic River, the sources are well known but they are not limited in number. There are a large number of CSOs, SWOs, and the tributaries to the Lower Passaic River, all of which contribute TOC to Lower Passaic River sediments. USEPA has amassed a large amount of data to characterize TOC in all of the major sources, facilitating its use as a normalizing factor in the Lower Passaic River.

An important concern in the application of TOC as a normalizing factor is the consistency in reported TOC levels for the same media by the various studies or sampling events conducted by different organizations. The distribution of TOC in the surface sediments of the Lower Passaic River as measured by the various studies is shown in Figure 1.3-1 for RM0 to RM2 and RM2 to RM8.[4] In general, for the six studies represented in the two diagrams, it was expected that each sampling event would have encompassed similar ranges of sediment properties in their samples. It was also anticipated that there might be analytical, year-to-year or seasonal variations that might affect the mean or median, causing differences in mean or median among the studies. Nonetheless, given sufficient data, the means and medians across studies would be expected to converge to an overall mean or median for surface sediment TOC. This was the case for five of the six studies wherein mean log concentrations (a statistical surrogate for the median) converged to a fairly narrow range, near 5 percent TOC ± 2-1/2 percent. Additionally, the overall range of values observed in five of the six studies is also fairly comparable, with extensive overlap across among the distributions. However, these diagrams also show markedly larger and statistically significant difference between the 1995 TOC measurements and several of the more recent studies (2008 and later). This is illustrated by the Tukey-Kramer circles shown at the right in the diagram. Circles represent the mean and its uncertainty for each of the sample groups examined. Circles that do not touch or intersect only slightly are indicative of sample groups that are statistically different from each other.[5] In each diagram, the highest circle represents the 1995 data set, which is statistically different from most of the other studies. While some of the more recent studies are also statistically different from each other, the differences are much smaller than the difference between the later studies and the 1995 study.

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[4] The use of the log-transformed data in the figure is in response to the amount of variability and the somewhat skewed distribution of the data. Given the skewed nature of the data, the statistical test on the mean log of the data is a statistical surrogate for the median of the distribution. The median is considered the best estimate of the central tendencies of these distributions since it is not strongly affected by outliers, unlike a simple arithmetic mean.

[5] The size of the circle reflects the uncertainty in the mean log value, with larger circles reflecting larger uncertainty. Thus small sample sizes or highly variable data sets have larger circles than those of large data sets or low variability data sets. Circles for means that are significantly different either do not intersect, or intersect slightly, so that the outside angle of intersection is less than 90 degrees. If the circles intersect by an angle of more than 90 degrees, or if they are nested, the means are not considered significantly different at an alpha level of 0.05 (95 percent confidence level).

The differences between the 1995 study and later studies are likely to be due to analytical differences between the studies and not due to changes in TOC over time. Notably, the dated sediment cores from the Lower Passaic River, which include a record of TOC concentrations from 1995 to 2005 do not show large variations in TOC from year to year, generally less than 25 percent, more typical of the variations among the later studies. This is further illustrated in Figure 1.3-2, which shows the TOC concentrations as a function of river mile for the entire 17-mile Lower Passaic River Study Area. While there are trends with river mile within the data, most data sets scatter within the same range. The notable exception being the 1995 data set, which is clearly higher than the rest of the TOC data. The variability in TOC concentrations shown in Figures 1.3-1 and 1.3-2 limits the usefulness of TOC normalization between the 1995 study and subsequent studies, since variations in the absolute TOC level among programs may introduce variation in normalized concentrations that are due to analytical issues and not due to real changes. The application of TOC normalization within the same study or across the more recent studies, however, is still useful to minimize differences between samples whose only real difference is the amount of coarser grained or non-absorbing sediment present in the samples.

Iron

In contrast to TOC, iron presents a more internally consistent variable for normalization. This is illustrated in Figure 1.3-3, which shows the distribution of iron concentrations for the various sampling programs for RM0 to RM2 and RM2 to RM8. Below RM2, only the 2008 USEPA data set is different. This may be due to the sampling distribution of this data set, which was obtained exclusively between RM0 and RM1. For RM2 to RM8, no data set was statistically different but the 2010 CPG data may be slightly higher than the other sets. This likely reflects the near-exclusive focus on shoal samples for this program, with higher fine-grained sediment contents. Overall, these data sets present a generally consistent level of iron concentrations across the programs, suggesting this variable will be useful for normalization across all studies. This is further supported by Figure 1.3-4, which shows iron concentrations as a function of river mile. In this diagram, iron content increases gradually from Dundee Dam across the length of the Lower Passaic River and into Newark Bay, consistent with the anticipated increase in fine-grained sediment content. Note that the scatter in iron concentrations is greater above RM8, consistent with the higher frequency of coarse-grained samples and much greater extent of coarse-grained areas above this river mile.

2 TEMPORAL AND SPATIAL TRENDS FOR 2,3,7,8-TCDD AND TOTAL TCDD

This section describes the spatial and temporal variations in 2,3,7,8-TCDD, Total TCDD, and the ratio of these two parameters in the surface sediments of the Lower Passaic River. Because the concentrations of 2,3,7,8-TCDD and Total TCDD are quite elevated in the sediments of the Lower Passaic River relative to all external sources (see Data Evaluation Report No. 2), these contaminants may be used to trace the migration of contaminated sediments from the RM0 to RM12 region of the Lower Passaic River into Newark Bay and the upper portion of the Lower Passaic River above RM12.

2.1 Spatial Distribution of 2,3,7,8-TCDD Concentrations

The first set of figures in this section presents the historical record of surface sediment monitoring in map form, beginning in 1991 and extending to 2012. Figure 2.1-1 presents the surface sediment sampling results from 1991 to 2000, including the extensive 1995 sampling program conducted by TSI and the near shore sampling programs conducted by TSI and USACE in 1999 and 2000. The map presents the region of the Lower Passaic River between RM0 and RM8, since nearly all of the samples collected during this period were obtained below RM8. As a background on this and all subsequent maps presented in this data evaluation report, the results of a 2005 side-scan sonar survey are presented, which defined sediment texture throughout the river. The side-scan sonar data illustrate the extensive areas of fine-grained sediments found in this region of the Lower Passaic River, as indicated by the blue (silt areas) and green (silt and sand) areas. The coincidence of 2,3,7,8-TCDD contamination and various sediment textures can be used to infer contaminant levels in unsampled areas.

Notable in the map is the spatial extent of elevated sediment levels. The vast majority of sediment samples between RM0 to RM8 have levels above 100 pg/g (picograms per grams of sediment or parts per trillion), at least an order of magnitude above background levels of 2 pg/g observed in the sediments above Dundee Dam. Additionally, there are extreme values greater than 1,000 pg/g scattered throughout the eight-mile reach presented here. Symbols of yellow, orange and red indicating concentrations of 1,000 pg/g or higher occur within each river mile interval from RM2 to RM7. They occur in an apparent random fashion throughout the river, on both the inside and outside of river bends.

Figure 2.1-2 presents the results from 2005 to 2012, covering the entire length of the Lower Passaic River. Notable in the first map in the sequence (Figure 2.1-2a), representing the region above RM12, is the substantially lower levels of 2,3,7,8-TCDD contamination above RM13, as denoted by the extent of blue symbols. This region is also marked by extensive areas of coarse-grained sediments as compared to the region below RM8. The lack of 2,3,7,8-TCDD contamination above RM13 indicates that tidal circulation is limited in its ability to transport contamination from the lower portions of the Lower Passaic River much upstream of RM12. As will be shown later in the discussion, the influence of the tidal transport of contamination gradually declines from RM12 to RM15. Additionally, the lack of fine-grained sediments in this region would indicate that there are few areas for contaminant-bearing fine-grained sediments to accumulate.

Figure 2.1-2b represents the middle portion of the Lower Passaic River, RM8 to RM12. This region is more contaminated than the upstream area and more heterogeneous in both 2,3,7,8-TCDD concentrations and sediment texture than the downstream region (compare with Figures 2.1-1 and 2.1-2c). While this region also has extreme levels of 2,3,7,8-TCDD contamination, it also has a much higher frequency of samples with low levels of contamination. In both regions, *i.e.*, below RM8 and in RM8 to RM12, high concentrations of 2,3,7,8-TCDD occur within areas of fine-grained sediments. However, nearly all of the region below RM8 is fine-grained, resulting in relatively random locations with extreme values whereas, between RM8 and RM12, most of the bottom is coarse-grained and the extreme values are limited to very small portions of the river bottom where fine-grained sediments accumulate.

The last map in the sequence, Figure 2.1-2c, shows similar levels of contamination to those observed in 1995.The occurrence of extreme values can be found throughout the river on the inside and outside of river bends as well as in the channel. The impact of the navigation channel and its history on the distribution of surface sediment concentrations are further explored in Section 2.4

2.2 Spatial and Temporal Comparisons of 2,3,7,8-TCDD Concentrations

A quantitative analysis of surface concentrations of 2,3,7,8-TCDD shows that there is no trend in surface concentrations of 2,3,7,8-TCDD over time. Figure 2.2-1 presents the concentration distributions from 0 to 6 inch samples for the large 1995 sampling program, as well as the various post-2005 sampling programs, grouped by the river mile intervals 0 to 2, 2 to 8, 8 to 12 and 12 to 17.4. The break points recognize the various regions of the Lower Passaic River, with the RM0 to RM2 interval characterizing the most depositional region; RM2 to RM8 being the large, contaminated fine-grained region of the Lower Passaic River; RM8 to RM12 being the contaminated but predominantly coarse-grained region; and RM12 to RM17.4 being the least contaminated (with respect to 2,3,7,8-TCDD) coarse-grained region.

In each diagram, the distribution of 2,3,7,8-TCDD concentrations are shown for each data set available in the region. At the far right of each diagram is a set of circles representing the Tukey-Kramer test for statistically significant differences. The diagrams are plotted in log scale and the Tukey-Kramer tests are also done in log-scale to provide an analysis of the central tendency in each data set while minimizing the effects of extreme values, essentially a test of medians.

For both RM0 to RM2 and RM2 to RM8, there are no statistically significant differences in the data sets between 1995 and 2012. The median values (calculated for the period between 2008 and 2012) for RM0 to RM2 and RM2 to RM8 are 208 and 280 pg/g, respectively. These results indicate that since 1995 there has been no statistically significant change in the surface concentration of 2,3,7,8-TCDD below RM8. This is consistent with the dated sediment core results described in Data Evaluation Report No.

3, which concluded that only a very gradual decline was occurring. Given the variance in the surface sediment samples and their depth, such a gradual decline would be difficult to detect by measurements of surface sediments alone.

In Figure 2.2-1b, the distributions for RM8 to RM12 and RM12 to RM17.4 are shown. In these areas, there are no data sets prior to 2008 of the 0 to 6 inch interval of sufficient size to provide a useful statistical test. The diagrams compare the results among the most recent studies. For RM8 to RM12, the four CPG studies have essentially the same median. The USEPA study, which sampled silt areas exclusively, has a somewhat higher value than the surveys but the difference is statistically significant only when the 2008 USEPA study is compared against all other CPG studies treated as a single group. The CPG studies were not limited to silt areas, but also incorporated samples from the less contaminated coarse-grained areas, resulting lower medians relative to the silt-only 2008 USEPA study. The simple median value for the entire set of samples for RM8 to RM12 (294 pg/g), which represents a combination of coarse- and fine-grained material, is very similar to that of RM2 to RM8 (280 pg/g), which represents fine-grained material only. However, the sampling locations above RM8 preferentially sampled silts rather than coarse-grained sediments. Coarse-grained sediments are spatially much more extensive above RM8. An area weighted geometric mean concentration (based on the mean of the logs of the concentrations) for the RM8 to RM12 region is only 200 pg/g, reflecting the generally lower concentrations observed in the coarse-grained areas.

Above RM12, concentrations drop off rapidly, as shown in the lower diagram in Figure 2.2-1b. The overall median value is only 3.3 pg/g. While all five data sets agree statistically, the USEPA samples are visibly higher than nearly all other measurements. However, these samples were obtained just upstream of RM12 in a fine-grained sediment deposit and cannot be considered spatially representative of the entire region above RM12. The 2010 and 2012 CPG data have the same caveat.

Figure 2.2-2 represents a similar sequence of results for Total TCDD. Given that 2,3,7,8-TCDD typically represents about 70 percent of the Total TCDD mass, these results should and do repeat the patterns seen in the 2,3,7,8-TCDD concentrations. Note that there are no results shown for Total TCDD for the 2008 CPG data set. This is due to analytical issues that prevented the calculation of a comparable Total TCDD value for these samples (see CSC and Interface, Inc., 2010 and 2011for a more detailed discussion). For this reason, there are also no results for the 2,3,7,8-TCDD to Total TCDD ratio for the 2008 CPG data as discussed below.

Figure 2.2-3 represents a similar sequence of results for the 2,3,7,8-TCDD to Total TCDD ratio. While there are some minor differences in the ratio for the 1995 and 2012 datasets relative to the 2008-2010 datasets, all sample results below RM12 yield values close to 0.7, which is the characteristic dioxin ratio of the Lower Passaic River. RM2 to RM8 and RM8 to RM12 have medians that are within error of this value, whereas RM0 to RM2 has values slightly lower, around 0.6, likely due to the influence of solids from Newark Bay.[6]

Above RM12, the distribution of this ratio becomes more variable, reflecting the mixing of sediment from above Dundee Dam with those of the Lower Passaic River. Thus the range extends from background values (about 0.05) to that of the highly contaminated areas of the Lower Passaic River (0.7). The variation of this ratio with river mile in the consistent manner just described is an important line of evidence supporting the conceptual site model and the premise that the sediments of the Lower Passaic River present a unique ratio signature easily identified against possible external sources.

2.3 Variation of Dioxin Concentrations with River Mile

After confirming the comparability of the various Lower Passaic River data sets in the previous discussion, it is then useful to combine them and examine the trends in dioxin contamination with river mile. As will be shown below, the 2,3,7,8-TCDD concentrations show less than a factor of 2 change in the median concentration between RM2 and RM12

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[6] Also notable on the figure are the occurrence of values greater than 1. While this is theoretically impossible based on the definition of the 2,3,7,8-TCDD to Total TCDD ratio, in reality, these quantities are actually determined separately. As a result, analytical variability can result in values slightly greater than 1.

when normalized to TOC. In contrast, 2,3,7,8-TCDD concentrations increase by more than 2 orders of magnitude between RM17.4 and RM12 as relatively clean Upper Passaic River solids are mixed with the highly contaminated solids of the Lower Passaic River. A similar but less steep gradient occurs below RM2, as less contaminated solids from Upper New York Bay are mixed with Lower Passaic River solids across Newark Bay and the lower 2 miles of the Lower Passaic River. The relative lack of a trend in concentrations with river mile in RM2 to RM12 indicates the effects of tidal mixing. The observation that this same stretch is 1 to 2 orders of magnitude more contaminated than the regions upstream and downstream indicates that a very large source of dioxin exists in this region. As shown elsewhere (*e.g.,* the Empirical Mass Balance in Appendix C), this source is the legacy[7] sediments of the Lower Passaic River.

Figure 2.3-1 presents the results for 2,3,7,8-TCDD for 0 to 6 inch samples for the Lower Passaic River as well as Newark Bay and the Upper Passaic River. Note the vertical scale: in order to represent the full range of concentrations observed in this 30 mile portion of the Passaic River and Newark Bay, the diagram spans 7 orders of magnitude.

It is evident from Figure 2.3-1 that the various data sets are similar in range and central tendency. Presented in this fashion, the surface concentrations describe several domains:

- The Upper Passaic River, with its extremely low 2,3,7,8-TCDD concentrations (less than 3 pg/g),
- RM12 to RM17.4 region, characterized by a two-order of magnitude gradient in the median 2,3,7,8-TCDD concentration, the result of the mixing of Upper Passaic solids with resuspended solids originating in the Lower Passaic River,
- RM8 to RM12 region, characterized by highly variable concentrations of 2,3,7,8-TCDD, ranging from about 5 to 23,000 pg/g but with relatively few samples around the median concentration of 294 pg/g.

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[7] The term “legacy sediments” is used to refer to contaminated sediments deposited in the river during the period that it was filling in, and that are the legacy of the long history of industrial and municipal discharges to the river.

- RM2 to RM8 region, characterized by a similar range in the 2,3,7,8-TCDD concentration (1 to 34,000 pg/g) but a stronger central tendency to the distribution, with many samples close to the median of 280 pg/g.
- RM0 to RM2 region, characterized by a shallower gradient than that observed at RM12 to RM17.4, declining from about 280 to 100 pg/g, as solids from Newark Bay are mixed into the Lower Passaic River.
- Newark Bay, where the gradient that begins at RM2 extends through the bay, as less contaminated solids from Upper New York Bay are mixed with solids from the Lower Passaic River.

Also shown on the diagram are samples from the tributaries to the Lower Passaic River, but below the head of tide. Because they were obtained below the head of tide, they may be impacted by solids transported from the Lower Passaic River during hide tide periods. Nonetheless, they are much lower than samples from the main stem of the river (less than 10 pg/g), consistent with the lack of 2,3,7,8-TCDD contamination in these water bodies, as concluded in Data Evaluation Report No.2.

Of particular note in Figure 2.3-1 is the lack of a concentration gradient in the RM2 to RM12 portion of the river. While surface sediments exhibit a large degree of variability, the central tendency remains the same, unlike the regions outside these river miles. This observation is strong evidence of the extent and intensity of tidal mixing. In this portion of the Lower Passaic River, gradients along the axis of the river are minimized and surface concentrations are the result of both recent deposition as well as the erosion of the legacy sediments.

Figure 2.3-2 presents the data available for samples 2 inches or less in thickness from the historical record for the Passaic River only. Samples for this interval were obtained only from 1991 to 1993 (0 to 2 inches) and in the 2007-2008 (0 to 1 inch) USEPA studies. While these data are much more limited, they still describe the same trends in concentration evident in Figure 2.3-1 while also exhibiting less variability at any given river mile interval. This is partially attributable to the sampling programs involved. The

2007-2008 USEPA programs specifically targeted recently-deposited Be-7 bearing sediment (discussed further below). This targeting produced the observations of low contaminant concentration variability in recently-deposited sediments. The objectives of the 1991 to 1993 programs were not as focused on Be-7 bearing sediments but were concentrated at the downstream end of the Lower Passaic River where sediment concentration variance tends to be reduced (see Figure 2.3-1). Nonetheless, the observation of greatly reduced variability in the 0 to 2 inch samples indicates that the 0 to 6 inch samples include more highly contaminated sediments, either as samples from highly contaminated areas or as samples from locations where highly contaminated sediments underlie more recently deposited sediments. Data Evaluation Report No. 3 provides evidence that highly contaminated sediments equate to older sediments. Thus, the presence of more contaminated sediments in the 0 to 6 inch samples also means that much older sediments, deposited in the 1950s and 1960s, lie at or very close to the sediment-water interface.

Figure 2.3-3 presents the results for recently-deposited sediments in the Lower Passaic River (0 to 1 inch, Be-7-bearing samples) as well as for samples from depositional locations (0 to 6 inch samples at locations with Be-7 present in the 0 to 2 inch interval). As noted previously, in the Lower Passaic River, the latter samples are not considered recently-deposited, but rather represent a mixture of recent deposition and older (pre-1990s), underlying sediments. The Newark Bay samples were collected in the same manner, also representing 0 to 6 in sediment intervals. However, the Newark Bay samples presented here were further restricted to channel areas, which are generally subject to frequent dredging. As such, much of the sediment in these samples is likely to be deposited since the last dredging event. As a result, these samples are expected to consist of sediments no more than 3 to 5 years old (the typical interval between dredging events). The reduced level of variation in these samples relative to similar samples obtained by the CPG in the Lower Passaic River suggests that the Newark Bay samples selected in this manner do avoid inclusion of older (pre-1990s), more contaminated sediments.

The recently-deposited sediments presented in Figure 2.3-3 describe a tightly defined function, with little variance between RM0 and RM12. The absolute concentration varies only about 2.5-fold over this interval (*i.e.*, from 250 to 550 pg/g), but variation between neighboring points (separated by 0.5 to 1 mile) is generally less than 25 percent. This is a dramatic reduction in the nearly 4 orders-of-magnitude variability (3 to 15,000 pg/g) observed in the 0 to 6 inch samples from this portion of the Lower Passaic River, as exhibited in Figure 2.3-1. The concentration gradients at RM0 to RM2 and RM12 to RM17.4, which became apparent only after the collection of many hundreds of 0 to 6 inch samples, are apparent here with just a few samples.

In the lower diagram of Figure 2.3-3, the 2,3,7,8-TCDD concentrations have been normalized to TOC in the samples. This normalization further reduces the gradient in the recently-deposited samples from RM2 to RM12 to about 2 fold, indicating that some of the gradient in the absolute 2,3,7,8-TCDD concentration is simply due to higher organic content in the Be-7 bearing samples upstream. Notably the normalization does little for the variability observed in the 0 to 6 inch samples obtained from depositional zones, further supporting the assertion that these samples do not represent recently-deposited sediments alone but incorporate a significant fraction of older, more contaminated sediments.

Figures 2.3-4 to 2.3-6 present the same sequence of results for Total TCDD. As expected, the distribution of this parameter closely mimics that of 2,3,7,8-TCDD, given the high percentage of 2,3,7,8-TCDD in the Total TCDD. Note that there are no Total TCDD results for the 2008 samples obtained by the CPG due to analytical issues as discussed above.

Figures 2.3-7 to 2.3-9 present the same sequence for the 2,3,7,8-TCDD to Total TCDD ratio. This ratio behaves somewhat differently from the concentration data, showing an even steeper gradient in the RM12 to RM17.4 portion of the river. This is expected since the ratio will remain fairly constant as Lower Passaic River solids are diluted with the much less contaminated Upper Passaic solids. Only when the mass contributions to a sediment sample from the Upper Passaic River and Lower Passaic River are comparable (*i.e.*, concentrations of 2,3,7,8-TCDD are less than 10 pg/g) will the ratio deviate from that observed in the main portion of the Lower Passaic River. The same arithmetic applies across Newark Bay. Thus with the elevated dioxin ratios observed in the Bay, it can be concluded that the vast majority of the 2,3,7,8-TCDD burden in Newark Bay sediments is due to loads delivered by the Lower Passaic River.

2.4 Influence of the Navigational Channel and Sediment Texture

The next sequence of figures considers the influence of the navigation channel and sediment texture on the concentrations of 2,3,7,8-TCDD. In Section 2.1, the examination of 2,3,7,8-TCDD concentrations and sediment textures on a map basis suggested that the region above RM8 was different than that below RM8. In this section, the distribution of concentrations from RM0 to RM12 is examined more closely to further explore these observations.

In Figure 2.4-1, 2,3,7,8-TCDD concentrations from RM8 to RM12 are contrasted with those observed from RM1 to RM7 based on 0 to 6 inch samples. In this comparison, the interval from RM1 to RM7 was used since it was extensively sampled in both 1995 and 2008. Notable in the figure for the RM1 to RM7 interval is the close agreement of the median values for 1995, the 2008 to 2010, and the 2012 samples, as represented by the horizontal lines. In this region, both coarse and fine-grained sediment samples from the 2008 to 2010 sampling programs have comparable median concentrations. The median values for the 2012 fine-grained sediment from RM1 to RM7 are almost the same as the median values for the 1995 and 2008 to 2010 samples. No median is represented for the 2012 coarse-grained sediment since the data are too limited in number. Note that the coarse and fine-grained sediment assignments for 2008 to 2012 are based on a 2005 side-scan sonar survey and not the individual sample descriptions. 1995 samples were not sorted in this manner since grain-size distribution data were not obtained for these samples and the 2005 side scan sonar survey was not considered representative of 1995 conditions due to the passage of time.

Above RM8, concentrations for coarse and fine-grained sediments for the 2008 to 2010 dataset as defined by side scan sonar differ by a factor of 3, with coarse-grained sediment concentrations (140 pg/g) about 3 times lower than fine-grained sediments concentrations (370 pg/g). Fine-grained sediments above RM8 are comparable in concentration to samples below RM8 (370 *vs.* 294 pg/g, respectively). For the limited 2012 dataset, the median values of the concentrations for fine-grained sediment are about 80 percent higher than the corresponding median values for the 2008 to 2010 dataset (578 *vs.* 370 pg/g, respectively). While the difference between the 2008 to 2010 and the 2012 datasets appear relatively large, similar median values are also observed for subsets for the 2008-2010 dataset, such as the 2008 USEPA dataset for RM8 to RM12 (median value 538 pg/g). In contrast, the median values of the concentrations for coarse grain sediments for 2012 dataset are 5 times lower than the corresponding median values for the 2008 to 2010 dataset (18 *vs.* 140 pg/g, respectively). The reason for the difference is not known but may be due to effects due to Hurricane Irene, which preceded the 2012 sampling event, or due to the limited sample size for 2012 (8 samples), among other possible causes.

The general consistency in the mean 2,3,7,8-TCDD concentrations in fine grained sediments throughout RM2 to RM12 is taken as further evidence for the dynamic and extensive nature of tidal mixing in the Lower Passaic River, generating comparable levels of fine-grained sediment concentration throughout the lower 12 miles of the estuary, particularly between RM2 and RM12. Given that the majority of fine-grained sediment areas are located below RM8.3, this observation also provides direct support for the focus of the FFS on the lower eight miles.

The Lower Passaic River has a navigation channel from RM0 to RM15. Maintenance dredging of this channel ceased in the 1950s to 1980s (depending on river mile). The coincidence of chemical disposal in the river prior to restrictions arising from the Clean Water Act, along with the construction and subsequent limited maintenance of the navigation channel, created an ideal situation for contaminated sediments to accumulate in the Lower Passaic River. The deepest portions of the channel were constructed below

RM8, with minimum channel depths of 16 ft or greater. This has led to the accumulation of thick beds of contaminated sediment both in the channel as well as in the shoals below RM8 (see Chapter 4 of the RI).

The region below RM8 was further examined, taking into account the navigation channel. Specifically, samples were assigned as in the navigational channel or in the shoals based on the USACE channel boundaries. These two populations of samples were then examined to see if concentrations in the navigational channel were in reality lower than those in the shoals, akin to the observations above RM8. To make the comparisons robust, all of the available 0 to 6 samples obtained in this portion of the Lower Passaic River were used in the analysis.

To make this comparison, log-transformed concentrations were compiled for channel and shoal areas for RM0 to RM2 and RM2 to RM8, reflecting the observed change in the 2,3,7,8-TCDD concentration trend with river mile that occurs around RM2, with the intention of maximizing the probability that a statistically significant difference would be observed if present. The results of these calculations are shown on an absolute concentration basis in Figure 2.4-2a and on a TOC-normalized basis in Figure 2.4-2b. In both river mile intervals, the results indicate no statistically significant differences between channel and shoal areas on an absolute basis. On a TOC-normalized basis, shoal and channel concentrations agree with uncertainty from RM0 to RM2 and channel concentrations are about 50 percent lower than the shoal concentrations from RM2 to RM8. The difference in channel and shoal is considered minor in comparison with the four order of magnitude variation in 2,3,7,8-TCDD concentrations observed in each of these areas. The channel and shoal areas equally show local variations but no systematic trends with river mile, consistent with expectations given the history of the channel dredging as described above.

The analyses presented in Figures 2.4-1 and 2.4-2 were repeated for Total TCDD but are not shown here since the results were essentially the same as those of 2,3,7,8-TCDD. A parallel analysis was conducted for the 2,3,7,8-TCDD to Total TCDD ratio, replicating the presentations in Figures 2.4-1 and 2.4-2. These results are shown in Figures 2.4-3 and 2.4-4. In Figure 2.4-3, it is evident that, unlike the 2,3,7,8-TCDD concentration results, the 2,3,7,8-TCDD to Total TCDD ratio shows little difference among sediments types or with river mile between RM2 and RM12 for the 2009 to 2010 data. The median values of the ratio for coarse-grained sediments between RM8 and RM12 for the 2012 dataset are the same as the corresponding the median values of the ratio for the 2009 to 2010 dataset (approximately 0.7), but the median values of the ratio for fine-grained sediments between RM8 and RM12 are slightly higher (0.8). The close agreement of the ratio across sediment texture and river mile reflects the fact that all of the 2,3,7,8-TCDD contamination in this portion of the Lower Passaic River is derived from the same industrial source or sources and bears the same 2,3,7,8-TCDD to Total TCDD ratio fingerprint. The slightly higher ratio and higher concentrations in the fine-grained sediments above RM8 for the 2012 data may identify these samples as older sediments present at the river bed surface. Dated sediment core results from this river section show higher 2,3,7,8-TCDD concentrations and higher 2,3,7,8-TCDD to Total TCDD ratios for older sediments. The differences in concentration in the RM0 to RM12 region are largely due to variations in fine-grained sediment content or TOC, variations that will not change the characteristic ratio. The 1995 results did yield a slightly higher 2,3,7,8-TCDD to Total TCDD ratio than the 2008 to 2012 results for RM0-8; however, these differences are minor in comparison to typical baseline ratios of 0.04 to 0.06. The reason for the difference between 1995 and subsequent studies is unknown but may be due minor analytical differences between 1995 and 2009 to 2012 studies in the Total TCDD sum (particularly since the median concentrations of 2,3,7,8-TCDD agree closely between the two periods[8]).

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[8] The lack of change in the median concentrations of 2,3,7,8-TCDD accompanied by the small decline in the ratio between the two studies indicates an increase in the reported Total TCDD values between the two periods. While the reason for the increase in Total TCDD is not known, a slight difference in analytical techniques is likely. The observation of a 0.07 decline in the value of the ratio needs only a 10 percent increase in the average Total TCDD value. This deviation is well within the likely accuracies of the studies involved.

The comparison of channel and shoal areas yielded no difference in ratio for the RM0 to RM2 portion but did show a statistically significant but substantively unimportant difference in the 2,3,7,8-TCDD to Total TCDD ratio (a difference of 0.04 on a mean value of 0.7). This difference parallels the difference between the 1995 results and those of the 2009 to 2012 dataset, illustrated by the horizontal median lines seen in Figure 2.4-3. The reason for this small difference is not known but it is similar in size to the small differences observed among analytical programs. Figure 2.4-5 contrasts the distribution of the ratio for the two study periods for the RM0 to RM2 and the RM2 to RM8 portions of the Lower Passaic River.

While these observations identify minor differences in the dioxin ratio among programs, the main conclusion to be drawn from the ratio analysis is that the ratio is nominally 0.7 with minor variations everywhere the same, regardless of sediment texture (note the small variability in linear scale in Figures 2.4-3, 2.4-4, and 2.4-5), and markedly different from all known external sources of 2,3,7,8-TCDD. This observation is a major supporting line of evidence to the conclusion that estuarine circulation in the Lower Passaic River mixes fine-grained sediment over its entire length, particularly from RM2 to RM12. Further, these observation are important evidence for the absence of external sources of 2,3,7,8-TCDD of any consequence.

2.5 Summary of Dioxin-Related Observations

Taken together, these quantitative analyses confirm the lack of change in surface sediment concentrations of 2,3,7,8-TCDD over time, as well as confirming the unique 2,3,7,8-TCDD to Total TCDD ratio first observed by Chaky (2003). The 2,3,7,8-TCDD concentrations in the top 6 inches of sediment show nearly 4 orders of magnitude variation within 1 mile intervals between RM2 and RM12, but less than a factor of 2 change in the median concentration over the same distance when normalized to TOC. An essentially identical trend is observed in recently-deposited Be-7 bearing sediments when normalized to TOC. In contrast, 2,3,7,8-TCDD concentrations increase by more than 2 orders of magnitude between RM17.4 and RM12 as Upper Passaic River solids are mixed with the highly contaminated solids of the Lower Passaic River. A similar but less steep gradient occurs below RM2, as less contaminated solids from Upper New York Bay are mixed with Lower Passaic River solids across Newark Bay and the lower 2 miles of the Lower Passaic River. The observations regarding the 2,3,7,8-TCDD to Total TCDD ratio further support these observations, as the ratio varies little between RM2 and RM12 and then declines across the concentration gradients at either end of the Lower Passaic River. Surface concentrations within RM2 to RM12 are affected by spatial variations in fine-grained sediment content, which occur primarily above RM8. Below RM8, the channel and shoal areas are comparably contaminated, with local variations but no systematic trends with river mile. While the variations in fine-grained sediments affect the distribution of 2,3,7,8-TCDD concentrations, they do not affect the 2,3,7,8-TCDD to Total TCDD ratio. In total, these observations are well explained by the historical industrial discharges of 2,3,7,8-TCDD and the occurrence of extensive tidal mixing and reworking of the sediment bed, generating locally variable concentrations as legacy sediments are exposed while recent deposition is evenly contaminated over intervals of several miles, yielding the observations seen in 0 to 6 inch samples and in recently-deposited Be-7 bearing sediments.

3 TEMPORAL AND SPATIAL TRENDS FOR OTHER CONTAMINANTS

This section describes the temporal and spatial distribution of the other COPCs and COPECs for the Lower Passaic River, constructed along the same analyses performed in Section 2. The other contaminants of the Lower Passaic River often follow the spatial and temporal trends observed in the 2,3,7,8-TCDD results, but there are occasional differences. Many times these differences are due to more significant external sources relative to those for 2,3,7,8-TCDD. In the following discussions, only the differences between the distributions of the various compounds of concern and the distribution of 2,3,7,8-TCDD are noted. The compounds of concern are addressed by compound class since trends are often similar within the class. The discussions are organized in this manner to keep the narrative text brief and focused on the important issues. However, the attached figures parallel the analyses completed for 2,3,7,8-TCDD.

For each compound examined, 1995 sampling results are contrasted with more recent measurements. While statistically significant differences are often seen in these comparisons, there are analytical issues due to changes in analytical techniques during the intervening years. For this reason, changes in surface sediment concentrations are noted but not considered definitive of the rate or even the direction of change. The dated sediment cores described in Data Evaluation Report No. 3 are used to estimate long term trends in surface sediment concentrations.

The following observations made for 2,3,7,8-TCDD were also confirmed by all other COPCs and COPECs:

- Surface concentrations are locally variable but largely without trend in river mile from RM2 to RM12.
- When upstream contamination is less than that of the Lower Passaic River, a decreasing concentration gradient occurs from RM12 to RM17.4.

- When downstream contamination is less than that of the Lower Passaic River, a decreasing concentration gradient occurs from RM2 to RM0 and sometimes extends to the southern end of Newark Bay.
- For organic contaminants, normalization to TOC reduces the longitudinal variation within the Lower Passaic River for Be-7 bearing sediments but does little to reduce local variability in 0 to 6 inch samples from depositional locations. Additionally, with the exception of PAHs, normalization to TOC reduces the concentration gradients observed above RM12 and below RM2. A similar statement for metals normalized to iron is made in the next set of bullet points below.
- Surface concentrations within RM2 to RM12 are affected by variations in fine-grained sediment content, which occur primarily above RM8. From RM2 to RM8, where the river bottom is dominated by fine-grained sediment, bank to bank, each contaminant showed comparable median concentrations in channel and shoal areas, with local variations. No contaminant showed a systematic trend with river mile between RM2 and RM8.
- The spatial distribution of the other COPCs and COPECs in the Lower Passaic River are well explained by the occurrence of extensive tidal mixing and reworking of the sediment bed, generating locally variable concentrations as legacy sediments are exposed while recent deposition is evenly contaminated over distances of several miles.

The following observations were made from several of the other contaminants, and add to the list above:

- Some component of the gradient above RM12 is due to the greatly reduced presence of fine-grained sediment above this river mile. In some instances, normalization to TOC or iron largely eliminates the gradient, indicating that the Upper Passaic River is contributing contaminant concentrations on a fine-grained particle basis that are comparable to those observed in the Lower Passaic River.
- Extreme values of many other compounds of concern do not always coincide with extreme 2,3,7,8-TCDD surface concentrations. This is likely to stem from

extensive tidal mixing and reworking of the sediment bed and from differences in release history relative to 2,3,7,8-TCDD, respectively.

- For metal contaminants, normalization to iron reduces sample-to-sample variability across sampling event, often fairly substantially, and typically more than TOC normalization does for organic contaminants, indicating that fine-grained sediment content, which parallels iron levels in the sediment, may control metal contamination levels more closely than organic contamination levels.
- Some compounds appear to have lower surface concentrations in the 2008-2012 sampling period than in 1995, unlike 2,3,7,8-TCDD. These observations are inconsistent with those from the dated sediment cores (see Data Evaluation Report No. 3) and probably result from analytical differences among sampling programs, an issue that is not a concern for the dated sediment cores since they were all analyzed over a six month period by the same laboratories and analytical techniques.

Because of the apparent variations in surface sediment concentrations over time for some contaminants [mercury, DDT and its metabolites (noted as Total DDx), and dieldrin in particular] and the associated analytical issues, summary statistics of surface sediment concentrations were compiled based on the 2008 to 2012 data alone. This summary is based on 0 to 6 inch samples only and includes both CPG and USEPA sampling efforts from this period. The summary statistics are provided in Table 3-1. The compiled values in the table are considered estimates of current surface sediment conditions.

3.1 Temporal and Spatial Trends of PCBs in Surface Sediments

In general, the observations of PCBs concentrations in the surface sediments of the Lower Passaic River are very consistent with the observations of 2,3,7,8-TCDD concentration trends. The primary analysis of PCBs was done as the sum of PCBs, or "Total PCBs", rather than individual congeners, homologues, or Aroclors. Not all data sets quantified PCBs in the same manner. Both the 1995 TSI data set and the 2008 USEPA data estimated Total PCBs as the sum of Aroclors, while all other recent sampling efforts collected PCB congener data. In order to reconcile the two PCB metrics, an adjustment factor was developed from a subset of the 2008 USEPA and CPG data in which both Total PCBs by congener and Total PCBs by Aroclor were developed (see Attachment B of Data Evaluation Report No 3). Based on matched pairs of congener analysis and Aroclor analysis, the congener sum was found to be, on average, 1.25 times higher than the Aroclor sum. On this finding, the 1995 TSI and 2008 USEPA Aroclor data were multiplied by a factor of 1.25 to make the measurements equivalent to the 2008-2010 CPG results and enables a much more extensive and robust series of analyses.

Unlike the 1995 TSI and 2008 USEPA data for PCBs, there were no matched pairings of PCB Aroclor and PCB congener analytical results made as part of the 1999-2000 surface sediment study by TSI and the Minish Park Study. To create a rough basis for comparison and enable some mapping of the 1999-2000 shoreline data in Figure 3.1-1, the 1999-2000 Total PCB concentration was estimated based on the sum of the reported 10 congeners multiplied by 17.8. This factor was based on the ratio between the average 1999-2000 surface sediment concentration and the average Total PCB concentration in the 1999-2000 horizons of the dated high-resolution sediment cores collected in 2005. Because of the uncertain nature of this factor, the 1999-2000 data are presented only in Figure 3.1-1 and were not used in any of the subsequent statistical analyses for PCBs presented later in this data evaluation report.

Figures 3.1-1 to 3.1-9 present a set of analyses that parallels the analyses done for 2,3,7,8-TCDD. Additionally, Figure 3.1-7 presents the results for three PCB congener peaks for the 2005 to 2008 Be-7 bearing samples and CPG samples containing Be-7. (Note that the 2012 CPG samples were not analyzed for Be-7 and so are not represented here.) The three PCB congeners were plotted to represent a range of PCB molecular weights, from light (BZ52+69), medium (BZ90+101+113), and heavy (BZ180+193). These diagrams represent the results of congener-specific analyses and were plotted to confirm that the trends seen in the Total PCB analyses are also observed on a congener level. In addition to confirming many of the 2,3,7,8-TCDD observations discussed above, the PCB analyses also yield the following observations:

- Surface sediment concentrations of Total PCBs appear unchanged over time, with some allowance for the difficulties in comparing the two analytical methods used. No statistically significant differences were observed. This is consistent with the very gradual decline in concentration observed in the dated sediment cores. A similar comparison of the two periods is made in Figure 3.1-8, but for RM1 to RM7 as opposed to the intervals used in Figure 3.1-3a. In this instance, the median value for the adjusted Total PCB concentrations in 1995 is within 10 percent of the 2008-2010 value for RM1 to RM7. Given the assumptions and uncertainties involved in applying the adjustment factor, any real change in the surface sediment concentration is too small to be distinguishable from the uncertainties and variability in the data sets.
- Relatively minor concentration gradients are observed above RM12 and below RM2, especially after TOC normalization of the Be-7 bearing sediment samples (Figure 3.1-6). Specifically, the RM2 to Newark Bay gradient for TOC-normalized PCB concentrations is reduced to a factor of 2 over its length and the Upper Passaic River to RM12 gradient is essentially eliminated. This indicates that surface sediment concentrations of Total PCBs in the Lower Passaic River are more similar to those found in the Upper Passaic River and Newark Bay as compared to the very large (2 orders of magnitude) gradients observed for 2,3,7,8-TCDD concentrations in these areas.
- The Total PCBs concentrations in Be-7 bearing sediments in the Upper Passaic River are very similar in concentration to concentrations in Be-7 bearing sediments in the Lower Passaic River, especially when TOC-normalized. This suggests that the load of PCBs from the Upper Passaic River is a significant portion of the Total PCB budget for the Lower Passaic River. This indication is confirmed by the Empirical Mass Balance Analysis (see Appendix C).
- Similar to 2,3,7,8-TCDD, Total PCB concentrations above RM8 are about twice as high in fine-grained sediments as compared to coarse-grained sediments, but show no difference in time (1995-2010) or river mile (RM1 to RM13, comparing fine sediments). Total PCBs concentrations also and show no significant difference between channel and shoal sediments below RM8.

3.2 Temporal and Spatial Trends of Pesticides in Surface Sediments

The three pesticides identified as COPC and COPECs in the risk assessment were analyzed for surface sediment concentration trends: Total 4,4’-DDT, including all 3 forms (4,4’- Dichlorodiphenyltrichloroethane (4,4’-DDT) and its metabolites 4,4’-Dichlorodiphenyldichloroethane (4,4’-DDD) and 4,4’- Dichlorodiphenyldichloroethylene (4,4’-DDE); abbreviated here as Total DDx), dieldrin, and total chlordane. Pesticides generally confirmed the observations obtained from the analysis of 2,3,7,8-TCDD. In particular, the observations relating to the current distribution of contamination along the main axis of the river, where the 0 to 6 inch surface concentrations are highly variable but show no trend with river mile from RM2 to RM12. Like 2,3,7,8-TCDD, the pesticides show decreasing concentration gradients with river mile above RM12 and below RM2. However, there are apparent differences in surface concentrations over time for two of the pesticides. Changes in analytical techniques during this period make it difficult to determine if these differences are real. Among other concerns, 4,4’-DDT quantitation in 1995 was relatively poor due to the presence of significant interference, resulting in many rejected and nondetect analyses. Note that gas chromatography/electron capture detector (GC/ECD) SW-846 Method 8081A used in 1995 was rejected in favor of high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS) USEPA Method 1699 and NYSEC HRMS-2, WS-ID-0014 in the later studies. For this reason, comparisons involving the 1995 data set are done on the basis of 4,4’-DDE alone (this compound was fairly frequently detected in surface sediment samples) while later comparisons use the sum of the 3 DDT forms (4,4’-DDE, 4,4’-DDD, and 4,4’-DDT). Figures 3.2-1 to 3.2-25 present the sequence of analysis for these pesticides, paralleling the 2,3,7,8-TCDD analyses. Following are the additional observations from the analysis of the pesticide results, including differences from the 2,3,7,8-TCDD observations:

- 4,4’-DDE, dieldrin, and total chlordane did exhibit higher concentrations in fine-grained sediments versus coarse-grained sediments above RM8 (2-3 times), as was observed for 2,3,7,8-TCDD. However, the concentrations in the fine-grained sediments above RM8 were notably higher than those below RM8 (about 1.5 to 2.0

times as high). This is different from the behavior for 2,3,7,8-TCDD, wherein fine-grained sediment concentrations were the same upstream and downstream of RM8.

- Both Total DDx and dieldrin exhibited little difference between shoal and channel areas for RM2 to RM8, as was observed for 2,3,7,8-TCDD. However, median channel and shoal concentrations for the two pesticides were different in RM0 to RM2, with shoal concentrations about 25 and 45 percent lower than channel, respectively for Total DDx and dieldrin. Total chlordane exhibited lower concentrations in the shoals than in the channel everywhere below RM8: about 25 percent lower for RM2 to RM8 and 45 percent lower for RM0 to RM2. The reason for the channel-shoal differences in pesticides that were not evident in 2,3,7,8-TCDD and PCBs is unknown. Nonetheless, while these differences are significant based on statistical considerations, they do not represent substantive differences between channel and shoal in the level of risk posed by these compounds. Specifically, risks to biota and humans are linearly related to environmental concentrations (see Data Evaluation Report No. 6). As a result, only order of magnitude changes yield substantive changes in risk. Therefore, the channel and shoal sediments would be expected to yield comparable risk levels for the same exposure scenarios since the concentration differences between channel and shoal sediments are a factor of 2 or less (*i.e.*, less than 50 percent).
- The concentration gradients with river mile above RM12 and below RM2 are substantially shallower than those observed for 2,3,7,8-TCDD. The Be-7 bearing sediments and TOC normalized data reduces the concentration gradients with river mile for pesticides even further. This observation highlights the greater importance of the Upper Passaic River in the mass budgets for these compounds in the Lower Passaic River. The substantive reduction of the gradient above RM12 by controlling for time (Be-7 bearing) and TOC content indicates that the Upper Passaic River is currently delivering solids with concentrations for these three pesticides that are comparable to Lower Passaic River concentrations on a TOC basis. Variations in absolute concentrations for these compounds between RM12 and RM17.4 are largely a factor of the organic carbon content and by inference, the coarse-grain sediment fraction. In a similar construct, the shallowness of the concentration gradient to

Newark Bay highlights the presence of substantive levels of these compounds on NY/NJ harbor suspended matter. In total, these observations indicate that these compounds are more strongly influenced by external solids loads to the Lower Passaic River, unlike 2,3,7,8-TCDD. The relative importance of external sources and resuspension of legacy sediment is quantitatively estimated in the Empirical Mass Balance Analysis (see Appendix C).

- The concentrations observed for 4,4',-DDE and dieldrin in the 1995 TSI study mimic the spatial distribution of these contaminants in 2008 to 2012 (*i.e.,* highly variable but with little to no trend with river mile). However, the absolute concentrations of these two pesticides are 2 to 5 times higher in 1995 than in 2008 to 2012 period for DDE and dieldrin, respectively. This observation is not borne out by other lines of evidence, such as the dated sediment cores (see Figures 3.2-26 and 3.2-27 and Data Evaluation Report No. 3) and fish body burdens (see Data Evaluation Report No. 6). For 4,4'-DDE, the decline in surface sediment concentrations appears much more rapid than the dated sediment cores or the fish tissue. Figure 3.2-26 shows the very slowly declining concentrations of 4,4'-DDE across all five dated sediment cores. For dieldrin, the dated sediment core evidence from both the Upper and Lower Passaic River indicates that concentrations for this compound are increasing over time at all dated sediment locations (see Figure 3.2-26), whereas the 1995 to 2008- 2012 trend for the surface sediments indicates a decline in concentration.
- Comparisons involving the 1995 data set for DDT were done on the basis of 4,4'-DDE alone, because of analytical concerns for 4,4'-DDT and its other metabolite in the 1995 data set. Specifically, the 1995 results were obtained using SW-846 Method 8081A, which involves GC/ECD. Quantitation by this method was relatively poor due to the presence of many interferences, resulting in many rejected and non-detect results. Comparisons among the later data sets are able to use the sum of the three DDT forms (4,4'-DDE, 4,4'-DDD, and 4,4'-DDT) to represent Total DDx concentration trends, because quantitation was improved through the use of a HRGC/HRMS (USEPA Method 1699 and NYSDEC HRMS-2, WS-ID-0014). In 2008, the CPG analyzed chlorinated pesticides by both the HRGC/HRMS method and the standard SW-846 GC/ECD method. The results show that the HRGC/HRMS

procedures offer greater sensitivity, improved accuracy, and enhanced compound identification.

- Given these concerns and observations, the calculated decline in concentrations from 1995 to 2012 suggested by the 0 to 6 inch samples for these compounds is unlikely to have actually occurred. Rather, the declines described by the dated sediment cores are considered more reflective of the true changes in these compounds over time.

3.3 Temporal and Spatial Trends of PAHs in Surface Sediments

Recognizing the close correlations among individual PAH compounds, PAHs were treated in three groups rather than as individual compounds for this analysis. Parallel analyses were conducted for high molecular weight (HMW) PAHs (4 or more rings per molecule), low molecular weight (LMW) PAHs (2 to 3 rings per molecule), and Total PAHs. The analyses are presented in Figures 3.3-1 to 3.3-24. In general, PAH compounds closely replicated the trends for 2,3,7,8-TCDD in nearly all aspects below RM8 and had no trend with river mile to RM12. The notable differences involved the following observations:

  - The PAH concentration trend above RM12 lacked a downward gradient toward RM17.4,
  - The correlation between PAHs and sediment characteristics above RM8 differed from the 2,3,7,8-TCDD spatial trends, and
  - A comparison of the 1995 to the later studies suggested an apparent increase in PAH concentrations to the present (*i.e.*, 1995 sediments were statistically lower than more recent samples).

The last observation is attributed to analytical differences between programs and is not considered accurate since the high resolution cores do not support increasing surface sediment PAH concentrations over time, indicating instead that PAH concentrations in surface sediments have remained nearly constant since about 1975 (see Data Evaluation Report No. 3). The following are the main observations derived from the PAH results:

- The trends with river mile for the three PAH sums are similar to each other and to observations from 2,3,7,8-TCDD concentrations, indicating the mixing ability of tidal transport, scour, and deposition.

- PAH concentrations do not decline appreciably above RM12, unlike 2,3,7,8-TCDD and to a lesser extent, 4,4’-DDE. If concentrations are normalized to TOC, they actually increase above RM12 for both coarse and fine-grained sediments.
- PAH concentrations in the Upper Passaic are comparable or higher than those observed in the Lower Passaic River. This is most easily evident when Be-7 bearing sediments are normalized to TOC; Upper Passaic River sediments are clearly higher in PAH concentrations. This difference indicates an on-going source of PAHs to the Lower Passaic River from the Upper Passaic River, given the magnitude of flow and solids that enter the Lower Passaic River from the Upper Passaic River. This data-based observation is confirmed by the Empirical Mass Balance analysis (see Appendix C), which finds the Upper Passaic River to be the most significant PAH source of benzo(a)pyrene and fluoranthene to the Lower Passaic River.
- A comparison of the PAH concentrations in fine-grained and coarse-grained sediments above RM8 yielded the smallest differential between the two sediment types for any of the organic compounds examined. Median concentrations on coarse-grained sediments were only 25 percent lower than the concentrations on fine-grained sediments. By contrast, most other organic compounds were at least 40 percent lower on coarse-grained sediments.

3.4 Temporal and Spatial Trends of Metals in Surface Sediments

The last compound class considered in this analysis of surface sediment contamination is the metals. In this analysis, cadmium, chromium, copper, lead, and mercury are examined for their spatial and temporal trends. Of these, copper, lead, and mercury are COPCs or COPECs. The other two metals were examined here due to their potential usefulness in geochemical data interpretation and the Empirical Mass Balance (see Appendix C). Figures 3.4-1 to 3.4-40 present the various analyses conducted for these five metals.

All five metals examined closely follow the spatial distribution pattern described by 2,3,7,8-TCDD, the main difference being the steepness of the concentration trend with river mile below RM2. In general, Newark Bay metal concentrations on solids are not very different from those observed in the Lower Passaic River so the concentration gradient below RM2 is rather shallow. The trend of metal concentrations with river mile above RM12 is more pronounced and more closely mimics the shape of the 2,3,7,8-TCDD trend. Overall, the spatial trends in metal concentrations confirm the observations based 2,3,7,8-TCDD. The important additional observations are noted below:

- Iron normalization significantly reduces the variability in concentrations in most metals for both Be-7 bearing samples as well as 0 to 6 inch samples obtained from depositional locations. As noted previously, this reduction in variance reflects the geochemistry of iron in that it is generally associated with the binding sites on fine-grained particles that will also absorb other metal species. Thus, increased iron levels indicate increased binding sites and increased fine-grained particle content in the sample. Iron normalization typically exhibited a greater effect reducing sample-to-sample variability for metal contaminants than TOC normalization did for organic contaminants, indicating that fine-grained sediment content may control metal contamination levels more closely than it controls organic contamination levels.
- Iron normalized data in RM2 to RM12 exhibit significantly reduced variability for four of the five metals (variability among Be-7 bearing mercury analyses did not decline as a result of normalization to iron). Sample to sample variability for three of the four remaining metals was ± 15 percent of the value or less. For lead, the variability was reduced to ± 20 percent.
- Based on the low degree of variability in recently-deposited sediments from RM2 to RM12, it can be inferred that variations in water column fine-grained suspended matter contaminant burdens (*i.e.*, the particles that are the source of these recently-deposited sediments) are reduced to the same degree or less on the scale of 6 months to 1 year. That is, water column concentrations of metals on suspended matter vary less than ±20 percent between RM2 and RM12 when averaged over a 6 to 12 month period. It is likely that water column concentrations of organic contaminants have a similar level of agreement over this portion of the Lower Passaic River, based on the similarly low variability noted in TOC-normalized samples. The distribution of metal concentrations is considered further evidence for the dynamic and extensive nature of tidal mixing in the Lower Passaic River.

- Metals contamination in 0 to 6 inch surface sediments exhibit the same spatial variation patterns as 2,3,7,8-TCDD, *i.e.*, surface sediments exhibit a large degree of variability but the central tendency remains the same from RM2 to RM12. The central tendency in the 0 to 6 inch samples is generally coincident with the mean value of the Be-7 bearing samples.
- Overall metal variability is less than that observed for the organic contaminants. This is most easily noted by comparing the number of log cycles on the organic sample presentations (typically 6 cycles) with those for the metal sample presentations (typically 4 cycles).
- For cadmium, chromium, copper, and lead, shoal and channel samples were within statistical agreement below RM8, while for mercury the data suggest some differences in channel and shoal although the differences were not statistically significant. All metals results showed reduced concentrations for coarse-grained sediment samples upstream of RM8 relative to fine-grained sediment samples.
- All five metals showed a decline in 0 to 6 inch sediment concentrations from 1995 to 2008-2012 for RM2 to RM8, with the greatest decline observed for mercury. While a decline in these concentrations is expected given the results of the dated sediment cores, the magnitude of the change obtained by comparing surface concentrations is much greater than predicted by other lines of evidence and suggests there may be analytical issues across the 0 to 6 inch sediment sampling programs leading to this observation. Notably, fish tissue concentrations in the Lower Passaic River for several of these metals have not declined consistently over this period, varying in trend from study to study and among species (see Data Evaluation Report No. 6). The dated sediment cores indicate much slower rates of decline across the entire river post-1995, but these rates appear consistent with the dated core-based rates of decline estimated for the post-1980 period. Because of the continuous nature of the records, their internal analytical consistency and their agreement across 12 miles of the Lower Passaic River, the rate of decline in metals concentrations from the dated sediment cores is considered the best estimate of the actual rate of decline in metal concentrations.

4 SUMMARY OF DATA EVALUATION REPORT NO. 4

The analysis of surface sediment contamination in the Lower Passaic River has provided a series of observations that form much of the basis for the conceptual site model. These observations provide insight into the processes at work in the Lower Passaic River that govern the fate and transport of the contaminants found there. In conducting the analysis, 2,3,7,8-TCDD was used to glean many of the original insights due to the scale of the differences between Lower Passaic River sediment concentrations and those of the external sources of solids. The analysis of the other 13 compounds, representing the compound classes PCBs, pesticides, PAHs and metals, confirmed the insights in nearly every instance, providing an extensive series of observations to support the construction of the conceptual site model. In a limited number of instances, the interpretation of the other compounds provided a more nuanced understanding of the processes involved, but did not change the main conclusions drawn from the 2,3,7,8-TCDD-based observations. This analysis and the conclusions that follow are based on a review of data from 16 different studies of sediment contamination in the Lower Passaic River, involving sampling intervals from 0 to 1 to 0 to 6 inches thick.

Listed below are the main conclusions of this data evaluation report:

- Surface concentrations are locally variable but largely without trend in river mile from RM2 to RM12. Of note, concentrations of 2,3,7,8-TCDD in 0 to 6 inch samples can vary over 4 orders of magnitude within a single river mile interval. However, 2,3,7,8-TCDD concentrations in recently-deposited sediments vary less than a factor of 3 from RM2 to RM12, slowly and regularly increasing in value moving upstream. This gradual increase is further reduced when concentrations are normalized to TOC. Other compounds show a similar distribution, with highly variable local concentrations but little variation in the concentrations measured in recently-deposited sediments from RM2 to RM12.
- When Upper Passaic River contamination on recently-deposited sediments is less than that of the Lower Passaic River, an increasing concentration gradient occurs from RM17.4 to RM12.

- When downstream contamination is less than that of the Lower Passaic River, a decreasing concentration gradient occurs from RM2 to RM0 and sometimes extends to the southern end of Newark Bay.
- For organic contaminants, normalization to TOC further reduces concentration variation within the Lower Passaic River for Be-7 bearing (*i.e.*, recently-deposited) sediments but does little to reduce variability in 0 to 6 inch results from samples in depositional locations. This is because 0 to 6 inch samples tend to incorporate much older materials (pre-1990s), which are generally more contaminated, thus reducing the interpretative value of normalization.
- Some component of the concentration gradient above RM12 is due to the greatly reduced presence of fine-grained sediment in this region. In some instances, normalization to TOC or iron largely eliminates the gradient for recently-deposited sediments, indicating that the Upper Passaic River is contributing contaminant concentrations on a fine-grained particle basis that are comparable to those observed in the Lower Passaic River for contaminants such as PAHs, dieldrin and Total Chlordane.
- For metal contaminants, normalization to iron reduces sample-to-sample variability, often fairly substantially, and typically more than TOC normalization does for organic contaminants, indicating that fine-grained sediment content may control metal contamination levels more closely than organic contamination levels.
- Iron-normalized data in RM2 to RM12 exhibit significantly reduced variability for cadmium, chromium, copper, and lead. Sample to sample variability for cadmium, chromium, and copper was ± 15 percent or less of the mean value for RM2 to RM12. For lead, the variability was reduced to ± 20 percent. Variation in mercury concentrations is larger (roughly ±45 percent) and was not reduced by normalization to iron. The reason for the lack of improvement in mercury variation has not been explored.
- The low variability in recently-deposited sediments indicates that tidal mixing homogenizes water column fine-grained suspended matter contaminant burdens (*i.e.*, the particles that are the source of these recently-deposited sediments). That

is, water column concentrations of metals on fine-grained suspended matter vary less than ± 20 percent between RM2 and RM12 (when averaged over a 6 to 12 month period, which is the measurement period of Be-7). It is likely that water column concentrations of organic contaminants have a similarly low range of variability over this region, based on the similarly low variability noted in TOC-normalized samples.

- Surface concentrations within RM2 to RM12 are affected by variations in fine-grained sediment content (*i.e.*, percent fines). Most variation in fine-grained sediment content in surface sediments occurs above RM8, where most of the river bottom is characterized as sands and coarser sediment with pockets of fine-grained sediments. In RM2 to RM8, each contaminant showed comparable concentrations in channel and shoal areas, with local variations. No contaminant showed a systematic trend with river mile in RM2 to RM8.
- Extreme values of the COPCs and COPECs occurred somewhat randomly across the river bottom and do not always coincide with extreme values of other COPCs or COPECs. These observations occurred in the 0 to 6 inch and 0 to 2 inch non-Be-7 bearing samples. The randomness of these values indicates that care is necessary in estimating local concentration averages. These extreme values are likely the result of differences in release history for the various compounds such that different compounds reach maximum values at different horizons with the sediment bed. Their presence at the riverbed surface is evidence for reworking of the sediment bed after initial deposition and burial. Alternatively, and probably less likely in the channel and deeper shoals, their presence at the riverbed surface may be evidence for lack of burial subsequent to deposition 30 to 40 years ago.
- Samples obtained from 0 to 6 inches integrate sediments over highly variable time scales, whereas Be-7 bearing samples represent just the last year of deposition or less. As a result, 0 to 6 inch samples have inherently more variable concentrations, incorporating deeper, more contaminated sediments.
- The observations of parallel trends in median contaminant concentrations across the Lower Passaic River from both 0 to 6 inch samples and the Be-7 bearing sediments is the result of the estuarine processes at work in the river. The spatial

distribution of the COPCs and COPECs in the Lower Passaic River is well explained by the occurrence of extensive tidal mixing and reworking of the sediment bed, generating locally variable concentrations as legacy sediments are exposed and reworked, while recent deposition is evenly contaminated over distances of several miles.

- Some compounds such as DDT, mercury and dieldrin appear to have lower surface concentrations in the 2008 to 2012 sampling period than in 1995, unlike 2,3,7,8-TCDD. The comparison of 0 to 6 inch samples indicated higher PAH concentrations in 2008 to 2012 relative to 1995. These observations are inconsistent with those from the dated sediment cores (see Data Evaluation Report No. 3) and probably result from analytical differences among sampling programs and over time. Analytical differences are not an issue for the dated sediment cores since a single analytical technique was used across all cores for all core layers for any given analyte. Thus, the magnitude of the differences suggested by comparison across the various surface sediment sampling programs may not be real.

Based on these observations, the Lower Passaic River Study area can be divided into the following regions for the purposes of the conceptual site model of contaminant transport:

- The Upper Passaic River exhibits a generally low level of contamination relative to the Lower Passaic River when viewed on a simple concentrations basis; the exception is PAHs. Normalized concentrations further reduce the differences between the Upper Passaic sediments for PCBs, dieldrin, and chlordane, which appear comparable to or higher than normalized levels in the Lower Passaic River. This indicates that the level of contamination in Upper Passaic River fine-grained sediment is comparable to levels found in recently-deposited Lower Passaic River sediments for PAHs, PCBs, dieldrin, and chlordane. Irrespective of normalization, however, the Upper Passaic River is still orders of magnitude lower in 2,3,7,8-TCDD concentrations relative to the Lower Passaic River.

- The RM12 to RM17.4 region is characterized by an increasing concentration gradient with decreasing river mile (a two-order of magnitude gradient in 2,3,7,8-TCDD concentration). This is the result of the mixing of cleaner Upper Passaic solids with more contaminated resuspended solids originating in the Lower Passaic River,
- The RM8 to RM12 region is characterized by highly variable contaminant concentrations but little-to-no trend in concentration with river mile. Some of the concentration variability can be explained by variations in fine-grained sediment content. In particular, the RM8 to RM12 region has wide areas of coarse-grained sediments and relatively few areas of fine-grained sediments. Higher contaminant concentrations occur primarily in fine-grained sediments in this region.
- The RM2 to RM8 region is also characterized by highly variable contaminant concentrations but has a stronger central tendency to the distribution compared to the RM8 to RM12 region, with many samples close to the median concentration for each contaminant. This is attributed in part to the more spatially extensive fine-grained sediment texture that is characteristic of this region. There is little area characterized as coarse-grained in RM2 to RM8.
- The RM0 to RM2 region is characterized by a shallow concentration gradient for most contaminants. This gradient is still substantively steeper than any trend observed from RM2 to RM12. For 2,3,7,8-TCDD, the gradient in this region is much shallower than that observed in the RM12 to RM17.4 region. The gradient in the RM0 to RM2 region is attributed to the mixing of solids from Newark Bay into the Lower Passaic River as the result of tidal exchange.

5 ACRONYMS

2,3,7,8-TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin
Be-7	Beryllium-7
BZ	Ballschmiter and Zell
COPC	Contaminants of Potential Concern
COPEC	Contaminants of Potential Ecological Concern
CPG	Cooperating Parties Groups
CSO	Combined Sewer Overflow
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
FFS	Focused Feasibility Study
GC/ECD	Gas Chromatography/Electron Capture Detector
HMW	High Molecular Weight
HRGC/HRMS	High Resolution Gas Chromatography/High Resolution Mass Spectrometry
K_d	partitioning coefficient
LMW	Low Molecular Weight
LPRSA	Lower Passaic River Study Area
NYSDEC	New York State Department of Environmental Conservation
pg/g	picograms per grams of sediment
PAH	Polycyclic Aromatic Hydrocarbon
PCA	Principal Components Analysis
PC1	First principal component
PC2	Second principal component
PC3	Third principal component
PCB	Polychlorinated Biphenyl
RI	Remedial Investigation
RM	River Mile
SWO	Stormwater Outfall

TOC	Total Organic Carbon
TOPS	Trace Organics Platform Sampler
Total DDx	Sum of the three DDT metabolites (4,4’-DDE, 4,4’-DDD and 4,4’-DDT
Total TCDD	Total Tetrachlorodibenzo-p-dioxin
TSI	Tierra Solutions, Inc.
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

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TABLES

Table 1-1: Surface Sediment Sampling Programs Used in Data Evaluation Report No. 4

Year	Study Name	Analytical Methods
1991	USEPA Core Sediment Investigation	Not Available
1991	NOAA NS&T Hudson-Raritan Phase I	Analytical Methods of the National Status and Trends Program Benthic Surveillance and Mussel Watch Projects 1984-1992 (Peven and Uhler, 1993)
1993	NOAA NS&T Hudson Raritan Phase 2	Analytical Methods of the National Status and Trends Program Benthic Surveillance and Mussel Watch Projects 1984-1992 (Peven and Uhler, 1993)
1993	USEPA Passaic Core Sediment Investigation	Not Available
1993	REMAP 1993	PAHs: Methylene chloride extraction; determination by GC/MSC. TSB SOP C-48 (USEPA Region 2, 1994a) PCB/Pesticides: Methylene chloride extraction; determination by HRGC/ECD; GERG SOPs-ST02, ST04 Total Metals: HNO3 and HF acid digestion; GERG SOPs ST08, ST09, ST10, ST11 Total recoverable metals: HNO3/H2O2 or microwave digestion; TSB SOPs C-5, C-8, C-72, C-73 C-74 (USEPA Region 2, 1994b-f) Hexavalent Chromium: Chelation with APDC, extraction with MIBK, determination by FAAS; MCAWW 218.4 (USEPA, 1983) Dioxins and Furans: Method 1613A AVS/SEM: GERG SOPs-9130, ST11, ST09, ST10 Butyltins: Tropolone extraction, determination by HRGC/FPD or HRGC/MS (GERG SOP-9013) TOC: Acidification with H3PO4, determination using CO2 analyzer; MCAWW 415.1 (USEPA 1983) Grain size: sieving and pipette analysis (USEPA, 1993)
1995	Passaic RI Sampling Program	Pesticide/PCBs: 3550/8081 Chlorinated Herbicides: INC/8150A PCDDs/PCDFs: INC/1613A Metals: 3050A/6010A Lead: 3050A/7421 Mercury: INC/7471 TOC: INC / Lloyd Kahn
1995	USACE Minish Park Investigation	Not Available
1999	1999 Sediment Sampling Program	Semi-VOAs (excluding PAHs): 3540C/8270C (biological) & 3550B/8270C (sediment) Percent Lipid: NOAA, 1993 PAHs: HRCG/LRMS/SIM (GERG, 1998) Pesticides: 8081A PCB Aroclors: 8082 PCB Congeners and Homologues: 1668M PCDD/PCDFs: 1613A Inorganics including Mercury: 3010A/3050B/3052/6010B/7470A/7471A Cyanide: 9010B/9012A/9013/9014 TOC: 9060 Lloyd Kahn DOC: 9060 TSS: 160.2 Ammonia: 350.3 Acid Volatile Sulfide/Simulataneously Extracted Metals (Allen et al., 1991) Sediment Toxicity Testing for Marine and Estuarine Amphipods: ASTM E1367 Sediment Toxicity Testing for Polychaetes (ASTM E1611)

Table 1-1: Surface Sediment Sampling Programs Used in Data Evaluation Report No. 4

Year	Study Name	Analytical Methods
1999	1999 Late Summer/ Early Fall Environmental Sampling Program	Semi-VOAs (excluding PAHs): 3540C/8270C (biological) & 3550B/8270C (sediment) Percent Lipid: NOAA, 1993 PAHs: HRCG/LRMS/SIM (GERG, 1998) Pesticides: 8081A PCB Aroclors: 8082 PCB Congeners and Homologues: 1668M PCDD/PCDFs: 1613A Inorganics including Mercury: 3010A/3050B/3052/6010B/7470A/7471A Cyanide: 9010B/9012A/9013/9014 TOC: 9060 Lloyd Kahn DOC: 9060 TSS: 160.2 Ammonia: 350.3 Acid Volatile Sulfide/Simulataneously Extracted Metals (Allen *et al.* , 1991) Sediment Toxicity Testing for Marine and Estuarine Amphipods: ASTM E1367 Sediment Toxicity Testing for Polychaetes (ASTM E1611)
1999-2000	USACE Minish Park Monitoring Program	Not Available
2000	2000 Spring Environmental Sampling Program	Semi-VOAs (excluding PAHs): 3540C/8270C (biological) & 3550B/8270C (sediment) Percent Lipid: NOAA, 1993 PAHs: HRCG/LRMS/SIM (GERG, 1998) Pesticides: 8081A PCB Aroclors: 8082 PCB Congeners and Homologues: 1668M PCDD/PCDFs: 1613A Inorganics including Mercury: 3010A/3050B/3052/6010B/7470A/7471A Cyanide: 9010B/9012A/9013/9014 TOC: 9060 Lloyd Kahn DOC: 9060 TSS: 160.2 Ammonia: 350.3 Acid Volatile Sulfide/Simulataneously Extracted Metals (Allen et al., 1991) Sediment Toxicity Testing for Marine and Estuarine Amphipods: ASTM E1367 Sediment Toxicity Testing for Polychaetes (ASTM E1611)
2005	USACE Sedflume Testing	Total Mercury: EPA-CLP (ILM0.5.3) with flex clause Trace Mercury:EPA 1631 plus modifications for extraction of sediment Methyl Mercury: EPA 1630 EPA 1630 plus modifications for extraction of sediment Chromium,Hexavalent: 7199/3060A SEM Metals (Cd, Pb, Hg, Ni and Zn): SW-846 methods or other approved USEPA methods for metals SVOCs including PAHs and PCB Aroclors: EPA-CLP SOM1.0, with flex cause options to achieve requested RLs PAHs: 8270 (modified) Pesticides: 8081 (modified) PCB congeners: EPA 1668A Dioxins/furans: EPA 1613B Screening for Dioxin_{TEQ} and PCB_{TEQ}: 4025 (modifiedd) Chlorinated Herbicides: 8151A TOC Combustion: Lloyd Kahne Be-7, Cs-137, Pb-210: HASL-300 EML and USEPA-600

Table 1-1: Surface Sediment Sampling Programs Used in Data Evaluation Report No. 4

Year	Study Name	Analytical Methods
2005	USEPA Gust Microcosm Testing	Total Mercury: EPA-CLP (ILM0.5.3) with flex clause Trace Mercury:EPA 1631 plus modifications for extraction of sediment Methyl Mercury: EPA 1630 EPA 1630 plus modifications for extraction of sediment Chromium,Hexavalent: 7199/3060A SEM Metals (Cd, Pb, Hg, Ni and Zn): SW-846 methods or other approved USEPA methods for metals SVOCs including PAHs and PCB Aroclors: EPA-CLP SOM1.0, with flex cause options to achieve requested RLs PAHs: 8270 (modified) Pesticides: 8081 (modified) PCB congeners: EPA 1668A Dioxins/furans: EPA 1613B Screening for Dioxin$_{TEQ}$ and PCB$_{TEQ}$: 4025 (modifiedd) Chlorinated Herbicides: 8151A TOC Combustion: Lloyd Kahne Be-7, Cs-137, Pb-210: HASL-300 EML and USEPA-600
2005	USEPA High Resolution Sediment Coring	Total Mercury: EPA-CLP (ILM0.5.3) with flex clause Trace Mercury:EPA 1631 plus modifications for extraction of sediment Methyl Mercury: EPA 1630 EPA 1630 plus modifications for extraction of sediment Chromium,Hexavalent: 7199/3060A SEM Metals (Cd, Pb, Hg, Ni and Zn): SW-846 methods or other approved USEPA methods for metals SVOCs including PAHs and PCB Aroclors: EPA-CLP SOM1.0, with flex cause options to achieve requested RLs PAHs: 8270 (modified) Pesticides: 8081 (modified) PCB congeners: EPA 1668A Dioxins/furans: EPA 1613B Screening for Dioxin$_{TEQ}$ and PCB$_{TEQ}$: 4025 (modifiedd) Chlorinated Herbicides: 8151A TOC Combustion: Lloyd Kahne Be-7, Cs-137, Pb-210: HASL-300 EML and USEPA-600
2005	Polytechnic Institute (RPI) and Lamont-Doherty Earth Observatory (L-DEO) Upper Passaic High Resolution Sediment Cores	Radionuclide measurements were carried out using a gamma counter with an intrinsic germanium detector (ORTEC GWL-120)
2005	Newark Bay Study Phase I Remedial Investigation	Cadmium: USEPA 6010B Mercury: USEPA 7471A PAHs: USEPA 8270C 4,4'-DDD, DDE & DDT: USEPA 8081 Dieldrin: USEPA 8081 Aroclor PCBs: USEPA 3550/8082 Congener PCBs: USEPA 1668A PCDDs/PCDFs: USEPA 1613B Total Organic Carbon: Lloyd Kahn

Table 1-1: Surface Sediment Sampling Programs Used in Data Evaluation Report No. 4

Year	Study Name	Analytical Methods
2006	USEPA Low Resolution Sediment Coring	Total Mercury: EPA-CLP (ILM0.5.3) with flex clause Trace Mercury:EPA 1631 plus modifications for extraction of sediment Methyl Mercury: EPA 1630 EPA 1630 plus modifications for extraction of sediment Chromium,Hexavalent: 7199/3060A SEM Metals (Cd, Pb, Hg, Ni and Zn): SW-846 methods or other approved USEPA methods for metals SVOCs including PAHs and PCB Aroclors: EPA-CLP SOM1.0, with flex cause options to achieve requested RLs PAHs: 8270 (modified) Pesticides: 8081 (modified) PCB congeners: EPA 1668A Dioxins/furans: EPA 1613B Screening for $\text{Dioxin}_{\text{TEQ}}$ and PCB_{TEQ}: 4025 (modifiedd) Chlorinated Herbicides: 8151A TOC Combustion: Lloyd Kahne Be-7, Cs-137, Pb-210: HASL-300 EML and USEPA-600
2007	Newark Bay Study Phase II Remedial Investigation	Cadmium: USEPA CLP, ILM06.X-Met Mercury: USEPA CLP, ILM06.X-Met PAHs: USEPA CLP, SOM01.2 4,4'-DDD, DDE & DDT: USEPA CLP, SOM01.2 Dieldrin: USEPA CLP, SOM01.2 Aroclor PCBs: USEPA CLP, SOM01.2 Congener PCBs: USEPA 1668A PCDDs/PCDFs: USEPA 1613B Total Organic Carbon: Lloyd Kahn
2007	USEPA Upper Passaic High Resolution Sediment Coring	Total Mercury: EPA-CLP (ILM0.5.3) with flex clause Trace Mercury:EPA 1631 plus modifications for extraction of sediment Methyl Mercury: EPA 1630 EPA 1630 plus modifications for extraction of sediment Chromium,Hexavalent: 7199/3060A SEM Metals (Cd, Pb, Hg, Ni and Zn): SW-846 methods or other approved USEPA methods for metals SVOCs including PAHs and PCB Aroclors: EPA-CLP SOM1.0, with flex cause options to achieve requested RLs PAHs: 8270 (modified) Pesticides: 8081 (modified) PCB congeners: EPA 1668A Dioxins/furans: EPA 1613B Screening for $\text{Dioxin}_{\text{TEQ}}$ and PCB_{TEQ}: 4025 (modifiedd) Chlorinated Herbicides: 8151A TOC Combustion: Lloyd Kahne Be-7, Cs-137, Pb-210: HASL-300 EML and USEPA-600
2007-2008	USEPA Supplemental Sediment Programs	Congener PCBs: USEPA Method 1668A PCDDs /PCDFs: USEPA Method 1613B Pesticides: Axys Method MLA-028 (HRGC/HRMS similar to 1613B) PAHs: Axys Method MLA-021 (similar to SW846-8270) PCB Aroclors: SW846-8082 TOC: USEPA Lloyd Kahn Method TAL Metals plus Titanium and Mercury: SW-846-6010B and 6020/7470A (The lab used ICP-AES and if necessary ICP-MS, which ever given the better detection limits) Radiochemistry Be-7, Cs-137 and K-40: HASL-300 EML or USEPA Method 4 80-032

Table 1-1: Surface Sediment Sampling Programs Used in Data Evaluation Report No. 4

Year	Study Name	Analytical Methods
2008	USEPA Suspended-Phase High Flow Storm Event Sampling	Congener PCBs: USEPA Method 1668A PCDDs /PCDFs: USEPA Method 1613B Pesticides: Axys Method MLA-028 (HRGC/HRMS similar to 1613B) PAHs: Axys Method MLA-021 (similar to SW846-8270) PCB Aroclors: SW846-8082 TOC: USEPA Lloyd Kahn Method TAL Metals plus Titanium and Mercury: SW-846-6010B and 6020/7470A (The lab used ICP-AES and if necessary ICP-MS, which ever given the better detection limits) Radiochemistry Be-7, Cs-137 and K-40: HASL-300 EML or USEPA Method 4 80-032
2008	USEPA Sedflume Consolidation Testing	Total Mercury: EPA-CLP (ILM0.5.3) with flex clause Trace Mercury:EPA 1631 plus modifications for extraction of sediment Methyl Mercury: EPA 1630 EPA 1630 plus modifications for extraction of sediment Chromium,Hexavalent: 7199/3060A SEM Metals (Cd, Pb, Hg, Ni and Zn): SW-846 methods or other approved USEPA methods for metals SVOCs including PAHs and PCB Aroclors: EPA-CLP SOM1.0, with flex cause options to achieve requested RLs PAHs: 8270 (modified) Pesticides: 8081 (modified) PCB congeners: EPA 1668A Dioxins/furans: EPA 1613B Screening for Dioxin$_{TEQ}$ and PCB$_{TEQ}$: 4025 (modifiedd) Chlorinated Herbicides: 8151A TOC Combustion: Lloyd Kahne Be-7, Cs-137, Pb-210: HASL-300 EML and USEPA-600
2008	2008 CPG Low Resolution Sediment Coring	Cadmium: USEPA 6020 Chromium (total): USEPA 6020 Chromium (hexavalent): USEPA 7199/3060A Copper: USEPA 6020 Lead: USEPA 6020 Mercury, low level: USEPA 1631 Methyl Mercury: USEPA 1630 modified TOC: Lloyd Kahn Method PCBs, Aroclors: Method 8082 PCBs – Homologs and Congeners: Method 1668A Dioxin/Furan: Method 1613B Organochlorine Pesticides: Method 8081A Organochlorine Pesticides; HRGC/HRMS Method (based on USEPA Methods 1613B, 1668, 8081A and New York State Department of Environmental C20Conservation [NYSDEC] HRMS-2 PAHs and Alkyl PAHs: Method KNOX-ID-0016, HRGC/LRMS-SIM
2009-2010	2009-2010 CPG Benthic and Surface Sediment Program	PCBs – Congeners: USEPA 1668A PCBs – Aroclors: USEPA SW-846 8082 PCDDs/PCDFs: USEPA 1613B PAHs: CARB 429 Modified Alkylated PAHs: USEPA SW-846 8270D Organochlorine Pesticides: USEPA 1699 Modified (NYSDEC HRMS-2) Metals (ICP/MS): USEPA SW-846 6020 Metals (ICP): USEPA SW-846 6010B Methylmercury: USEPA 1630 Total Mercury: USEPA 1631

Table 1-1: Surface Sediment Sampling Programs Used in Data Evaluation Report No. 4

Year	Study Name	Analytical Methods
2012	2012 CPG Low Resolution Coring Supplemental Sampling Program	SVOCs: Method 8270C PCDD/PCDFs: EPA 1613B PCB Congeners: EPA 1668A PAHs: NOAA 130 Pesticides: EPA 3640A, EPA 1699, NYSDEC HRMS-2 Grain Size: ASTM D422 or D4464 Specific Gravity: ASTM D854 Atterberg Limits: ASTM D4318 TPH: NJ Method OQA-QAM-025-10/91 Butyltins,:SOP based on Krone, 1988, SOC-BUTYL, Rev. 9 Metals: USEPA 6010/6010B/6020 Mercury: USEPA 1631 AVS/SEM: USEPA Methods 821-R-91-100, 6010C/6020 SEM Mercury: EPA 7470A Radionuclides: HASL-300/USEPA 901.1 Total Sulfides EPA 9030B TOC: Llyod Kahn Amonia: EPA 350.1 Total Cyanides and Cyanides: EPA 335.2 Phosphorus: EPA 365.3 Nitrogen, Total and Soluble Kjeldahl: ASTM D3590-89A, ASTM D1426-93B Percent solids, Total Solids, Percent Moisture: EPA 160.3

Table 1-2: Compounds Evaluated in Data Evaluation Report No. 4

Chemical	Human Health COPC	Ecological COPEC	Considered in Geochemical Analyses
Cadmium			X
Chromium			X
Copper		X	X
Lead		X	X
Mercury	X	X	X
Total PAHs			X
High Molecular Weight PAHs		X	X
Low Molecular Weight PAHs		X	X
Chlordane	X		X
Dieldrin	X	X	X
Total DDT		X	X
DDD, DDE & DDT	X		
Total PCBs	X	X	X
2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)	X	X	X
Total TCDD	X	X	X

Notes:
COPC = Contaminants of Potential Concern
COPEC = Contaminants of Potential Ecological Concern

Table 1-3: Ratio of 2,3,7,8-TCDD/Total TCDD Measured on Surface Sediment and Suspended Solids

Analyte[a]	Average Surface Sediment	Average USGS TOPS	Infiltrex Program	TOPS Laboratory
2,3,7,8-TCDD (µg/kg)	0.28 ±0.079 (N = 3)	0.57 ±0.57 (N = 18)	0.22 (N = 1)	0.17 (N = 1)
Total TCDD (µg/kg)	0.42 ±0.11 (N = 3)	0.78 ±0.62 (N = 18)	0.32 (N = 1)	0.25 (N = 1)
Ratio 2,3,7,8-TCDD/Total TCDD	0.65 ±0.024 (N = 3)	0.72 ±0.15 (N = 18)	0.69 (N = 1)	0.68 (N = 1)

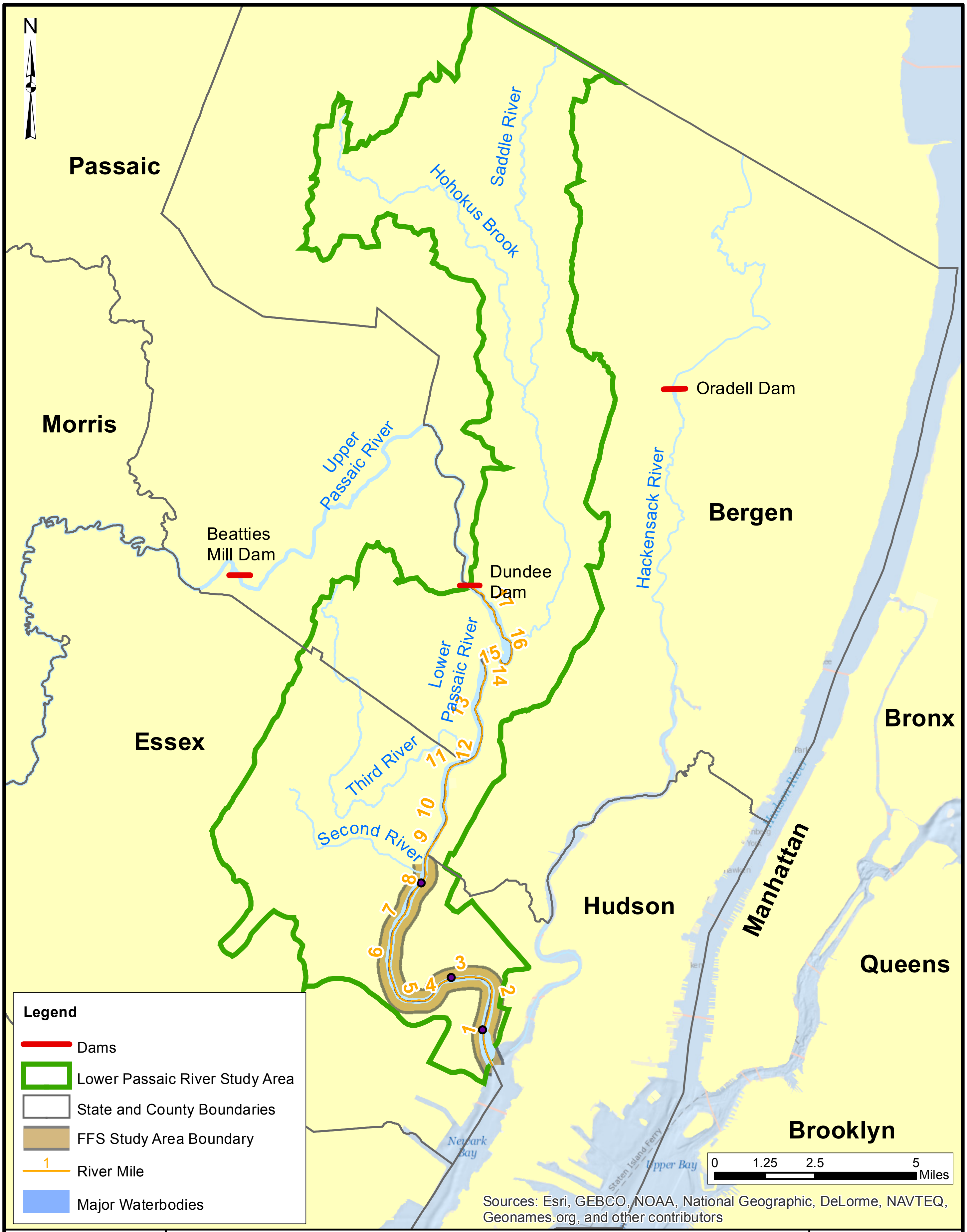
a: Arithmetic average and standard deviation (± 1 sigma) based on a normal distribution of sample size.
N = sample size

Table 3-1
Summary Statistics Used in Data Evaluation Report No. 4
(0-6 inch Surface Sediments)

Year and River Mile Interval			2008-2012 River Mile 0-2						2008-2012 River Mile 2-8						2008-2012 River Mile 8-12						2008-2012 River Mile 12-17.4					
Chemical Grou	Analyte	Unit	N	Minimum	Median	Maximum	Mean	Std Dev	N	Minimum	Median	Maximum	Mean	Std Dev	N	Minimum	Median	Maximum	Mean	Std Dev	N	Minimum	Median	Maximum	Mean	Std Dev
Metals	Cadmium	mg/kg	63	0.14	2.40	29.4	2.83	3.56	137	0.16	3.00	34.7	4.25	4.92	80	0.05	2.94	32.8	4.88	6.07	60	0.06	0.73	11.3	1.53	1.98
	Chromium	mg/kg	63	25.7	104	187	103	31.3	137	13.0	102	1,140	145	173	80	5.45	94.5	1,580	155	235	60	7.97	21.6	245	41.9	45.8
	Copper	mg/kg	63	21.8	132	249	134	40.5	137	17.9	154	930	182	132	80	5.67	146	778	173	144	60	7.72	43.8	382	69.2	68.2
	Lead	mg/kg	62	28.0	173	488	177	76.3	137	36.8	221	906	264	157	80	8.56	232	1,030	261	193	58	14.1	127	641	154	127
	Mercury	mg/kg	63	0.32	1.80	5.07	2.03	0.92	137	0.06	1.95	16.2	2.82	3.11	81	0.02	1.77	15.6	2.46	2.79	60	0.02	0.35	5.50	0.81	1.06
	Alumium	mg/kg	63	3,740	11,600	16,800	11,251	2,703	137	2,220	10,700	18,500	10,205	3,759	80	2,250	9,830	19,800	9,806	4,946	60	1,840	4,245	19,000	5,627	3,700
	Iron	mg/kg	63	6,920	26,500	41,400	25,727	6,116	137	7,360	25,000	47,500	24,489	7,329	80	6,540	22,800	39,100	21,644	8,066	60	6,190	12,150	53,100	15,038	7,994
Dioxin	2,3,7,8-TCDD	pg/g	56	0.09	208	2,370	304	359	137	0.77	280	34,100	1,609	4,569	80	4.92	294	23,200	1,357	3,581	60	0.05	3.30	585	77.4	146
	Total TCDD	pg/g	35	31.5	330	2,880	449	499	105	18.0	413	37,900	2,104	5,564	64	7.66	440	25,100	1,925	4,390	38	3.15	24.2	666	124	192
	2,3,7,8-TCDD to Total TCDD Ratio	Unitless	35	0.33	0.63	0.83	0.62	0.094	105	0.04	0.68	0.97	0.69	0.14	64	0.021	0.71	0.94	0.72	0.15	38	0.019	0.16	0.78	0.34	0.31
PCB	Total PCBs by Congener	ug/kg	56	11.9	898	6,960	1,087	1,005	137	5.41	1,023	28,600	2,346	4,476	81	6.02	1,150	199,429	7,652	23,516	60	7.60	193	19,043	1,216	3,336
Pesticides	4,4'-DDE	ug/kg	56	0.00	24.0	110	30.7	23.8	137	0.00	34.0	771	70.7	117	80	1.00	32.5	615	75.9	126	60	0.00	5.50	150	15.6	25.4
	Total DDx	ug/kg	56	3.30	52.7	410	74.7	69.1	137	0.32	84.2	2,959	180	324	80	1.55	85.1	1,045	142	197	60	0.19	17.5	568	41.5	83.0
	Total Chlordane	ug/kg	56	0.05	27.5	230	37.5	38.1	137	0.31	40.0	254	43.7	31.0	80	0.43	46.6	154	50.4	36.1	60	0.38	25.0	330	32.7	44.4
	Dieldrin	ug/kg	56	0.02	3.10	25.0	4.72	4.74	137	0.01	3.97	152	7.44	17.3	80	0.11	4.74	85.4	6.89	10.4	60	0.02	2.62	43.0	4.07	5.95
PAH	High Molecular Weight PAHs	ug/kg	56	2,531	24,775	358,700	34,374	49,809	137	1,696	30,711	341,890	39,625	43,345	81	500	32,170	92,560	31,125	18,350	60	671	23,615	208,900	30,145	34,484
	Low Molecular Weight PAHs	ug/kg	56	405	3,648	102,305	6,798	14,602	137	306	4,620	749,070	14,788	66,668	81	83.5	4,548	26,838	5,241	4,068	60	78.8	4,135	63,100	7,133	11,419
	Total PAHs	ug/kg	56	2,936	27,295	358,700	37,501	50,341	137	2,002	32,307	480,800	45,402	56,182	81	500	35,100	97,680	35,139	20,777	60	750	28,093	240,800	36,647	42,812
TOC	Total Organic Carbon	%	63	0.38	4.00	18.9	4.87	3.45	137	0.28	5.02	24.2	5.34	3.20	81	0.32	4.30	17.8	4.42	2.99	60	0.19	2.23	18.4	3.28	3.20

Notes:
1) MPI 2008, CPG 2008, CPG 2009, CPG 2010 and CPG 2012 datasets are used in the summary statistics.
2) Total PCB is calculated by summing detected congeners; non-detected congeners are equal to zero.
3) Total DDx is calculated by summing detected 4,4'-DDE, 4,4'-DDD and 4,4'-DDT.
4) Total Chlordane is calculated by summing detected alpha-chlordane and gamma-chlordane.
5) High Molecular Weight PAHs is calculated by summing detected Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene and Pyrene.
6) Low Molecular Weight PAHs is calculated by summing detected Acenaphthene, Acenaphthylene, Anthracene, Fluorene, Naphthalene, Phenanthrene and 2-Methylnaphthalene.

FIGURES



Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, NAVTEQ, Geonames.org, and other contributors

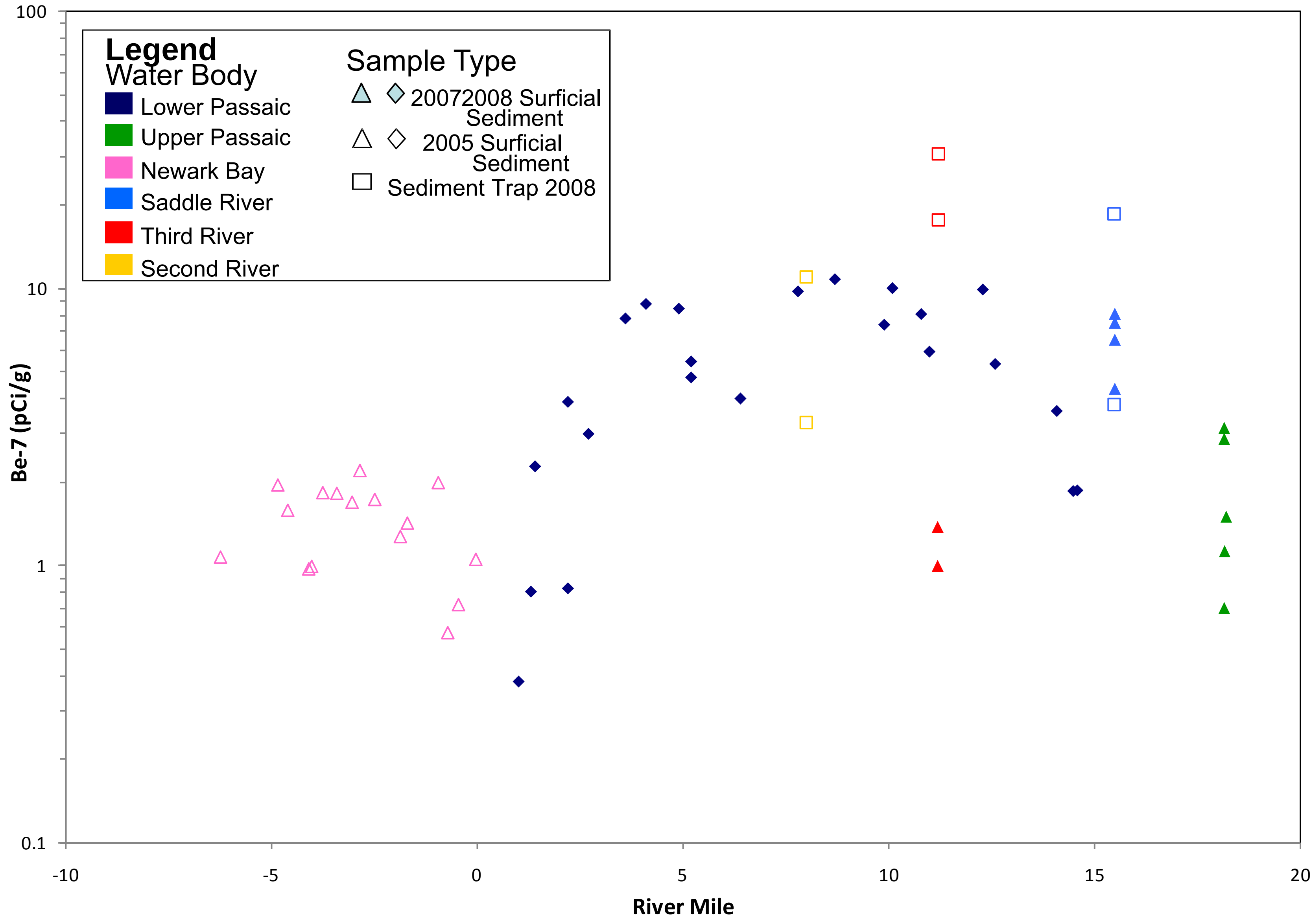
FFS Study Area Location Map

Lower Eight Miles of the Lower Passaic River

Figure 1-1

2014

Path: P:\0285924\Mapping\CSM_MassBalance\sitelocation_CSM_no_logos.mxd

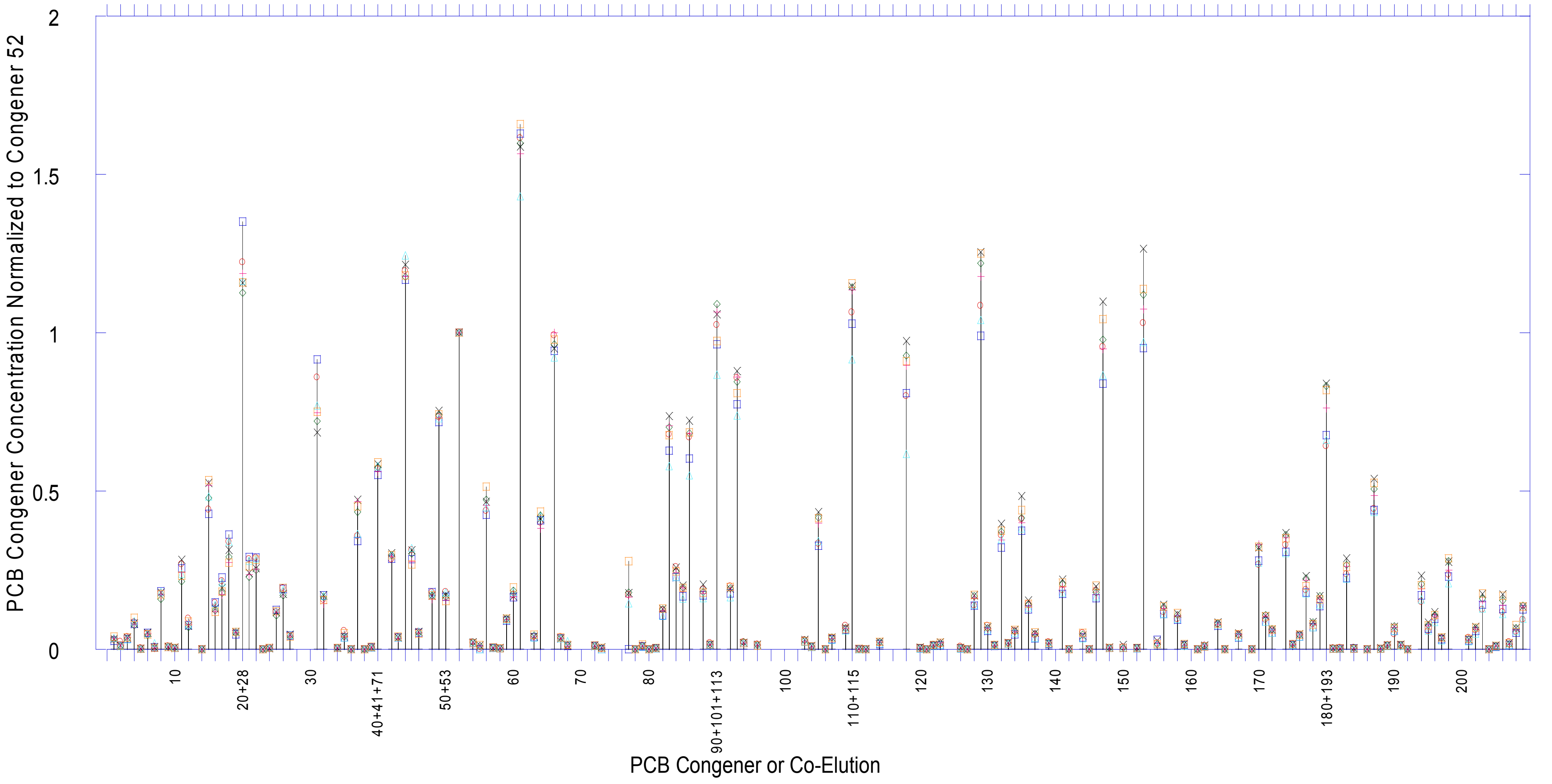


Beryllium-7 Activity vs. River Mile

Lower Eight Miles of the Lower Passaic River

Figure 1.2-1

2014



Legend

○ Dec5 Downriver
□ Dec6 Downriver
◇ Dec6 Upriver
× Dec7 Upriver
+ Dec8 Upriver
△ Dec10 Downriver
□ Dec12 Downriver

Notes

Upriver and downriver refer to the flow direction as it changes with the tide.

"Dec5 Downriver" represents the average PCB congener concentration from morning and afternoon samples collected on December 5, 2005.

"Dec6 Downriver" represents the average PCB congener concentration from morning and afternoon samples collected on December 6, 2005.

"Dec6 Upriver" represents the average PCB congener concentration from morning and afternoon samples collected on December 6, 2005.

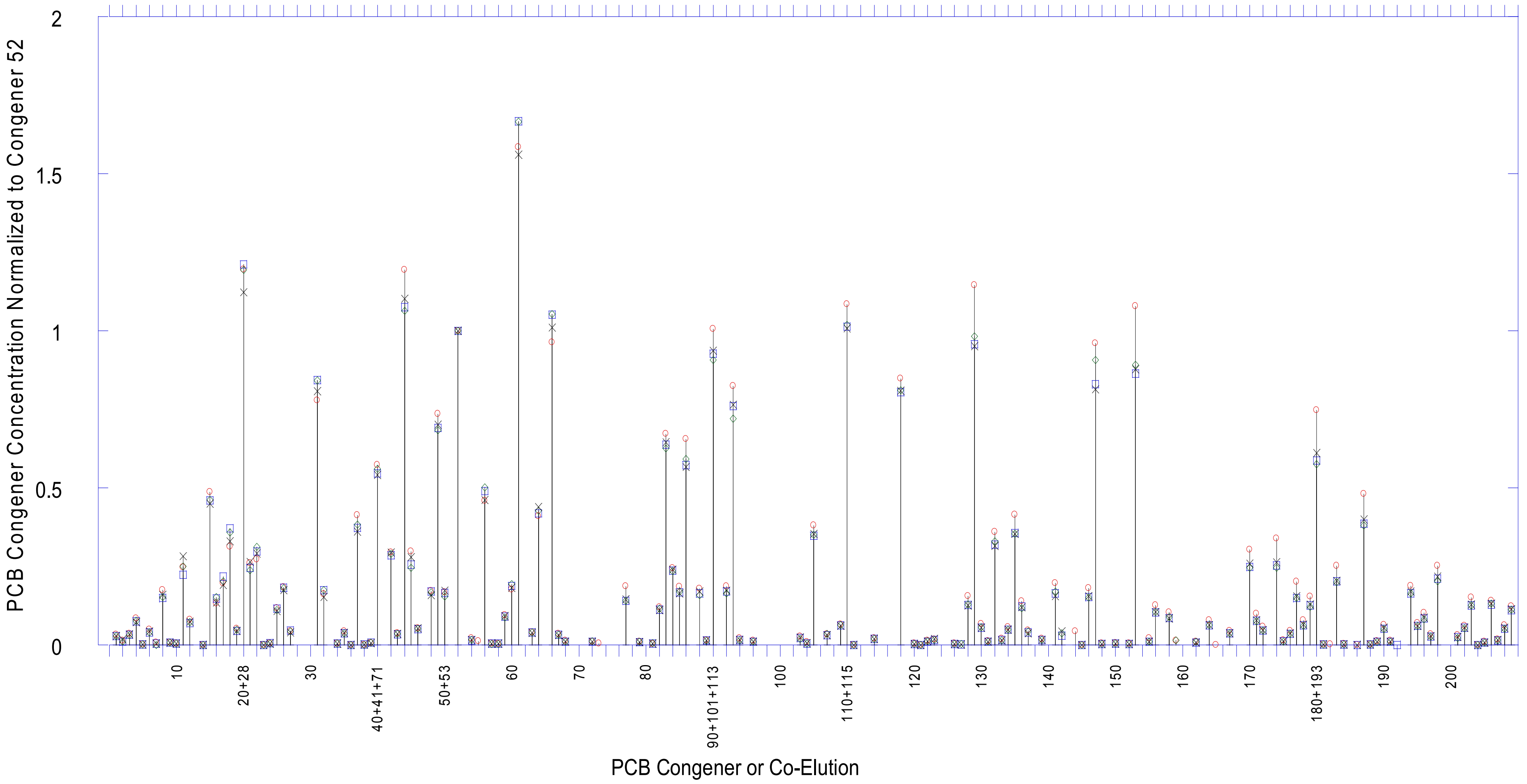
"Dec10 Downriver" represents the average PCB congener concentration from morning and afternoon samples collected on December 10, 2005.

PCB Congener Concentration Normalized to Congener 52 Pattern on Suspended Solids: USGS TOPS

Lower Eight Miles of the Lower Passaic River

Figure 1.2-2

2014



Legend

○ Average USGS TOPS
□ Field-Filtered TOPS
◇ Laboratory-Filtered TOPS
× Infiltrex

Notes

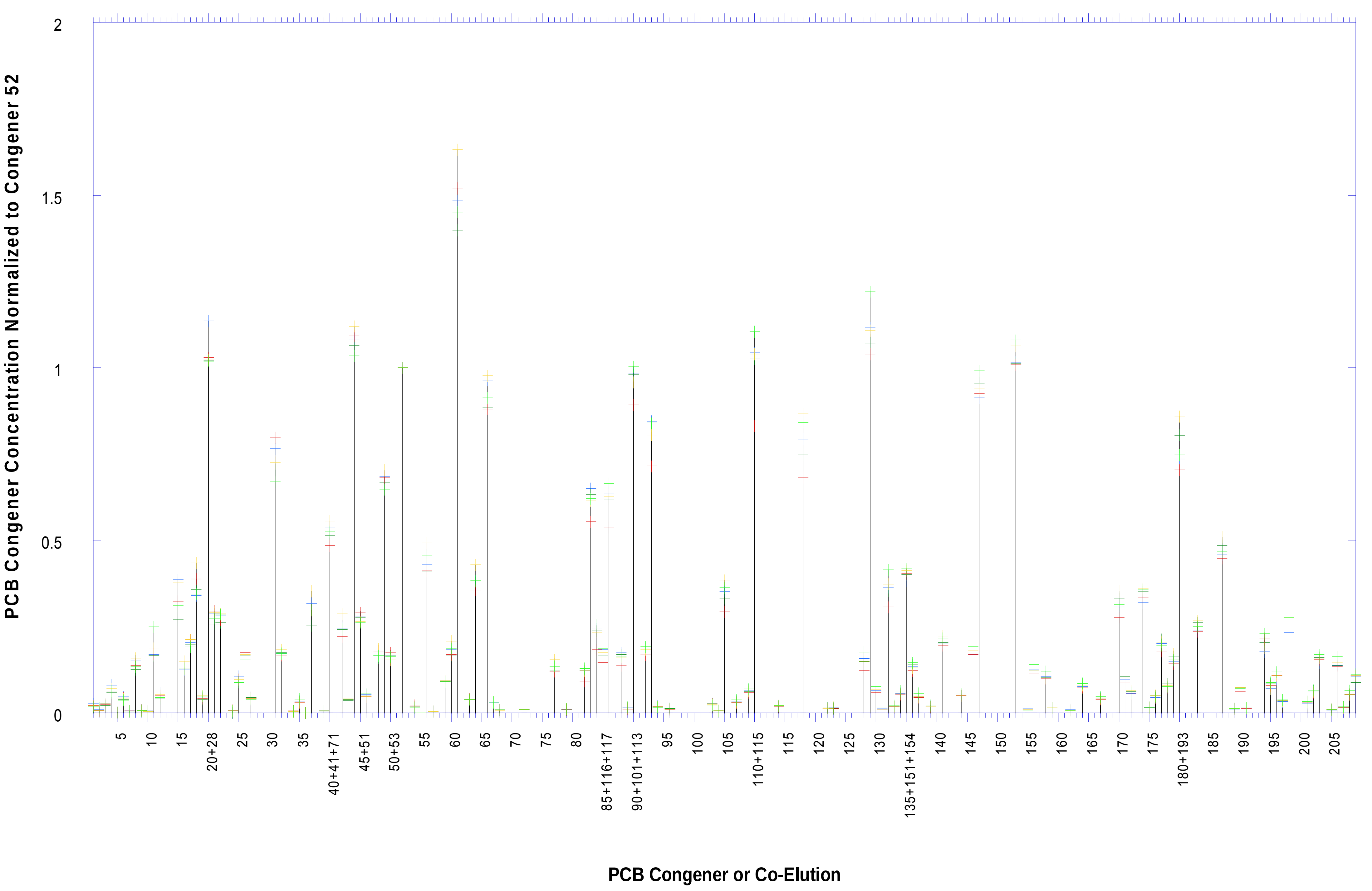
"Average USGS TOPS" represents the average PCB congener concentration from samples collected on December 5, 2005 through December 12, 2005.

PCB Congener Concentration Normalized to Congener 52 Pattern on Suspended Solids: USGS TOPS, Field-Filtered TOPS, Laboratory-Filtered TOPS, and Infiltrex

Lower Eight Miles of the Lower Passaic River

Figure 1.2-3

2014



Legend

+ RM1.4
+ RM2.2
+ RM7.8
+ RM11
+ RM12.6

Notes

Normalized PCB congener concentration <0.01 are not plotted.

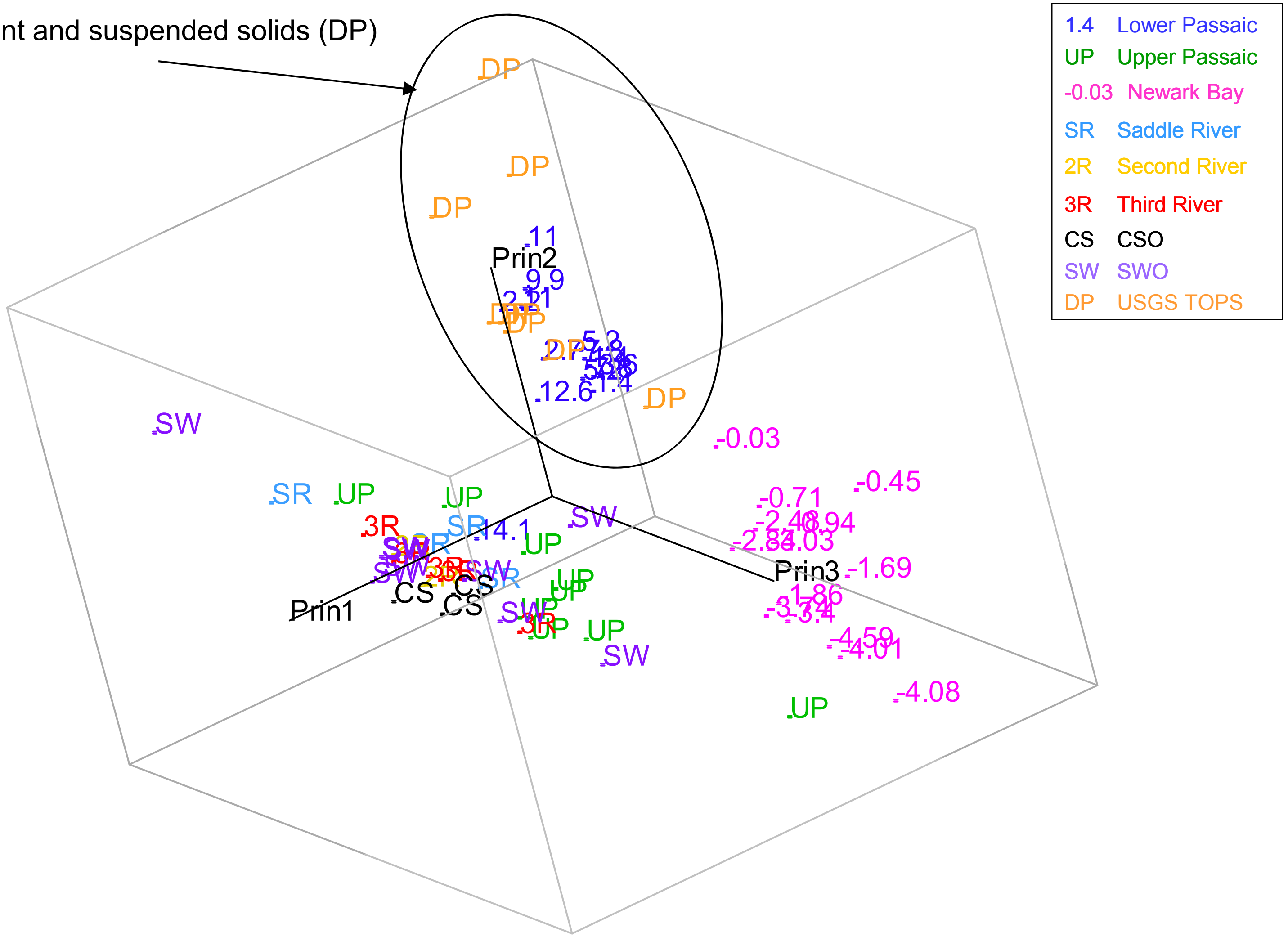
PCB Congener Concentration Normalized to Congener 52 for the Lower Passaic River High Resolution Cores Surface Sediments

Lower Eight Miles of the Lower Passaic River

Figure 1.2-4

2014

Surface sediment and suspended solids (DP)
are the same

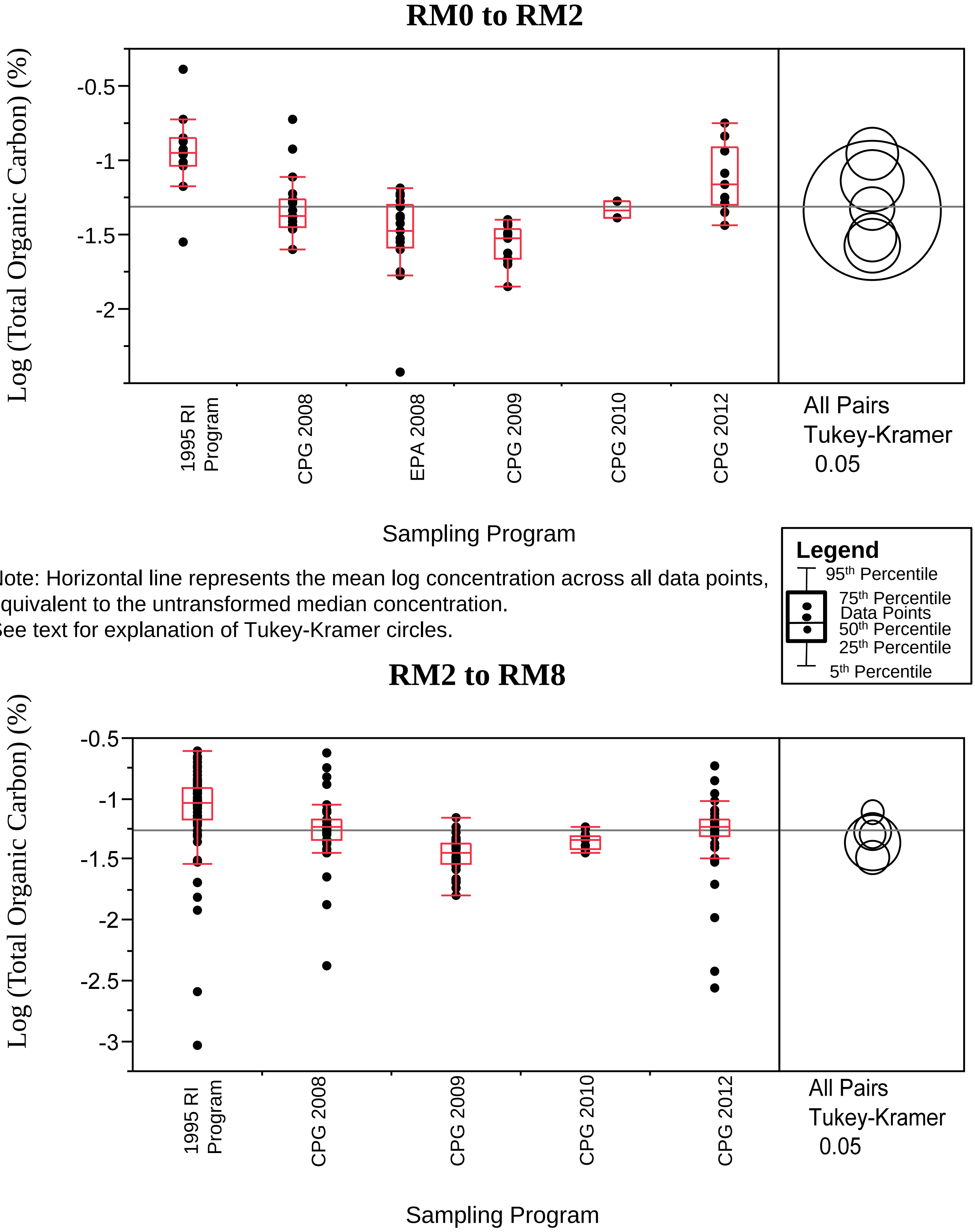


Surface Sediment and Suspended Solids
Principal Components

Lower Eight Miles of the Lower Passaic River

Figure 1.2-5

2014



RM0 to RM2

Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.

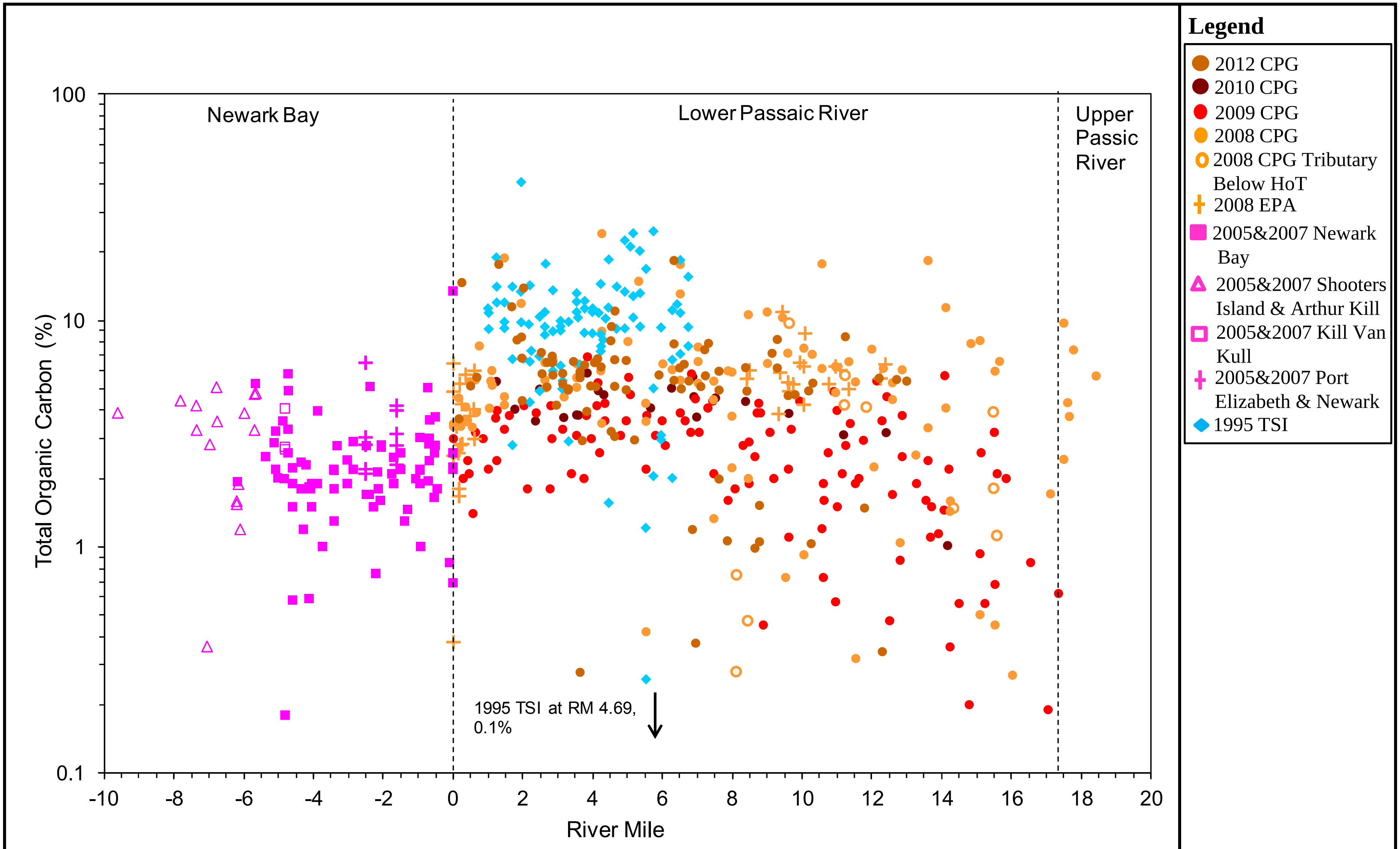
RM2 to RM8

Total Organic Carbon (0-6 inch) by Sampling Program at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 1.3-1

2014



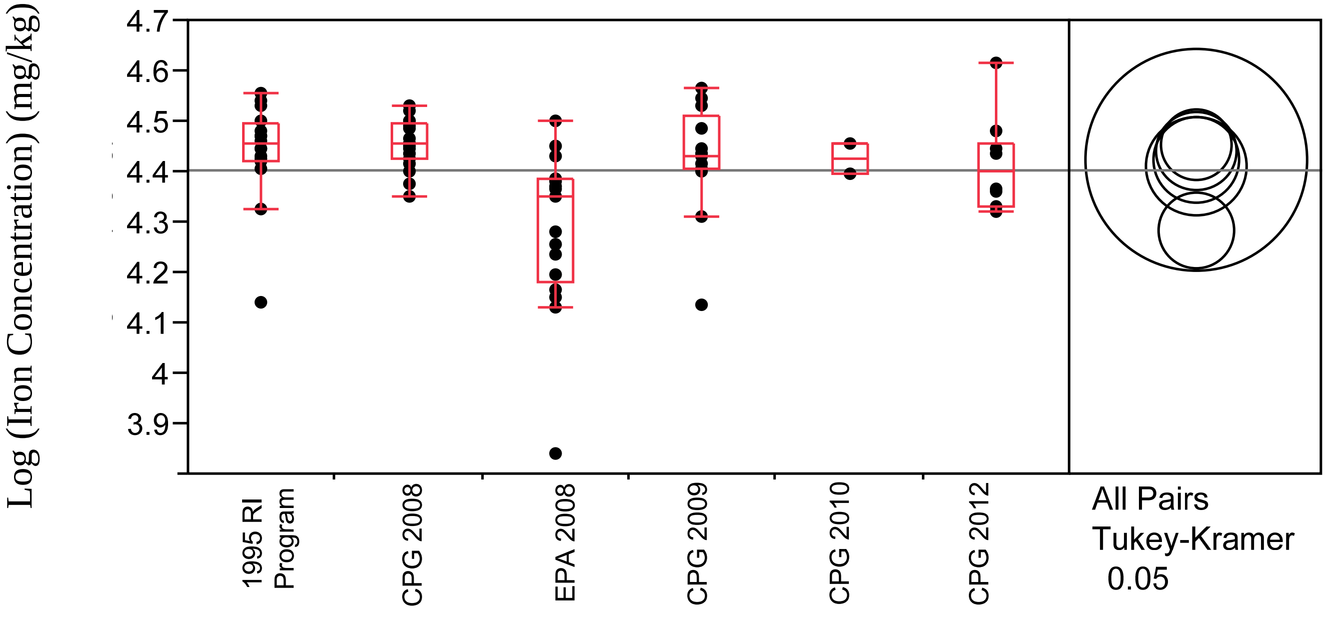
Total Organic Carbon (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

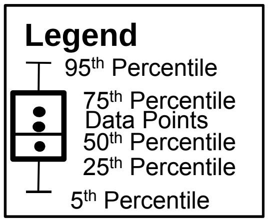
Figure 1.3-2

2014

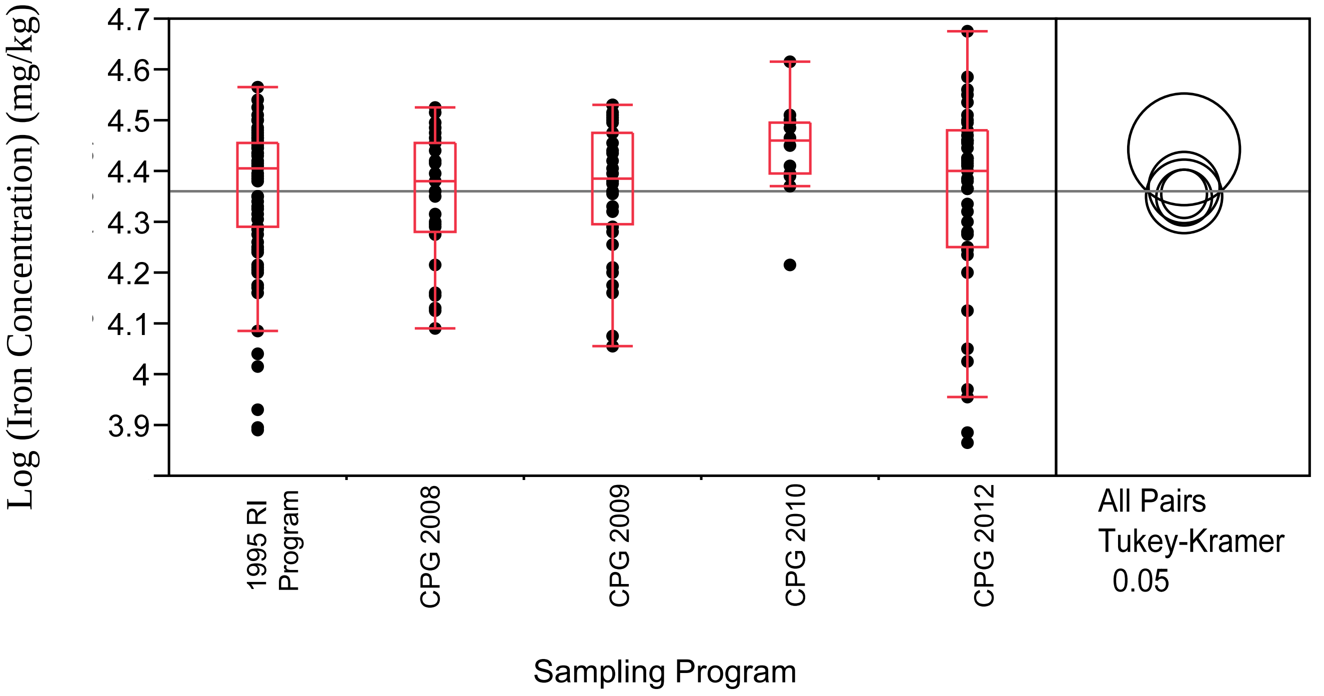
RM0 to RM2



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.



RM2 to RM8

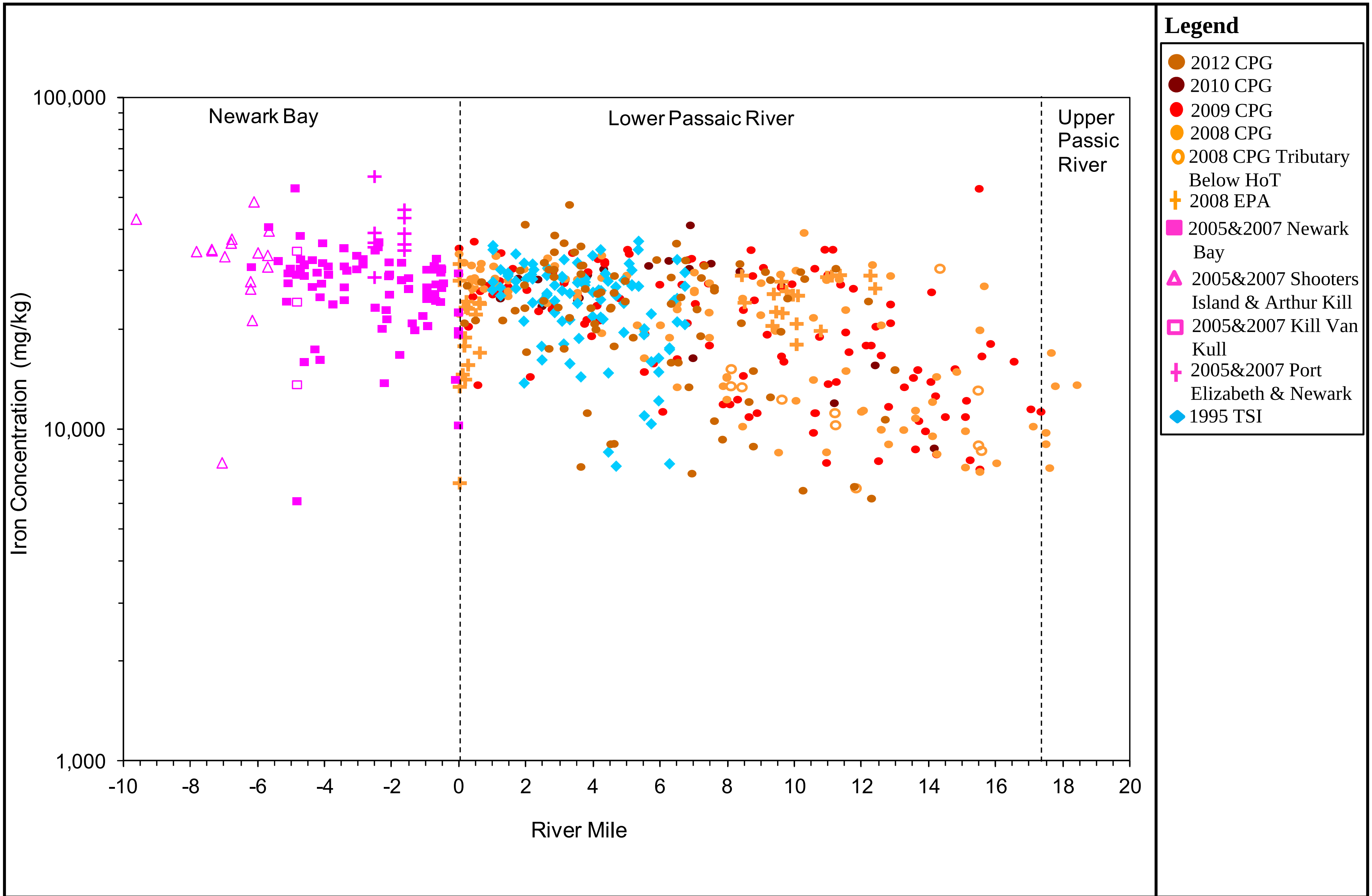


Iron Concentration by Sampling Program at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 1.3-3

2014



Iron Concentration (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 1.3-4

2014

2,3,7,8-TCDD Surface Sediment Samples from 1991 to 2000

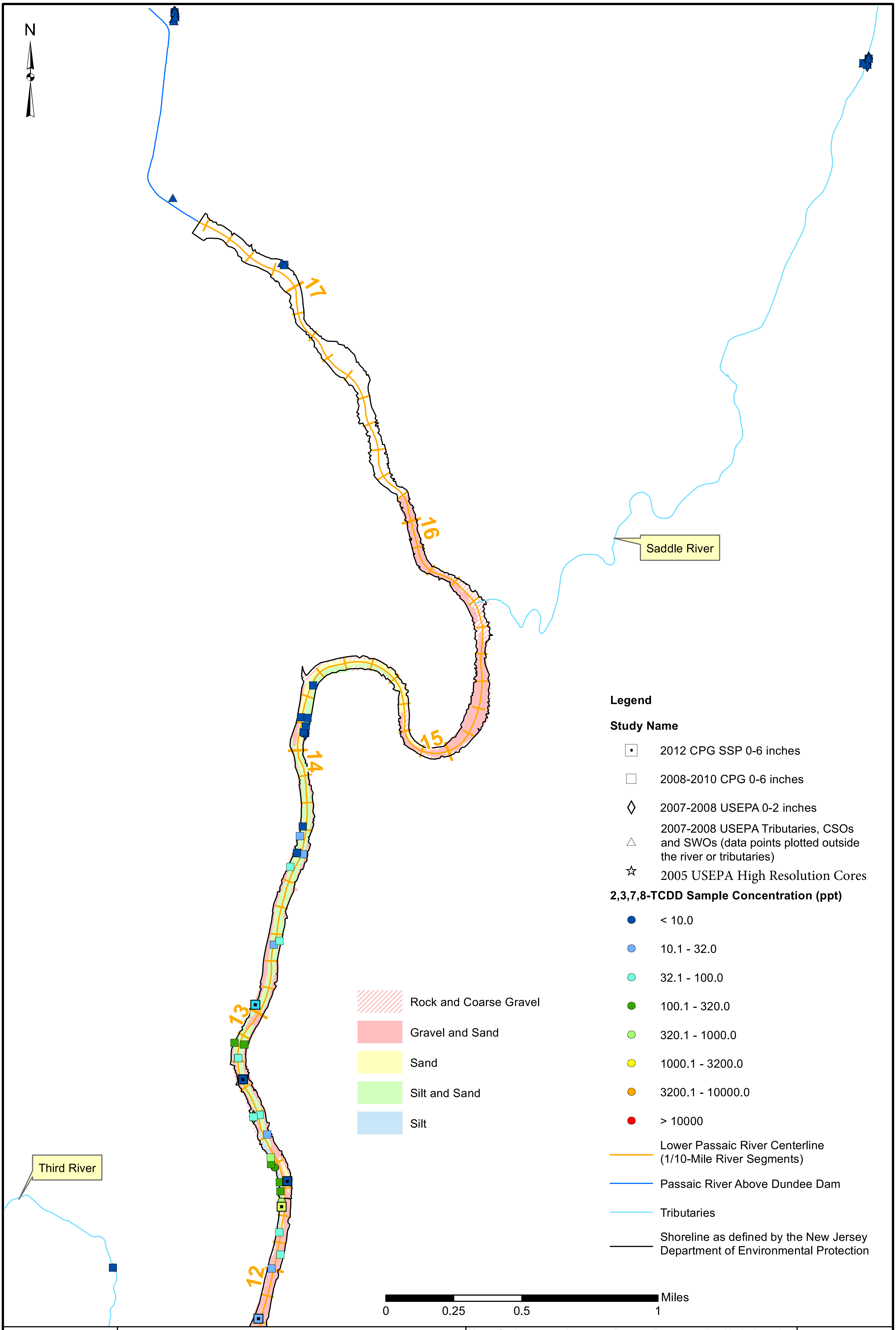
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 2.1-1

2014

Path: P:\02859241\Mapping\CSM_MassBalance\SurfaceSed_Maps\2,3,7,8-TCDD_Surficial_Sed_1991_2000_Samples.mxd



2,3,7,8-TCDD Surface Sediment Samples from 2005 to 2012

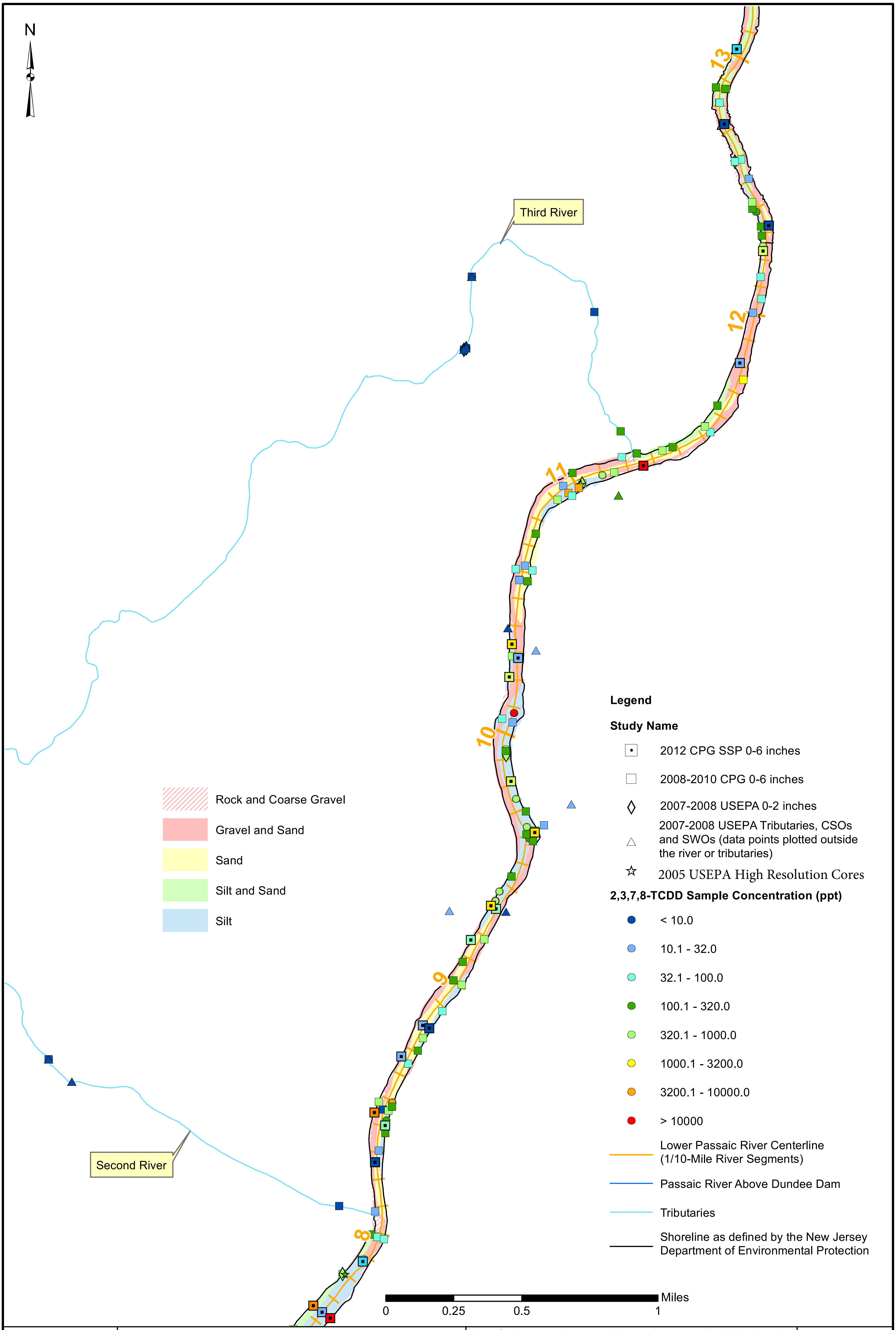
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 2.1-2a

2014

Path: P:\02859241Mapping\CSM_MassBalance\SurfaceSed_Maps\2,3,7,8-TCDD_Surficial_Sed_05_12_Samples.mxd



2,3,7,8-TCDD Surface Sediment Samples from 2005 to 2012

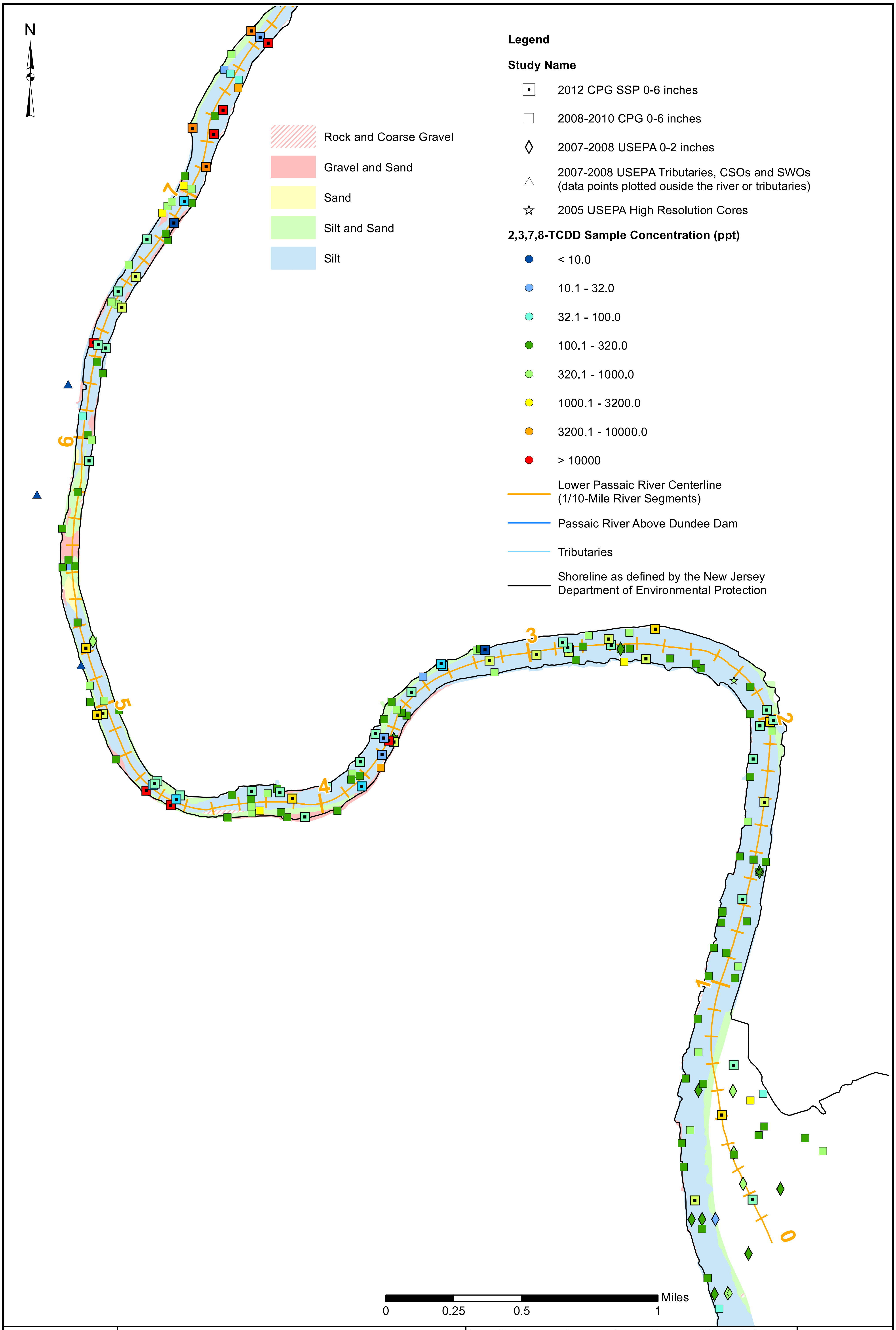
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 2.1-2b

2014

Path: P:\0285924\Mapping\CSM_MassBalance\SurfaceSed_Maps\2,3,7,8-TCDD_Surficial_Sed_05_12_Samples.mxd



2,3,7,8-TCDD Surface Sediment Samples from 2005 to 2012

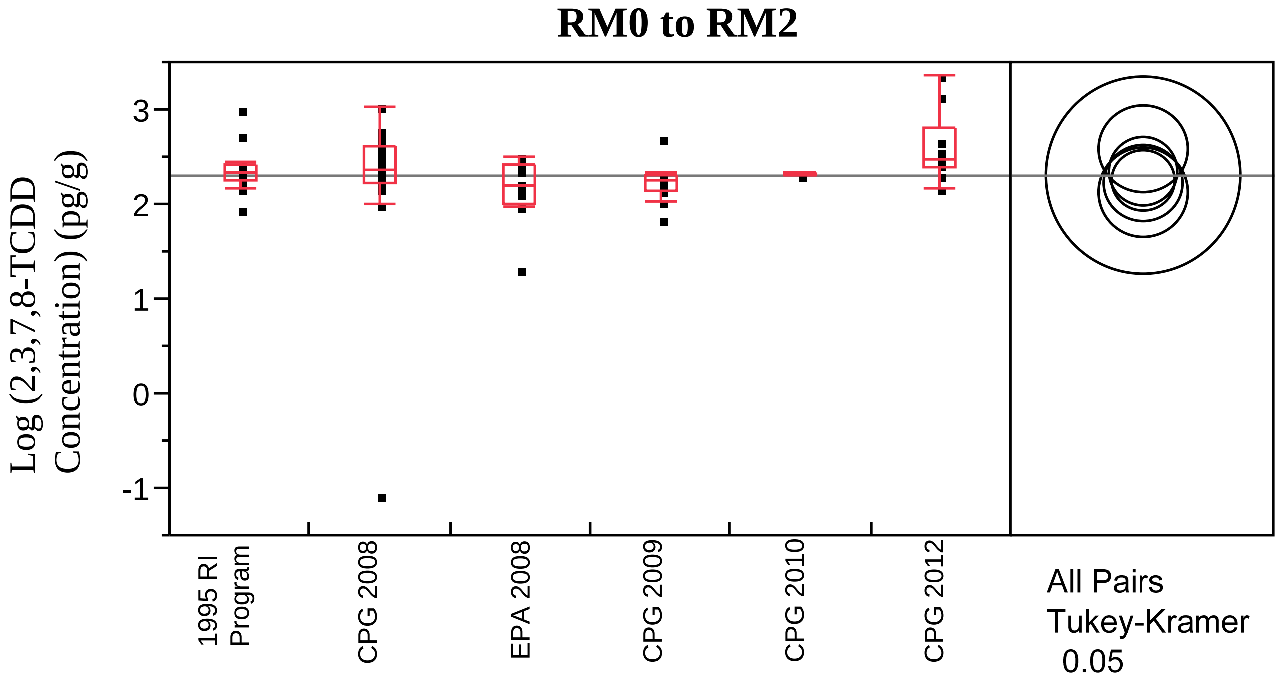
Lower Eight Miles of the Lower Passaic River

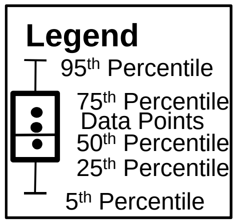
Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 2.1-2c

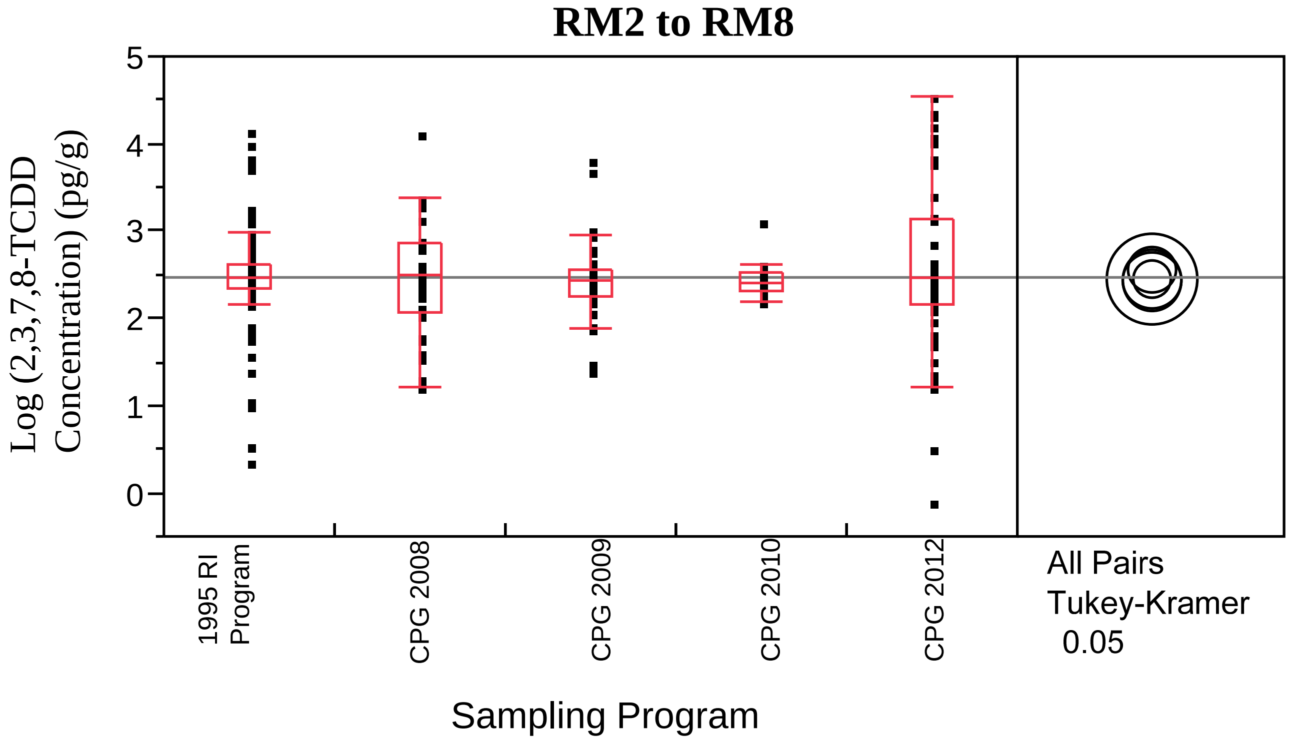
2014

Path: P:\0285924\Mapping\CSM_MassBalance\SurfaceSed_Maps\2,3,7,8-TCDD_Surficial_Sed_05_12_Samples.mxd



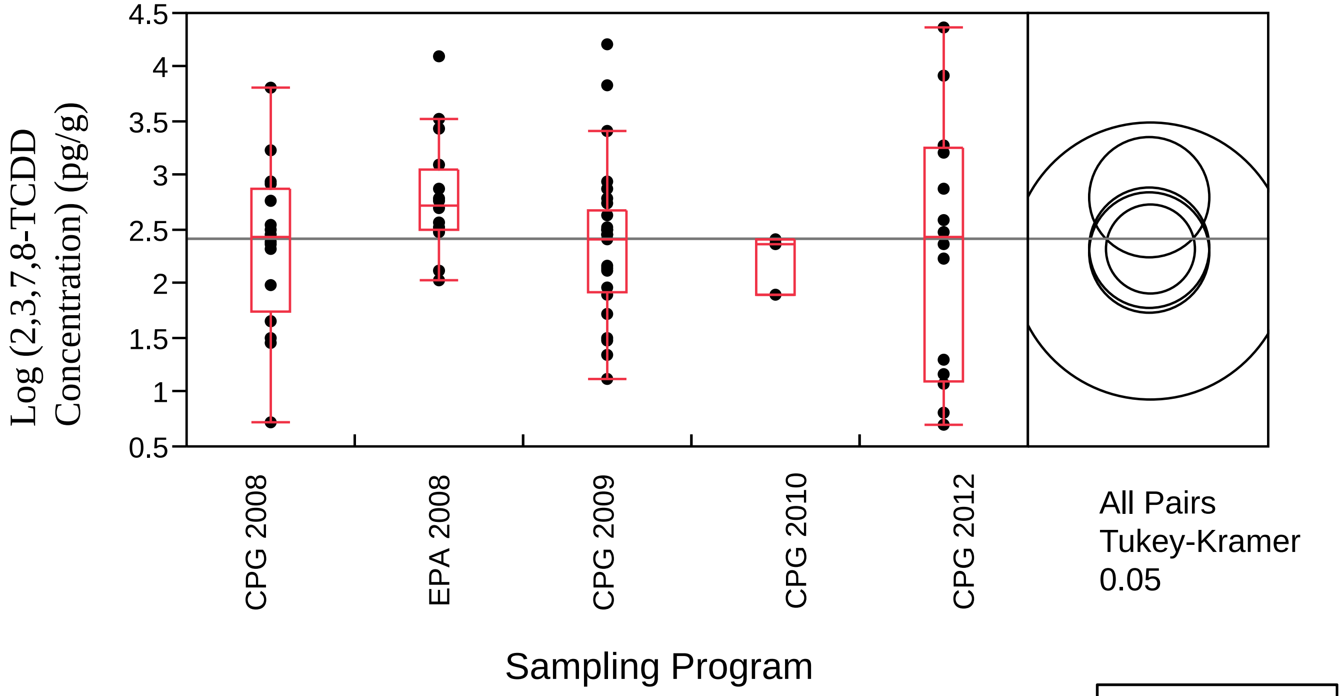


Notes: 1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) 2008 CPG data was corrected by applying a factor of 1.89 (CSC and Interface, Inc., 2010)

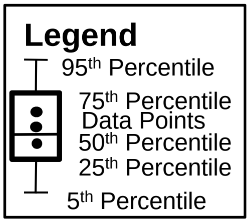


2,3,7,8-TCDD (0-6 inch) by Sampling Program at RM0 to RM2 and RM2 to RM8 *Lower Eight Miles of the Lower Passaic River*	**Figure 2.2-1a** 2014

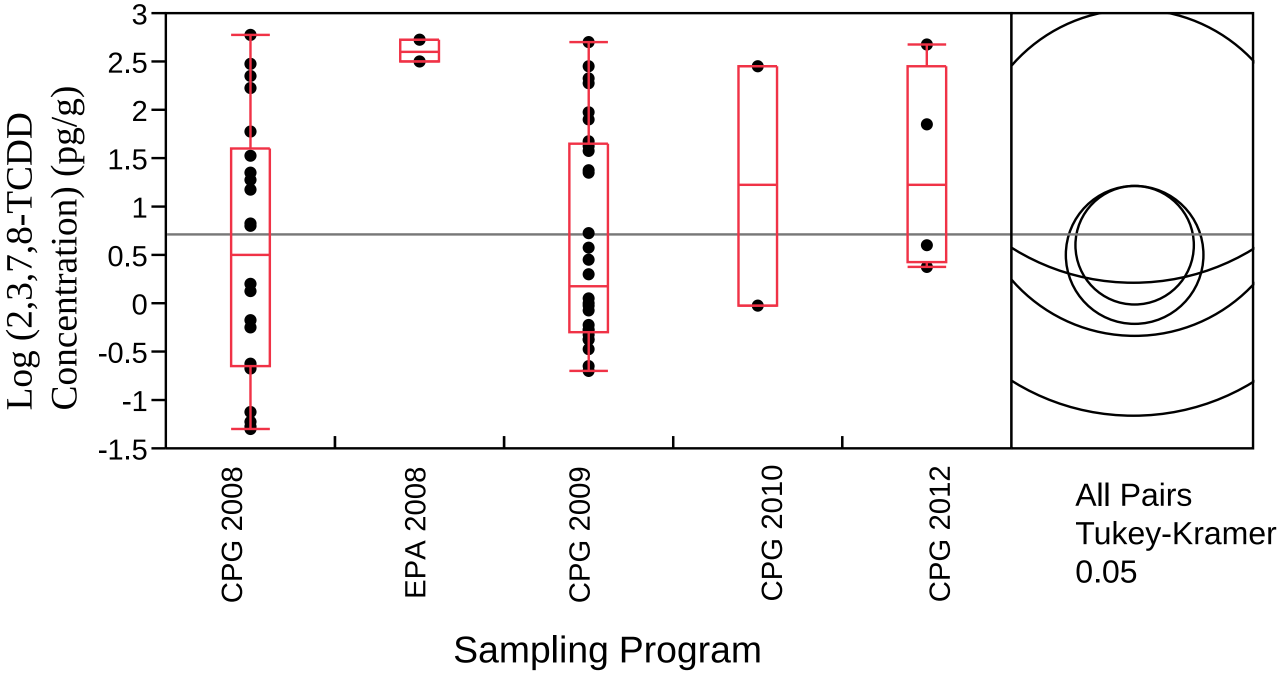
RM8 to RM12



Notes: 1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) 2008 CPG data was corrected by applying a factor of 1.89 (CSC and Interface, Inc., 2010)



RM12 to RM17.4

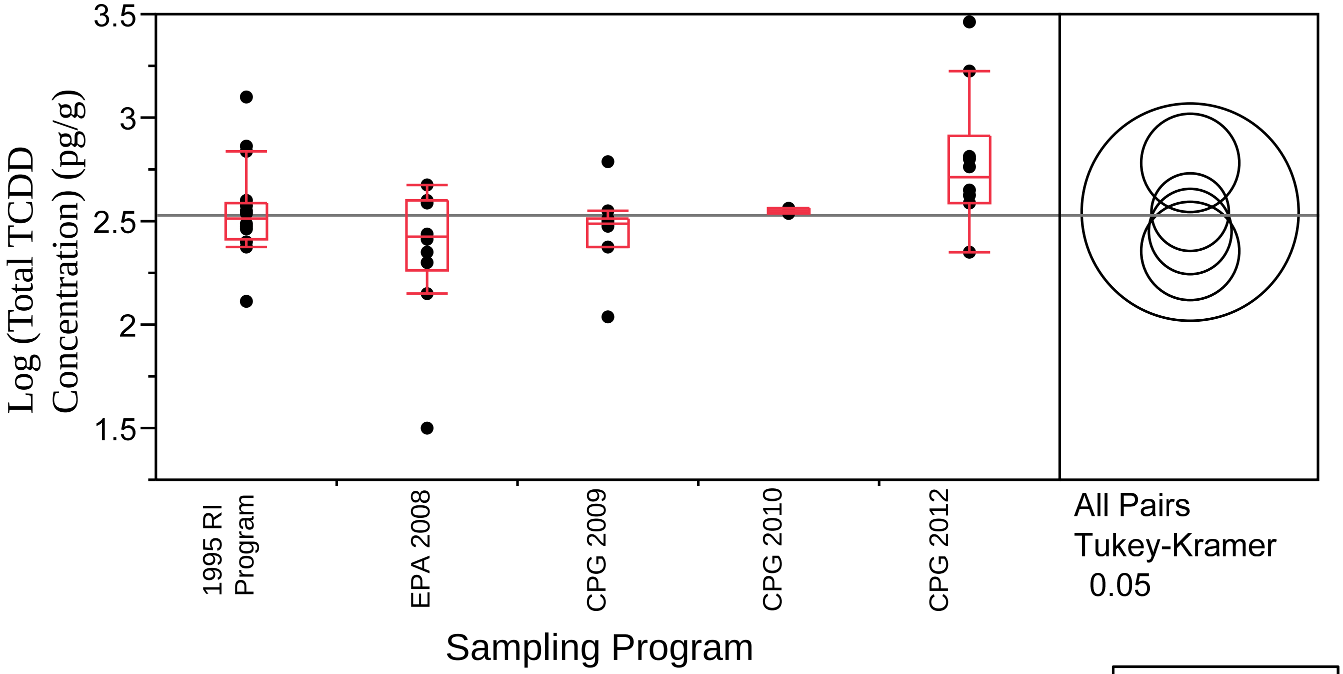


2,3,7,8-TCDD (0-6 inch) by Sampling Program at RM8 to RM12 and RM12 to RM17.4

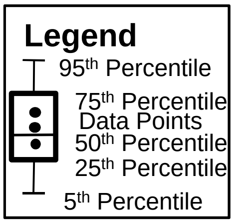
Lower Eight Miles of the Lower Passaic River

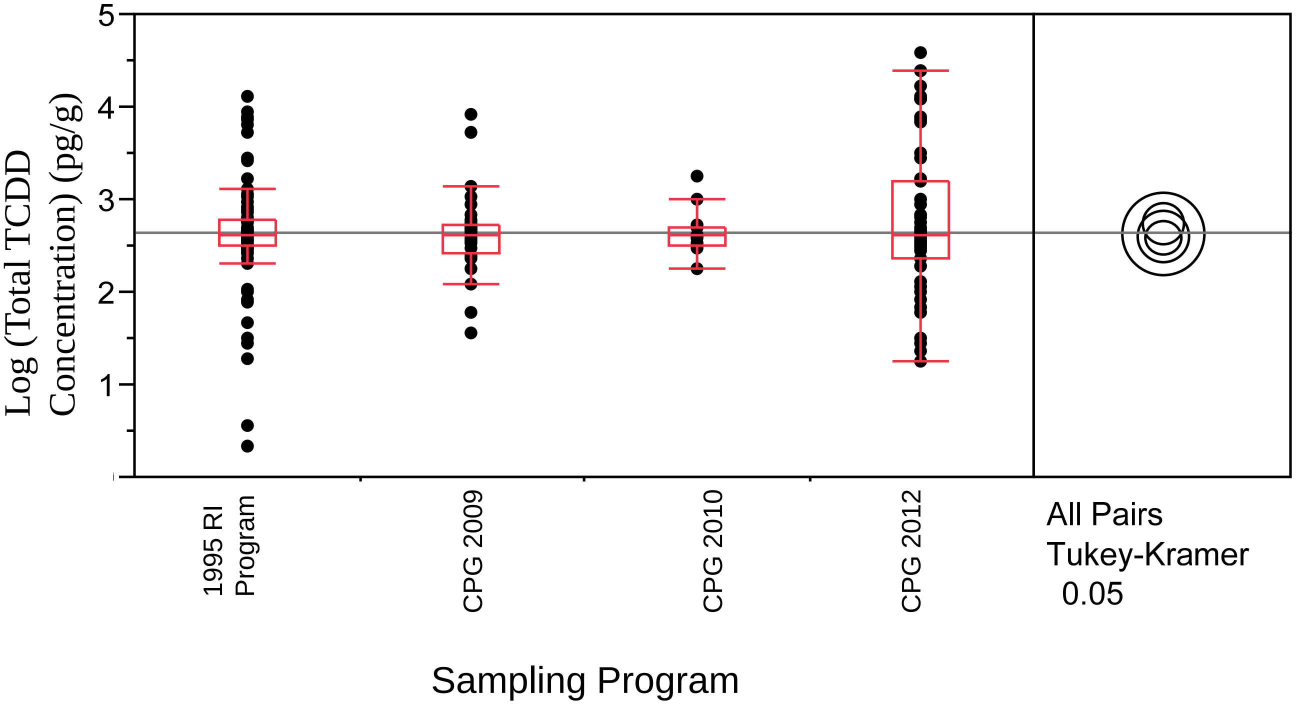
Figure 2.2-1b

2014


RM0 to RM2

Notes: 1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Note: the 2008 CPG Total TCDD data were not plotted because a correction factor was not developed to address the low bias in the results.




RM2 to RM8

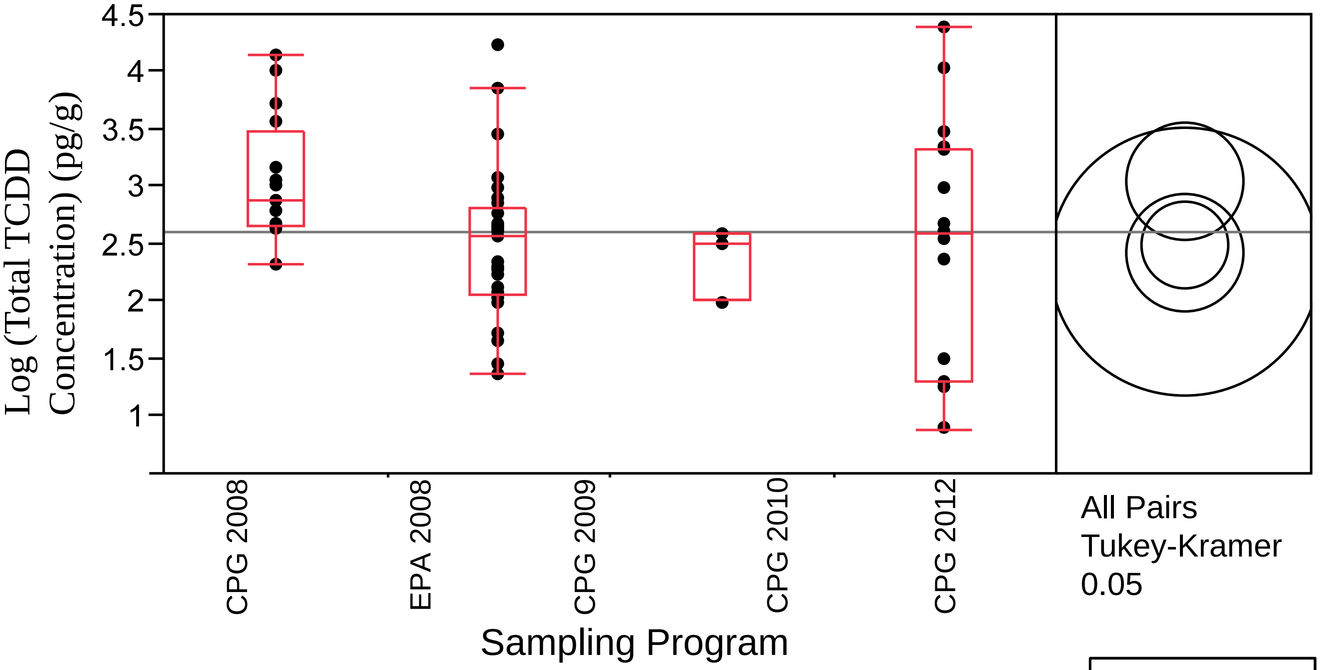
Total TCDD (0-6 inch) by Sampling Program at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

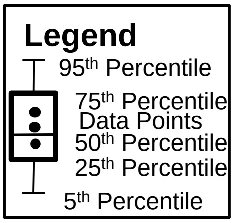
Figure 2.2-2a

2014

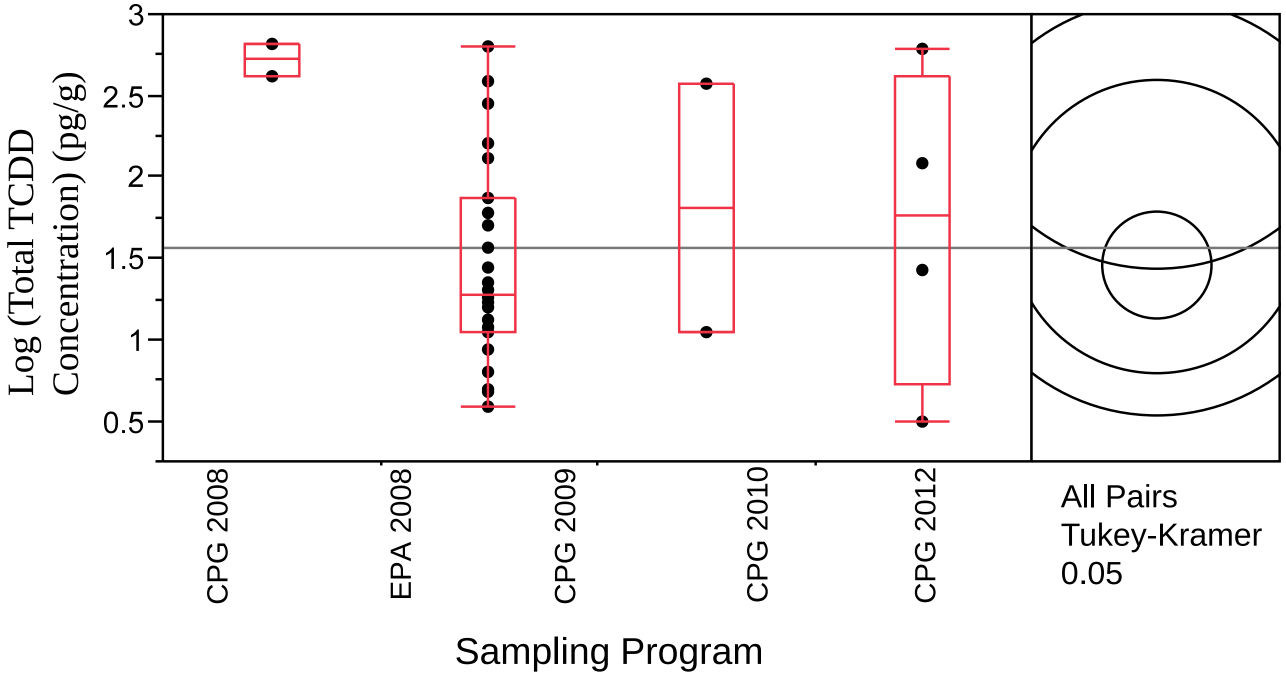
RM8 to RM12



Notes: 1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Note: the 2008 CPG Total TCDD data were not plotted because a correction factor was not developed to address the low bias in the results.



RM12 to RM17.4



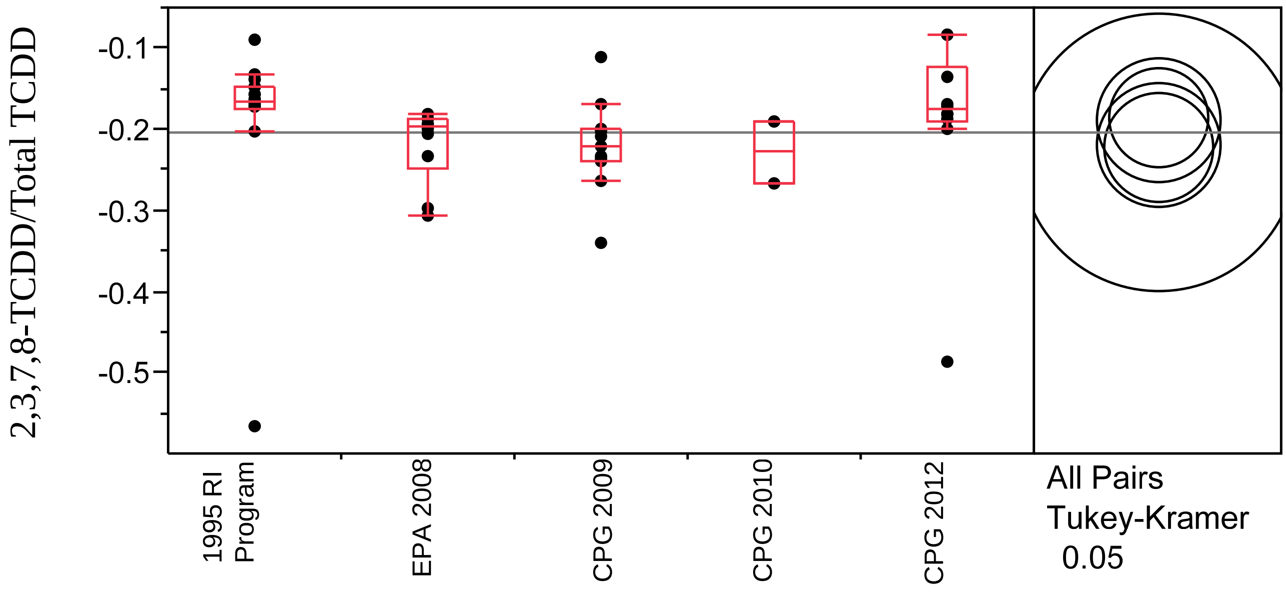
Total TCDD (0-6 inch) by Sampling Program at RM8 to RM12 and RM12 to RM17.4

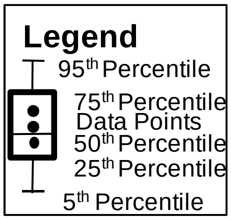
Lower Eight Miles of the Lower Passaic River

Figure 2.2-2b

2014

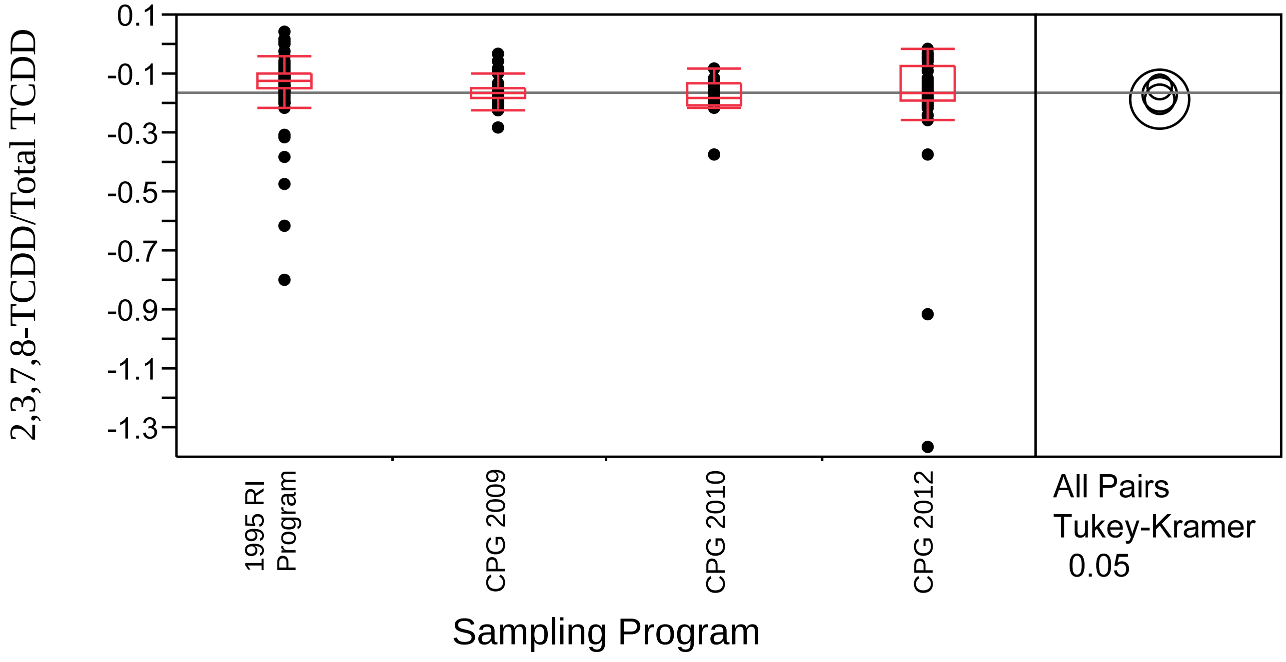
RM0 to RM2





Notes: 1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Note: the ratios for the 2008 CPG data were not plotted due to analytical issues with the 2008 Total TCDD data that resulted in low bias, non-representative results.

RM2 to RM8



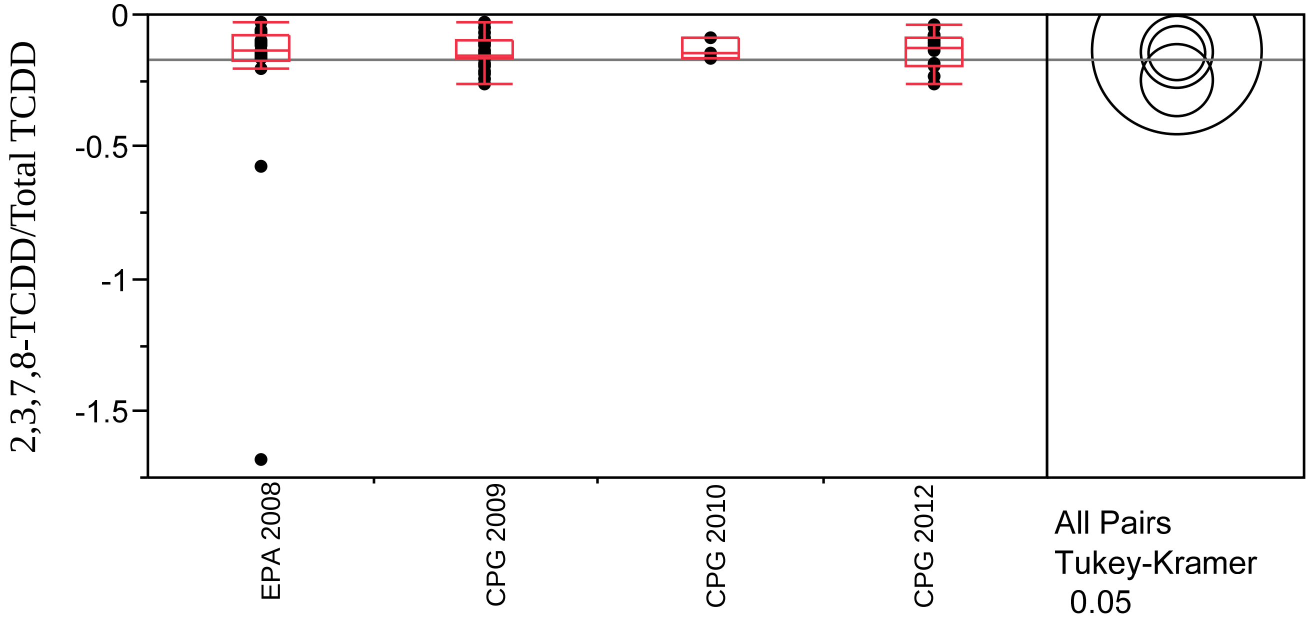
2,3,7,8-TCDD to Total TCDD Ratio (0-6 inch) by Sampling at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

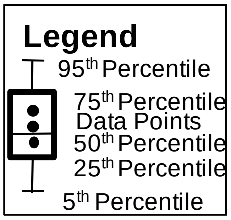
Figure 2.2-3a

2014

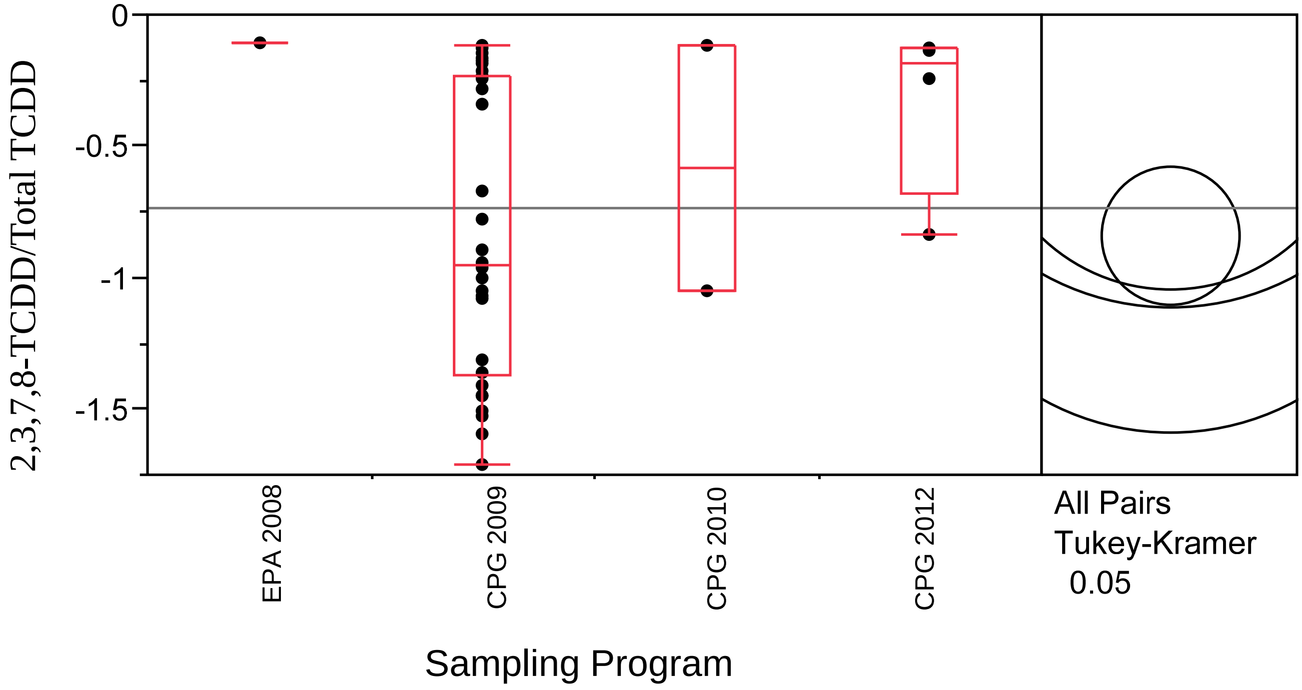
RM8 to RM12



Notes: 1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Note: the ratios for the 2008 CPG data were not plotted due to analytical issues with the 2008 Total TCDD data that resulted in low bias, non-representative results.



RM12 to RM17.4

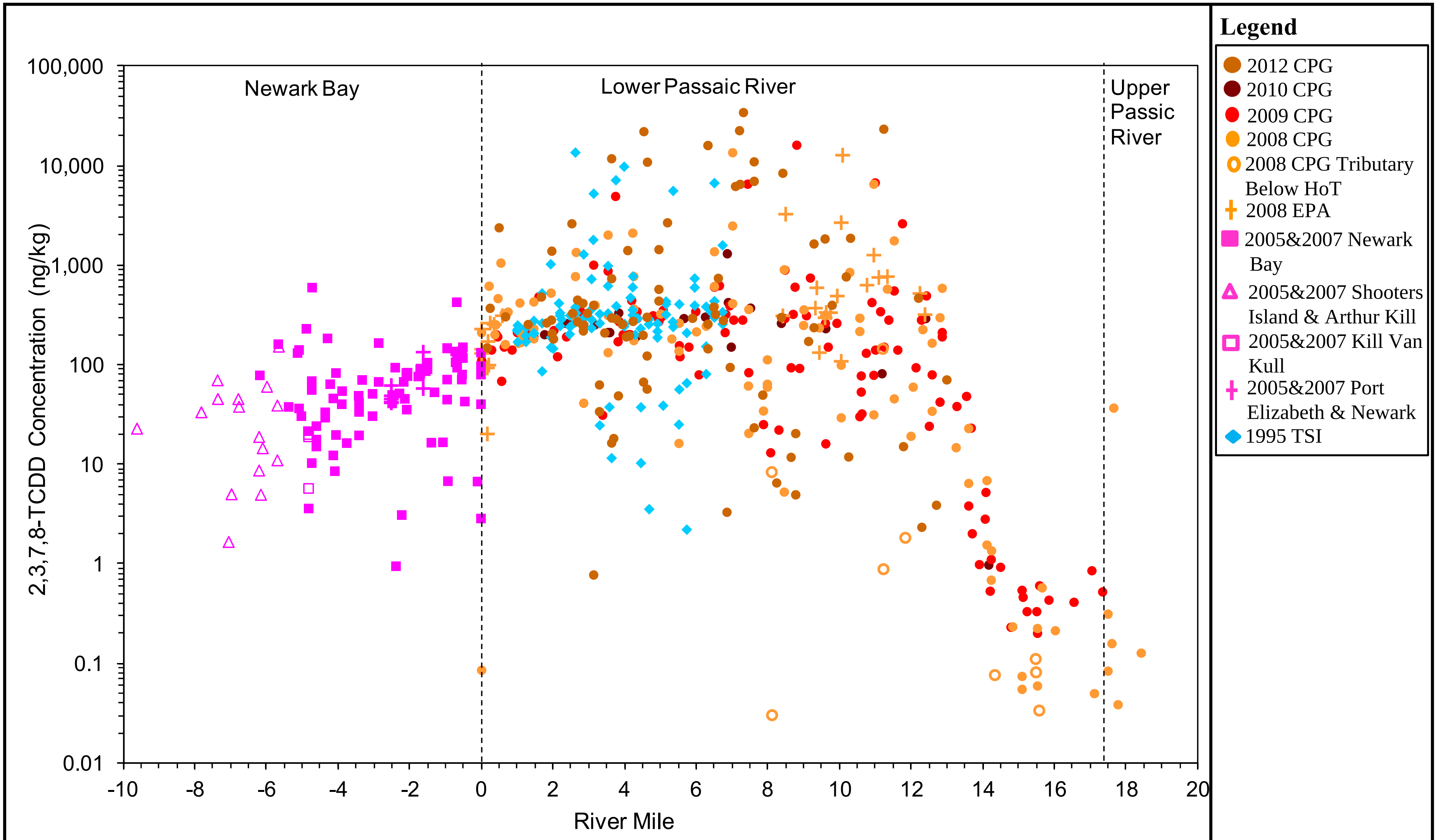


2,3,7,8-TCDD to Total TCDD Ratio (0-6 inch) by Sampling Program at RM8 to RM12 and RM12 to RM17.4

Lower Eight Miles of the Lower Passaic River

Figure 2.2-3b

2014



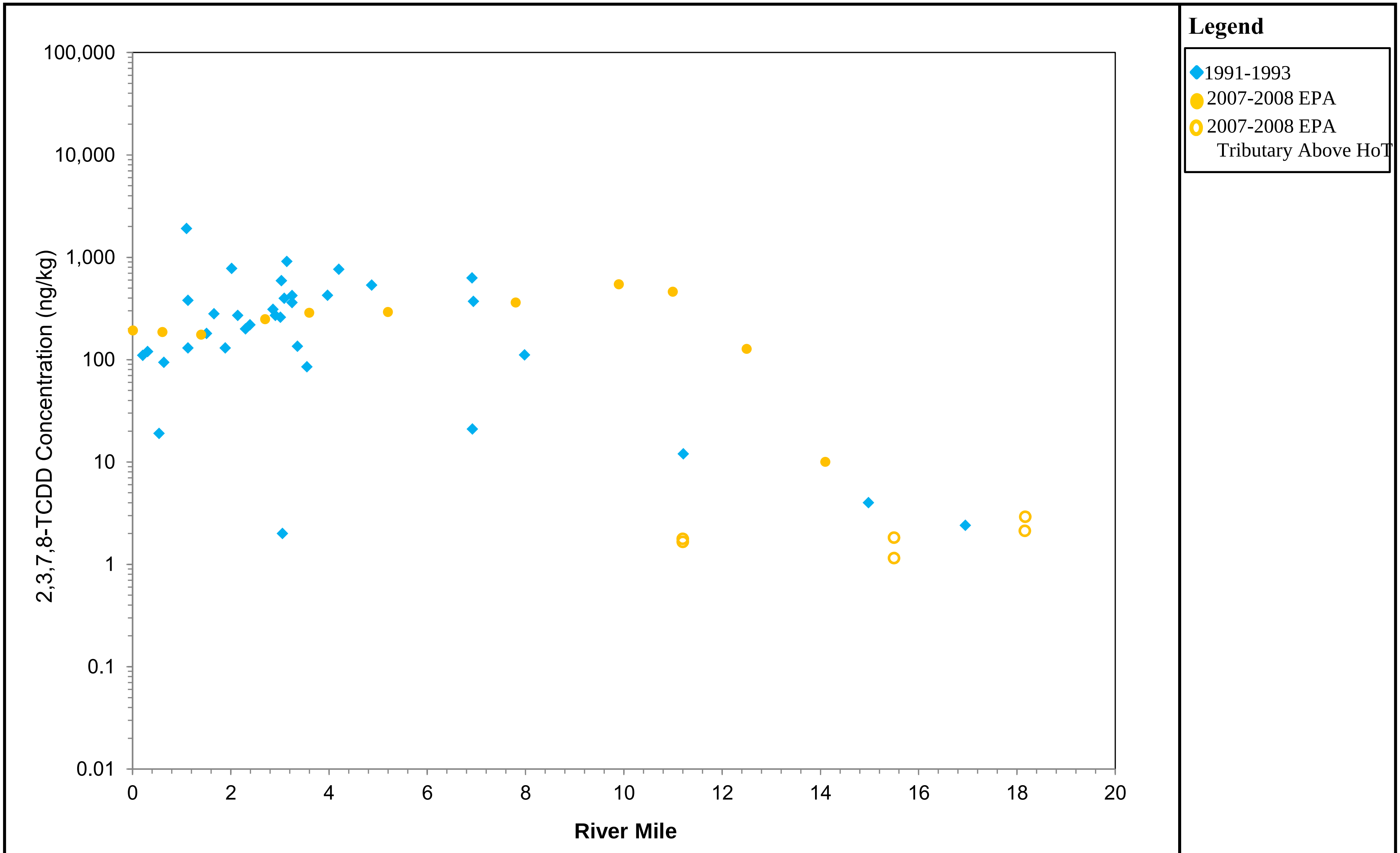
Note:: 2,3,7,8-TCDD Concentrations generated during the 2008 CPG coring program were biased low and have been corrected by applying a factor of 1.89. The factor was provided by CSC and Interface, Inc. 2010.

2,3,7,8-TCDD Concentration (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 2.3-1

2014



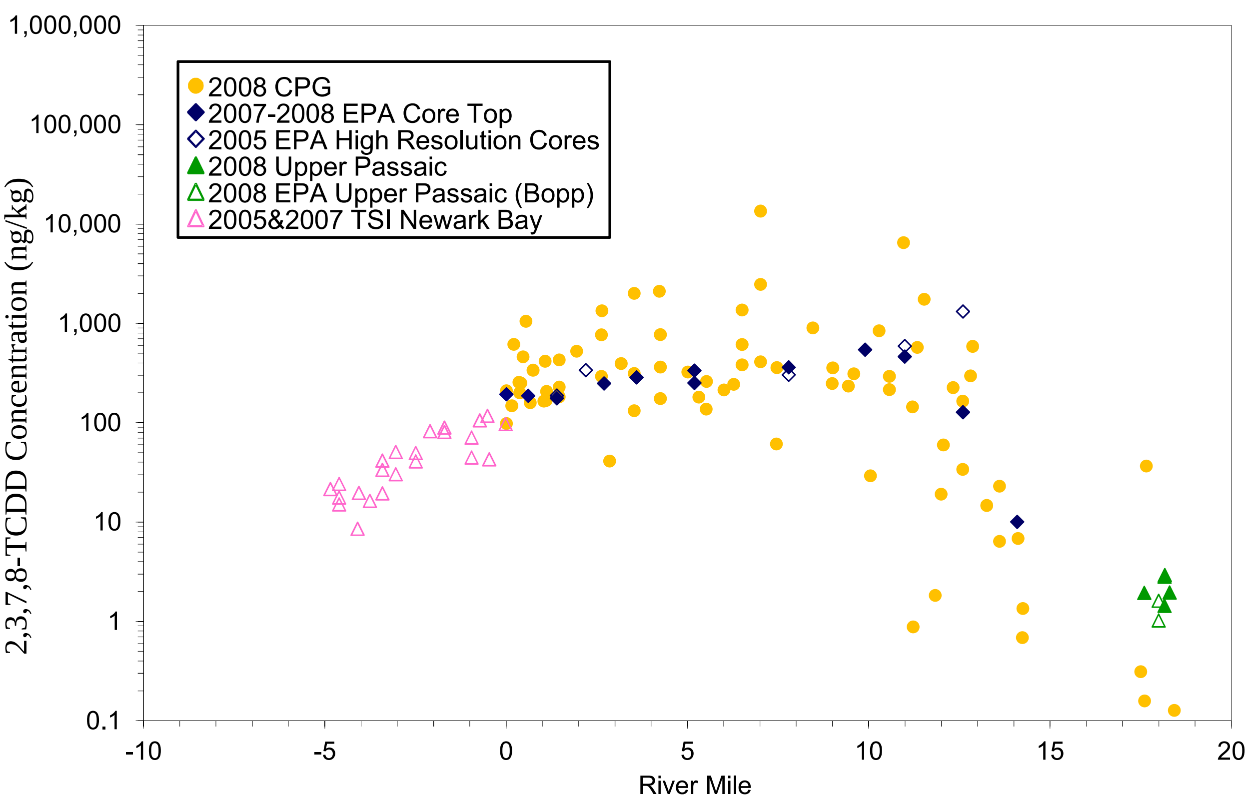
2,3,7,8-TCDD Concentration (0 - ≤2 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

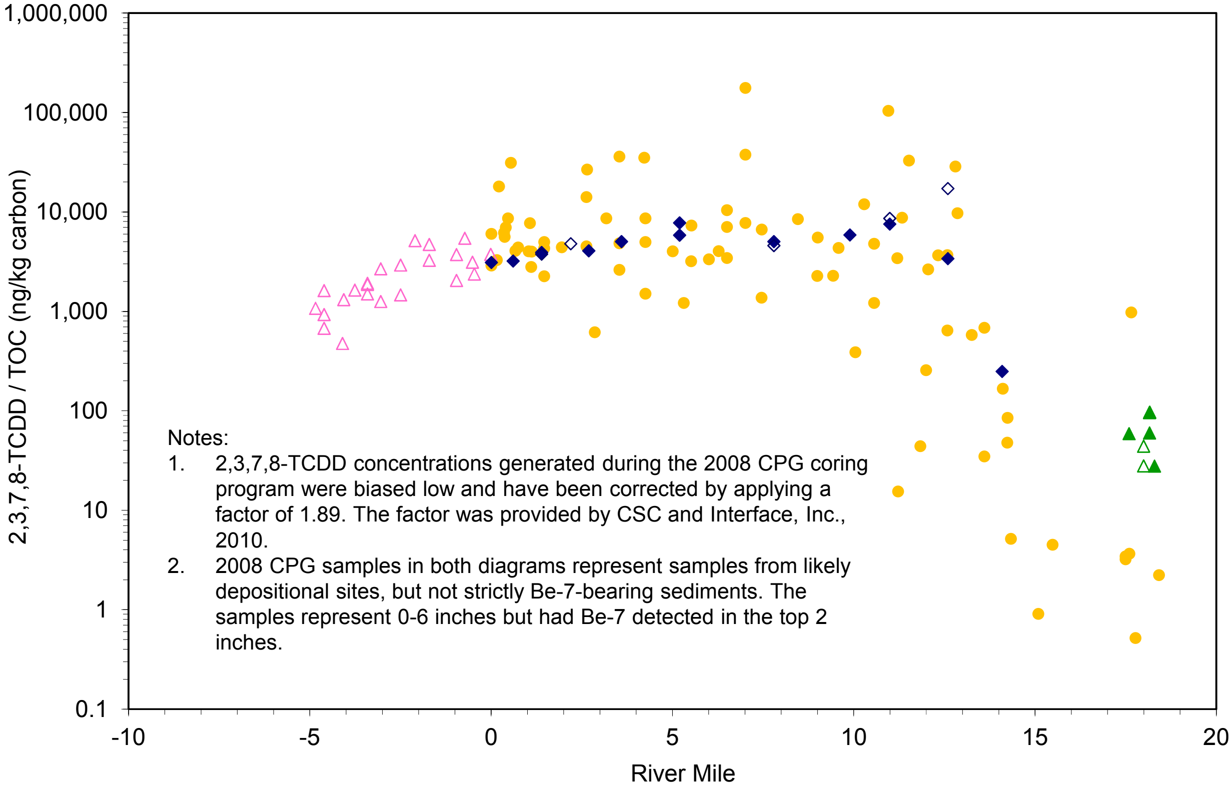
Figure 2.3-2

2014

2,3,7,8-TCDD *vs.* River Mile



2,3,7,8-TCDD TOC Normalized *vs.* River Mile



Notes:

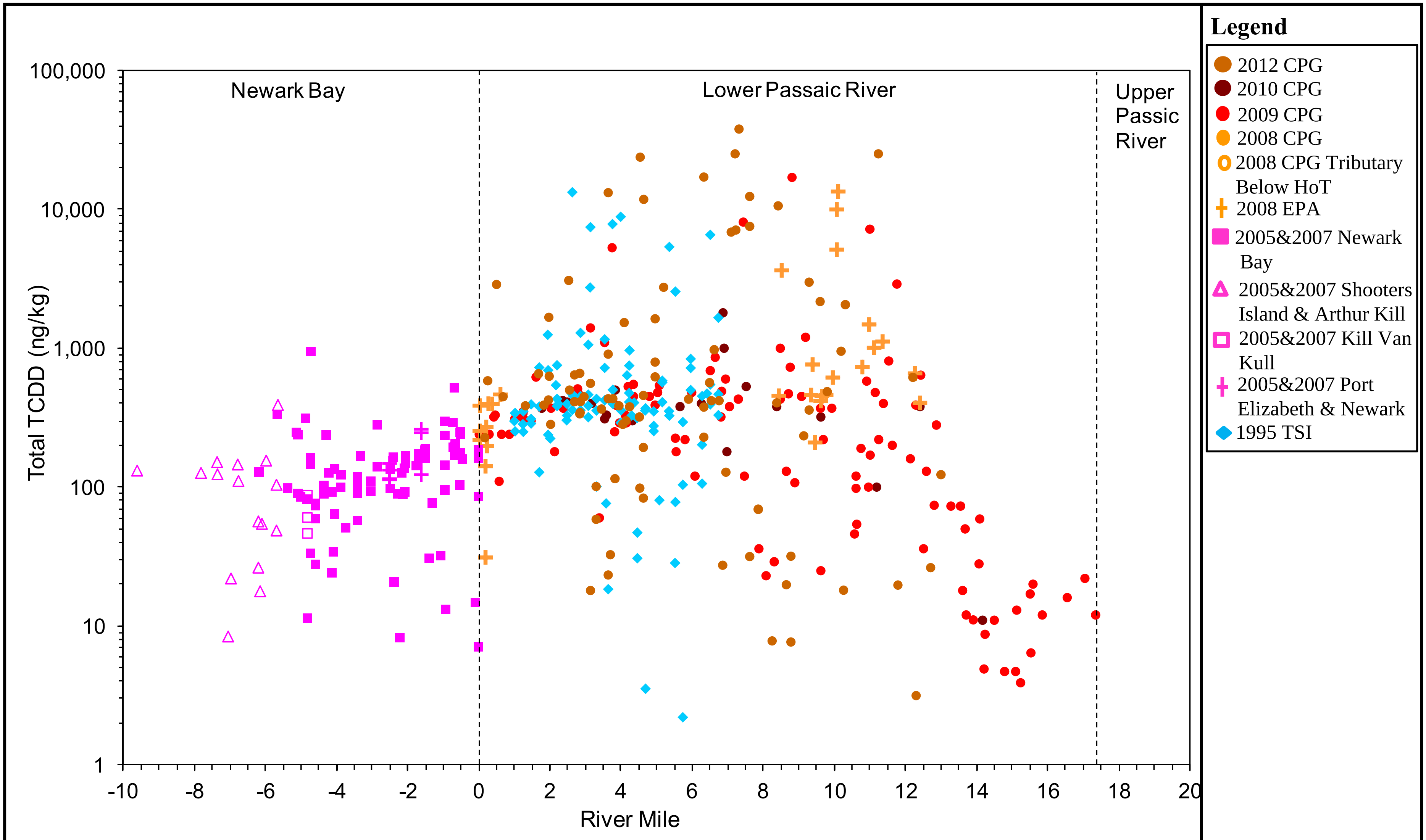
1. 2,3,7,8-TCDD concentrations generated during the 2008 CPG coring program were biased low and have been corrected by applying a factor of 1.89. The factor was provided by CSC and Interface, Inc., 2010.
2. 2008 CPG samples in both diagrams represent samples from likely depositional sites, but not strictly Be-7-bearing sediments. The samples represent 0-6 inches but had Be-7 detected in the top 2 inches.

2,3,7,8-TCDD in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Lower Passaic River

Figure 2.3-3

2014



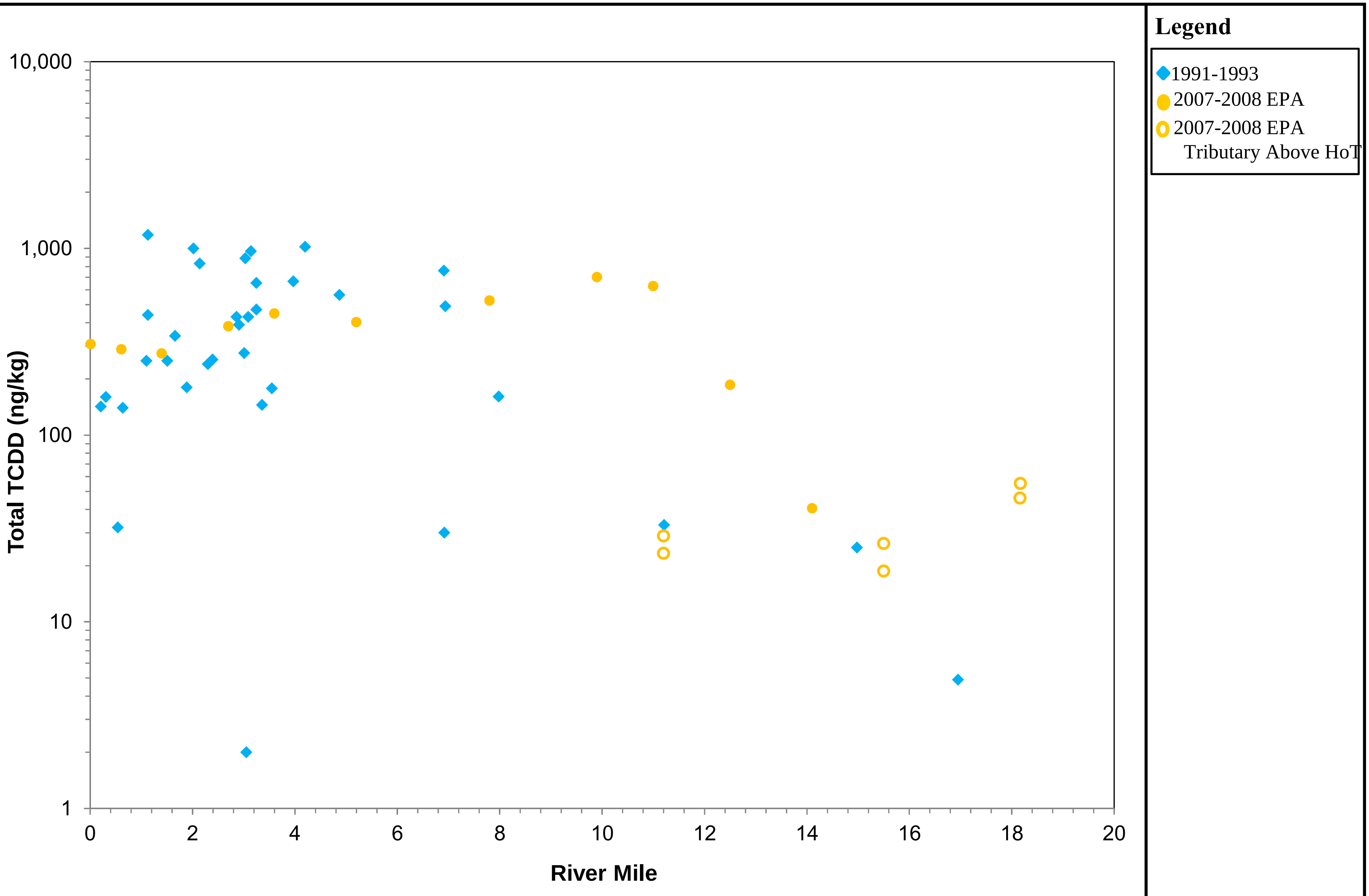
Note: the 2008 CPG Total TCDD data were not presented on this diagram due to analytical issues with the 2008 data that resulted in low bias, non-representative results.

Total TCDD Concentration (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 2.3-4

2014

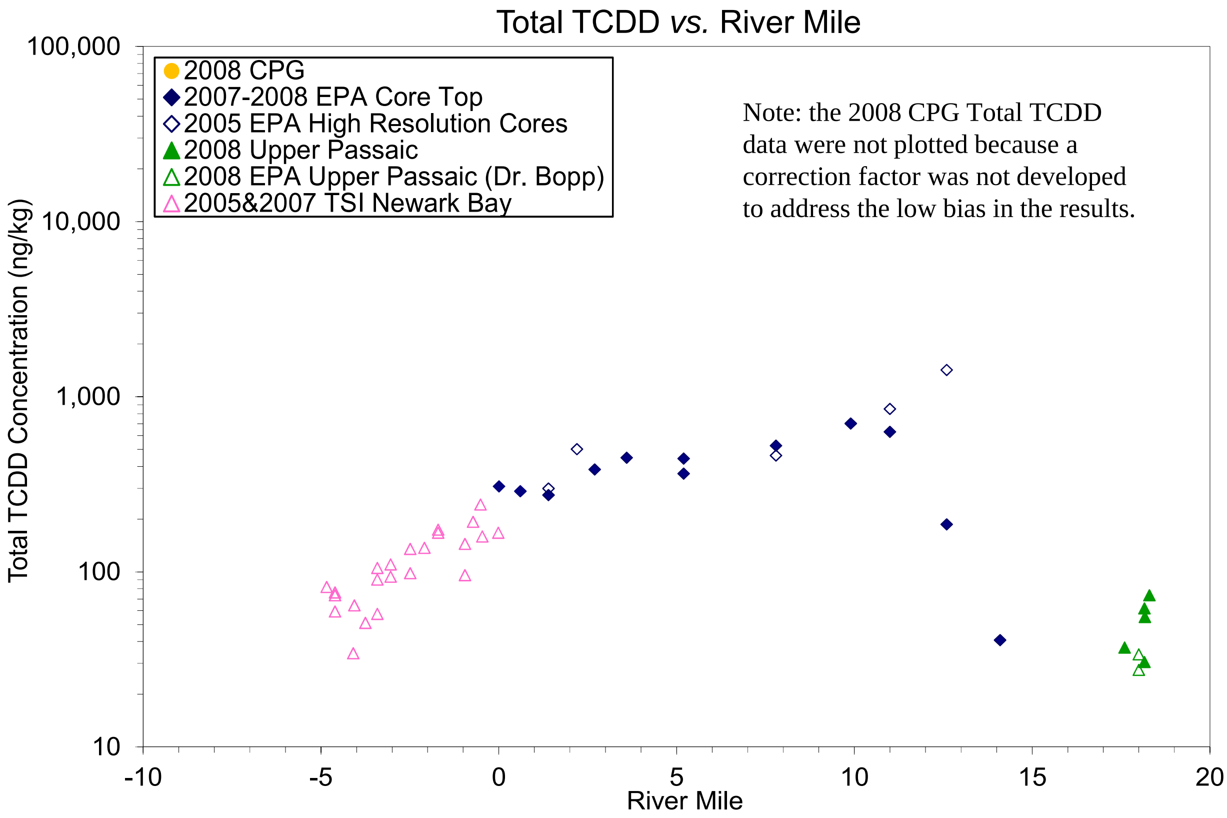


Total TCDD Concentration (0 - ≤2 inches) *vs.* River Mile

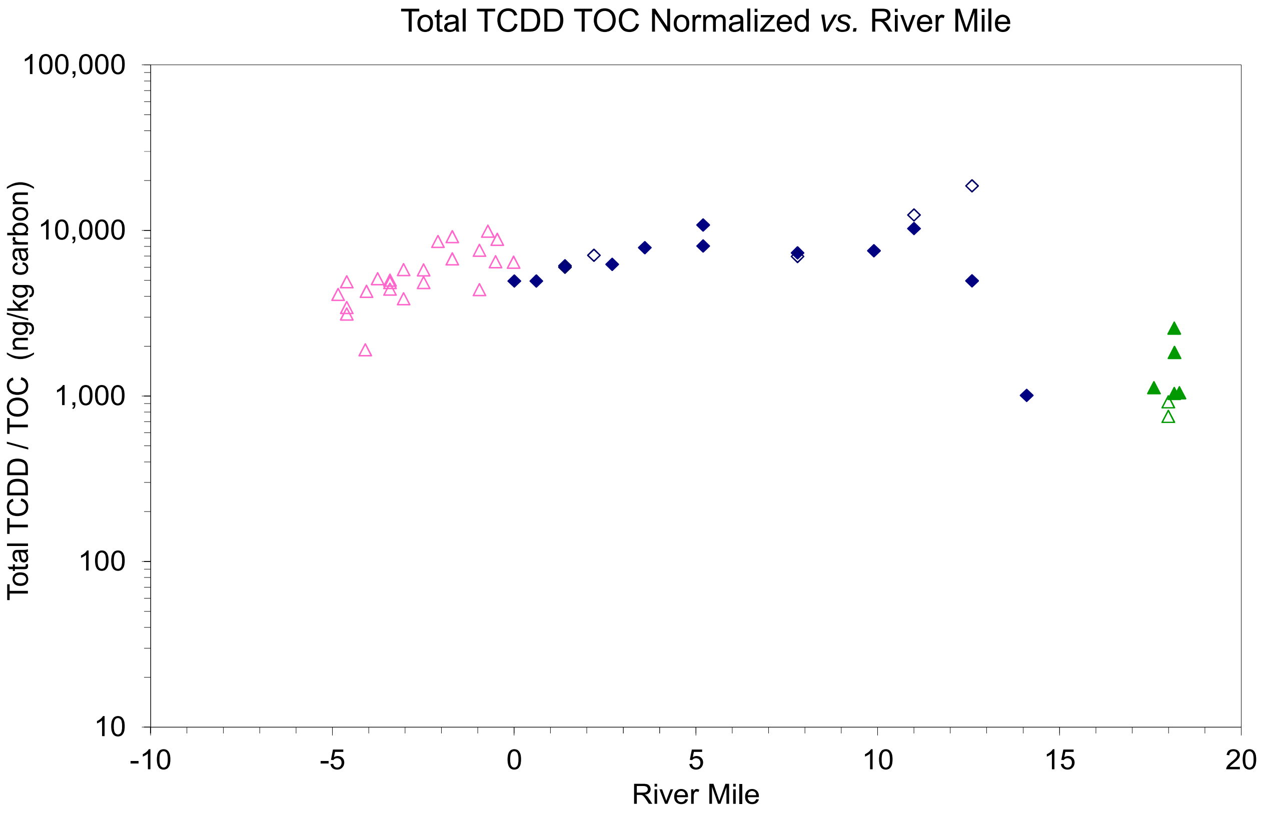
Lower Eight Miles of the Lower Passaic River

Figure 2.3-5

2014



Note: the 2008 CPG Total TCDD data were not plotted because a correction factor was not developed to address the low bias in the results.

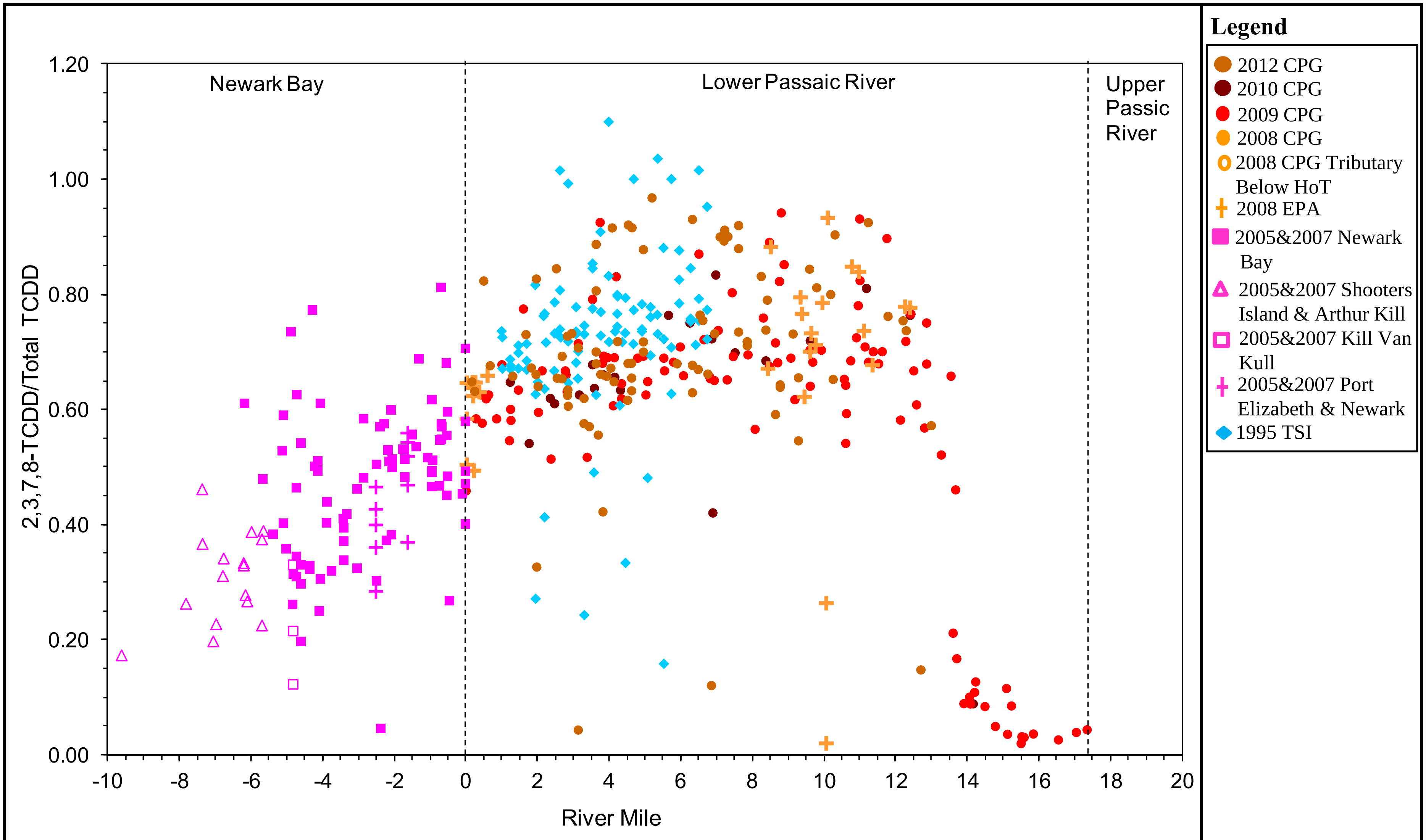


Total TCDD in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Lower Passaic River

Figure 2.3-6

2014



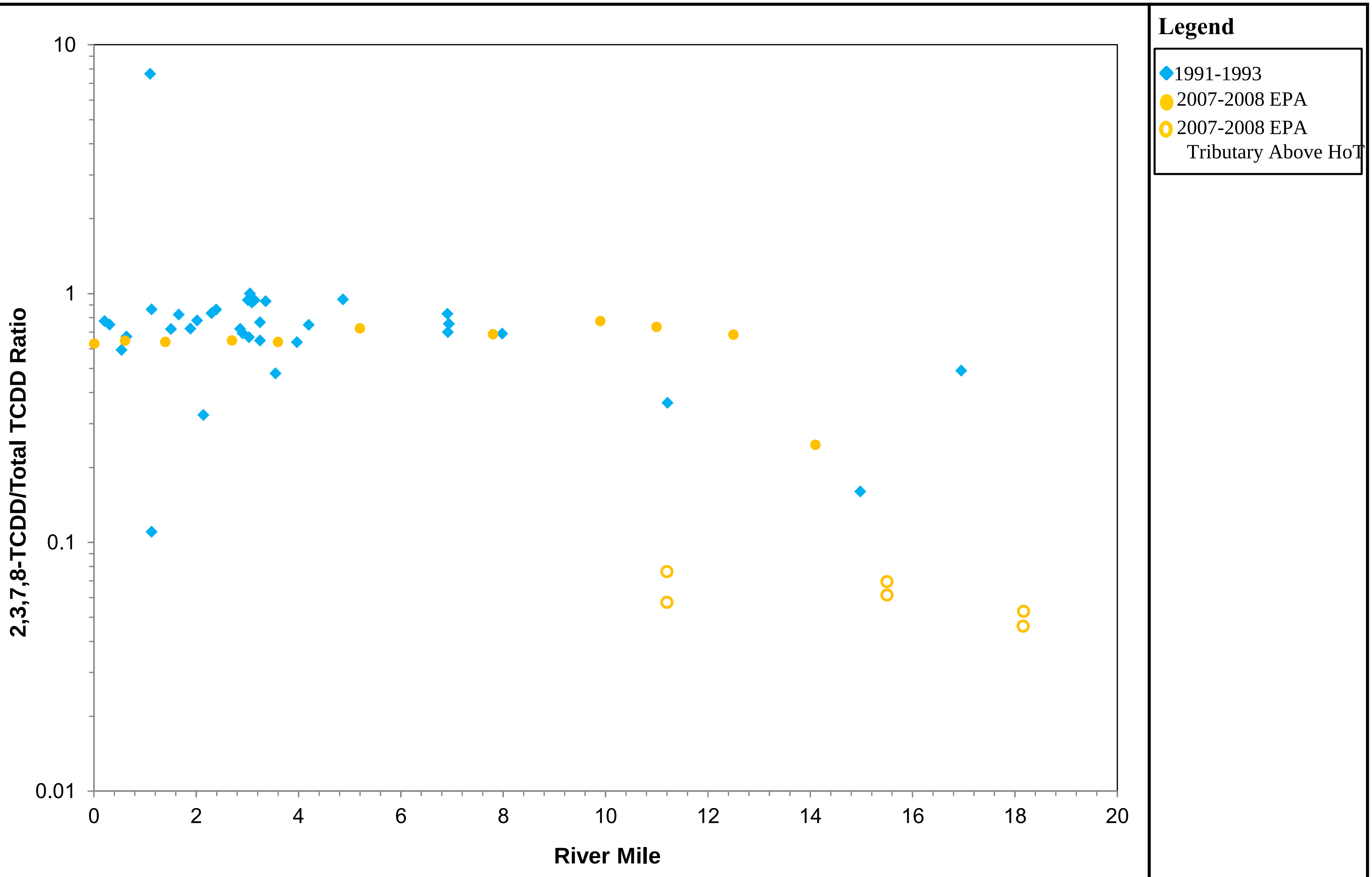
Note: the ratios for the 2008 CPG data were not plotted due to analytical issues with the 2008 Total TCDD data that resulted in low bias, non-representative results.

2,3,7,8-TCDD to Total TCDD Ratio (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 2.3-7

2014

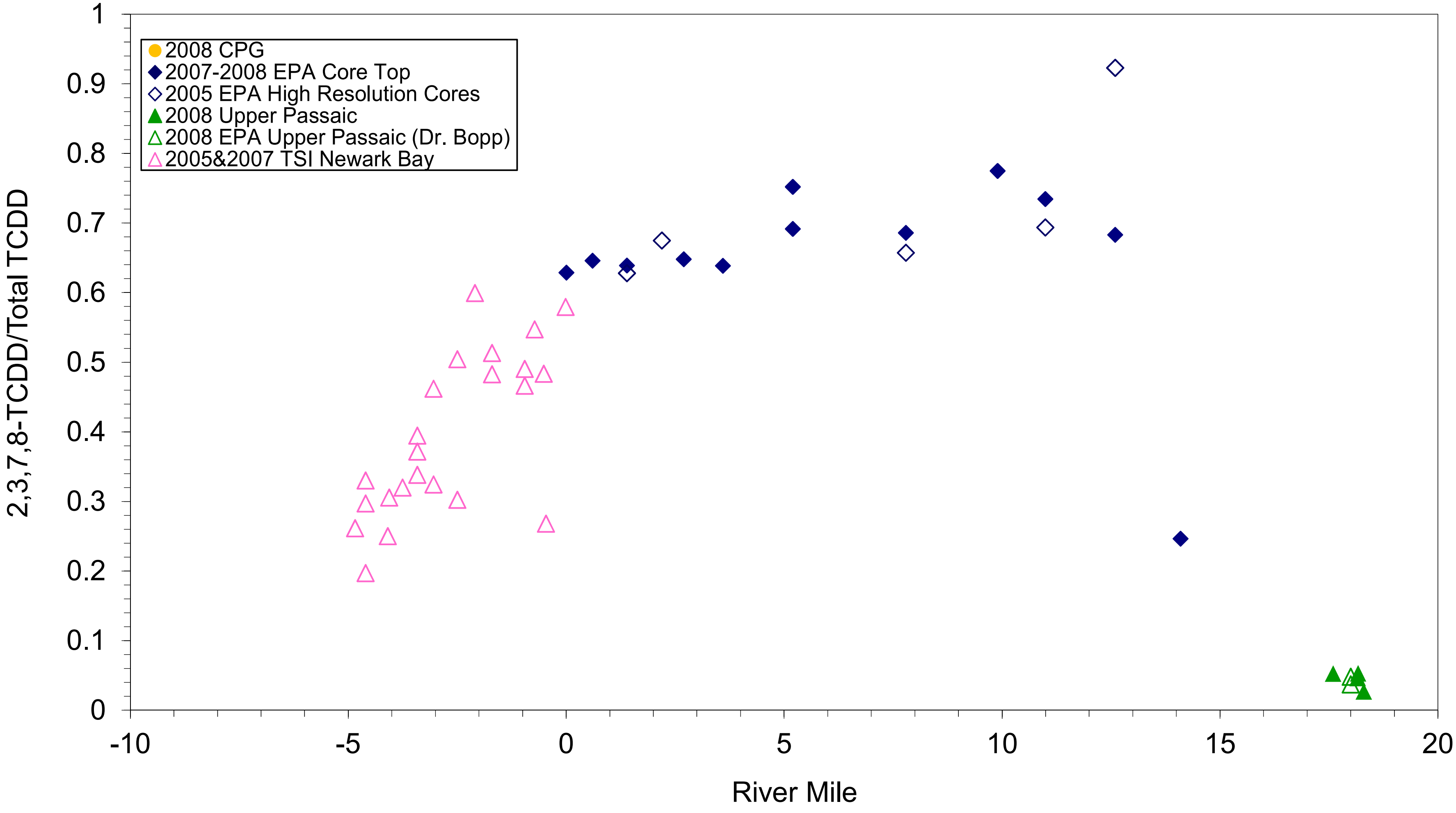


2,3,7,8-TCDD to Total TCDD Ratio (0 - ≤2 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 2.3-8

2014



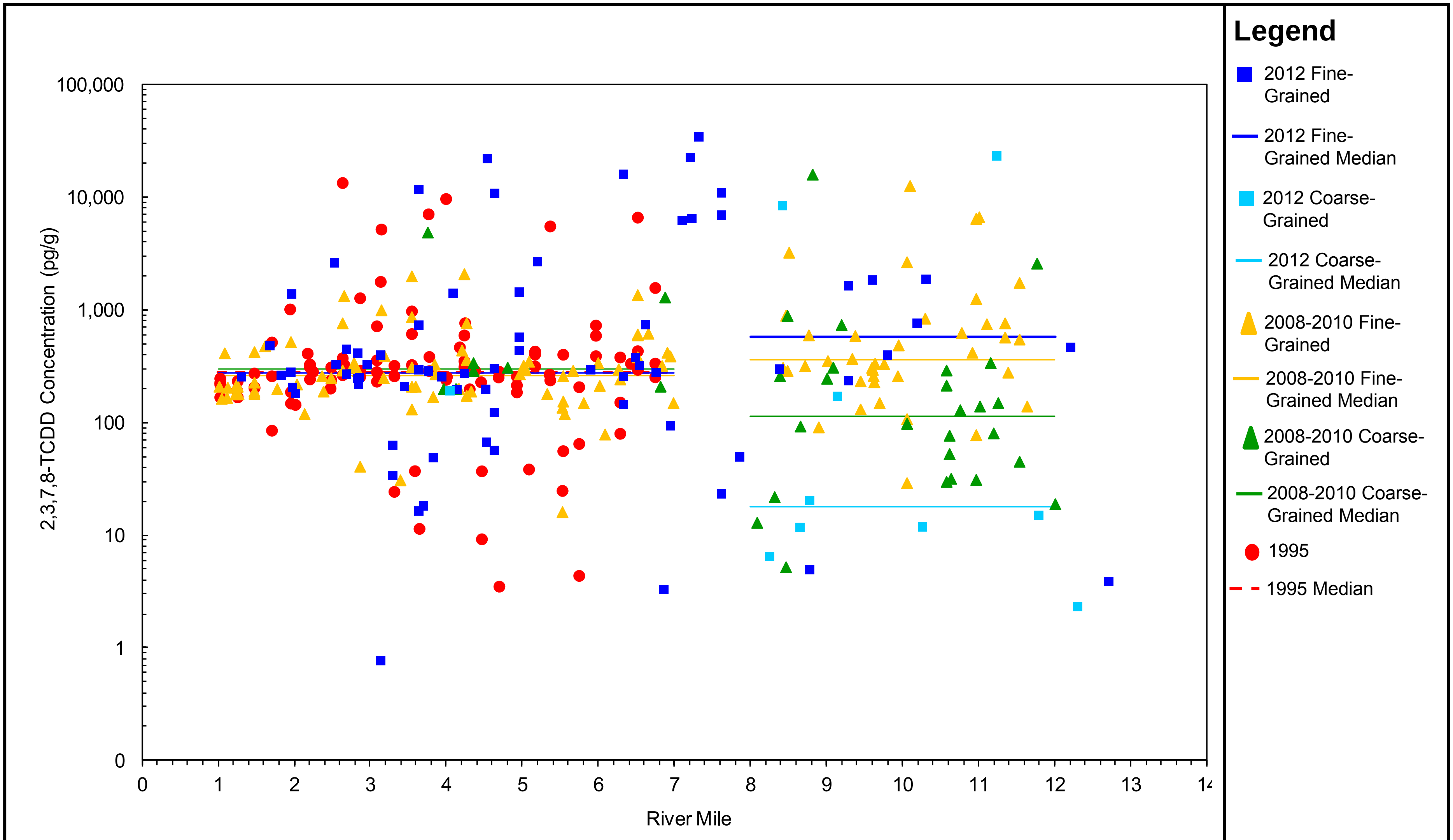
Note: the ratios for the 2008 CPG data were not plotted due to analytical issues with the 2008 Total TCDD data that resulted in low bias, non-representative results.

2,3,7,8-TCDD to Total TCDD Ratio in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Lower Passaic River

Figure 2.3-9

2014



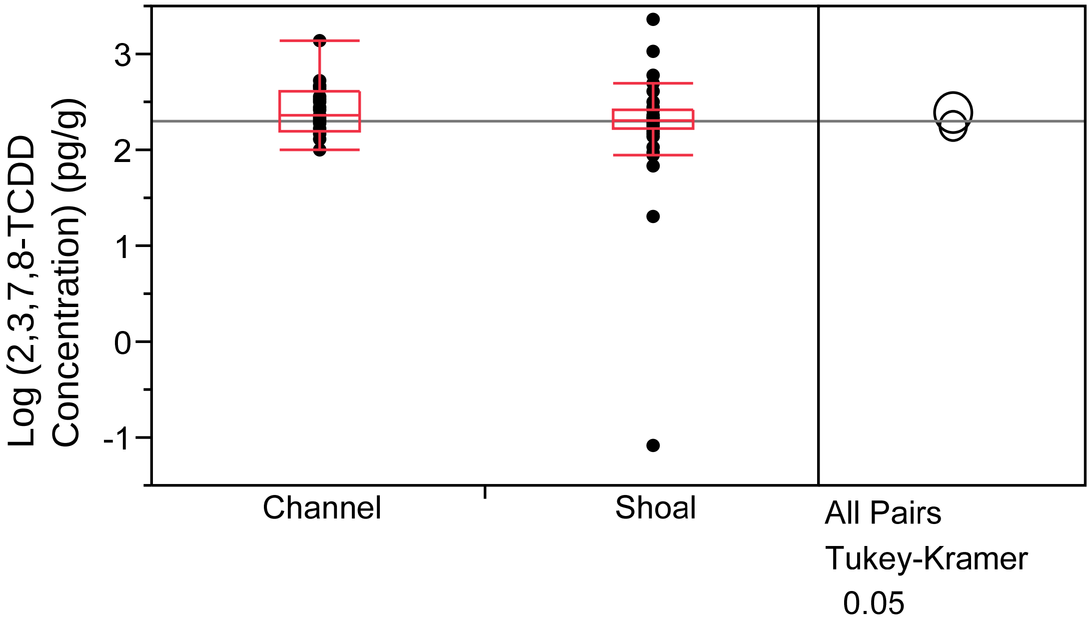
Comparison of 2,3,7,8-TCDD Surface Concentration (0-6 inches)
RM1 to RM7 *vs.* RM8 to RM12

Lower Eight Miles of the Lower Passaic River

Figure 2.4-1

2014

RM0 to RM2



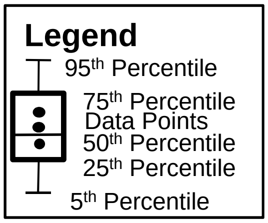
Notes:

1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.

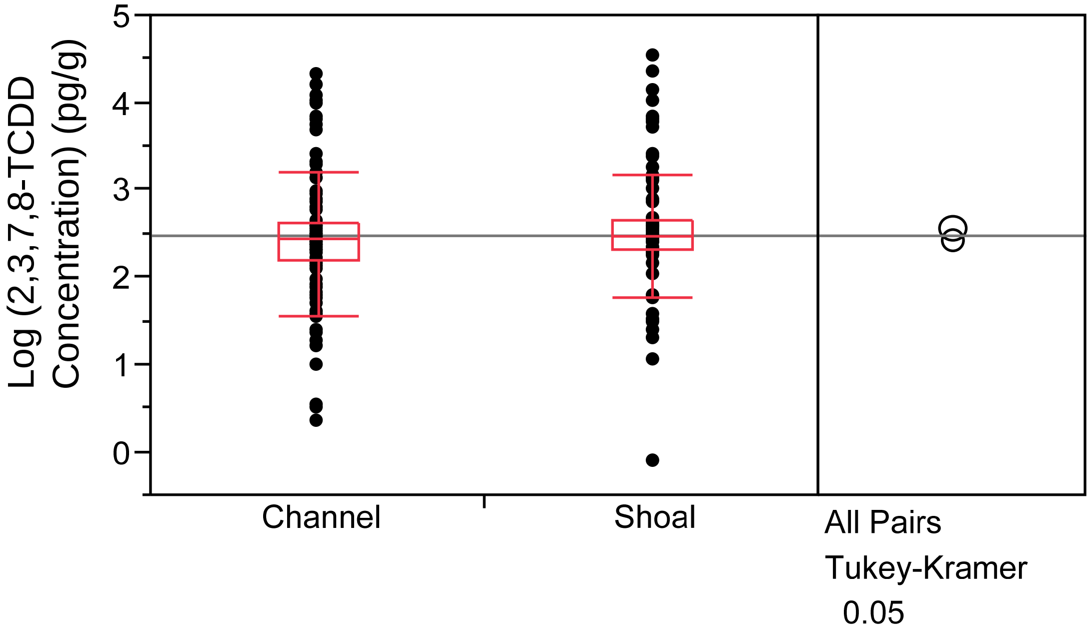
See text for explanation of Tukey-Kramer circles.

2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG and 2010 and 2012 CPG.

3) 2008 CPG data was corrected by applying a factor of 1.89 (CSC, 2010)



RM2 to RM8

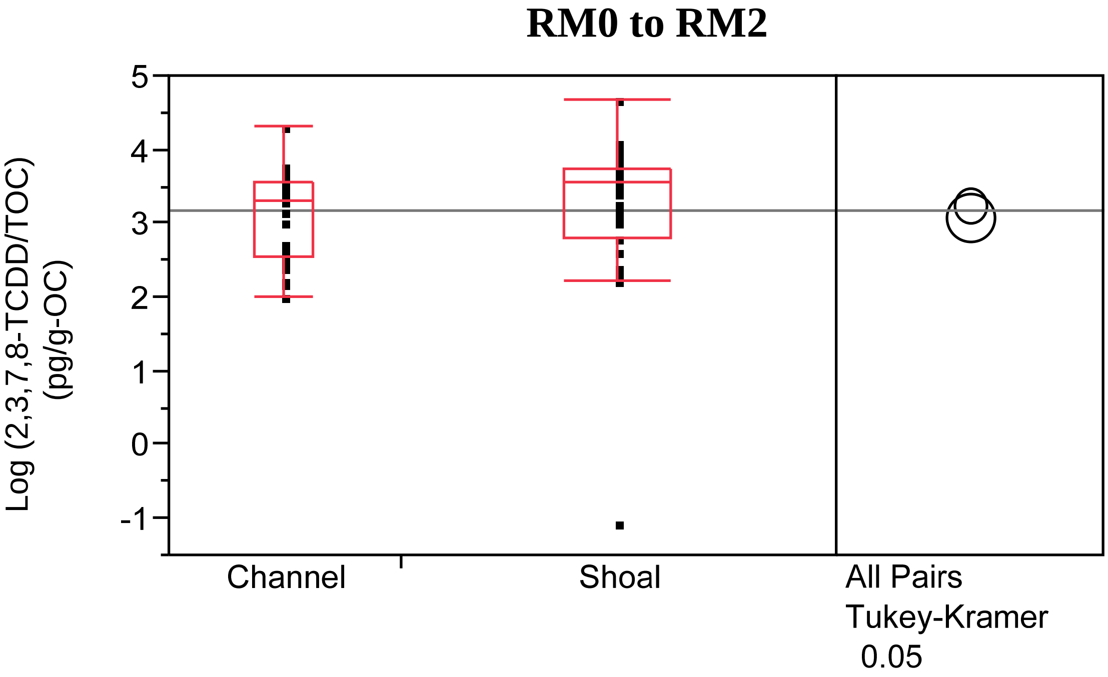


2,3,7,8-TCDD (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 2.4-2a

2014



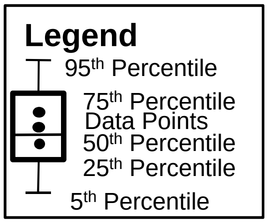
Notes:

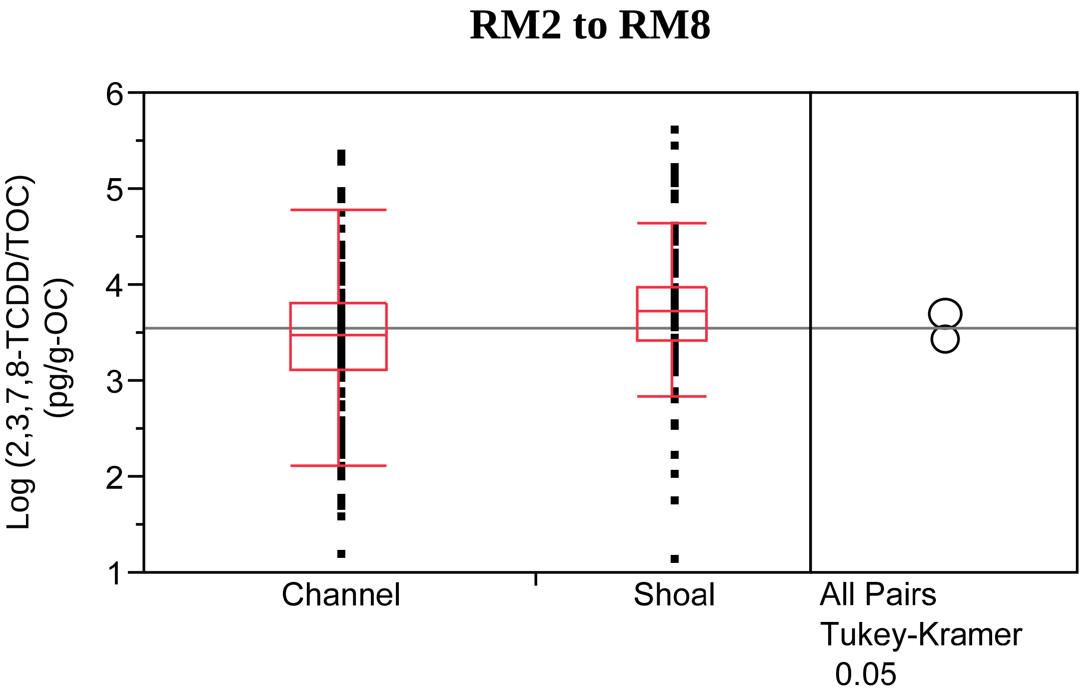
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.

See text for explanation of Tukey-Kramer circles.

2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG and 2010 and 2012 CPG.

3) 2008 CPG data was corrected by applying a factor of 1.89 (CSC, 2010)



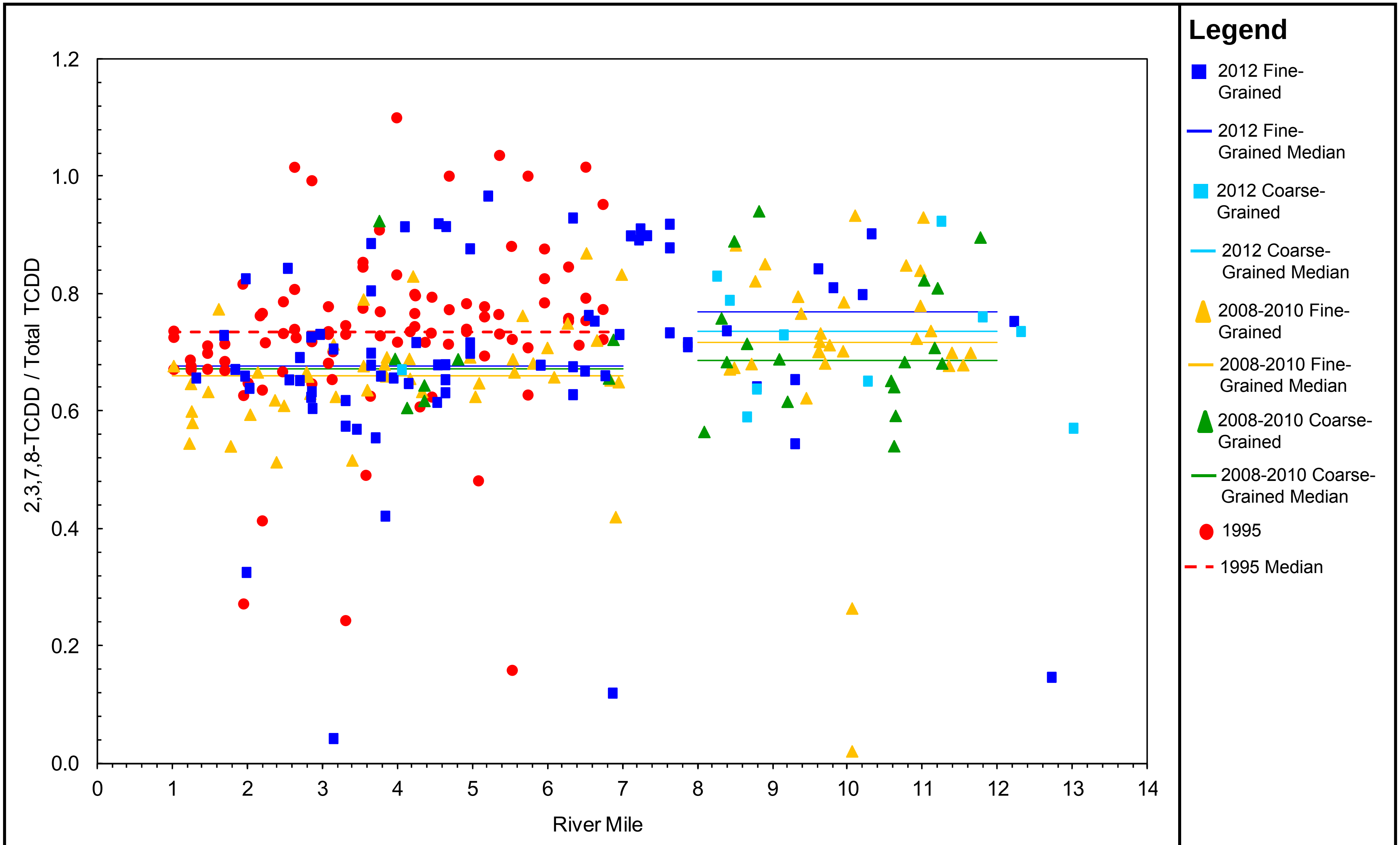


TOC Normalized 2,3,7,8-TCDD (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 2.4-2b

2014



Note: the ratios for the 2008 CPG data were not plotted due to analytical issues with the 2008 Total TCDD data that resulted in low bias, non-representative results.

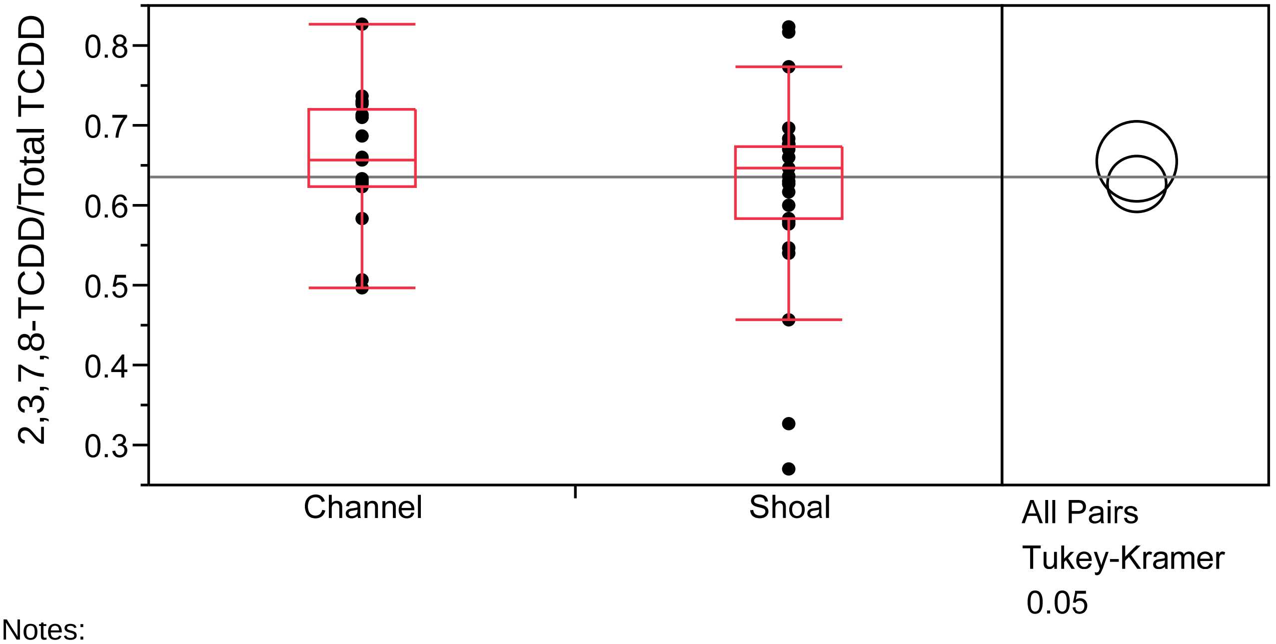
Comparison of 2,3,7,8-TCDD to Total TCDD Ratio (0-6 inches)
RM1 to RM7 *vs.* RM8 to RM12

Lower Eight Miles of the Lower Passaic River

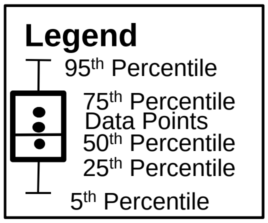
Figure 2.4-3

2014

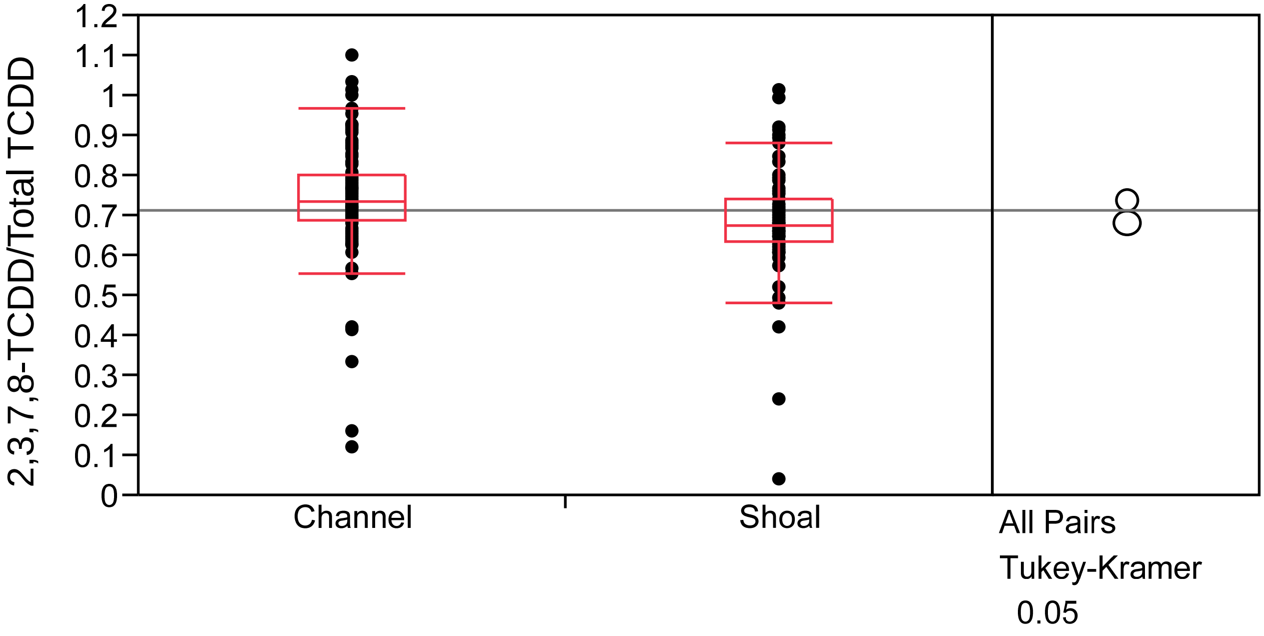
RM 0-2



Notes:
1) Horizontal line represents the mean concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2009 CPG, 2010 CPG and 2012 CPG.
3) The ratios for the 2008 CPG data were not included because a correction factor was not developed to address the low bias in the results.



RM 2-8

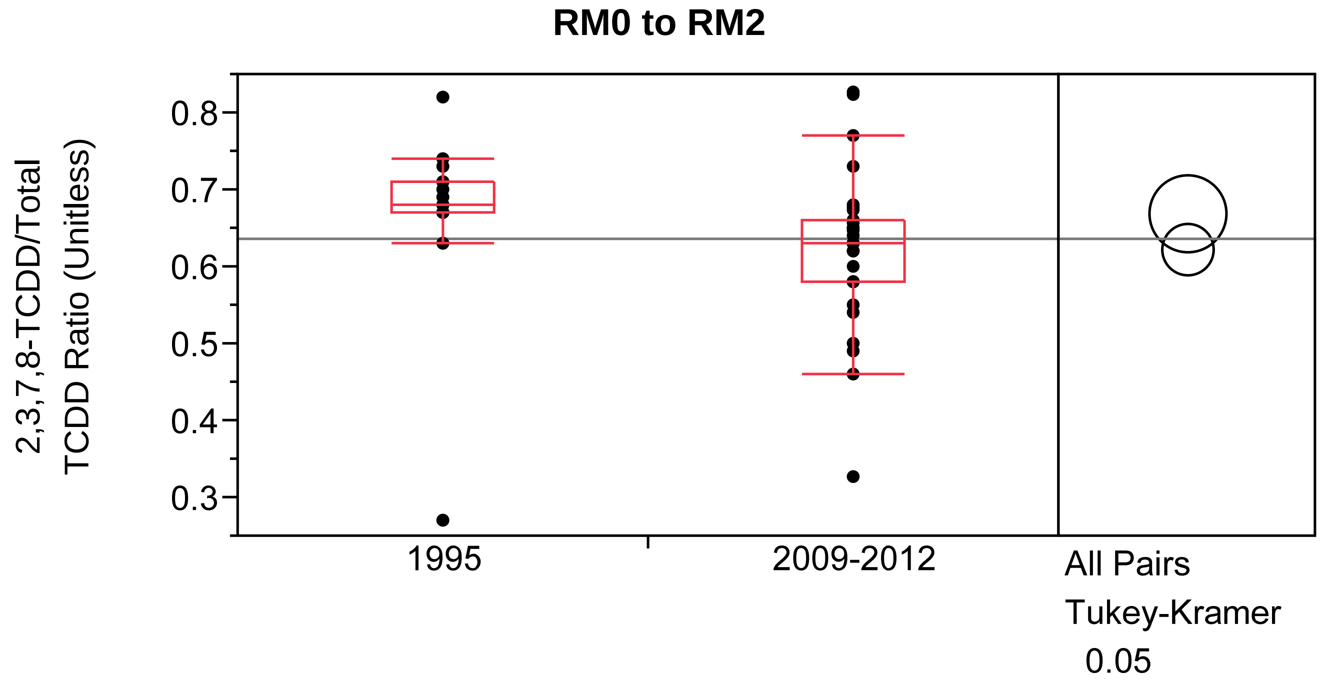


2,3,7,8-TCDD to Total TCDD Ratio (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

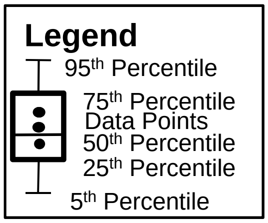
Lower Eight Miles of the Lower Passaic River

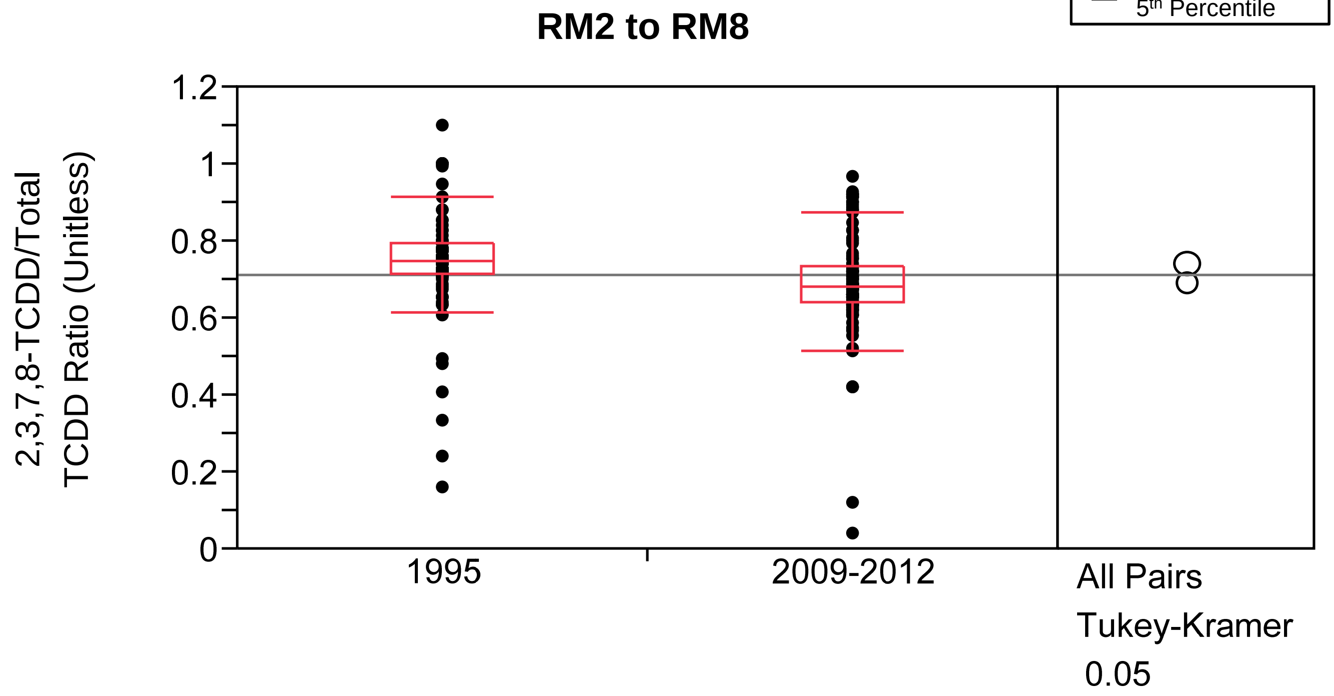
Figure 2.4-4

2014



Notes:
1) Horizontal line represents the mean concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2009 CPG, 2010 CPG and 2012 CPG.
3) The ratios for the 2008 CPG data were not included because a correction factor was not developed to address the low bias in the results.



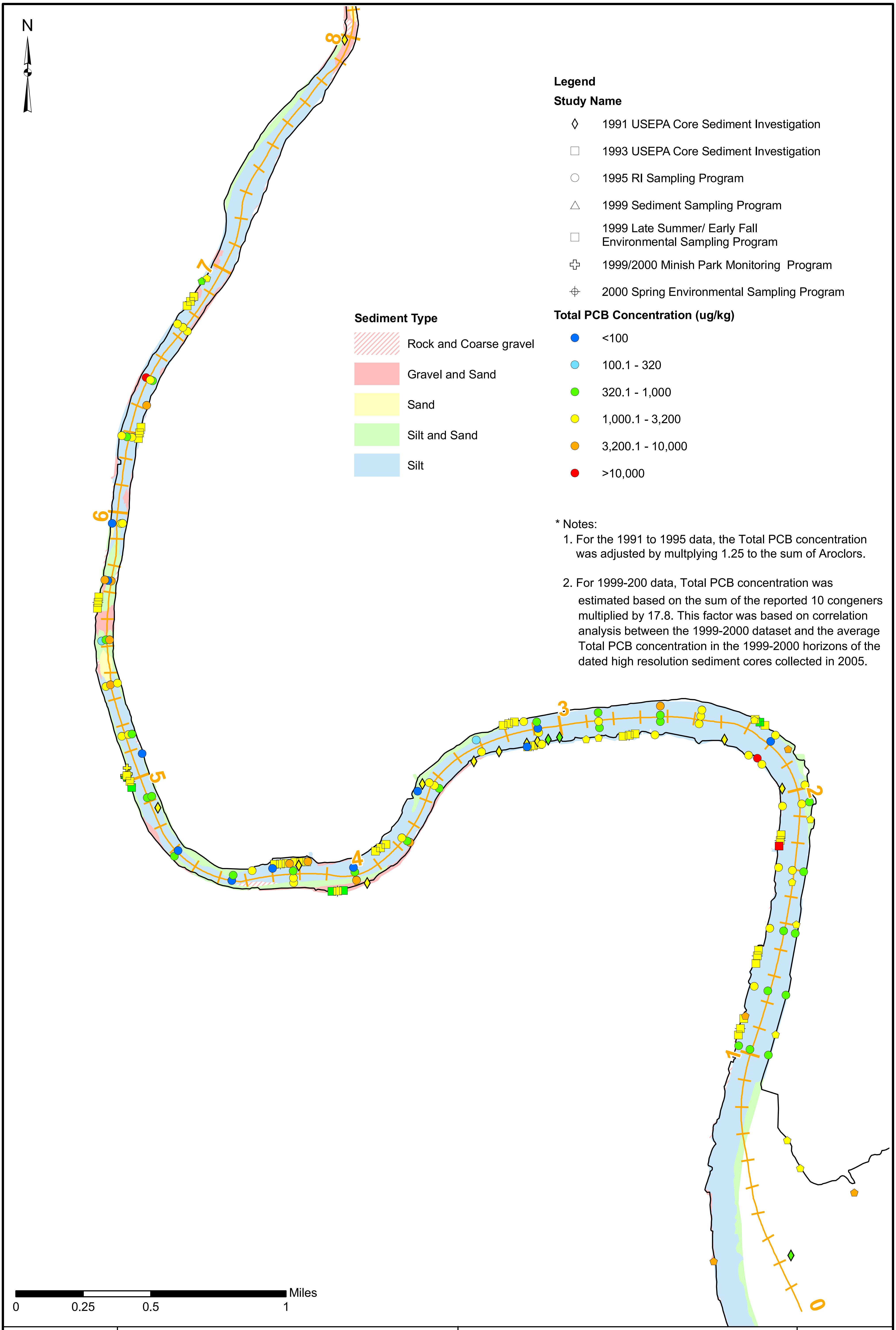


2,3,7,8-TCDD to Total TCDD Ratio (0-6 inch) by Study Period: 1995 *vs.* 2009-2012

Lower Eight Miles of the Lower Passaic River

Figure 2.4-5

2014



* Notes:

1. For the 1991 to 1995 data, the Total PCB concentration was adjusted by multplying 1.25 to the sum of Aroclors.

2. For 1999-200 data, Total PCB concentration was estimated based on the sum of the reported 10 congeners multiplied by 17.8. This factor was based on correlation analysis between the 1999-2000 dataset and the average Total PCB concentration in the 1999-2000 horizons of the dated high resolution sediment cores collected in 2005.

Total PCB in Surface Sediment Samples from 1991 to 2000

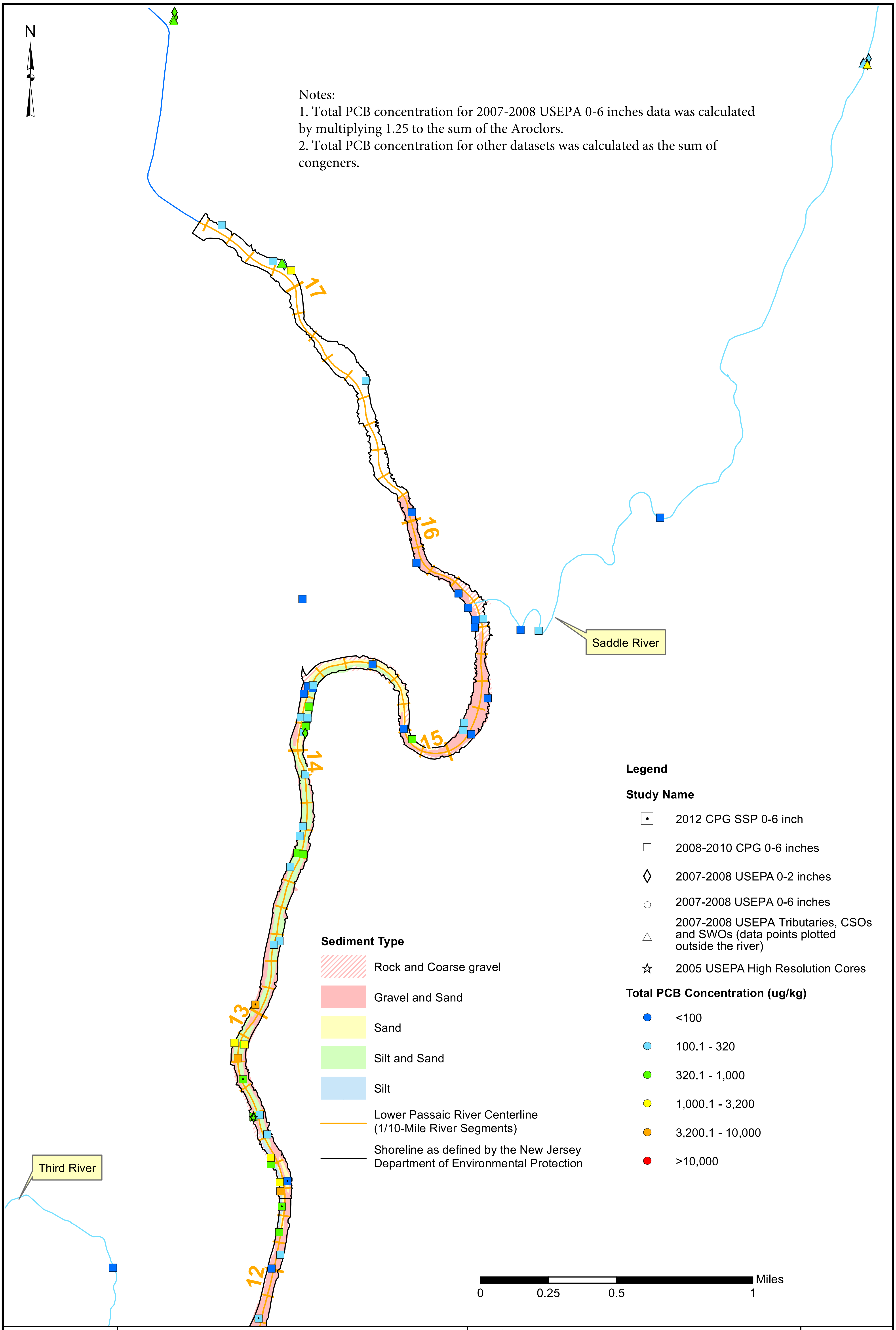
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.1-1

2014

Path: S:\Projects\passaic\MapDocuments\4553001-CERCLA\2012_Update\TotalPCB_Surficial_Sed_1991_2000



Notes:
1. Total PCB concentration for 2007-2008 USEPA 0-6 inches data was calculated by multiplying 1.25 to the sum of the Aroclors.
2. Total PCB concentration for other datasets was calculated as the sum of congeners.

Total PCB Surface Sediment Samples from 2005 to 2012

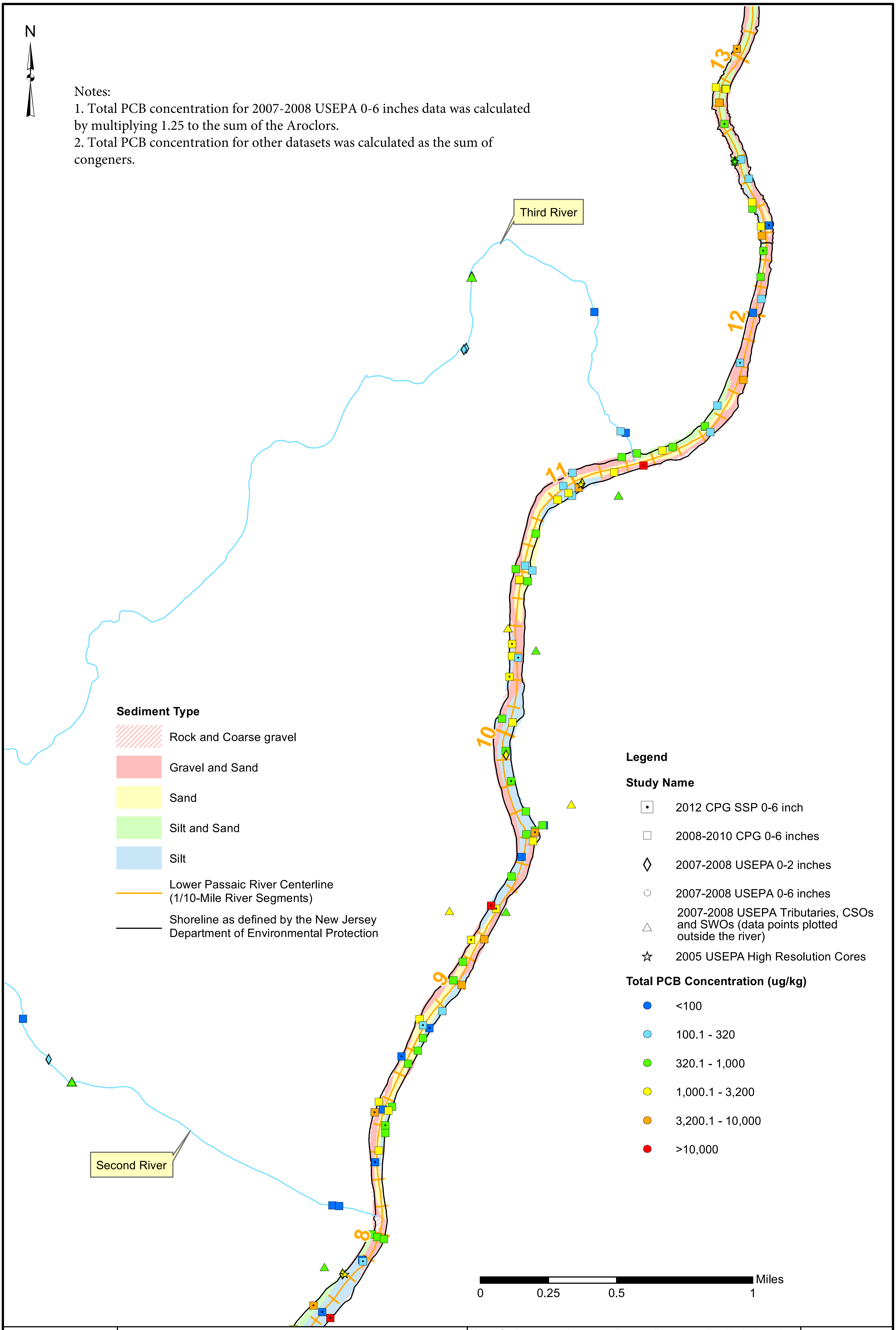
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.1-2a

2014

Path: P:\0285924\Mapping\CSM_MassBalance\SurfaceSed_Maps\TotalPCB_Surficial_Sed_2005_2012.mxd



Notes:
1. Total PCB concentration for 2007-2008 USEPA 0-6 inches data was calculated by multiplying 1.25 to the sum of the Aroclors.
2. Total PCB concentration for other datasets was calculated as the sum of congeners.

Total PCB Surface Sediment Samples from 2005 to 2012

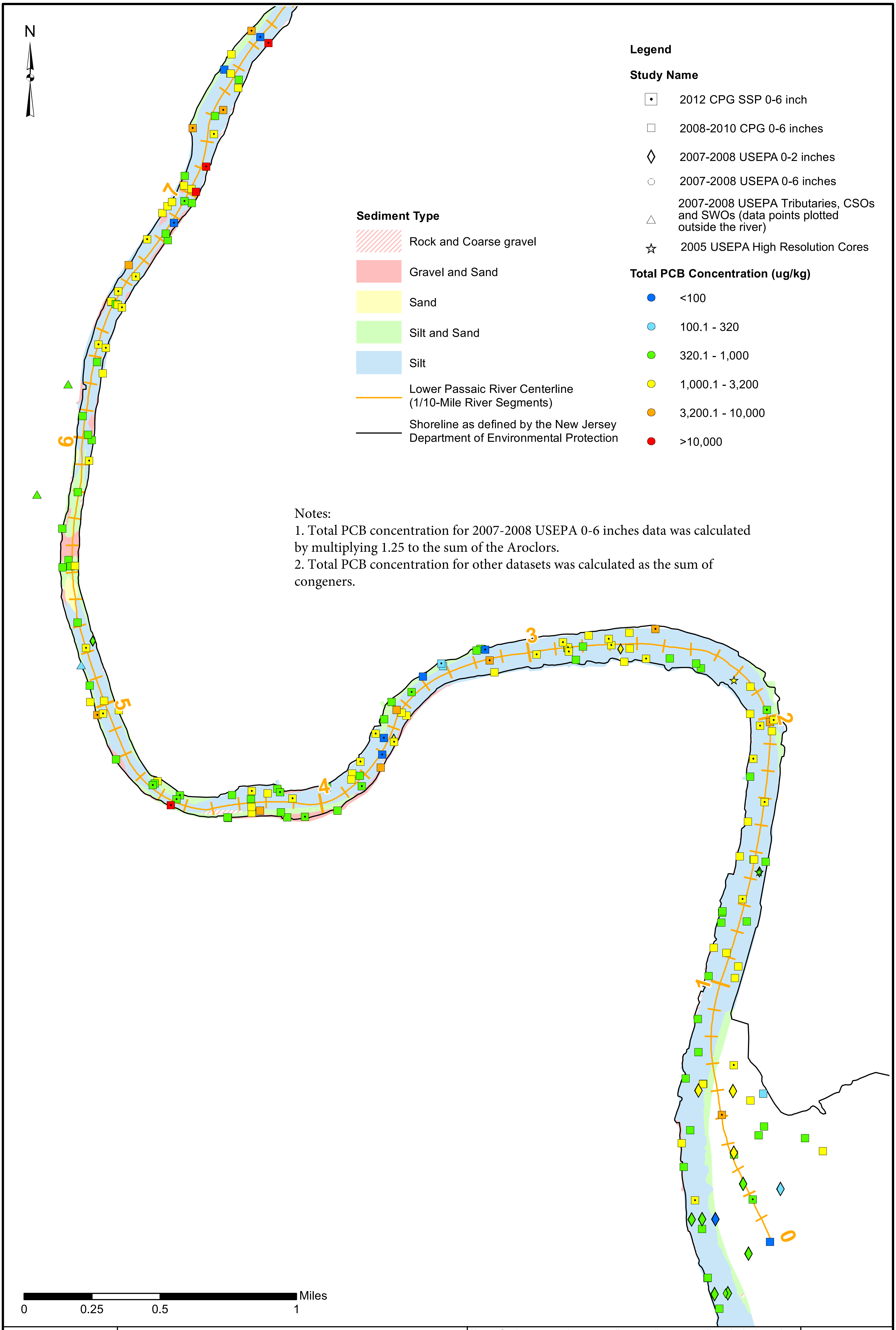
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.1-2b

2014

Path: P:\0285924\Mapping\CSM_MassBalance\SurfaceSed_Maps\TotalPCB_Surficial_Sed_2005_2012.mxd



Notes:
1. Total PCB concentration for 2007-2008 USEPA 0-6 inches data was calculated by multiplying 1.25 to the sum of the Aroclors.
2. Total PCB concentration for other datasets was calculated as the sum of congeners.

Total PCB Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

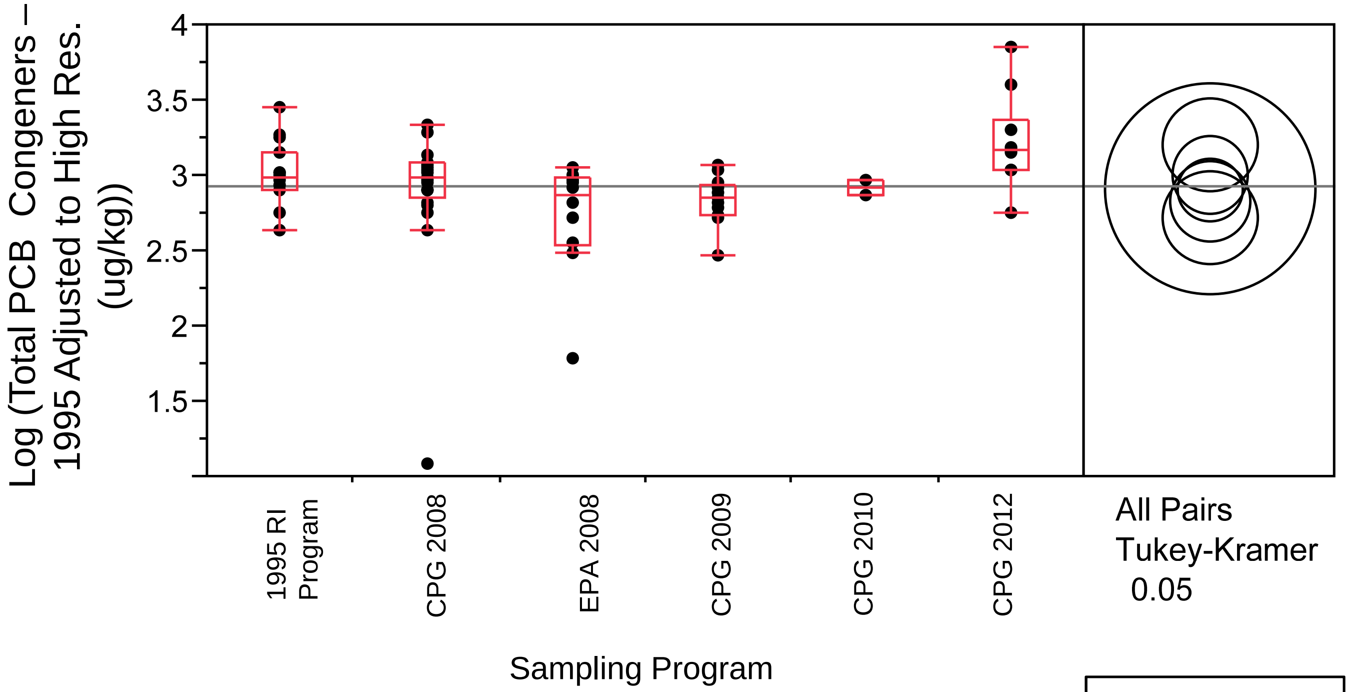
Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.1-2c

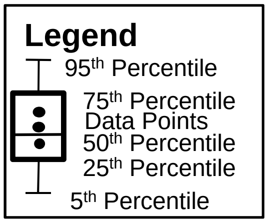
2014

Path: P:\0285924\Mapping\CSM_MassBalance\SurfaceSed_Maps\TotalPCB_Surficial_Sed_2005_2012.mxd

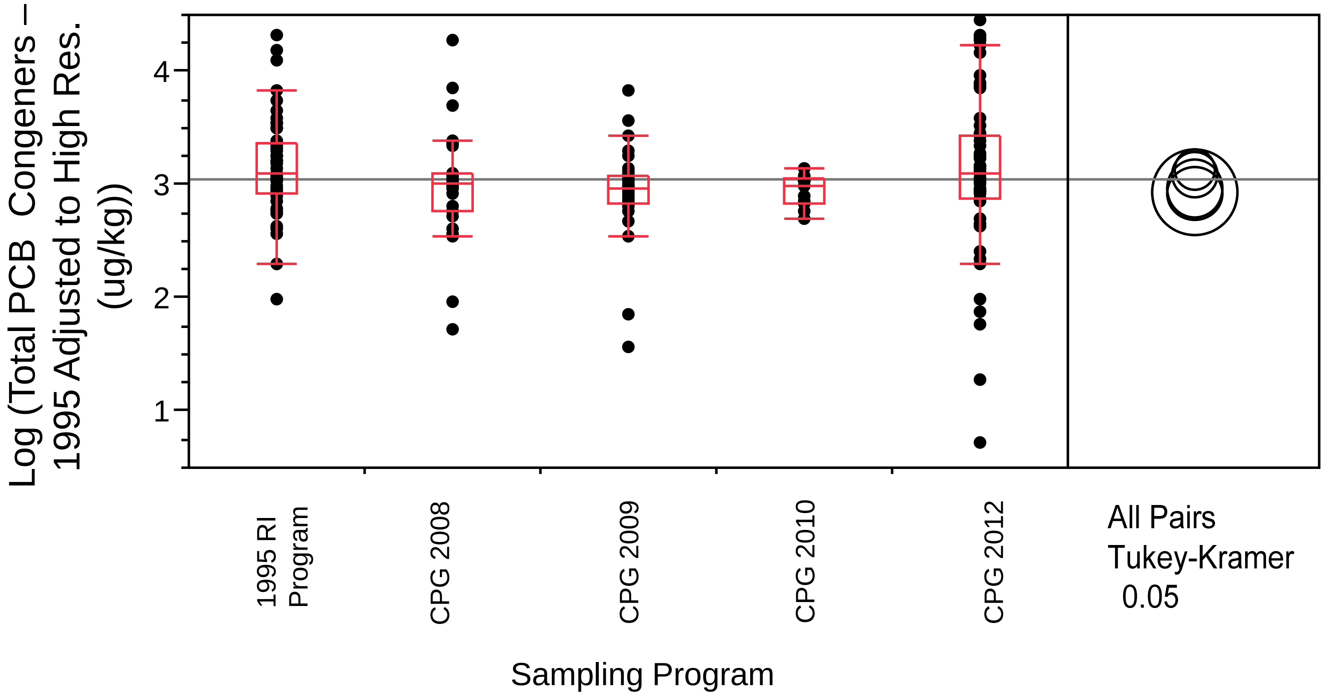
RM0 to RM2



Note: Horizontal line represents the mean concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.



RM2 to RM8



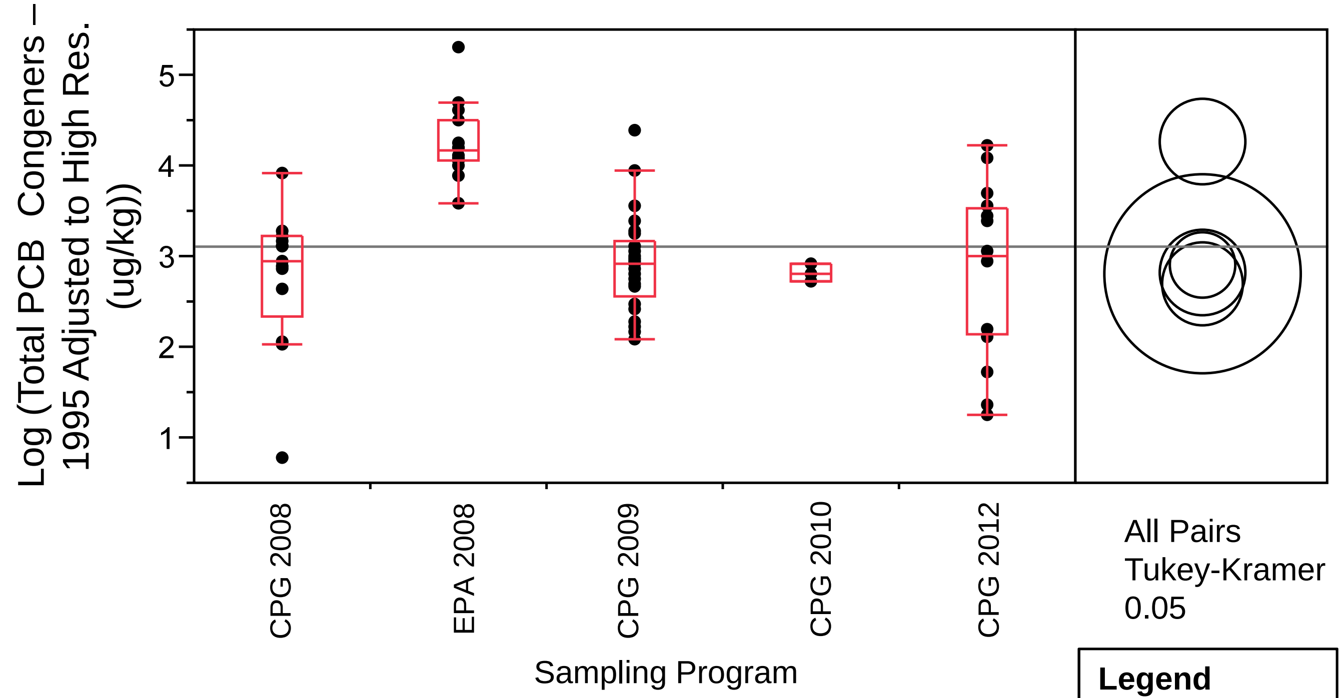
Total PCBs (0-6 inch) by Sampling Program at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 3.1-3a

2014

RM8 to RM12

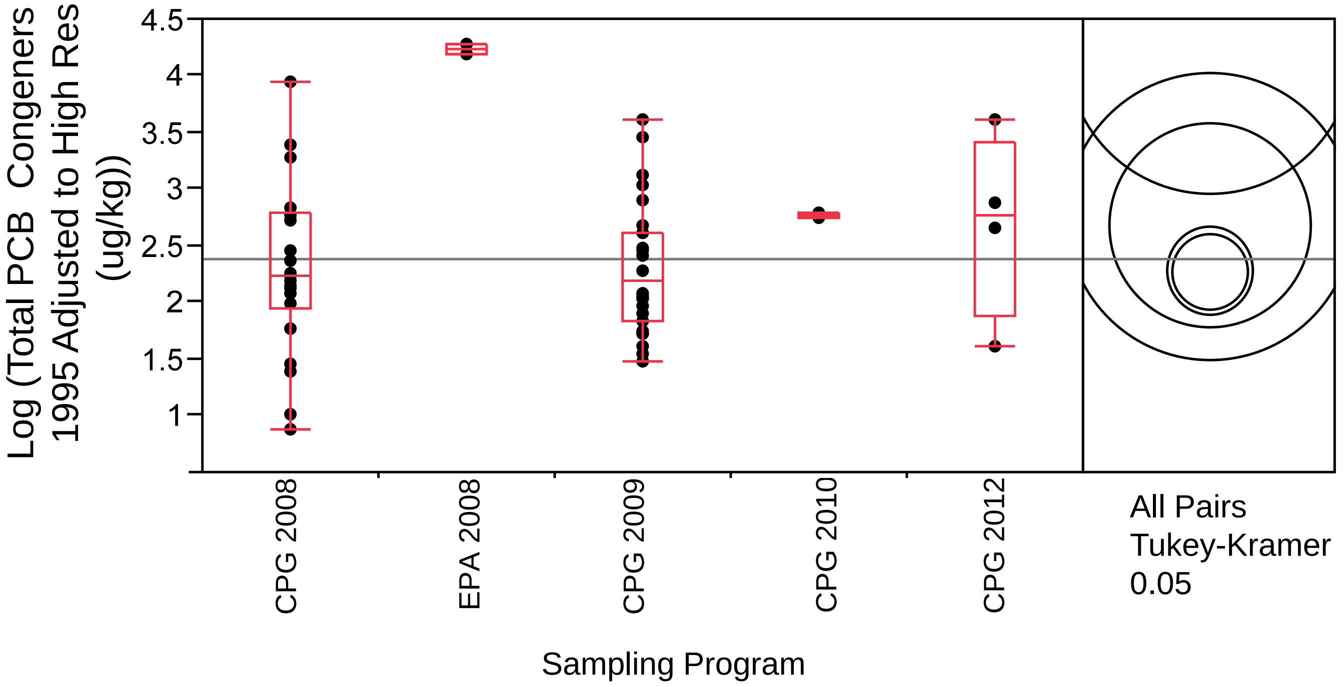


Note: Horizontal line represents the mean concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.

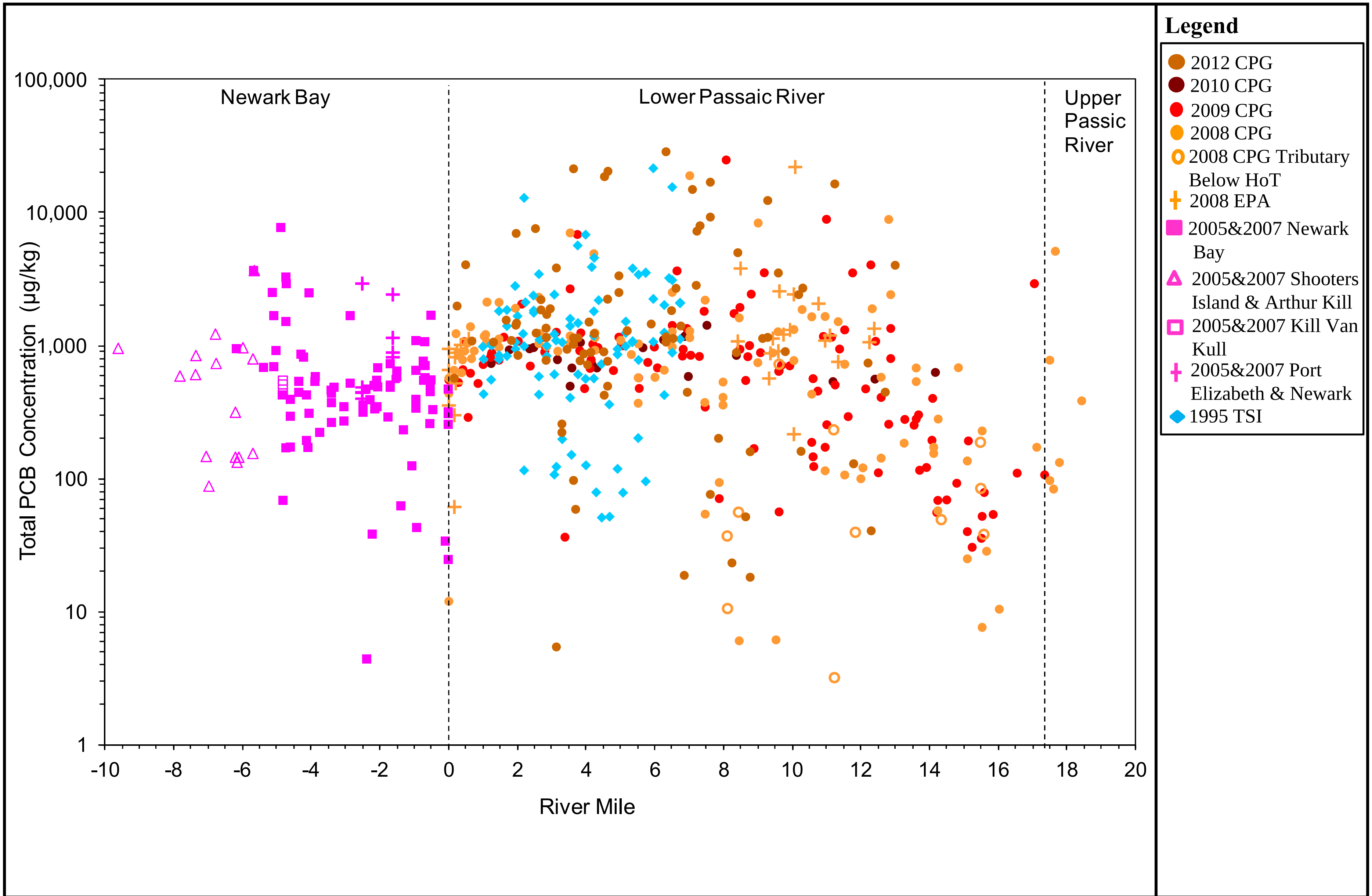
Legend

95th Percentile
75th Percentile
Data Points
50th Percentile
25th Percentile
5th Percentile

RM12 to RM17.4



Total PCBs (0-6 inch) by Sampling Program at RM8 to RM12 and RM12 to RM17.4 *Lower Eight Miles of the Lower Passaic River*	Figure 3.1-3b 2014

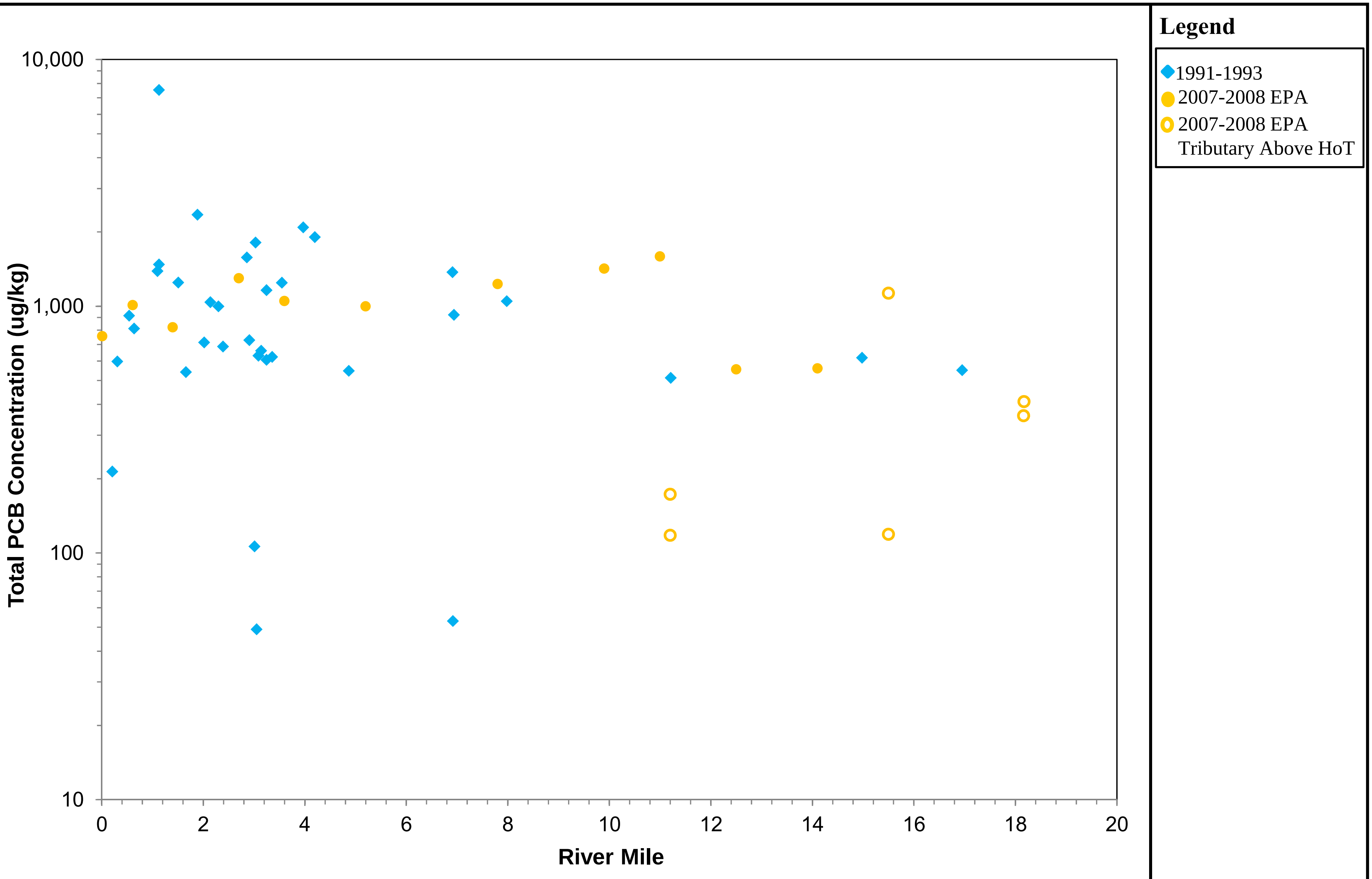


Total PCBs Concentration (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.1-4

2014

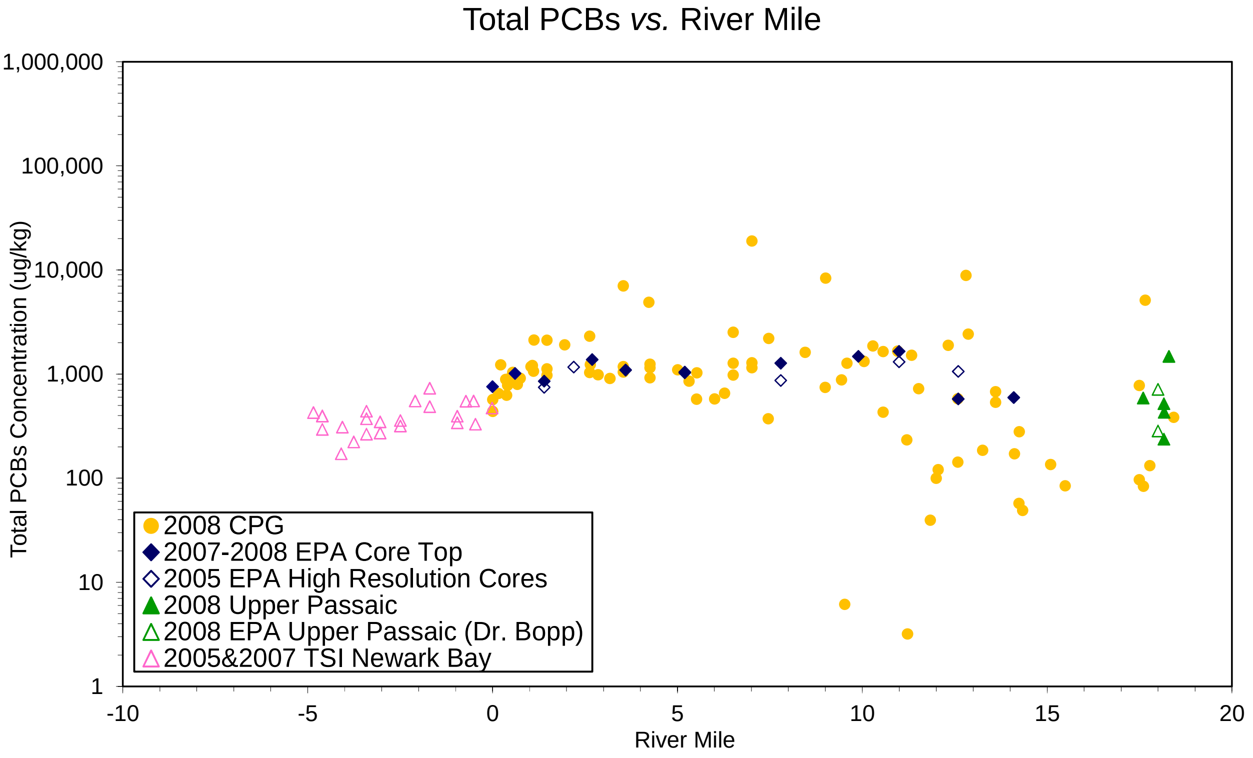


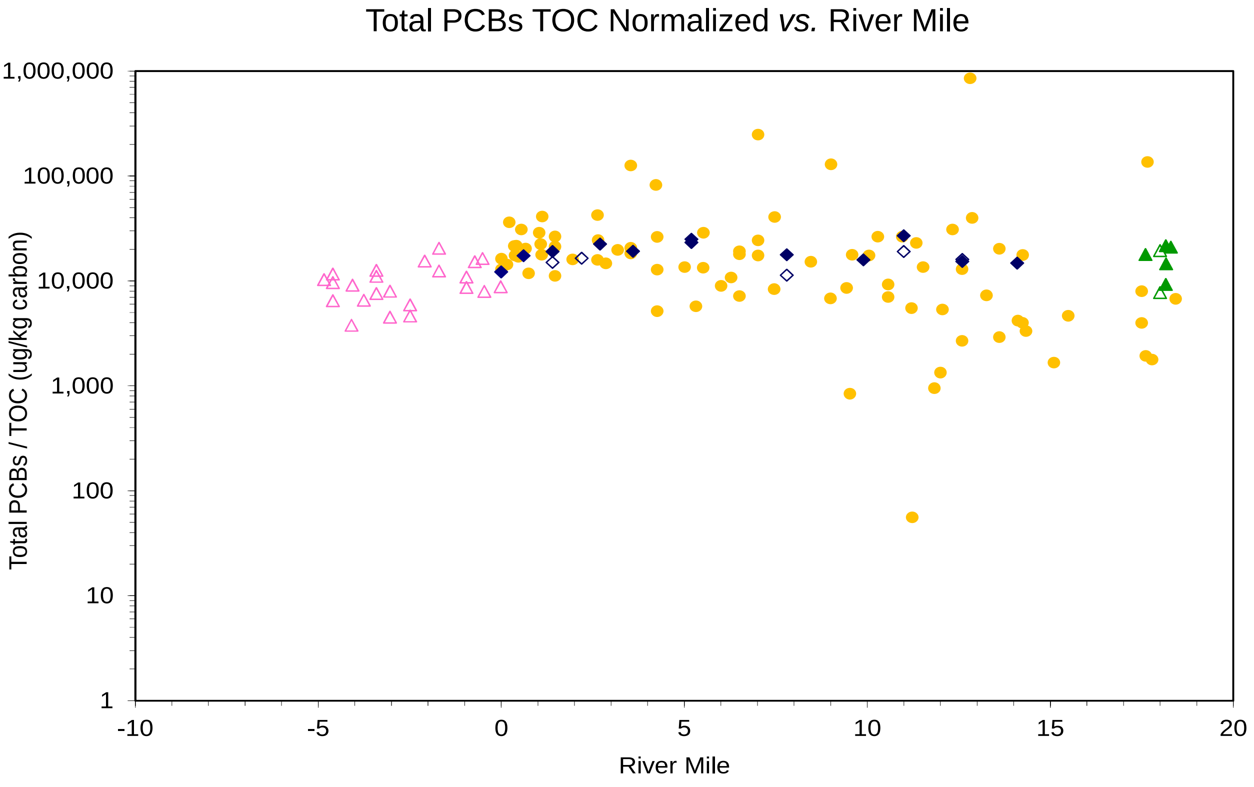
Total PCBs Concentration (0 - ≤2 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.1-5

2014



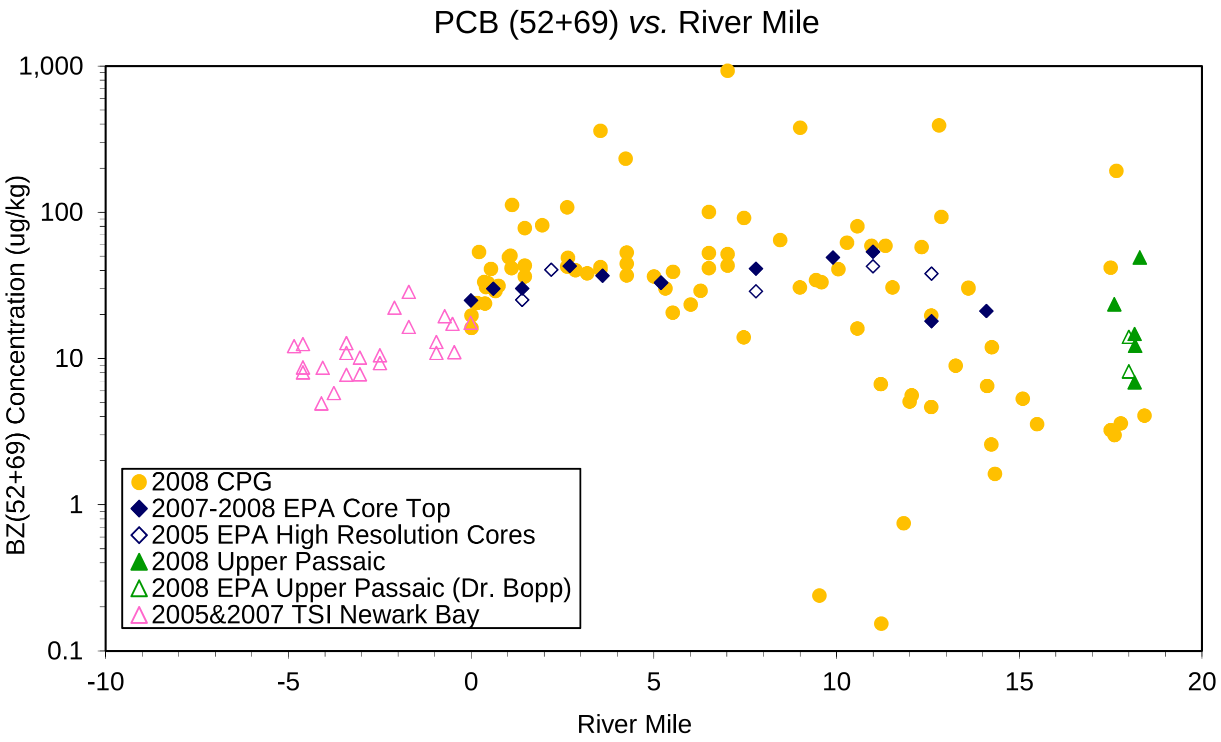


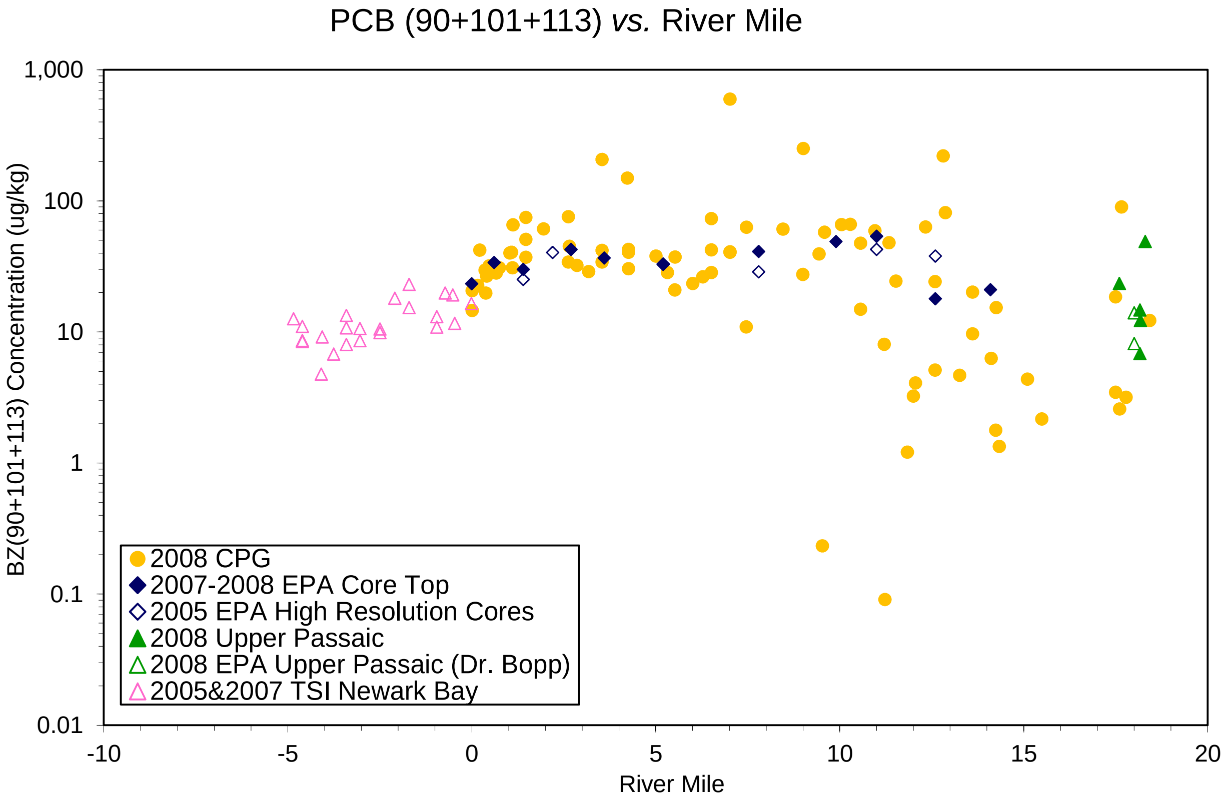
Total PCBs in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Lower Passaic River

Figure 3.1-6

2014



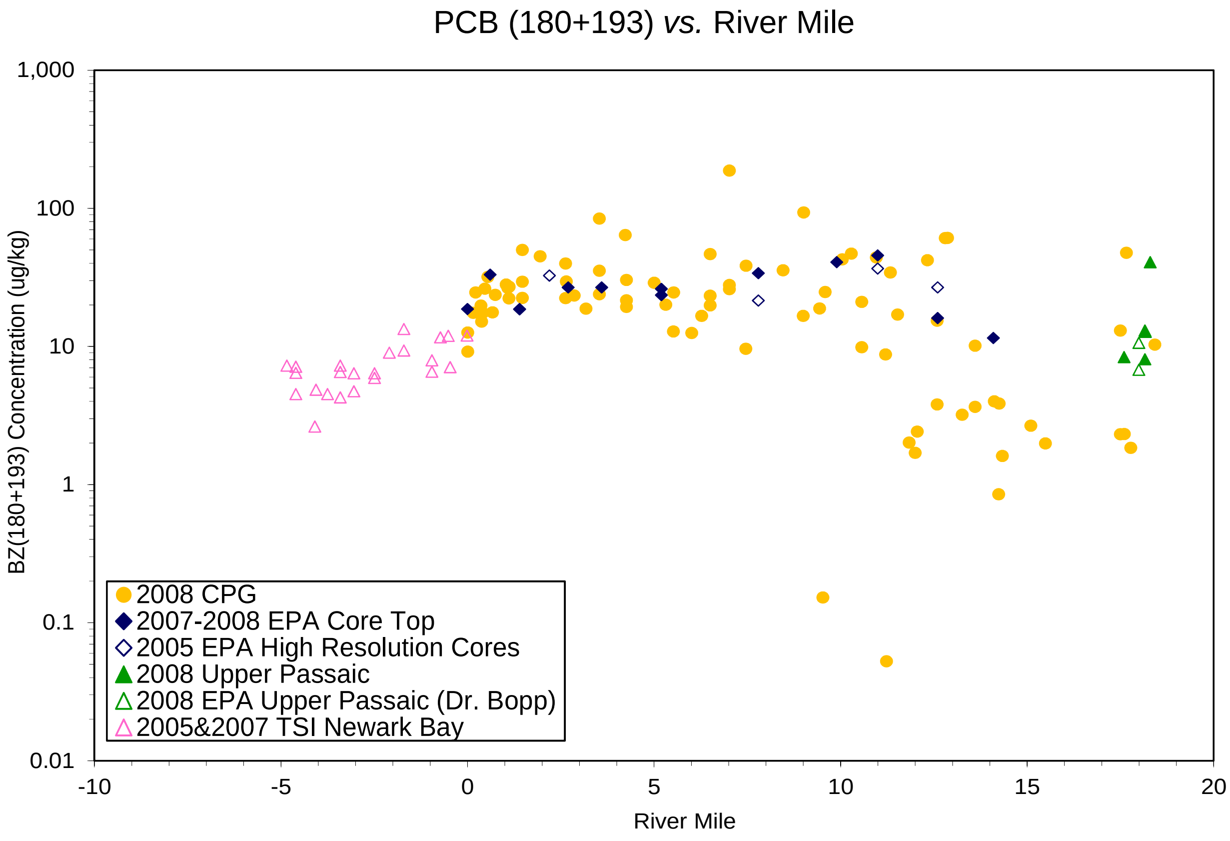


PCB (52+69) and PCB (90+101+113) in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Lower Passaic River

Figure 3.1-7a

2014

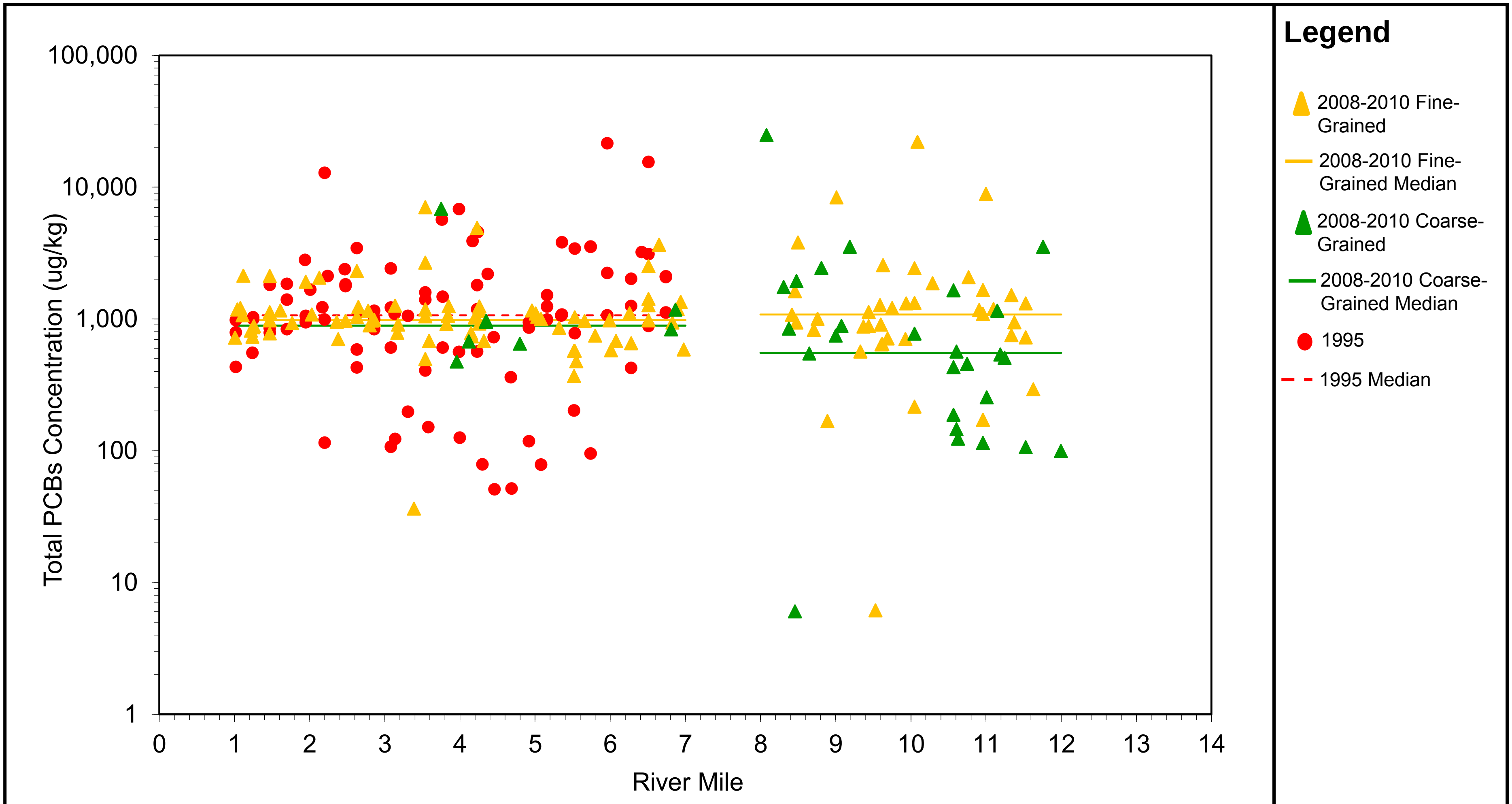


PCB (180+193) in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Lower Passaic River

Figure 3.1-7b

2014



Note: 2012 CPG data are not plotted since there are no PCB Aroclors data available, the CPG analyzed PCB congeners only.

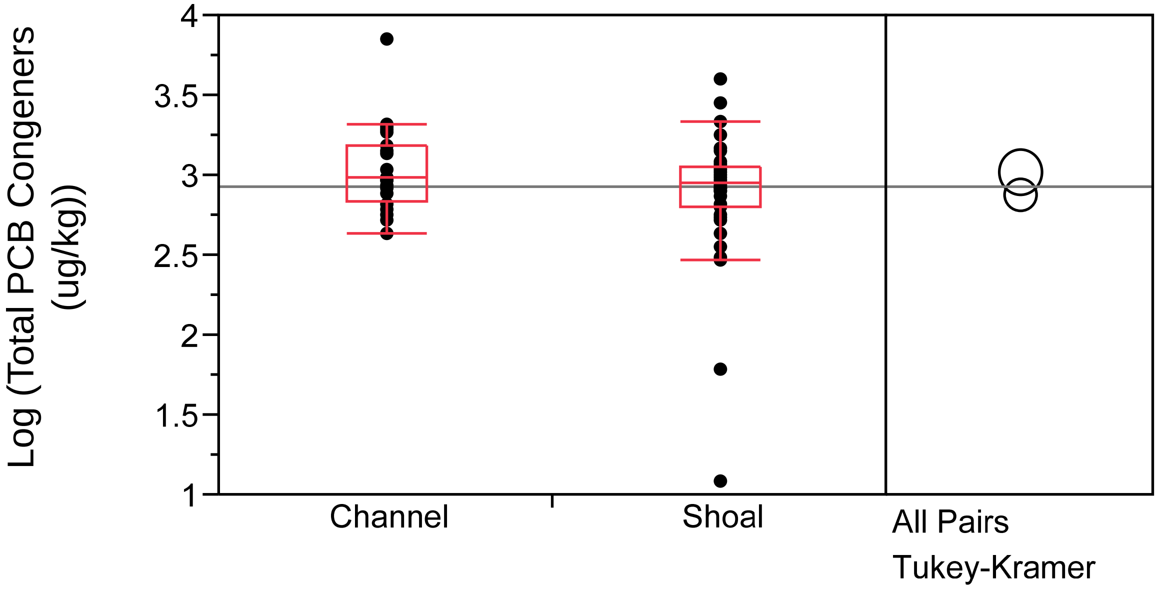
Comparison of Total PCB Aroclors Surface Concentration (0-6 inches)
RM1 to RM7 *vs.* RM8 to RM12

Lower Eight Miles of the Lower Passaic River

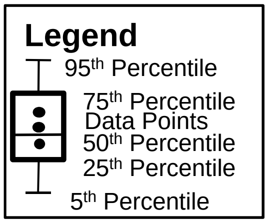
Figure 3.1-8

2014

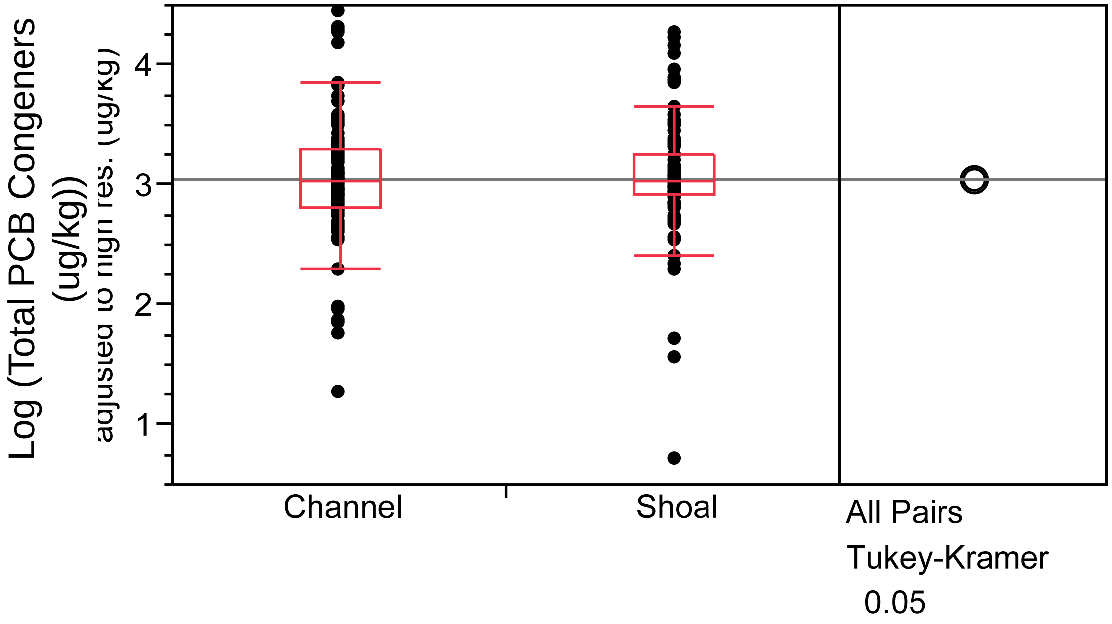
RM0 to RM2



Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.
3) A factor 1.25 was applied to the1995 TPCB concentrations based on matched pairs of congener and Aroclor analysis (see Data Evaluation No. 4 for further discussion).



RM2 to RM8

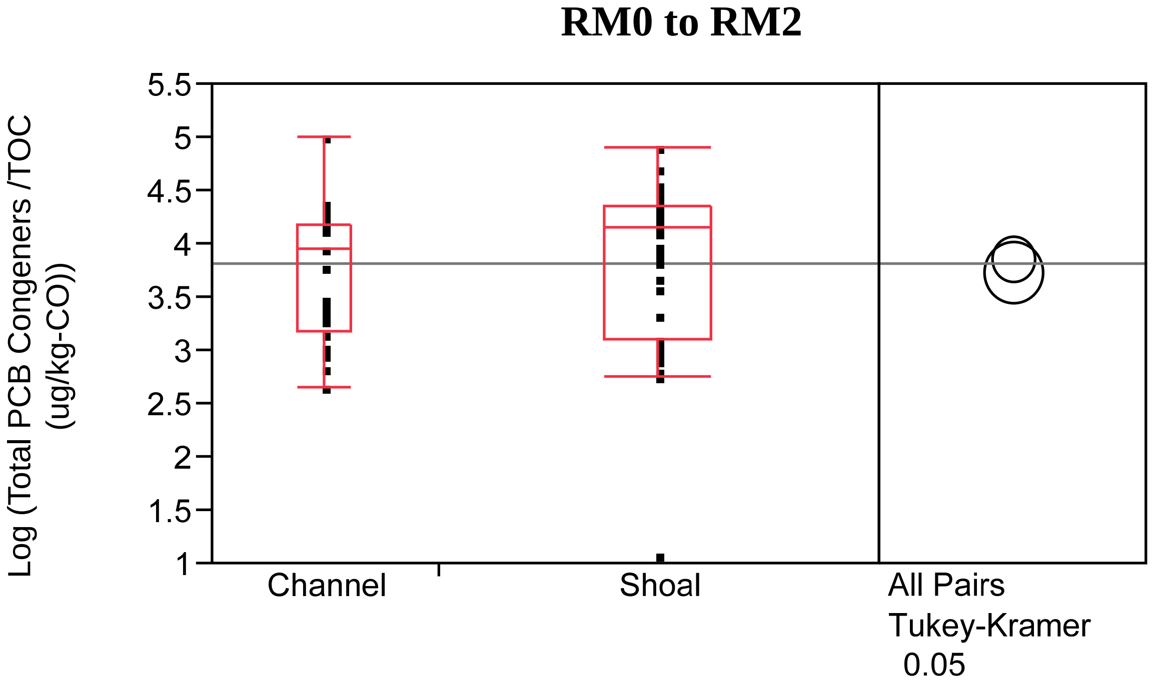


Total PCBs (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

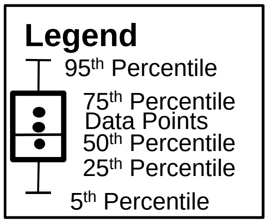
Lower Eight Miles of the Lower Passaic River

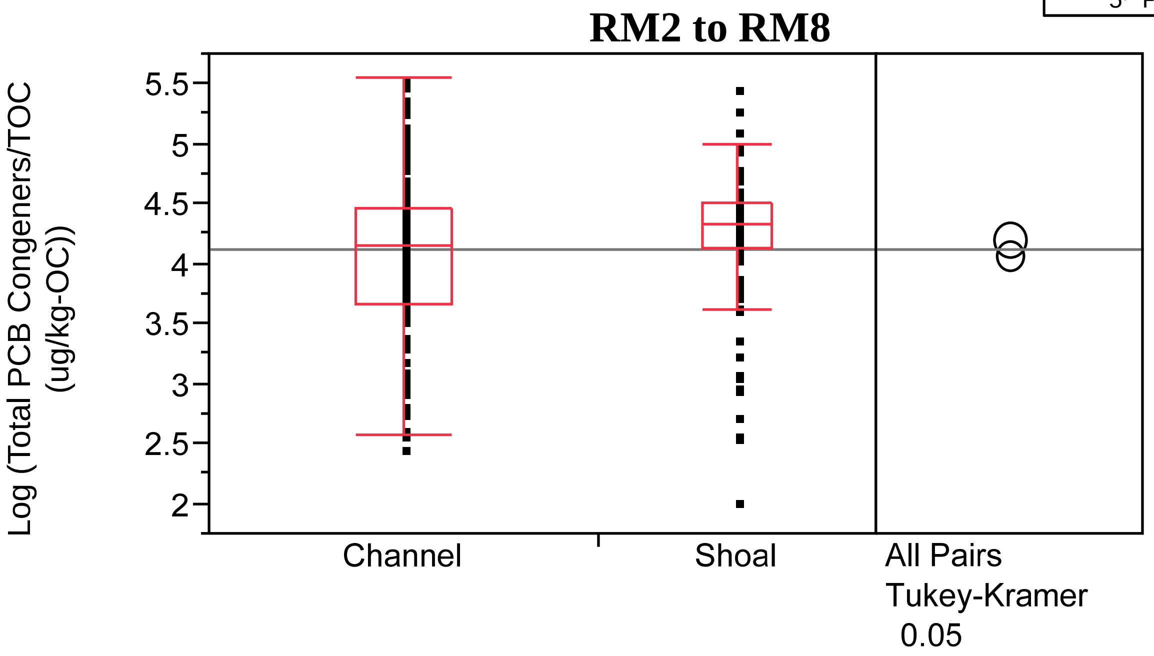
Figure 3.1-9a

2014


RM0 to RM2

Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.
3) A factor 1.25 was applied to the1995 TPCB concentrations based on matched pairs of congener and Aroclor analysis (see Data Evaluation No. 4 for further discussion).




RM2 to RM8

TOC Normalized Total PCBs (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 3.1-9b

2014

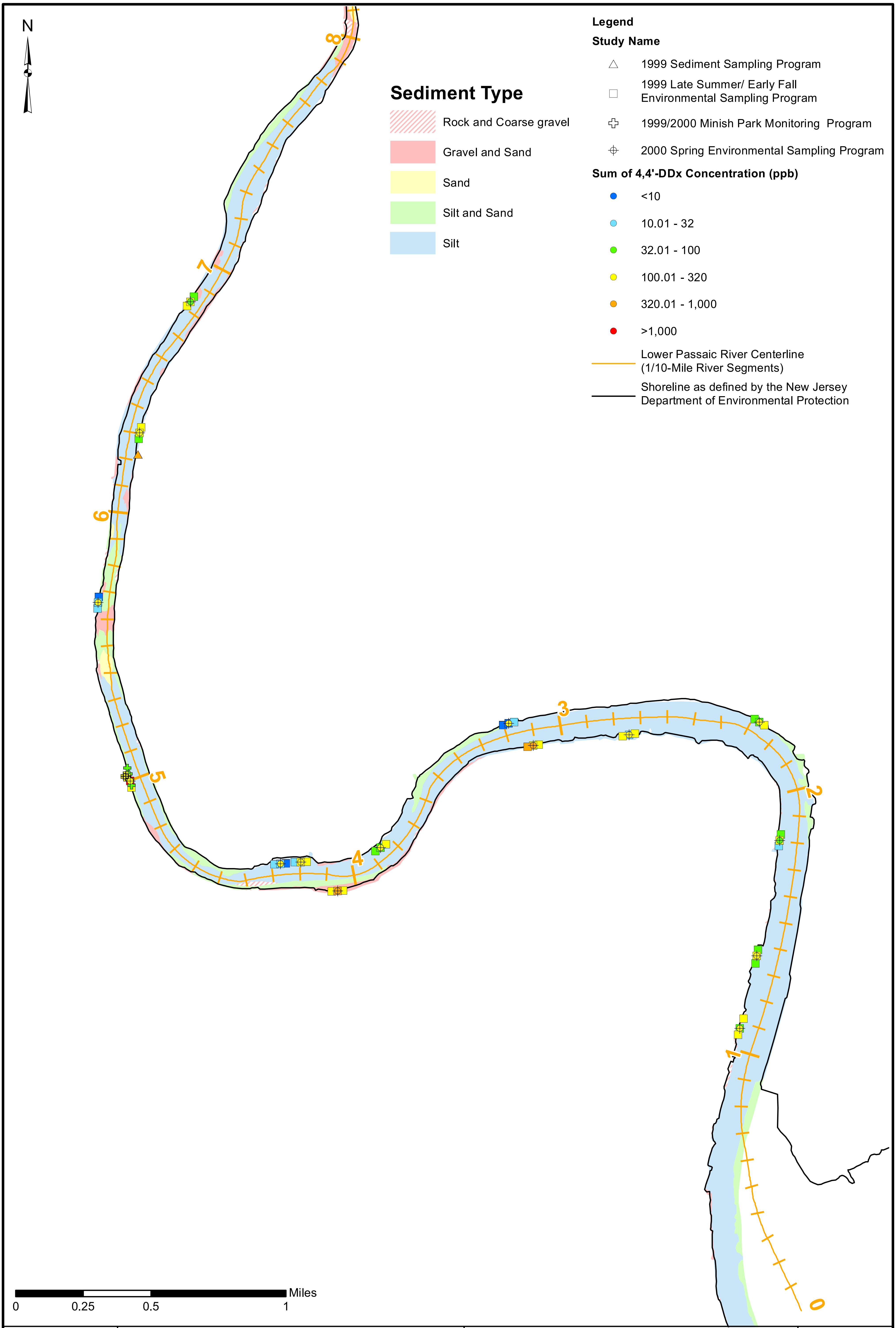
Figure 3.2-1

4,4'-DDE Surface Sediment Samples from 1991 to 1995

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

2014



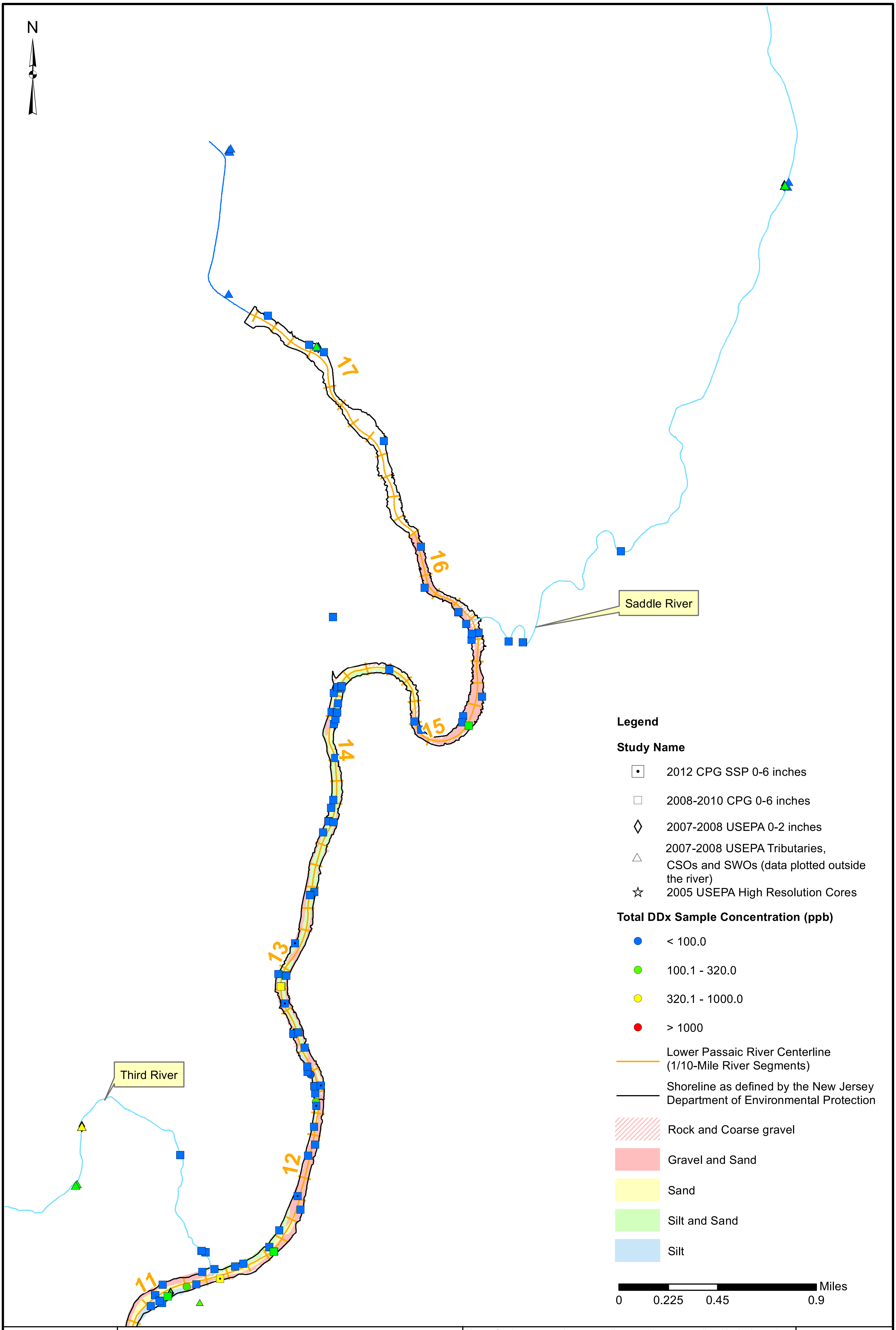
Total DDx Surface Sediment Samples from 1999 to 2000

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.2-2

2014



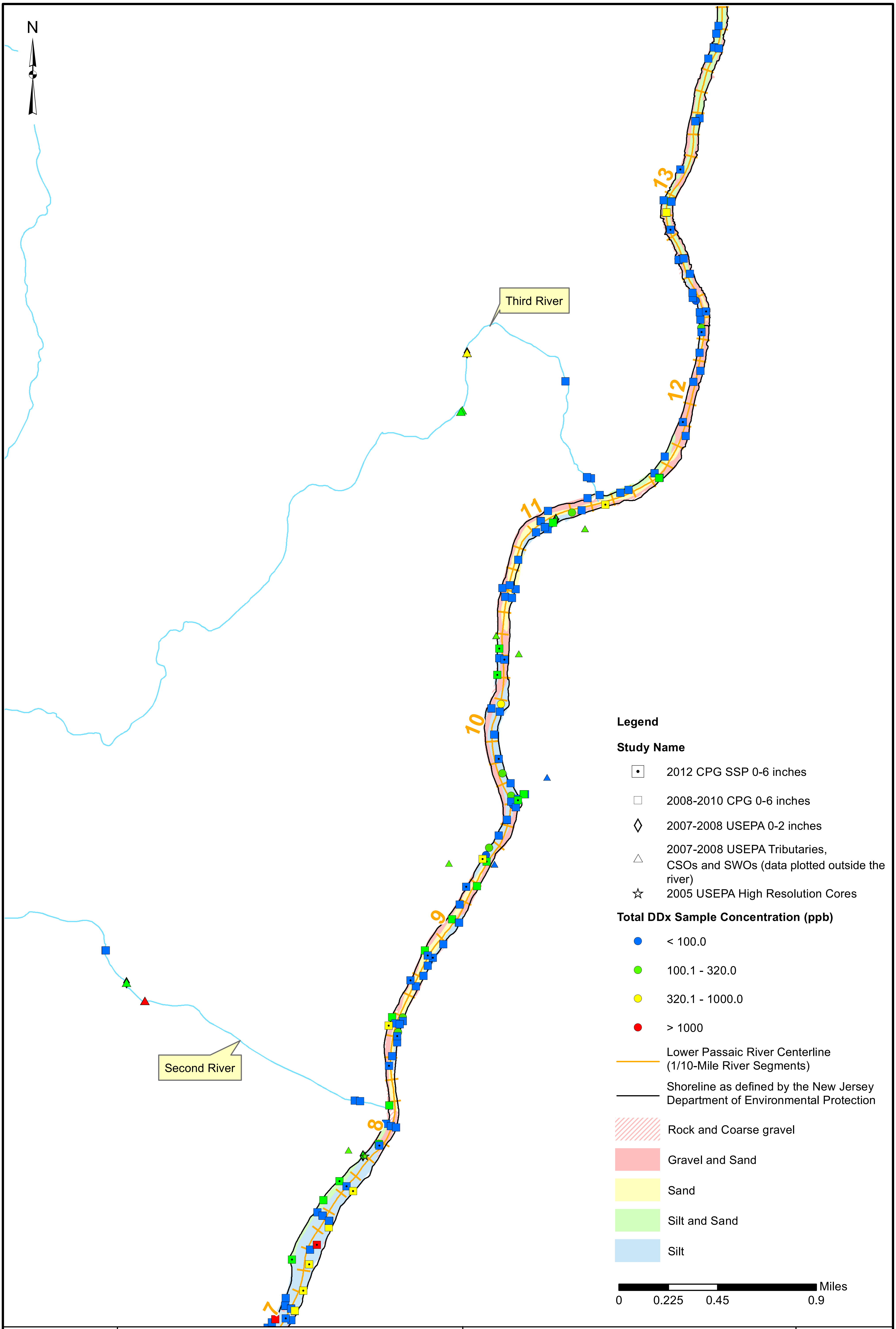
Total DDx Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.2-3a

2014



Total DDx Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.2-3b

2014

Path: P:\02859241\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\44DDX_Surficial_Sed_2005_2012.mxd

Total DDx Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.2-3c

2014

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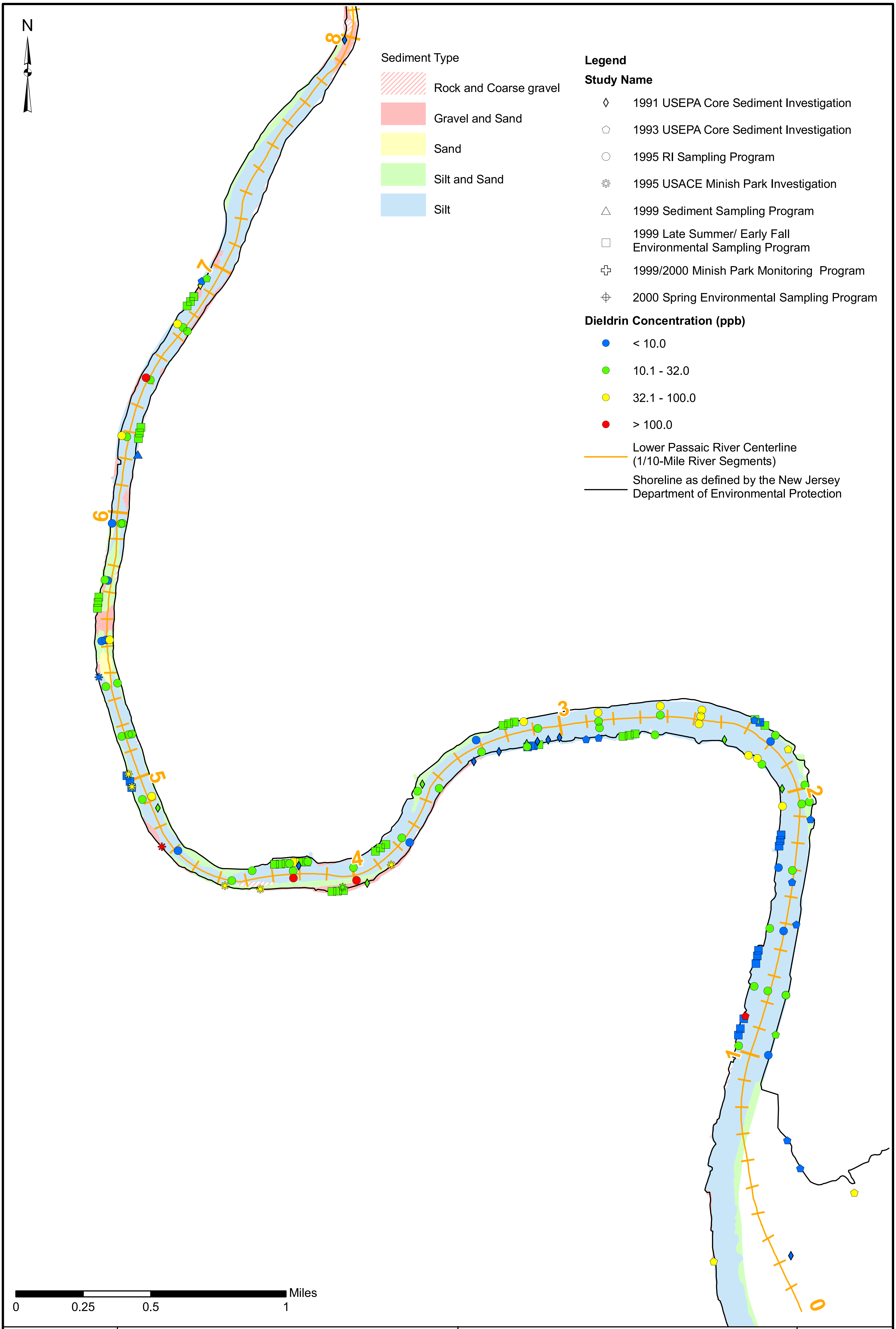


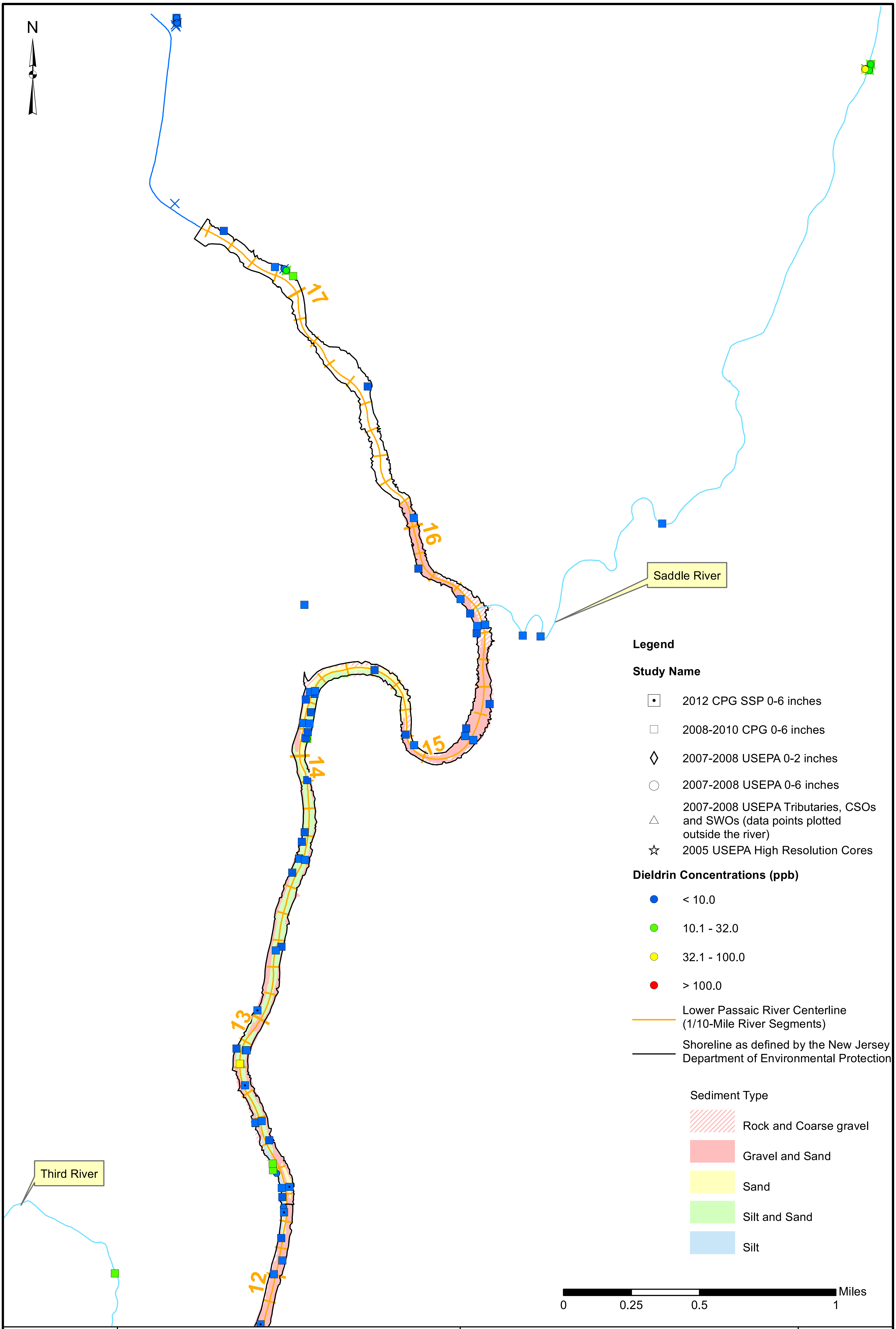
Dieldrin in Surface Sediment Samples from 1991 to 2000

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.2-4

2014



Path: P:\02855924\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\Dieldrin_Surficial_Sed_2007_2010RM12-DD_Fig14-3g1.mxd

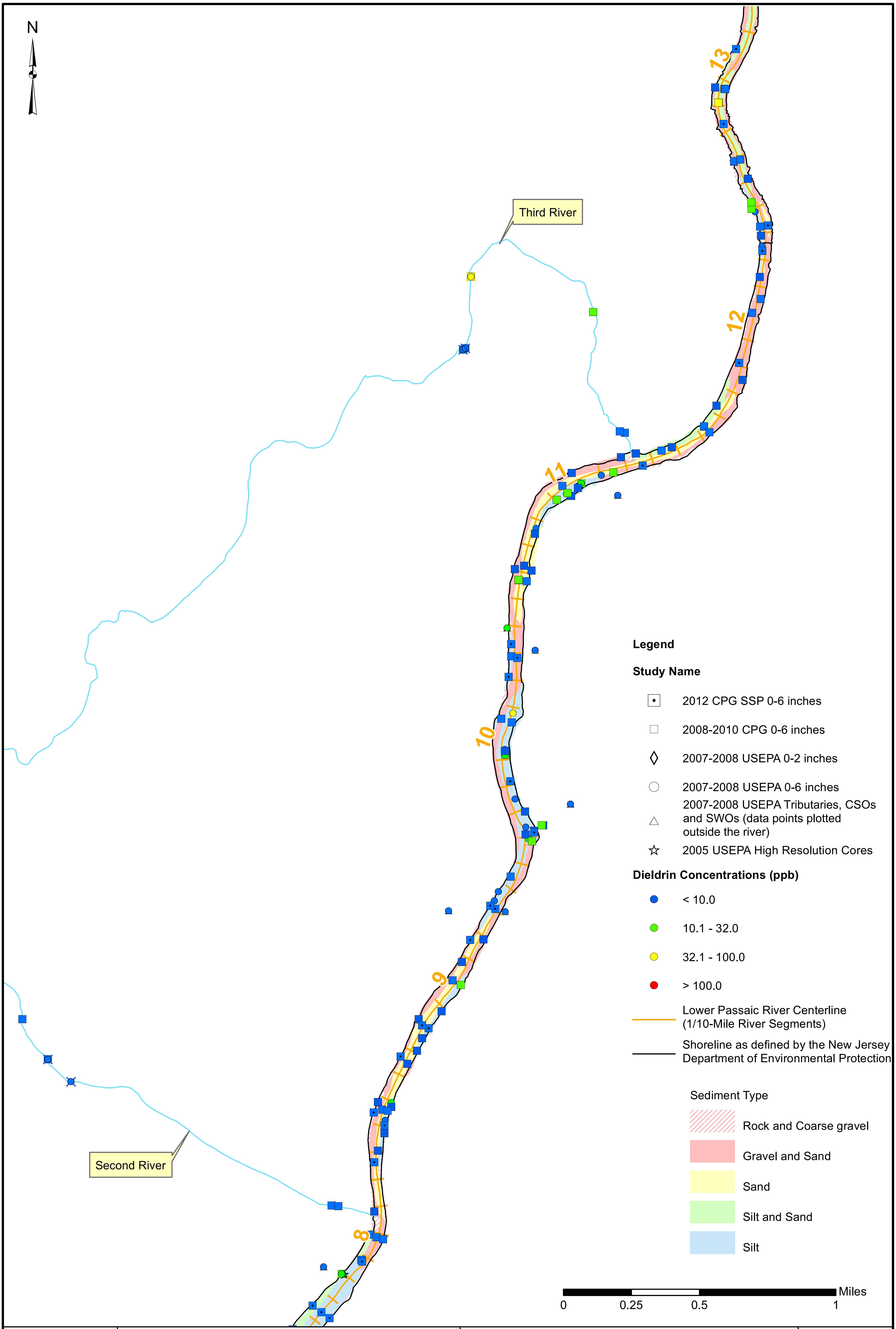
Dieldrin Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.2-5a

2014



Dieldrin Surface Sediment Samples from 2005 to 2012

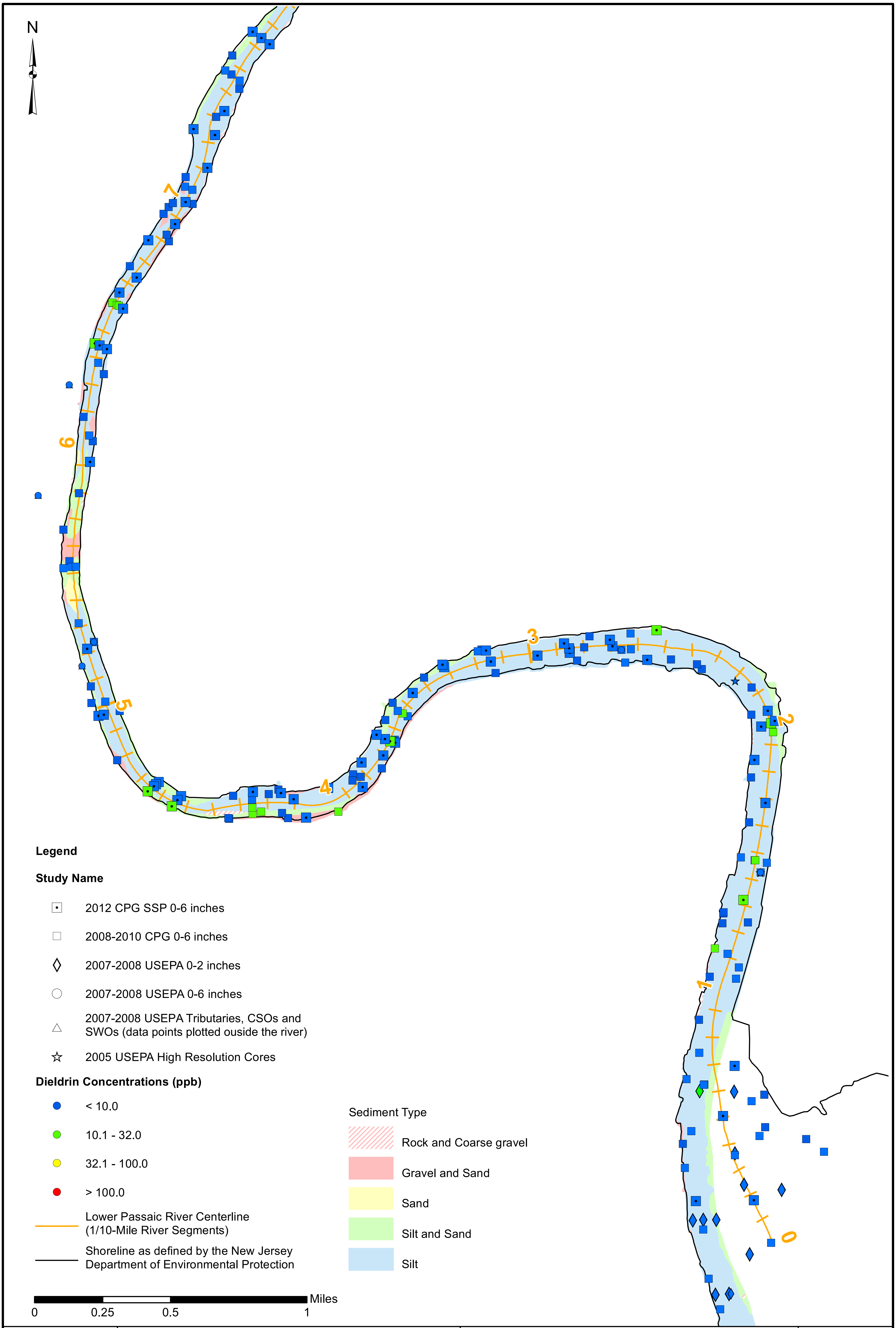
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.2-5b

2014

Path: P:\02859241\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\Dieldrin_Surficial_Sed_2007_2010RM12-DD_Fig14-3g1.mxd



Dieldrin Surface Sediment Samples from 2005 to 2012

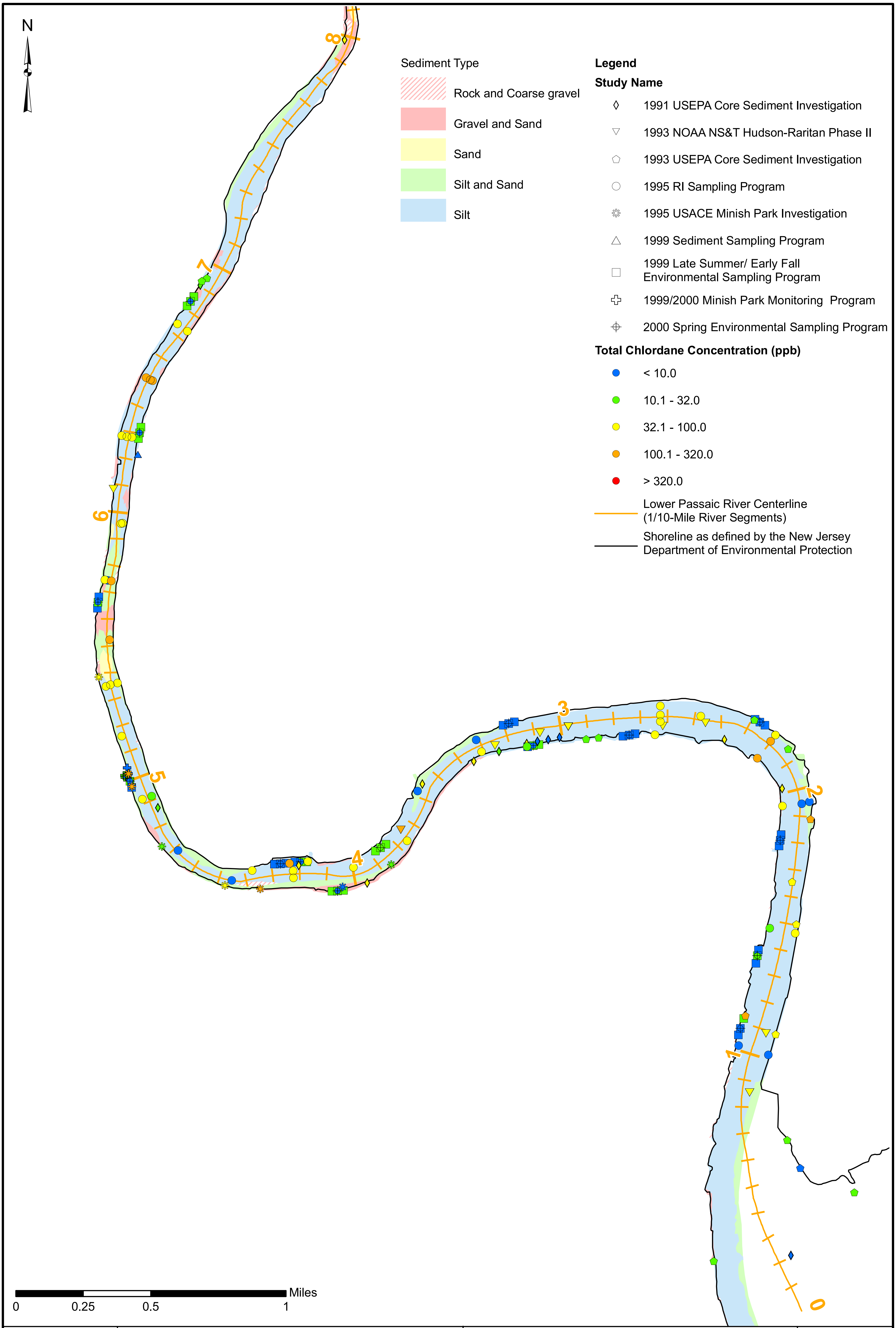
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.2-5c

2014

Path: P:\02859241\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\Dieldrin_Surficial_Sed_2007_2010RM12-DD_Fig14-3g1.mxd



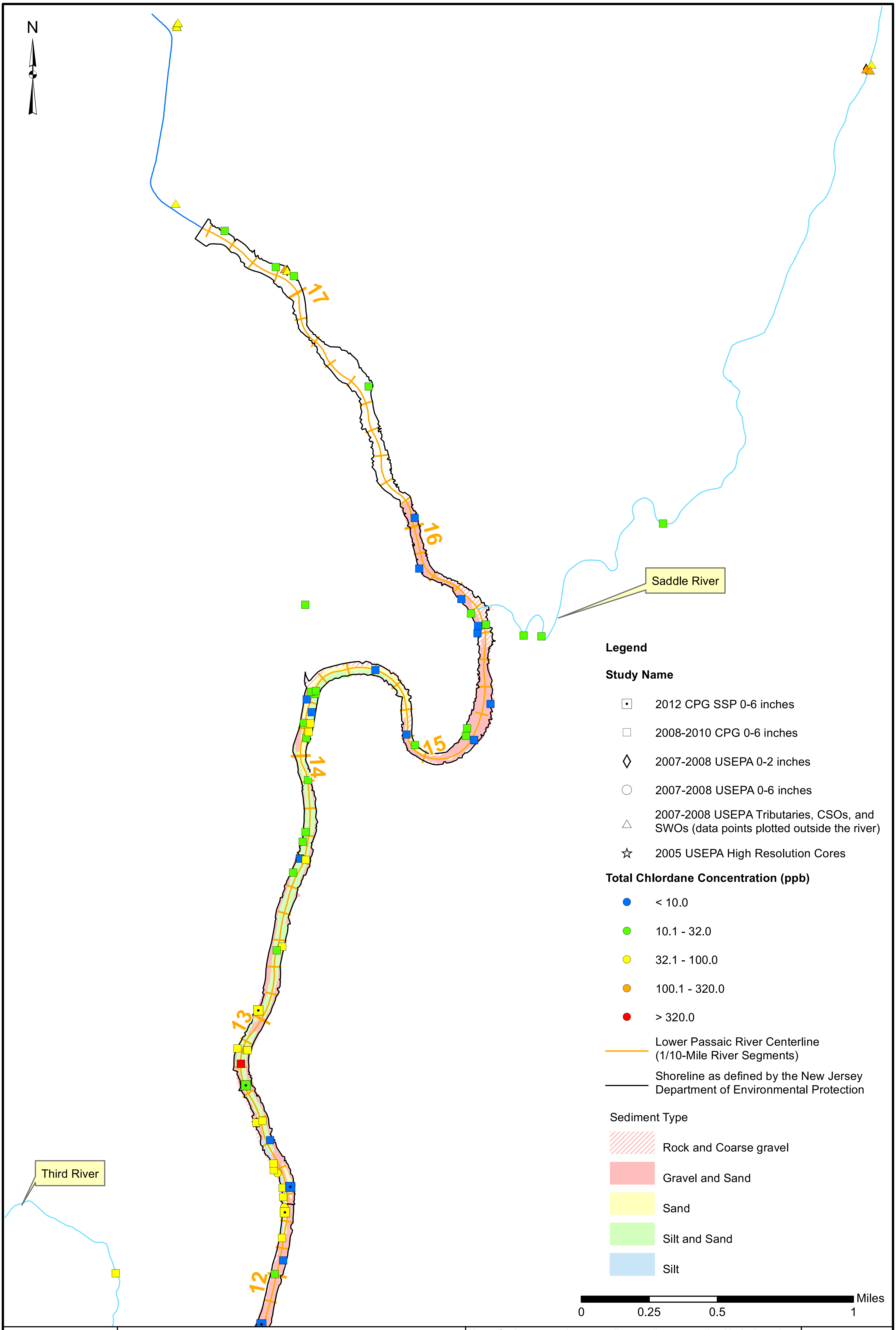
Total Chlordane Surface Sediment Samples from 1991 to 2000

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.2-6

2014



Total Chlordane Surface Sediment Samples from 2005 to 2012

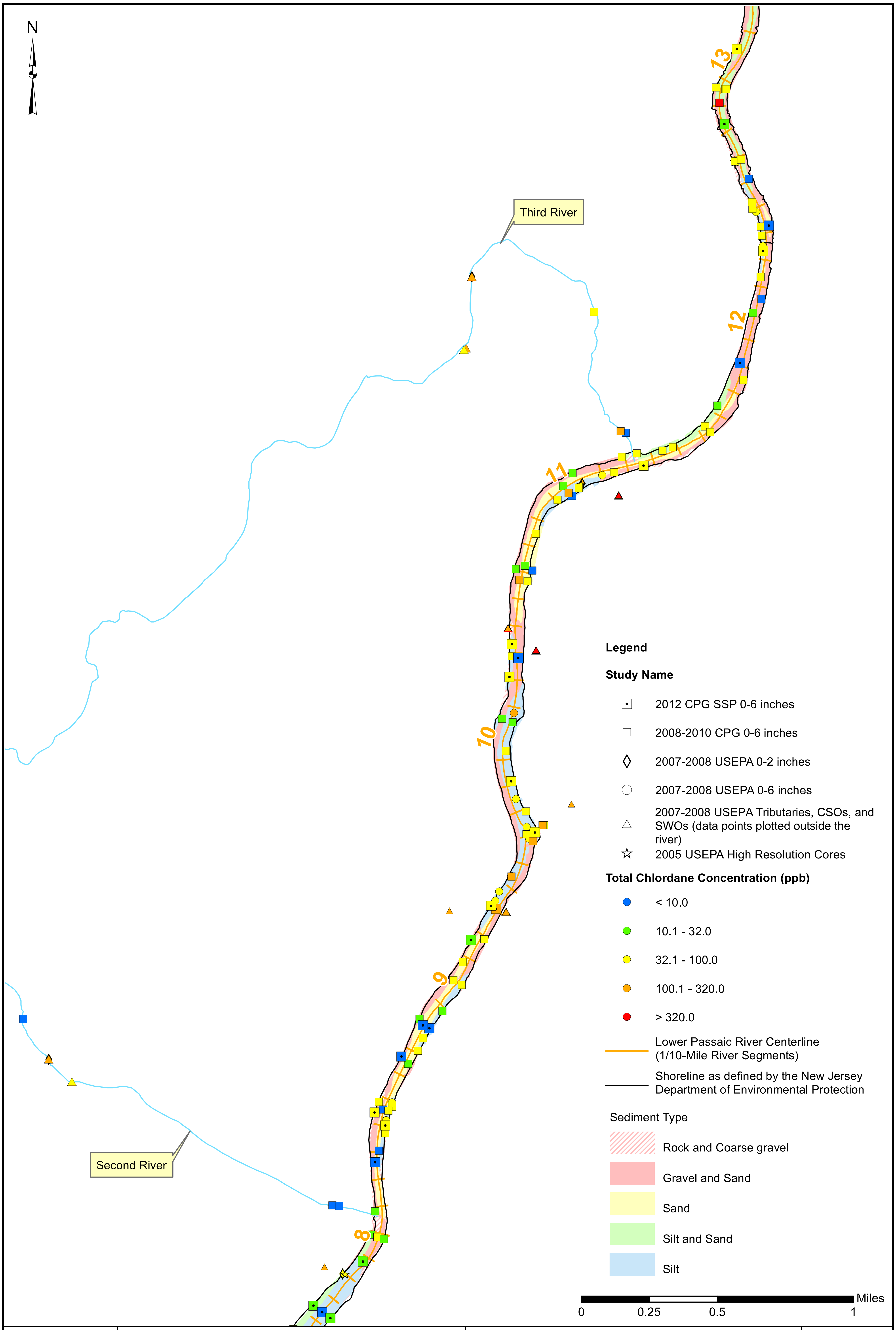
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.2-7a

2014

Path: P:\02859241\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\Chlordane_Surficial_Sed_07_10_Samples_RM12-DD_Fig14-3f1.mxd



Total Chlordane Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.2-7b

2014

Path: P:\02859241\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\Chlordane_Surficial_Sed_07_10_Samples_RM12-DD_Fig14-3f1.mxd

Path: P:\02859241\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\Chlordane_Surficial_Sed_07_10_Samples_RM12-DD_Fig14-3f1.mxd

Total Chlordane Surface Sediment Samples from 2005 to 2012

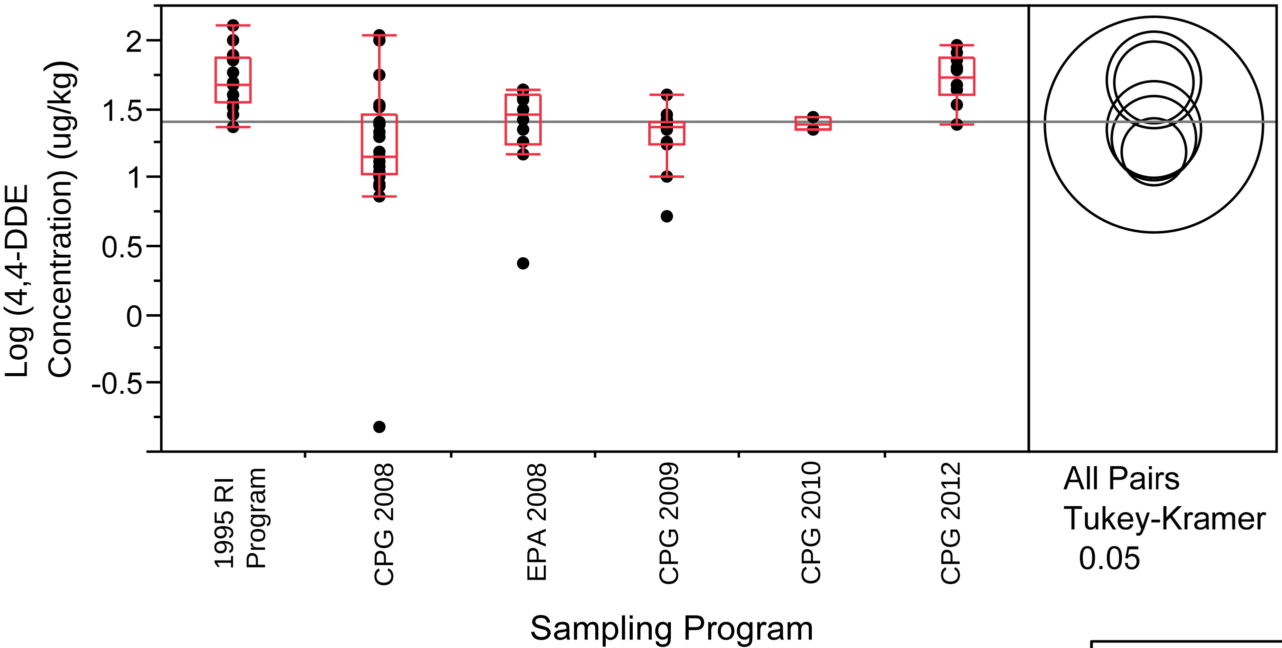
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

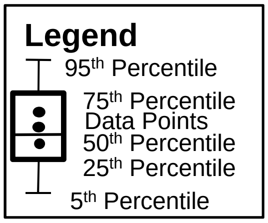
Figure 3.2-7c

2014

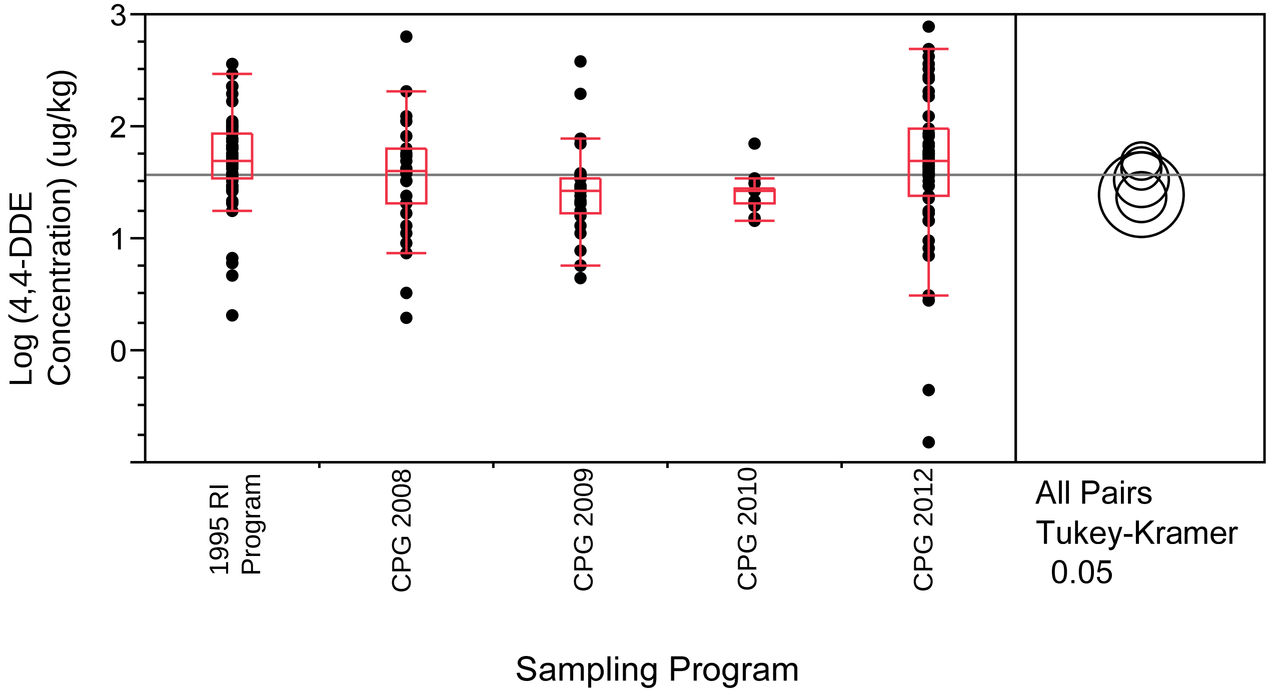
RM0 to RM2



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.



RM2 to RM8



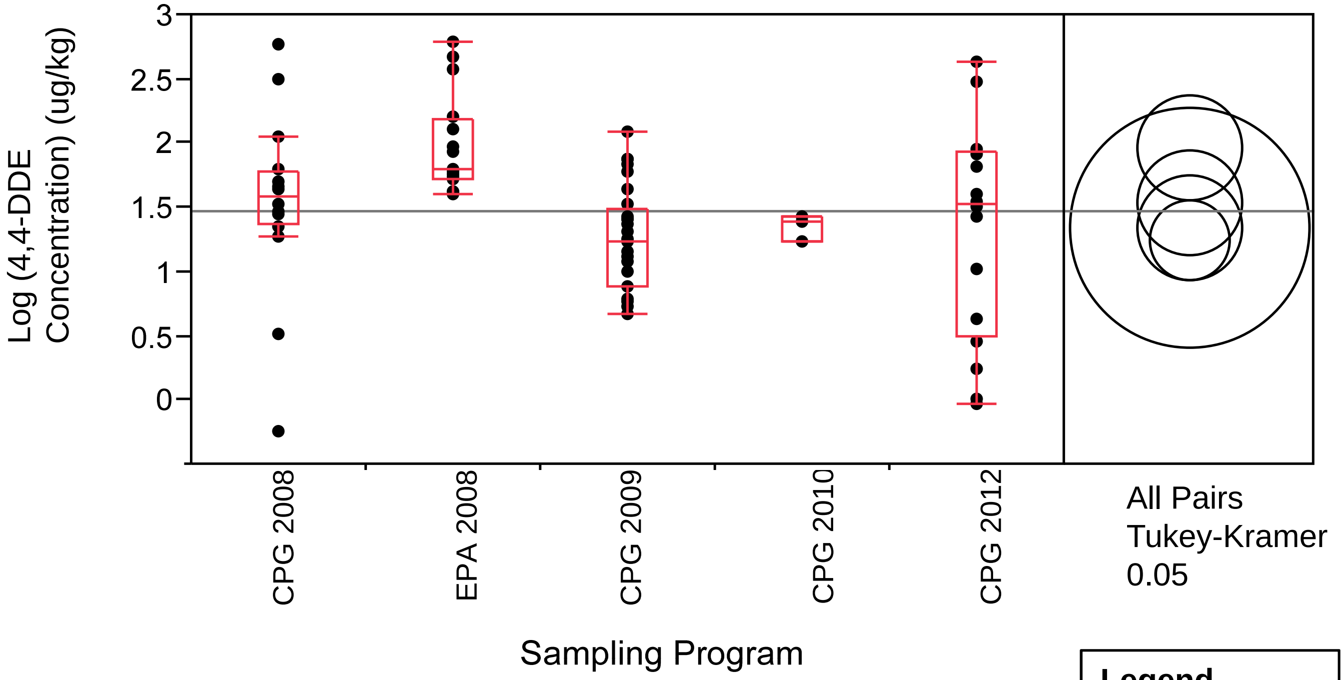
4,4’-DDE (0-6 inch) by Sampling Program at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

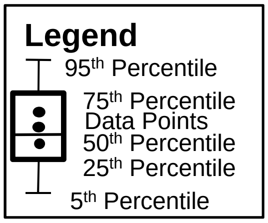
Figure 3.2-8a

2014

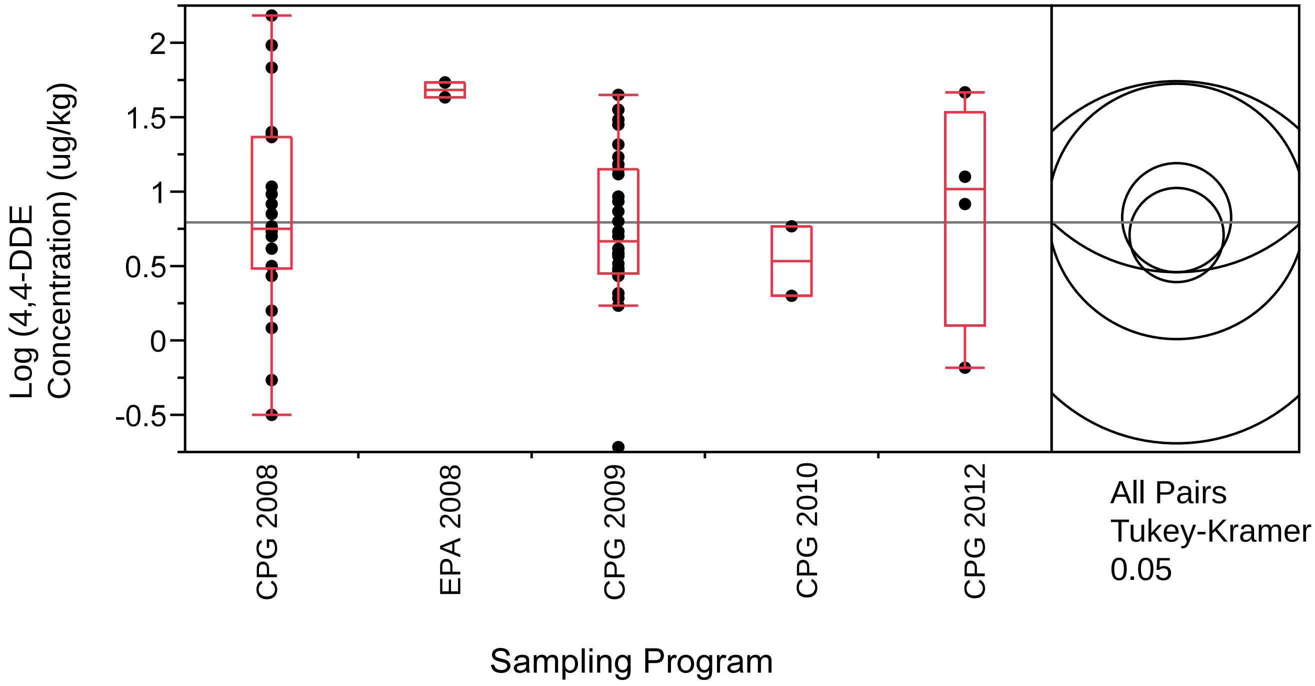
RM8 to RM12



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.



RM12 to RM17.4



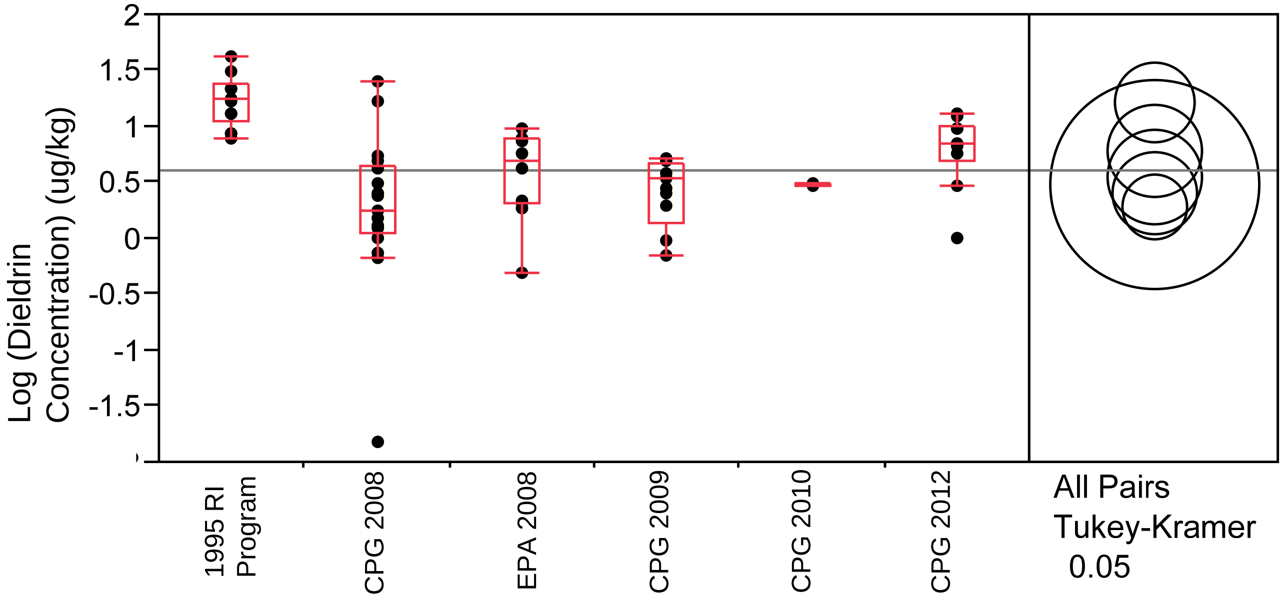
4,4'-DDE (0-6 inch) by Sampling Program at RM8 to RM12 and RM12 to RM17.4

Lower Eight Miles of the Lower Passaic River

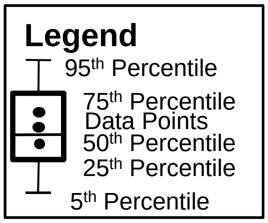
Figure 3.2-8b

2014

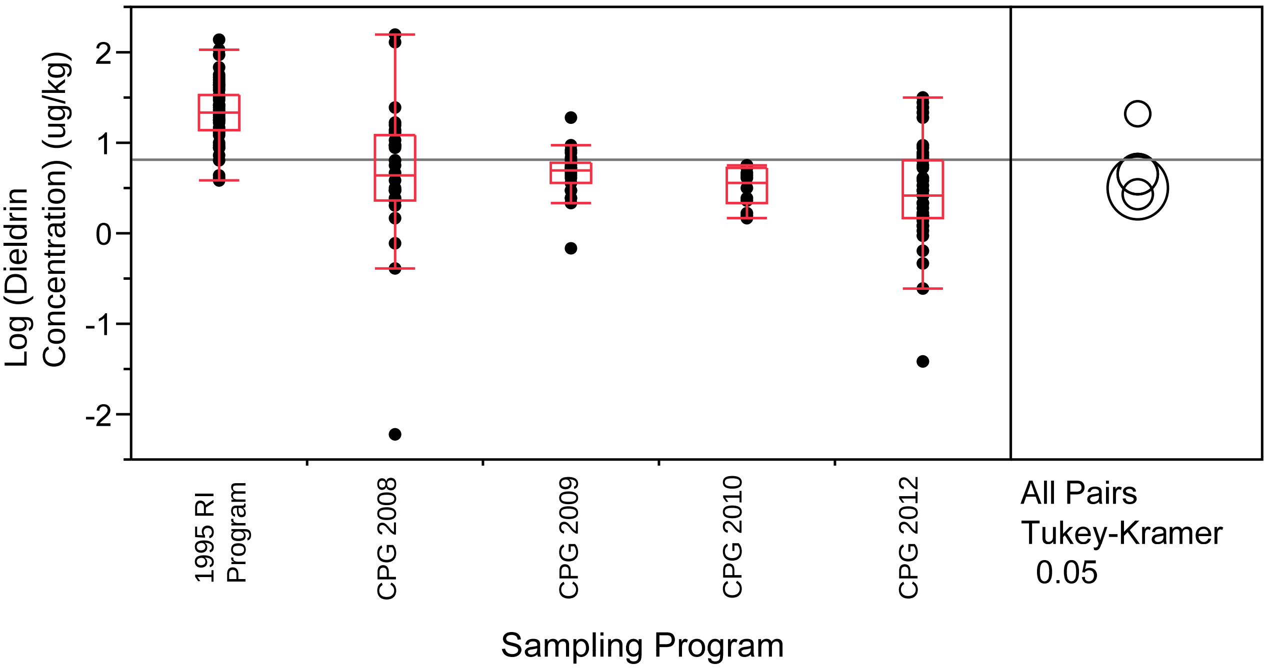
RM0 to RM2



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.



RM2 to RM8



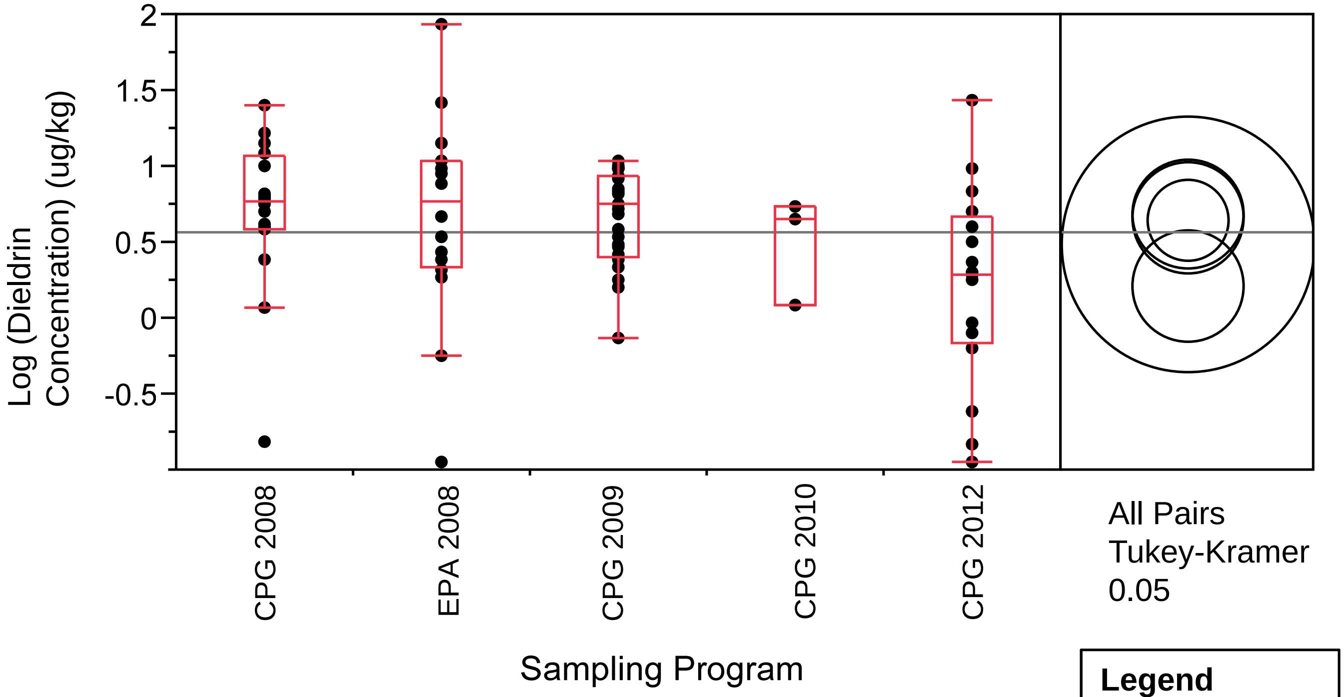
Dieldrin (0-6 inch) by Sampling Program at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

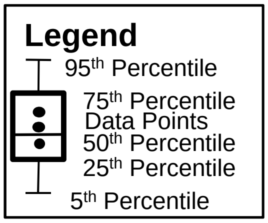
Figure 3.2-9a

2014

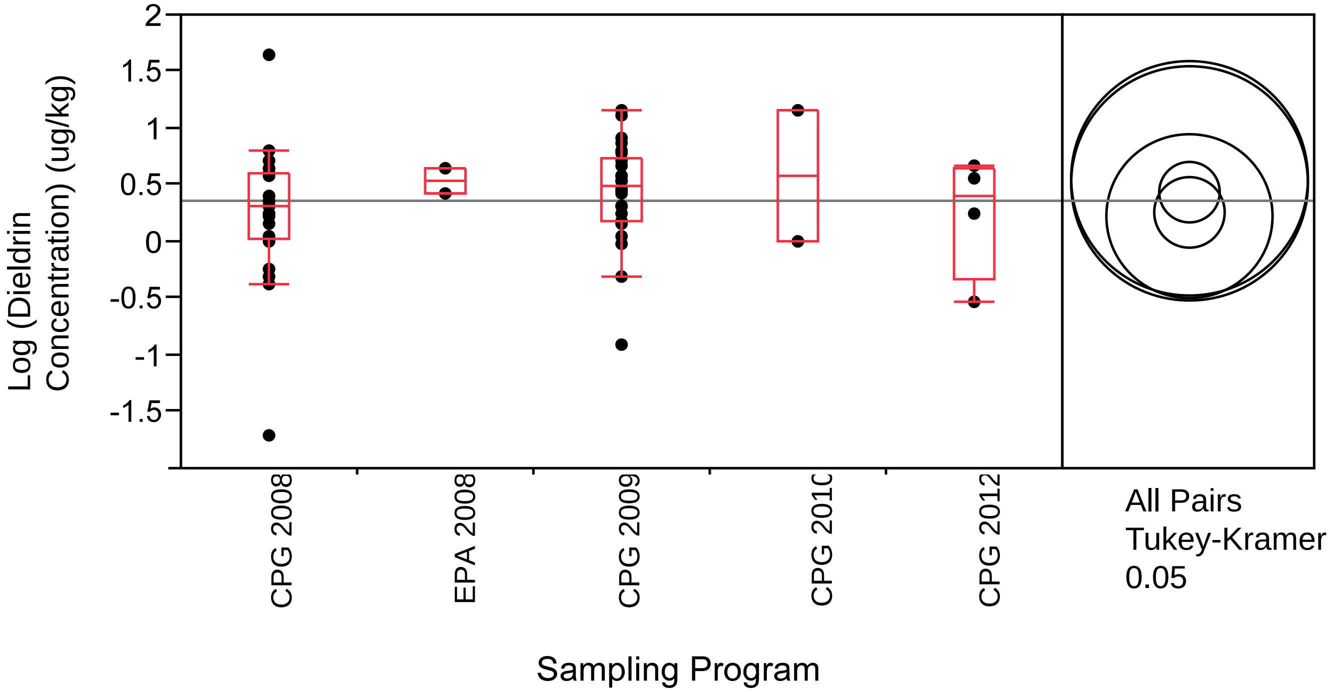
RM8 to RM12



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.



RM12 to RM17.4



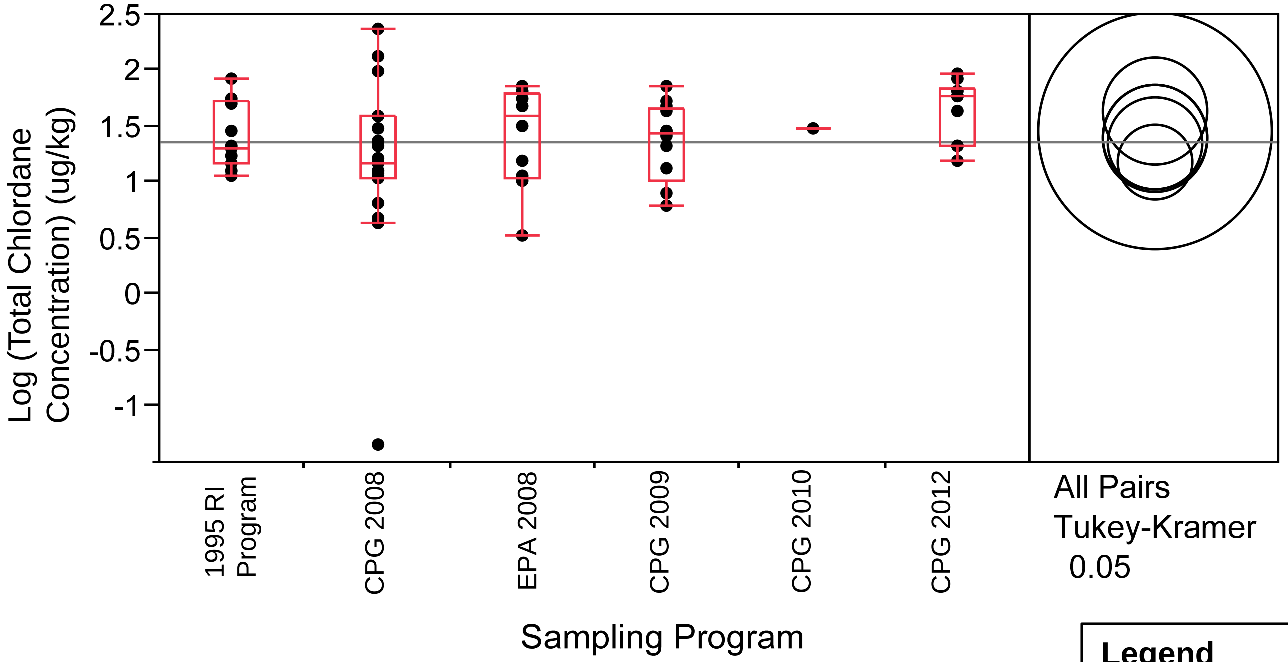
Dieldrin (0-6 inch) by Sampling Program at RM8 to RM12 and RM12 to RM17.4

Lower Eight Miles of the Lower Passaic River

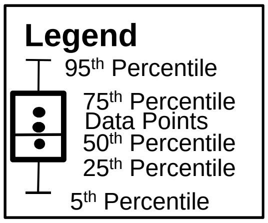
Figure 3.2-9b

2014

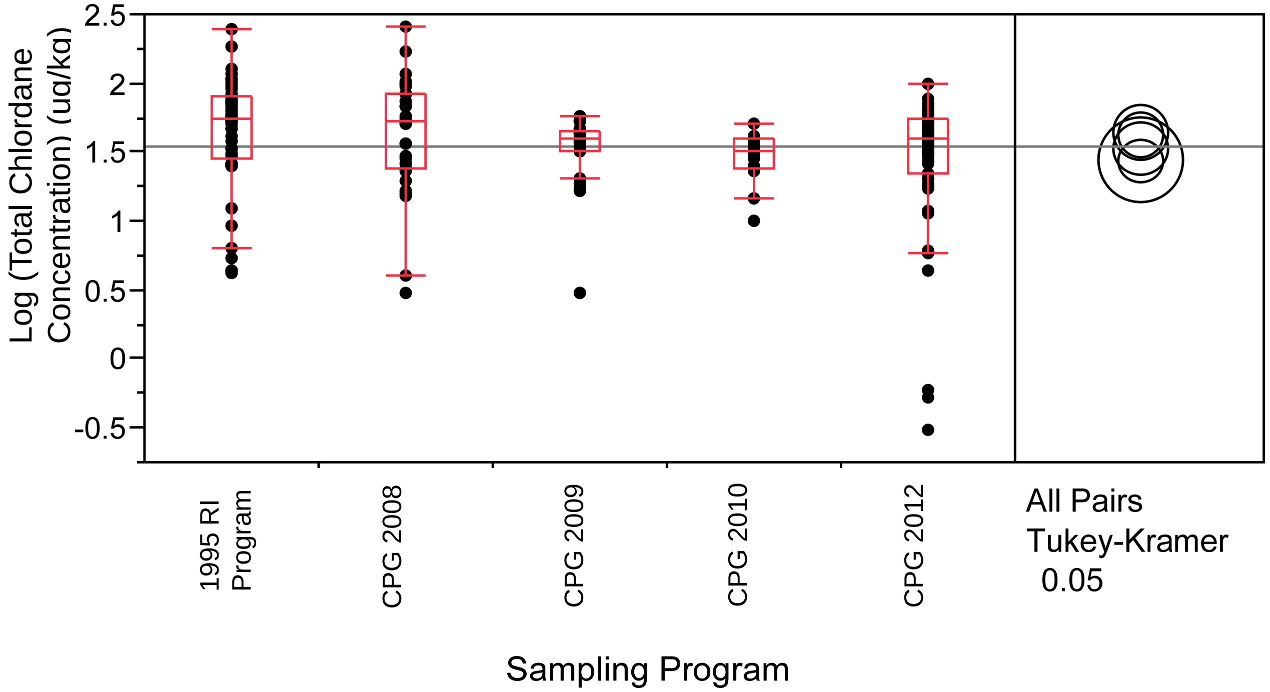
RM0 to RM2



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.



RM2 to RM8



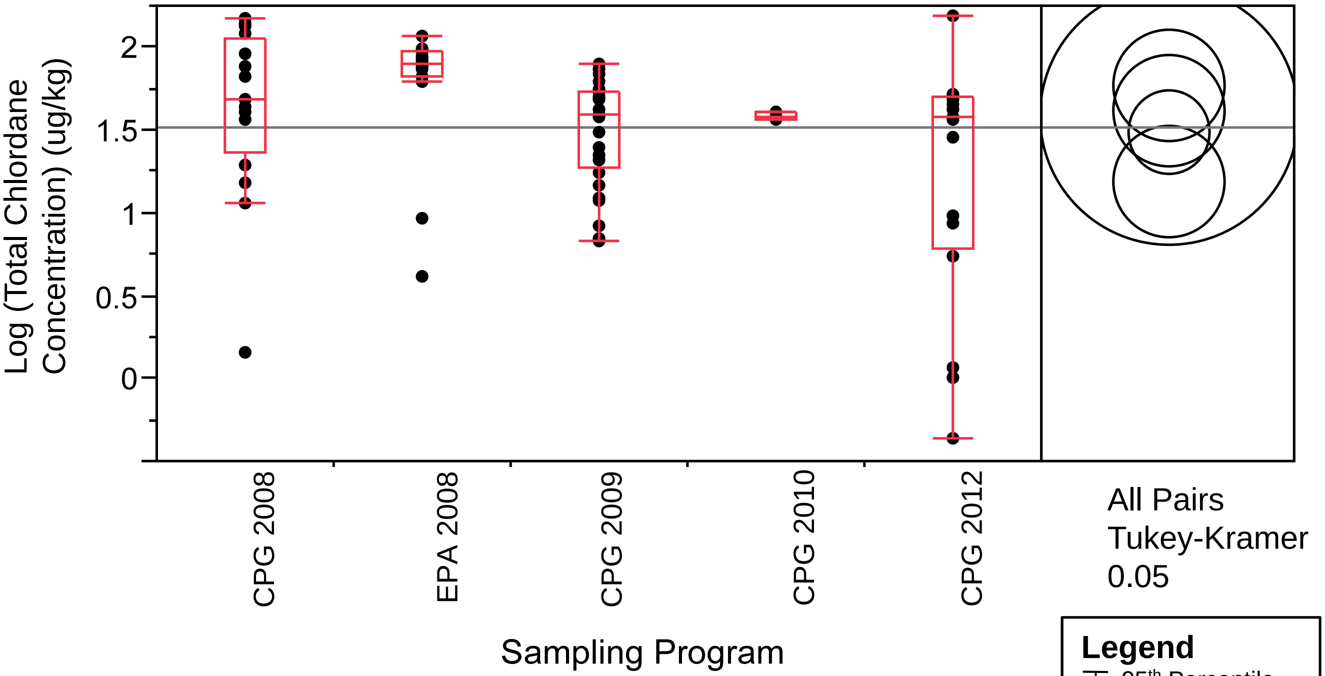
Total Chlordane (0-6 inch) by Sampling Program at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

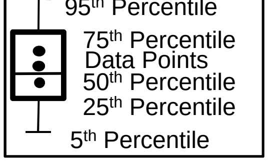
Figure 3.2-10a

2014

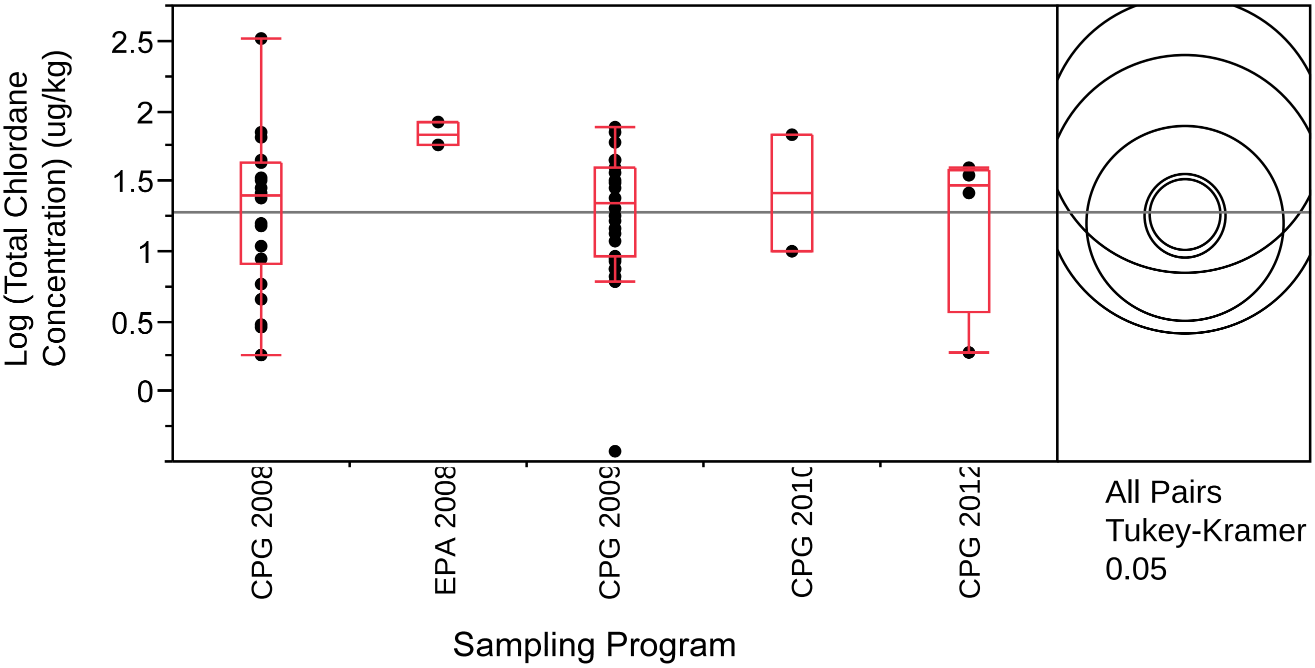
RM8 to RM12



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.



RM12 to RM17.4

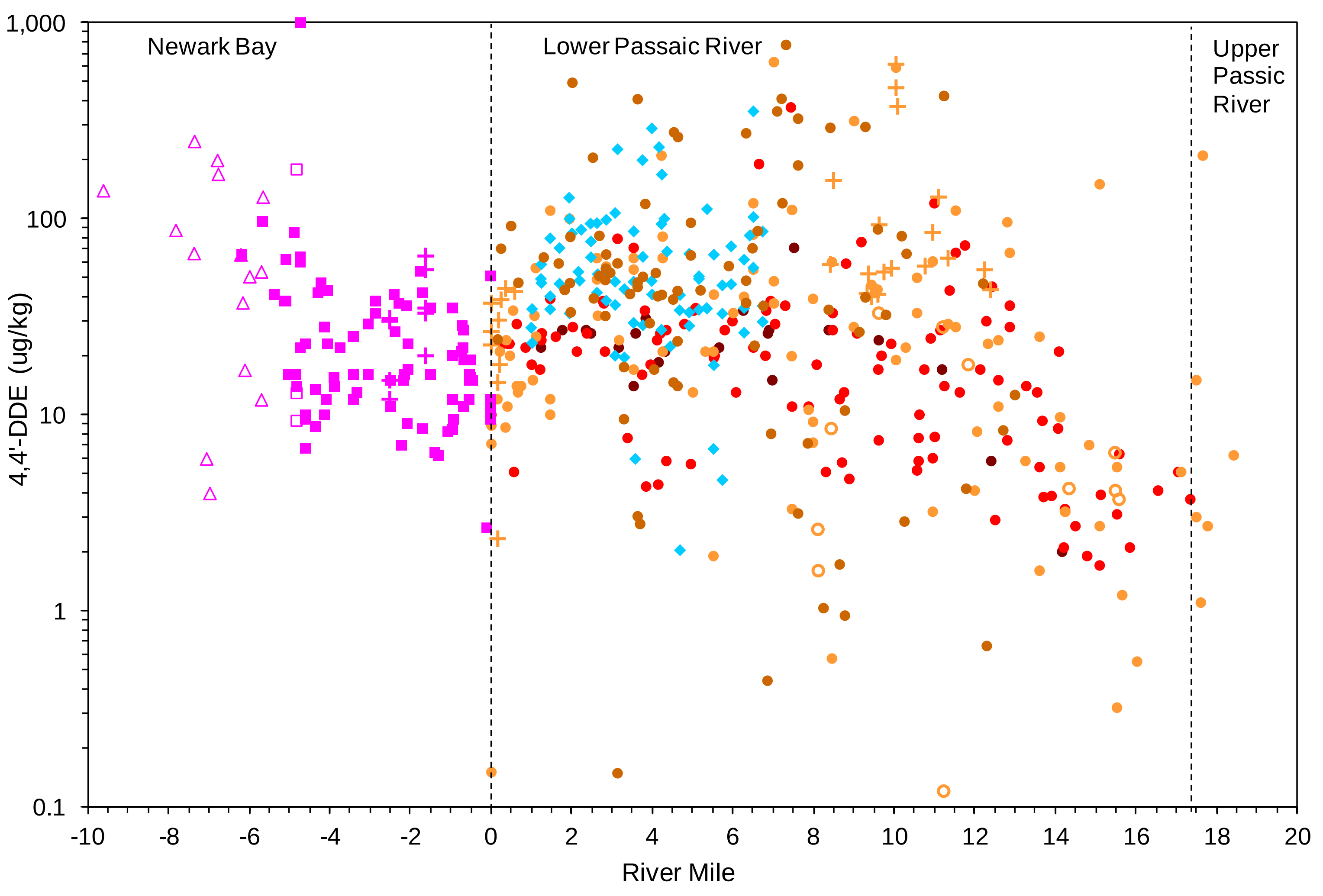


Total Chlordane (0-6 inch) by Sampling Program at RM8 to RM12 and RM12 to RM17.4

Lower Eight Miles of the Lower Passaic River

Figure 3.2-10b

2014



Legend

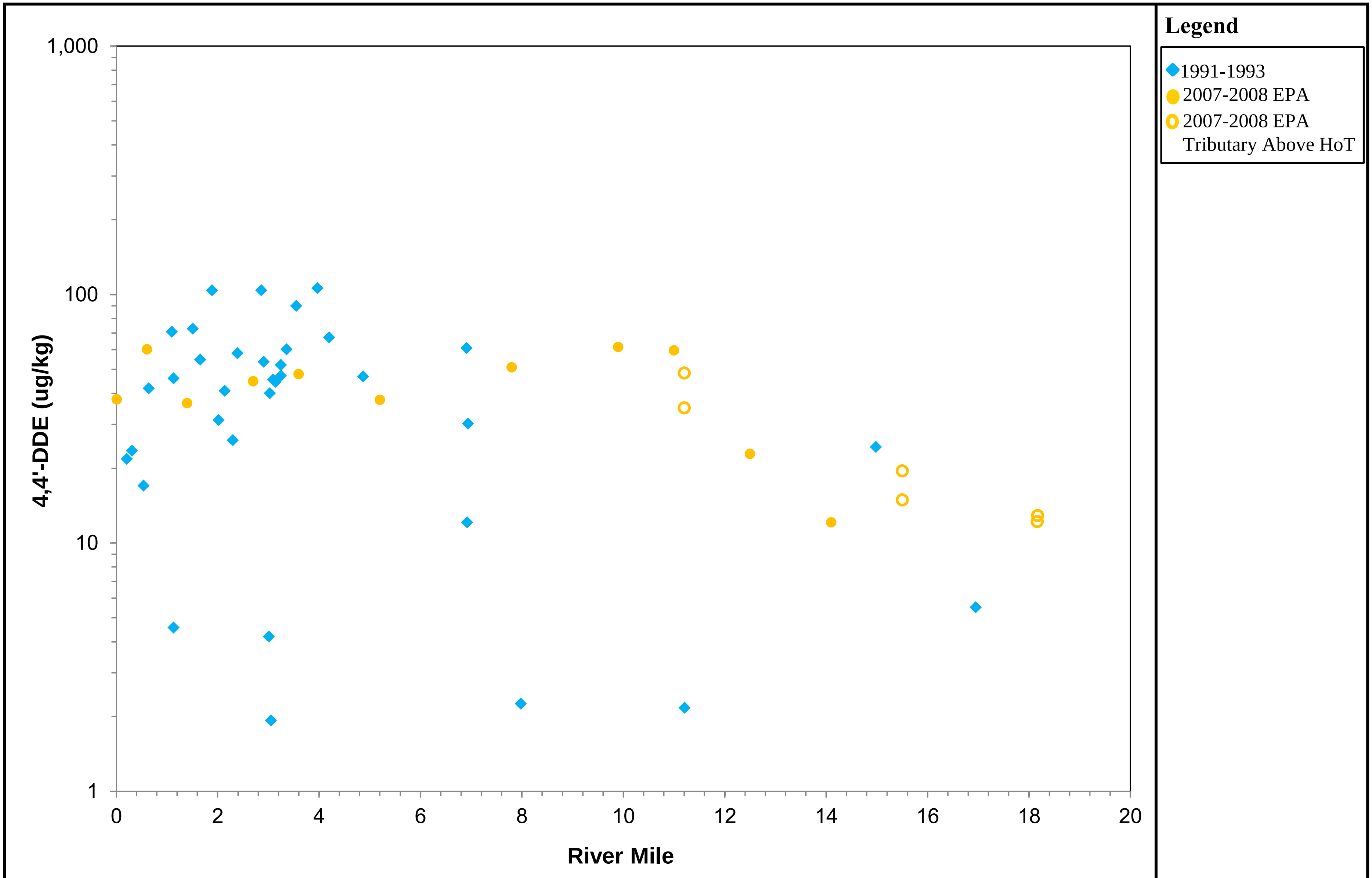
- ● 2012 CPG
- ● 2010 CPG
- ● 2009 CPG
- ● 2008 CPG
- ○ 2008 CPG Tributary Below HoT
- ✚ 2008 EPA
- ■ 2005&2007 Newark Bay
- △ 2005&2007 Shooters Island & Arthur Kill
- □ 2005&2007 Kill Van Kull
- ✚ 2005&2007 Port Elizabeth & Newark
- ◆ 1995 TSI

4,4'-DDE Concentration (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.2-11

2014

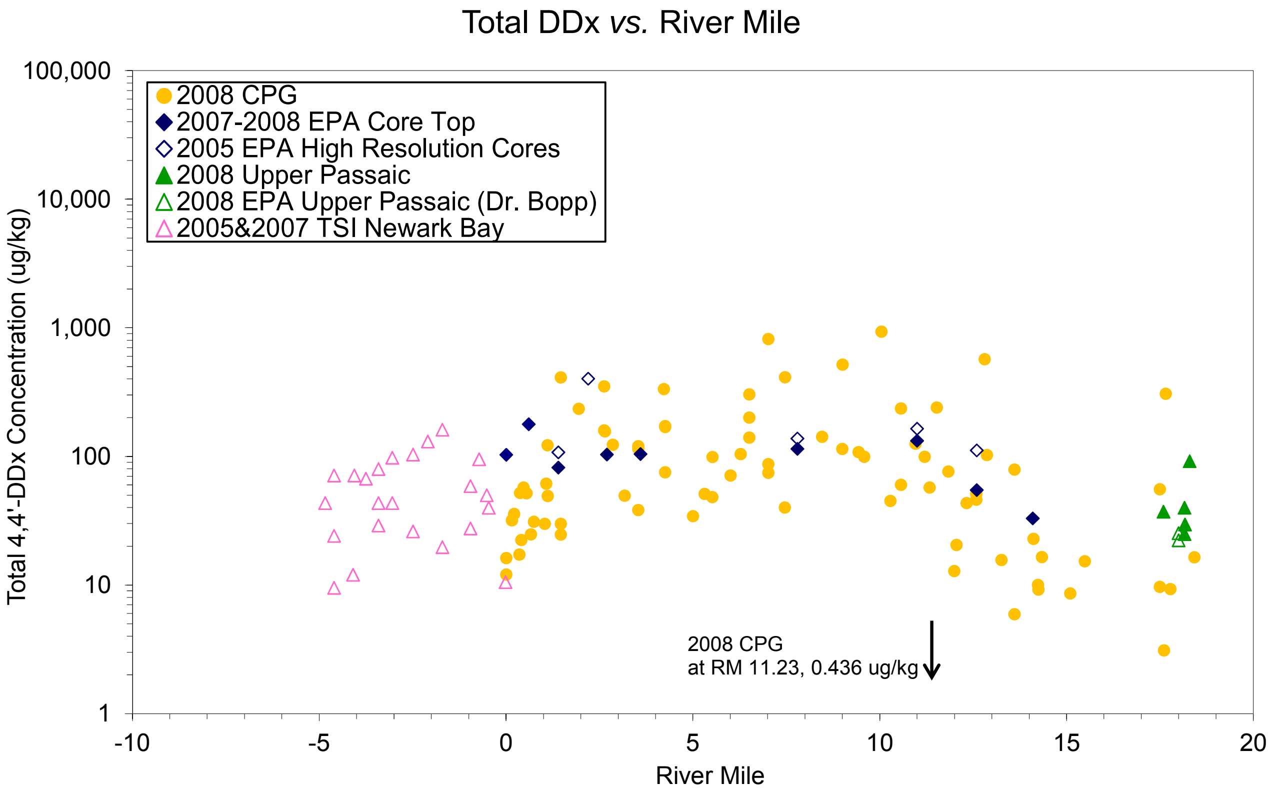


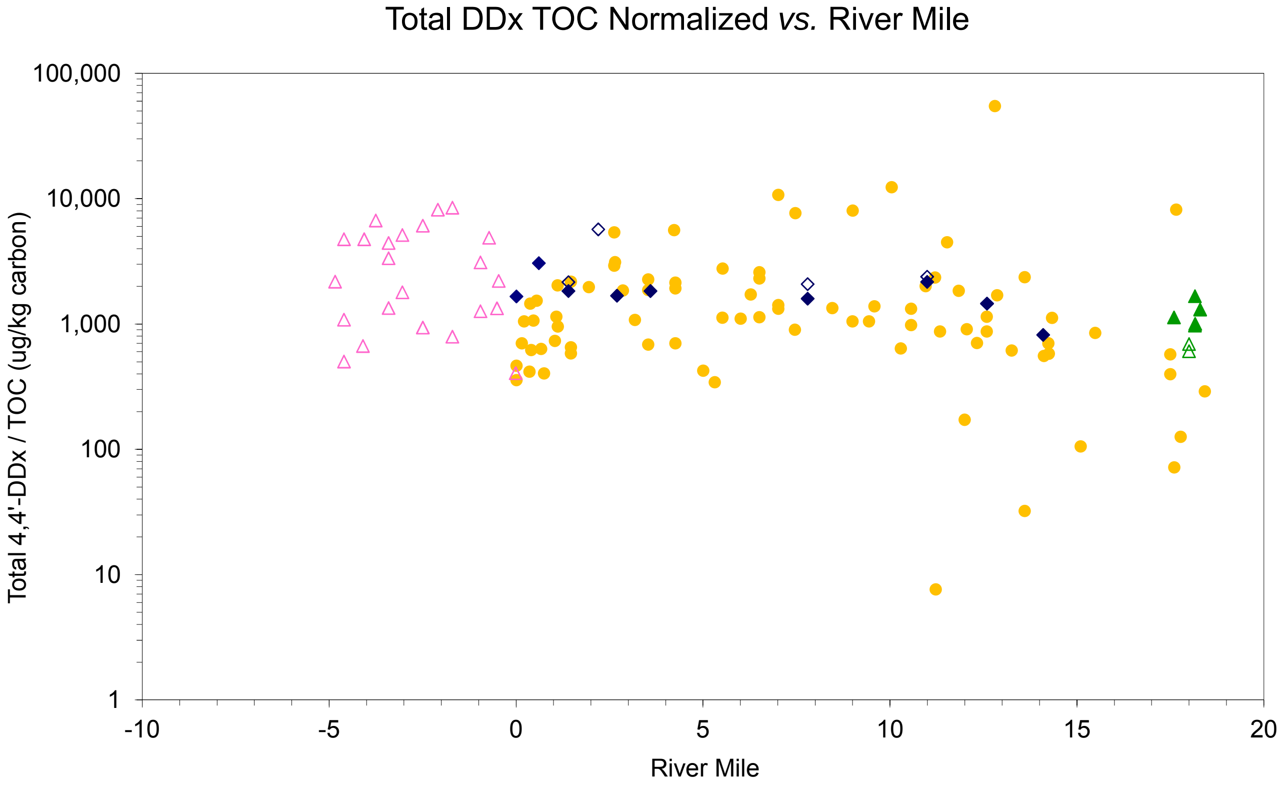
4,4’-DDE Concentration (0 - ≤2 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.2-12

2014


Total DDx *vs.* River Mile

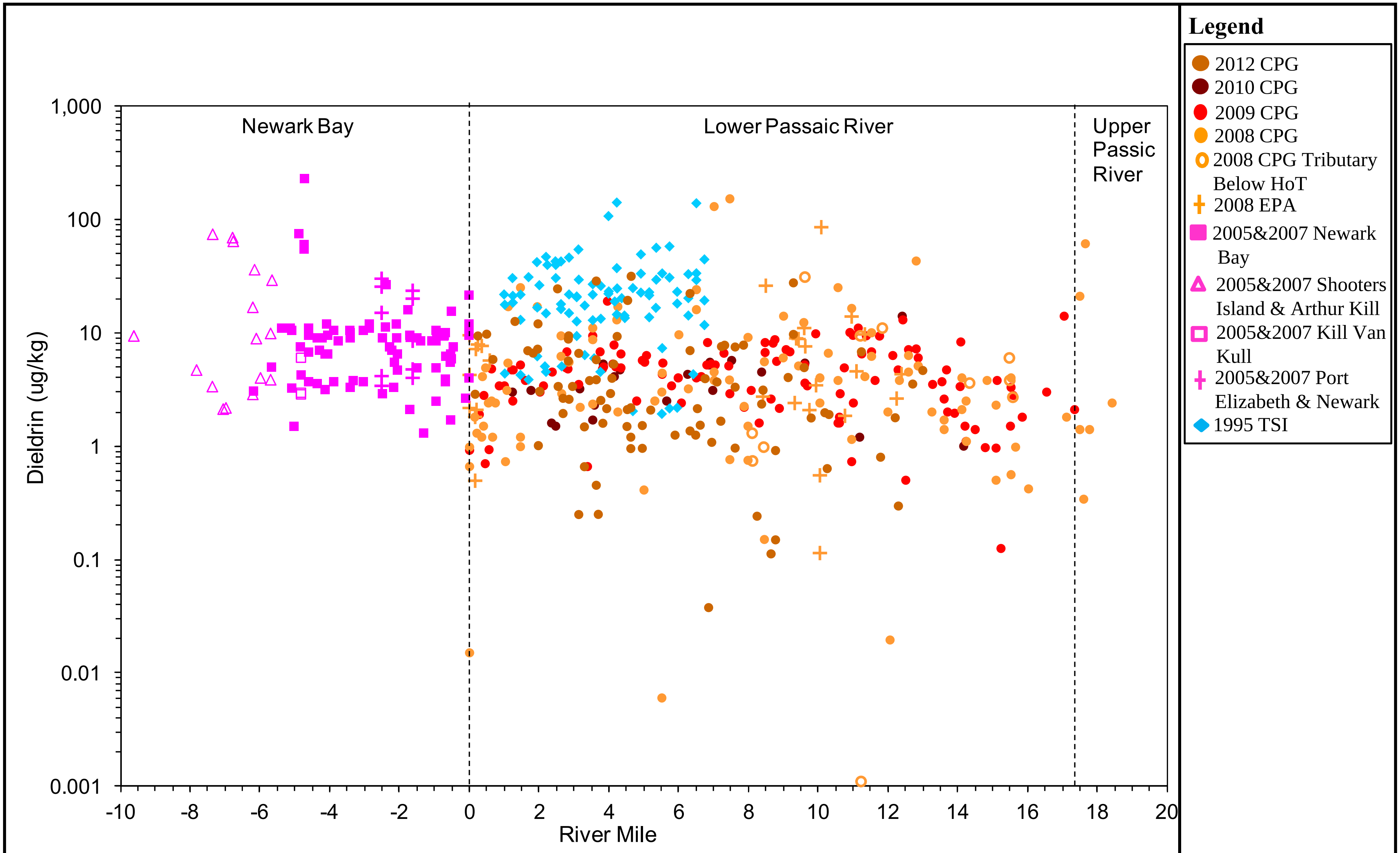

Total DDx TOC Normalized *vs.* River Mile

Total DDx in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Lower Passaic River

Figure 3.2-13

2014

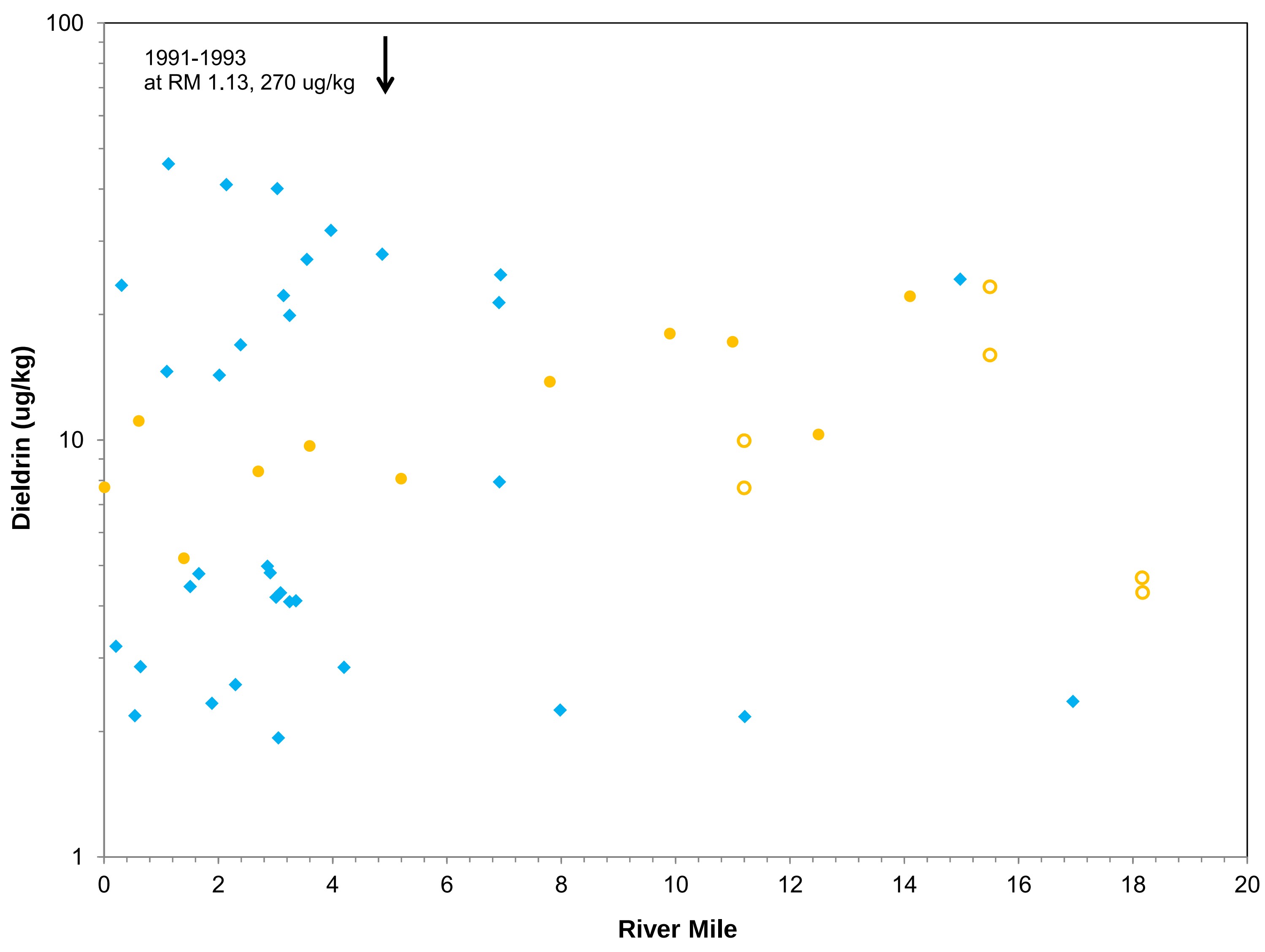


Dieldrin Concentration (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.2-14

2014



Legend

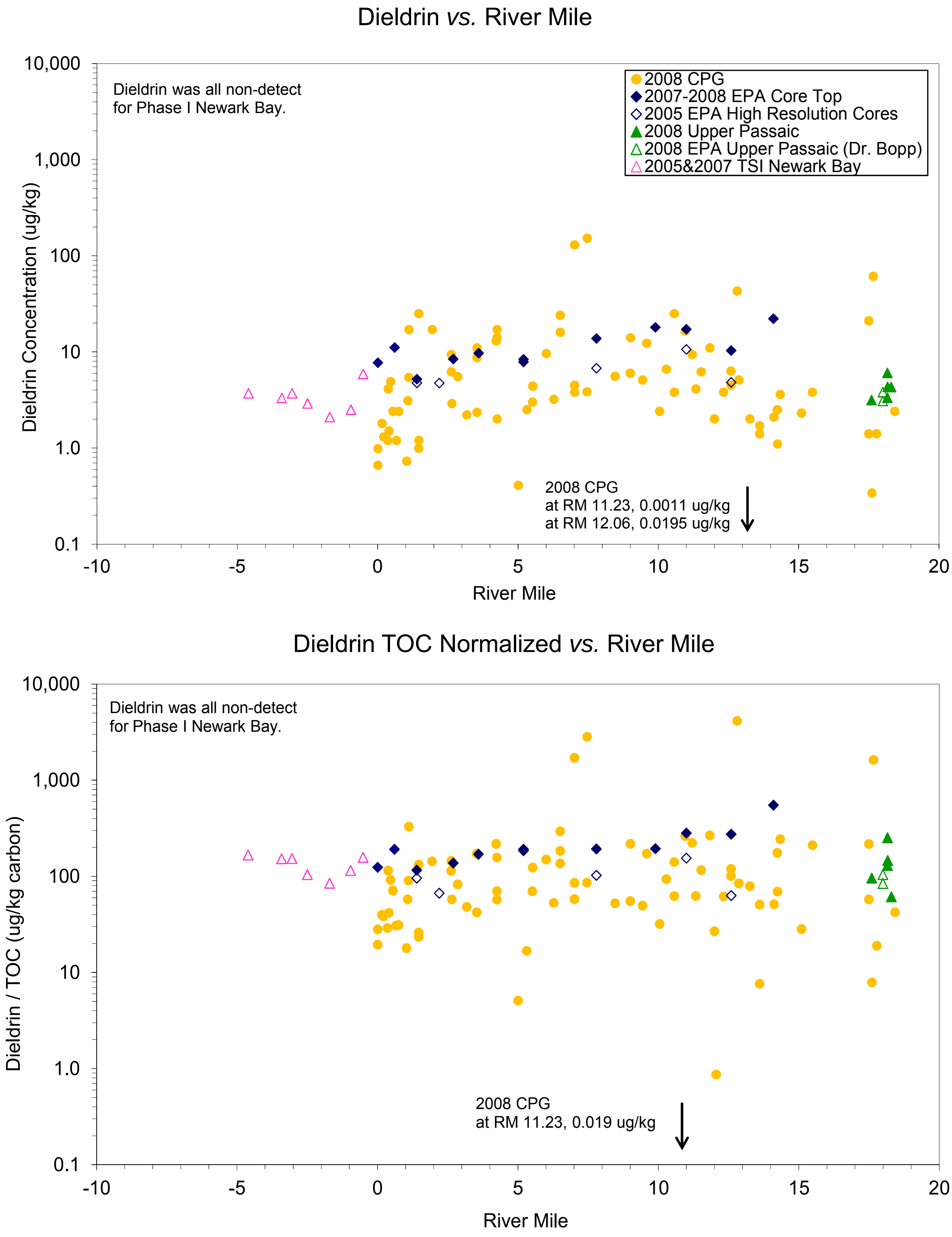
◆ 1991-1993
● 2007-2008 EPA
○ 2007-2008 EPA Tributary Above HoT

Dieldrin Concentration (0 - ≤2 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.2-15

2014



Dieldrin *vs.* River Mile

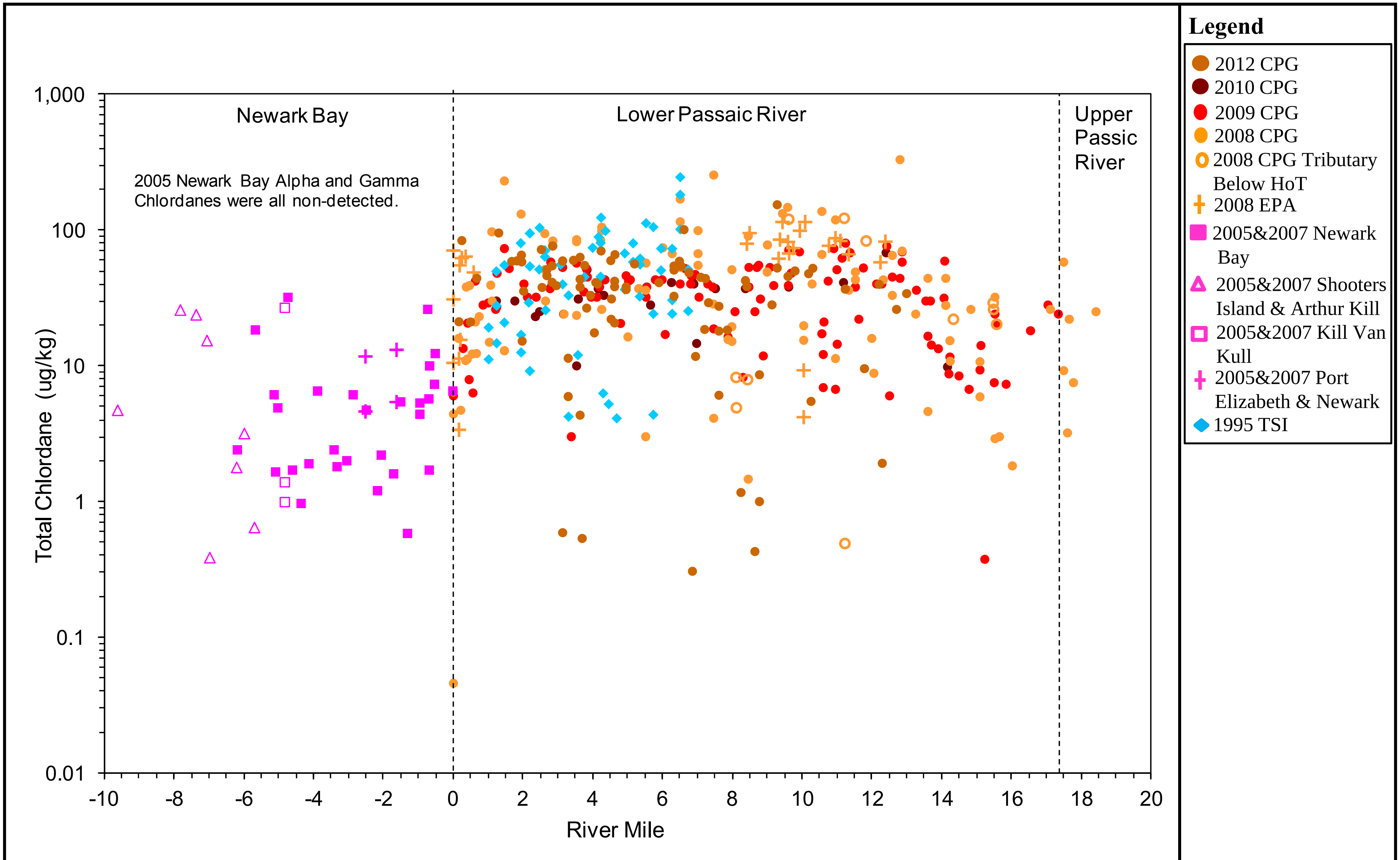
Dieldrin TOC Normalized *vs.* River Mile

Dieldrin in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Lower Passaic River

Figure 3.2-16

2014

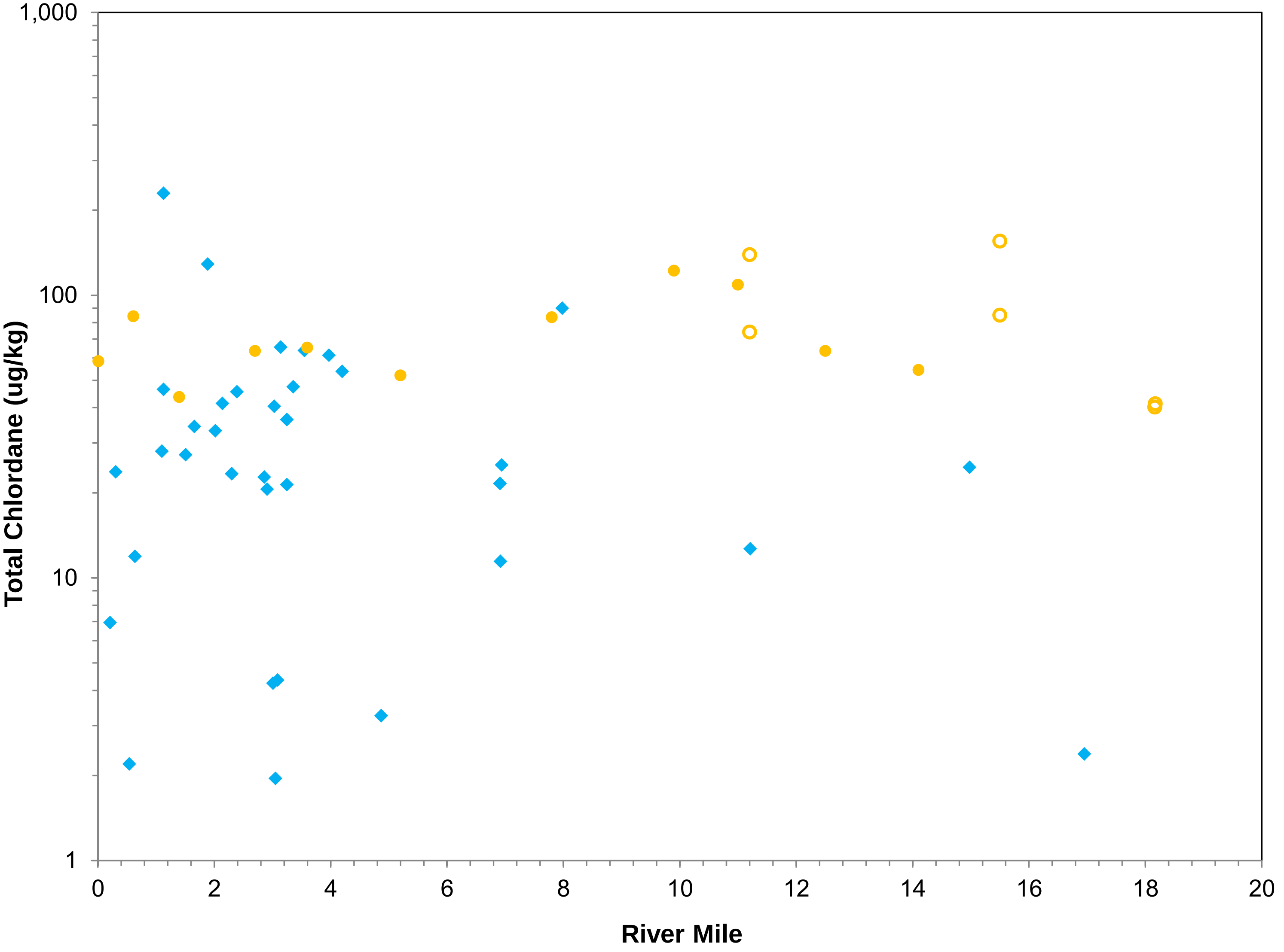


Total Chlordane Concentration (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.2-17

2014



Legend

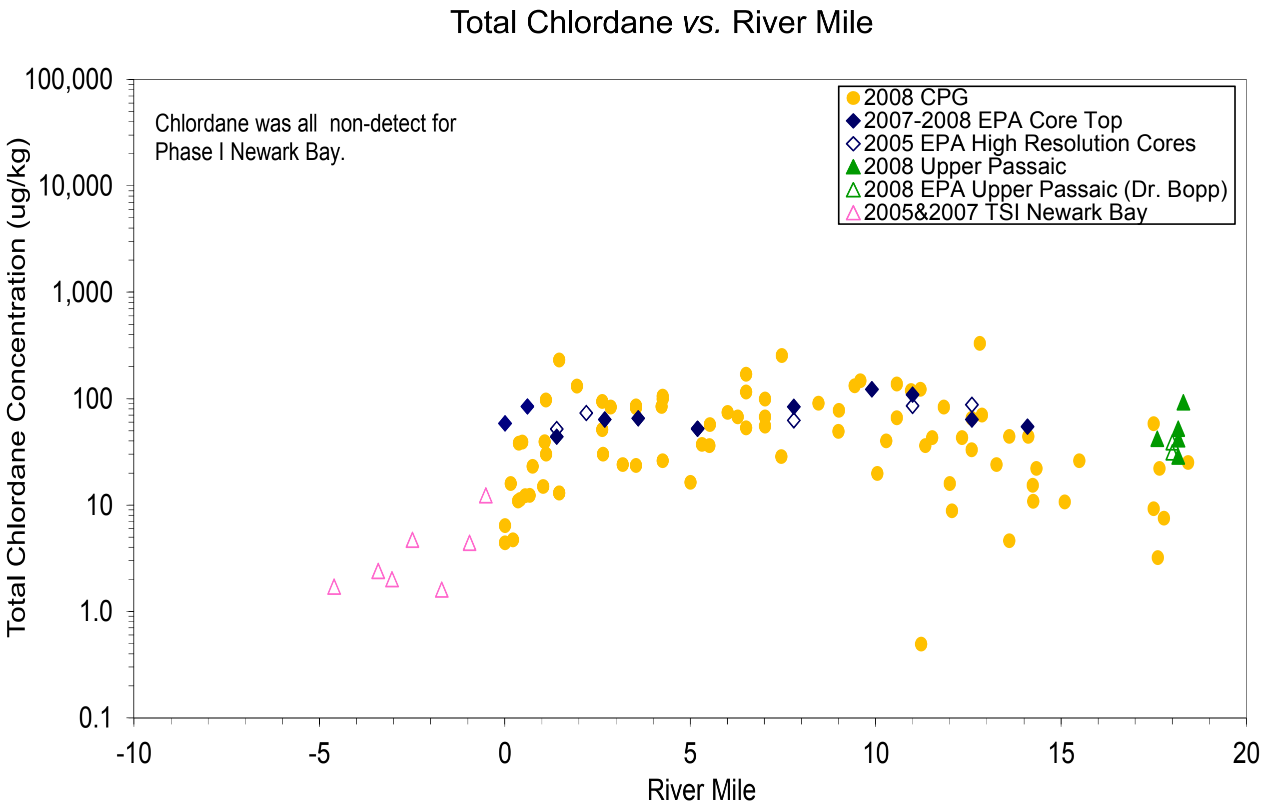
- ◆ 1991-1993
- ● 2007-2008 EPA
- ○ 2007-2008 EPA Tributary Above HoT

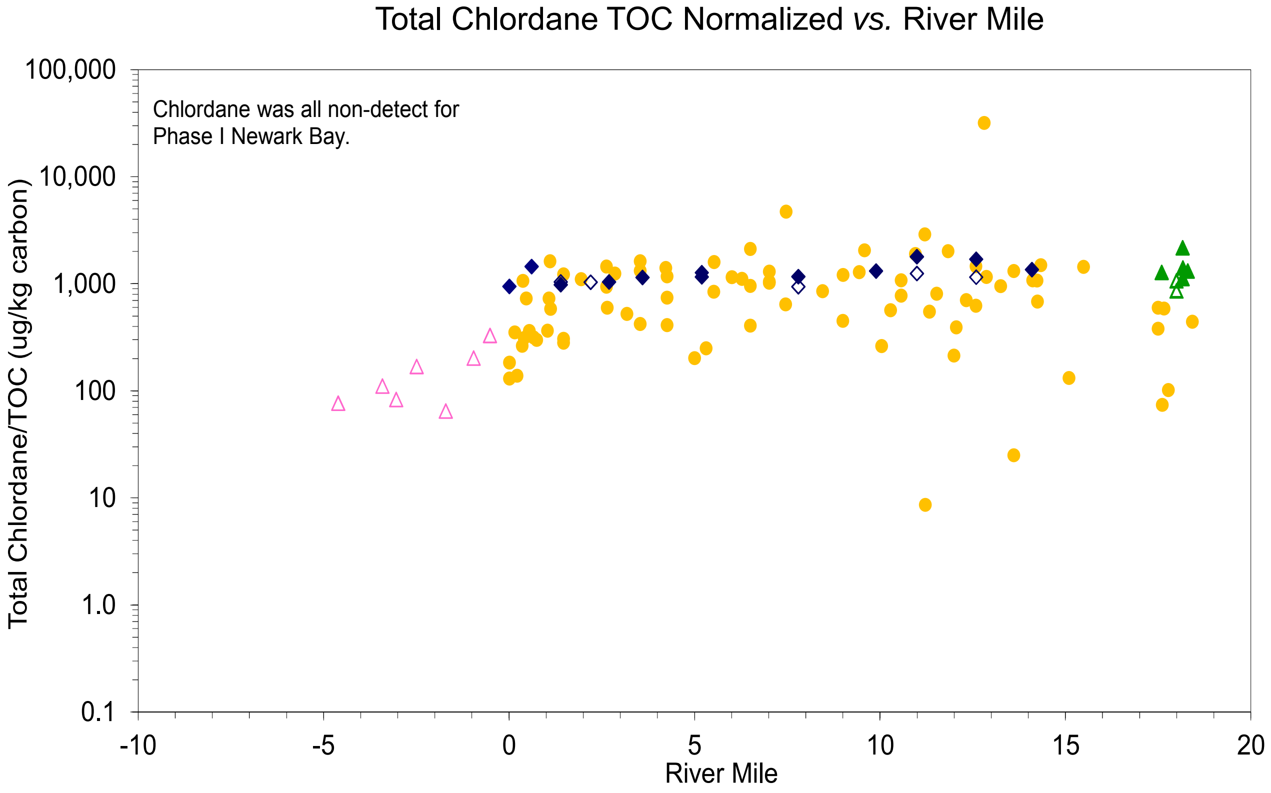
Total Chlordane Concentration (0 - ≤2 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.2-18

2014



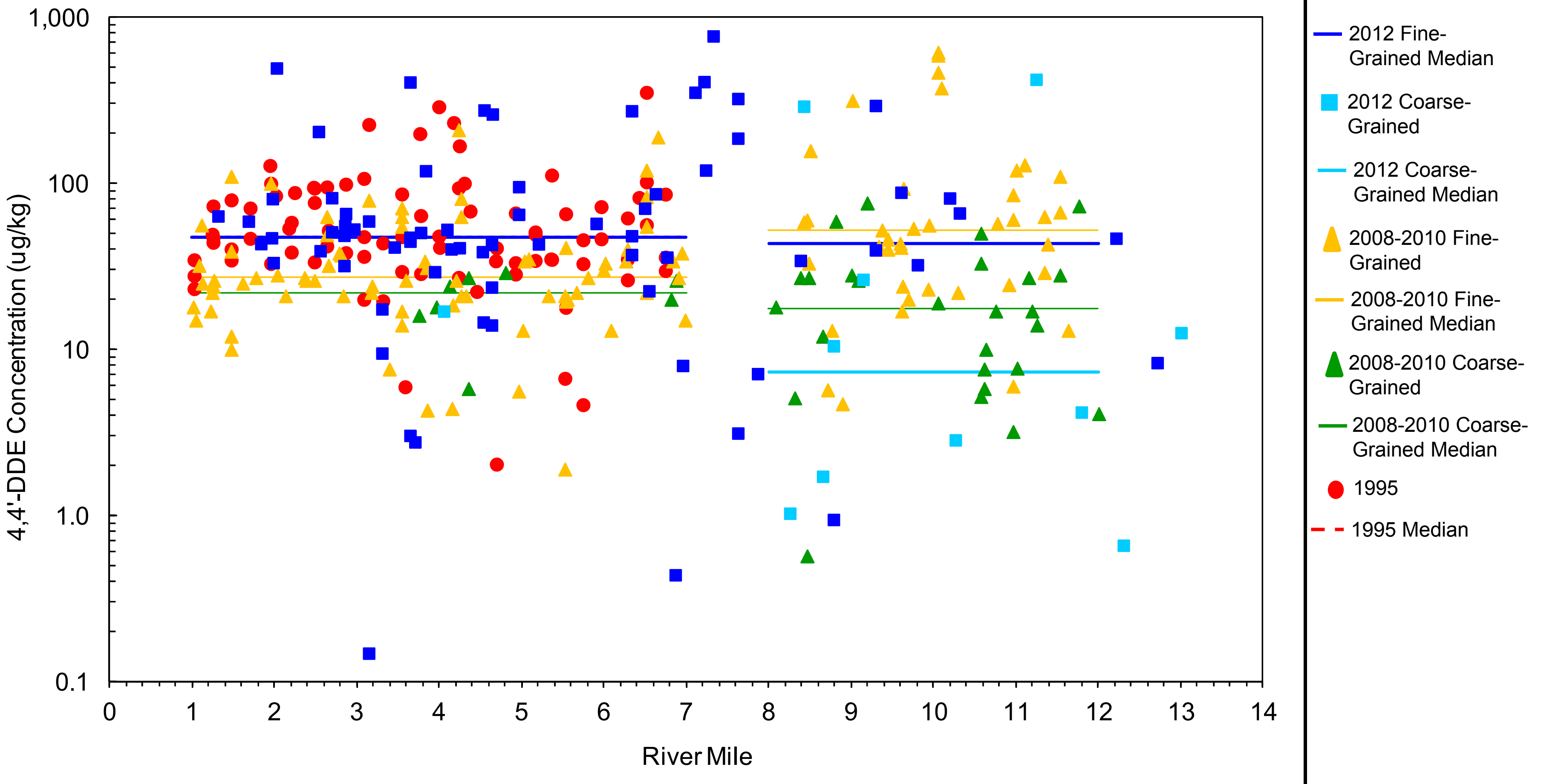


Total Chlordane in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Lower Passaic River

Figure 3.2-19

2014

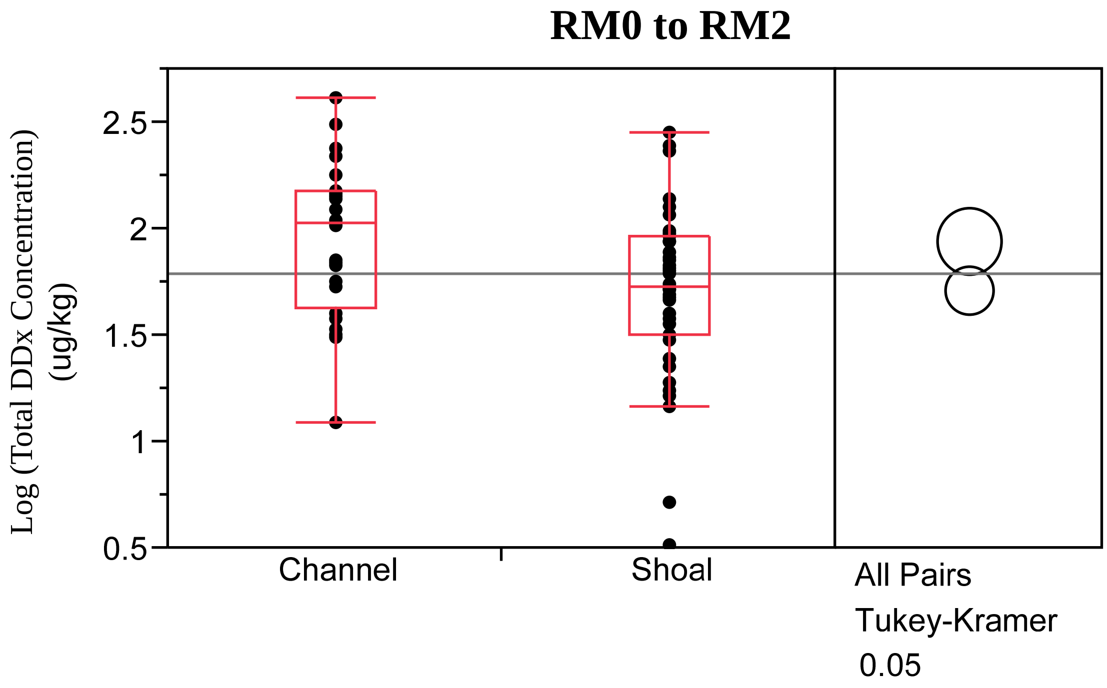


Comparison of 4,4'-DDE Surface Concentration (0-6 inches)
RM1 to RM7 *vs.* RM8 to 12

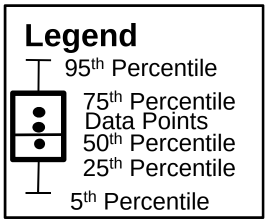
Lower Eight Miles of the Lower Passaic River

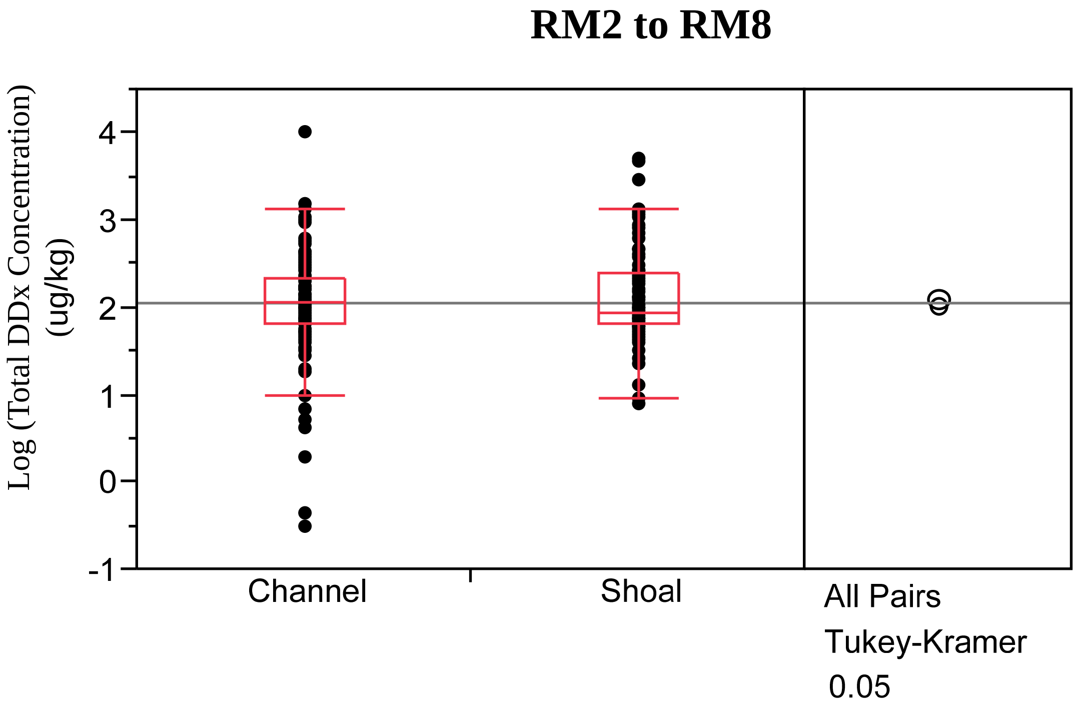
Figure 3.2-20

2014



Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.





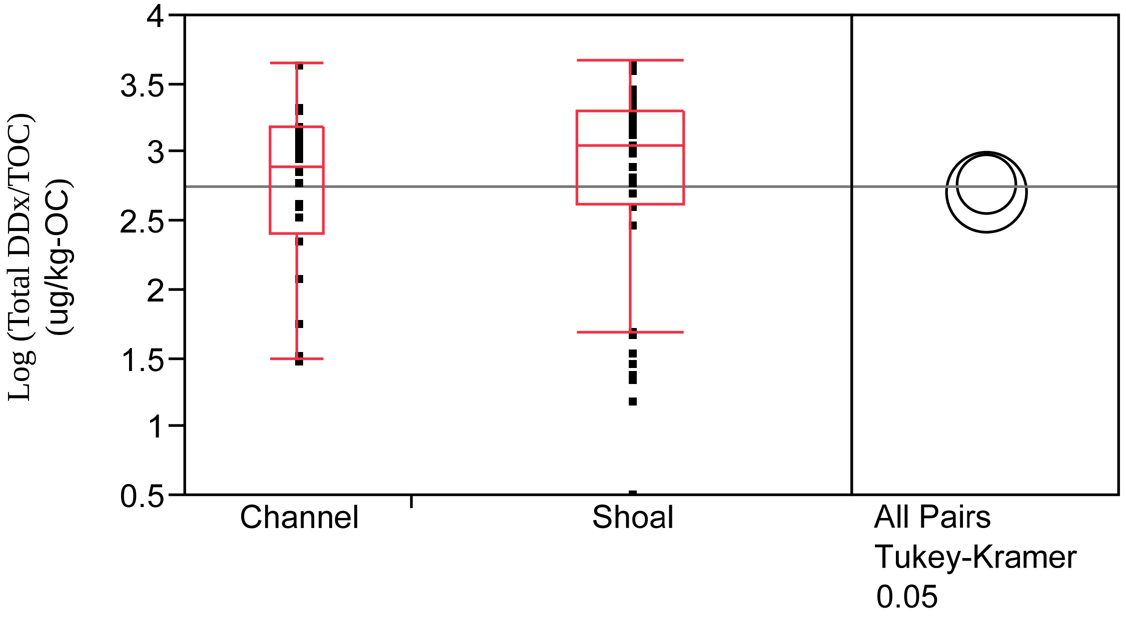
Total DDx (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

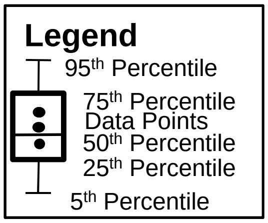
Figure 3.2-21a

2014

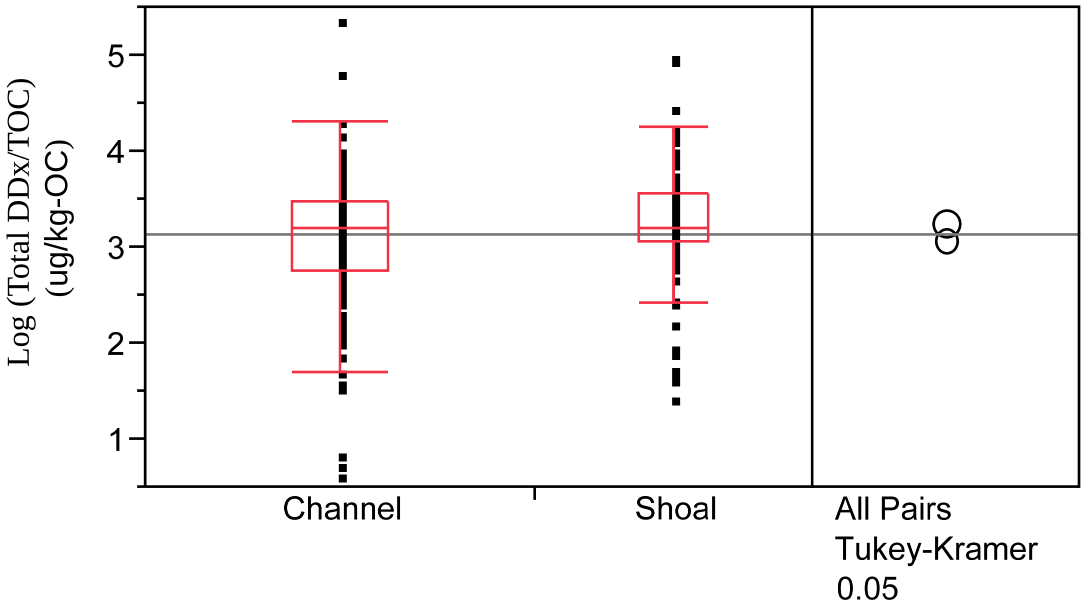
RM0 to RM2



Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



RM2 to RM8

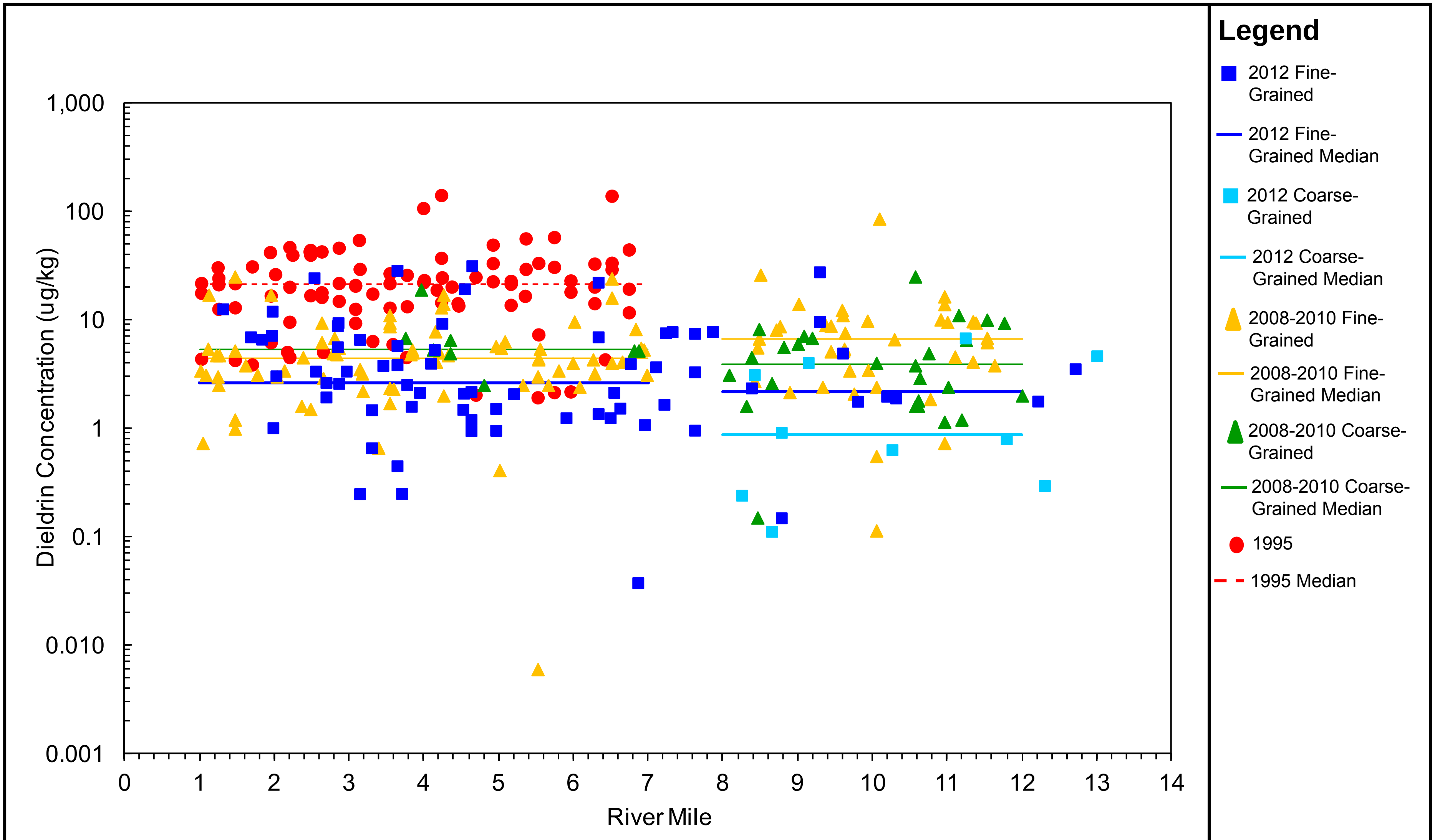


TOC Normalized Total DDx (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 3.2-21b

2014

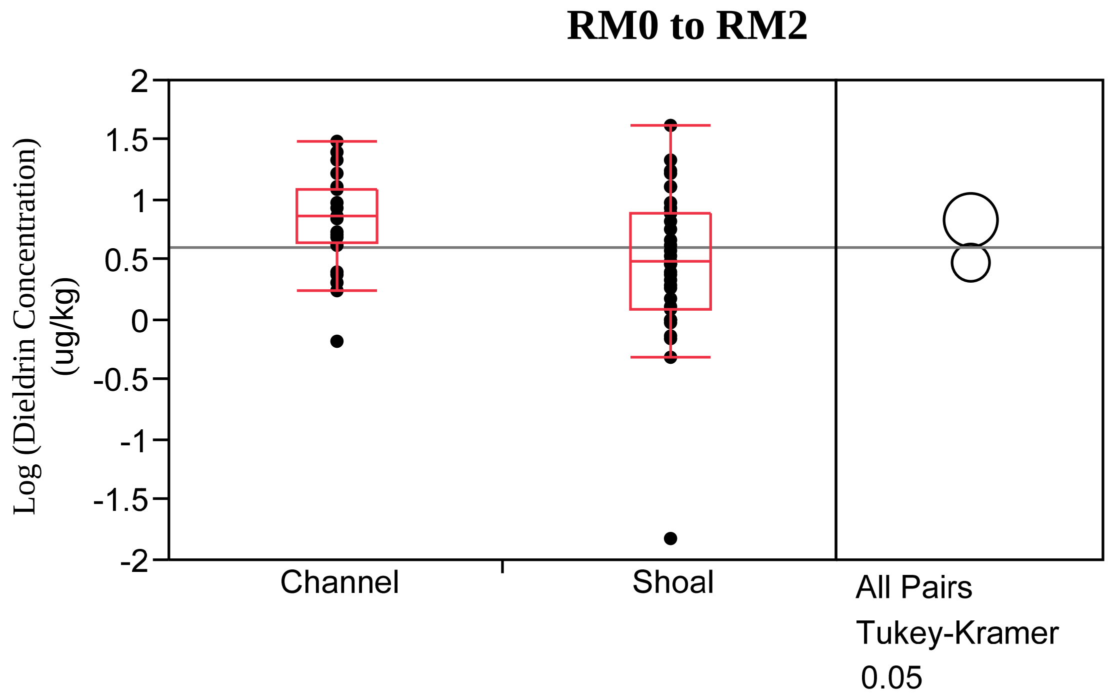


Comparison of Dieldrin Surface Concentration (0-6 inches)
RM1 to RM7 *vs.* RM8 to 12

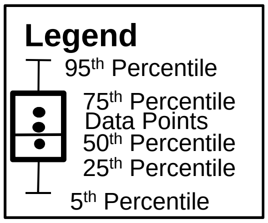
Lower Eight Miles of the Lower Passaic River

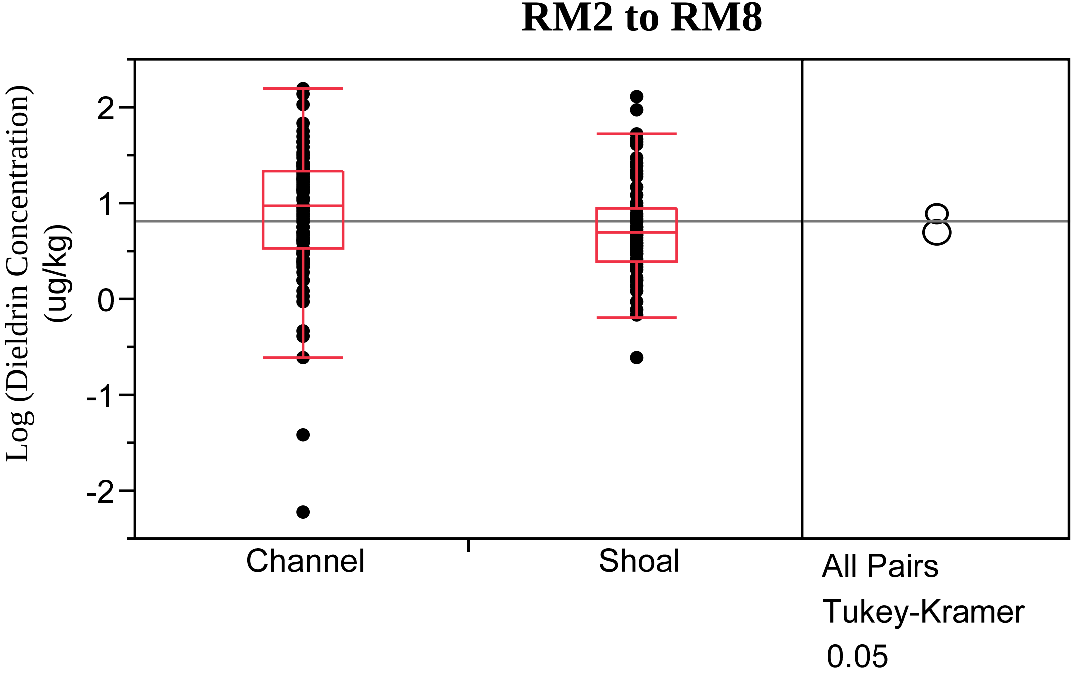
Figure 3.2-22

2014


RM0 to RM2

Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.




RM2 to RM8

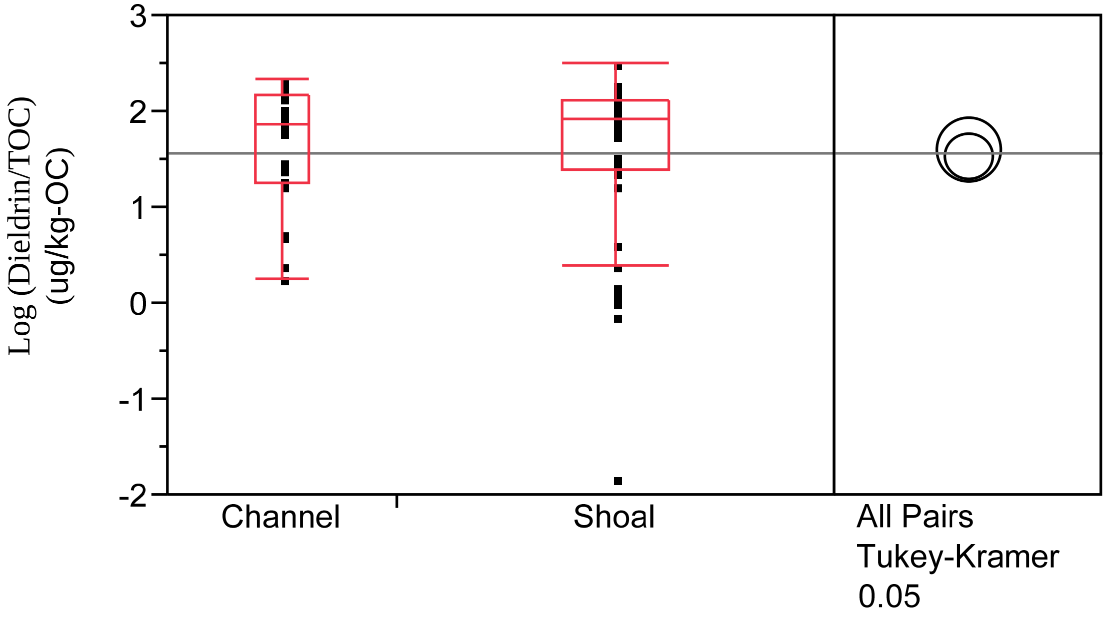
Dieldrin by (0-6 inch) Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

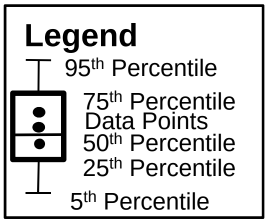
Figure 3.2-23a

2014

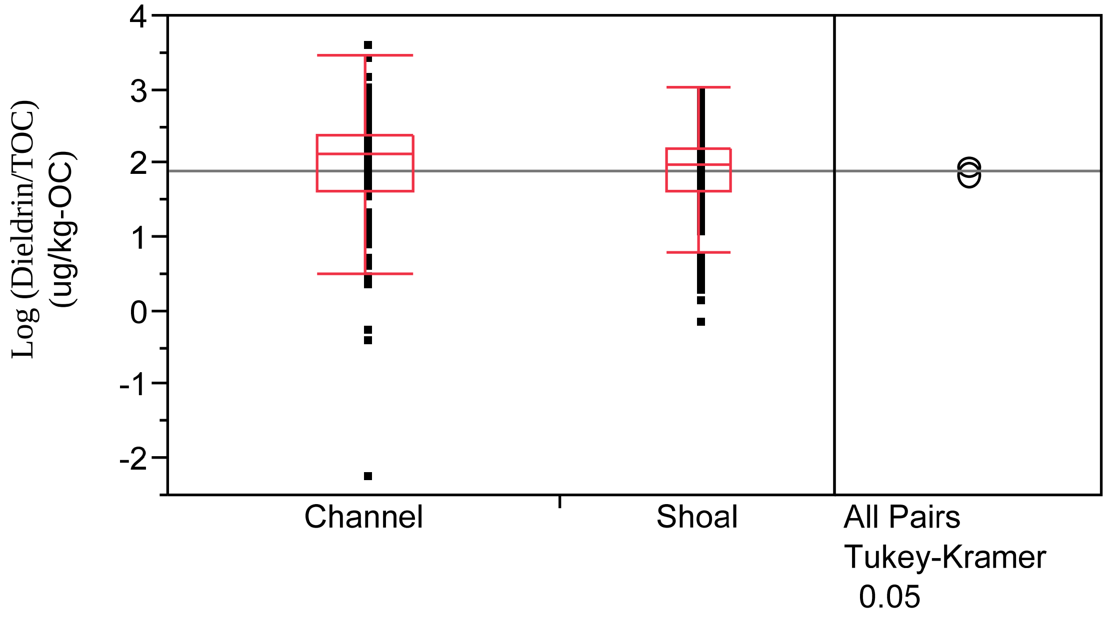
RM0 to RM2



Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



RM2 to RM8

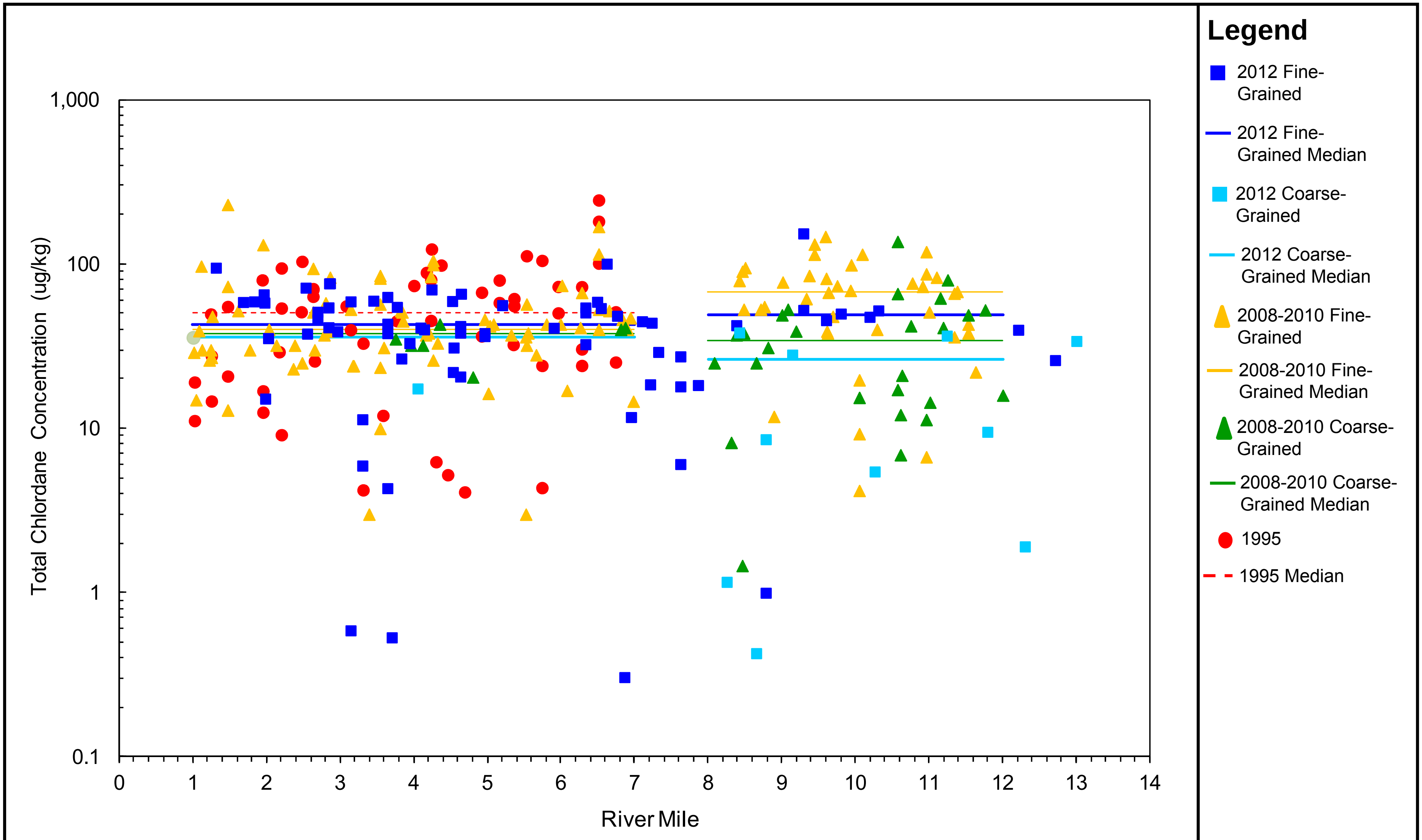


TOC Normalized Dieldrin (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 3.2-23b

2014



Legend

- ■ 2012 Fine-Grained
- — 2012 Fine-Grained Median
- ■ 2012 Coarse-Grained
- — 2012 Coarse-Grained Median
- ▲ 2008-2010 Fine-Grained
- — 2008-2010 Fine-Grained Median
- ▲ 2008-2010 Coarse-Grained
- — 2008-2010 Coarse-Grained Median
- ● 1995
- - - 1995 Median

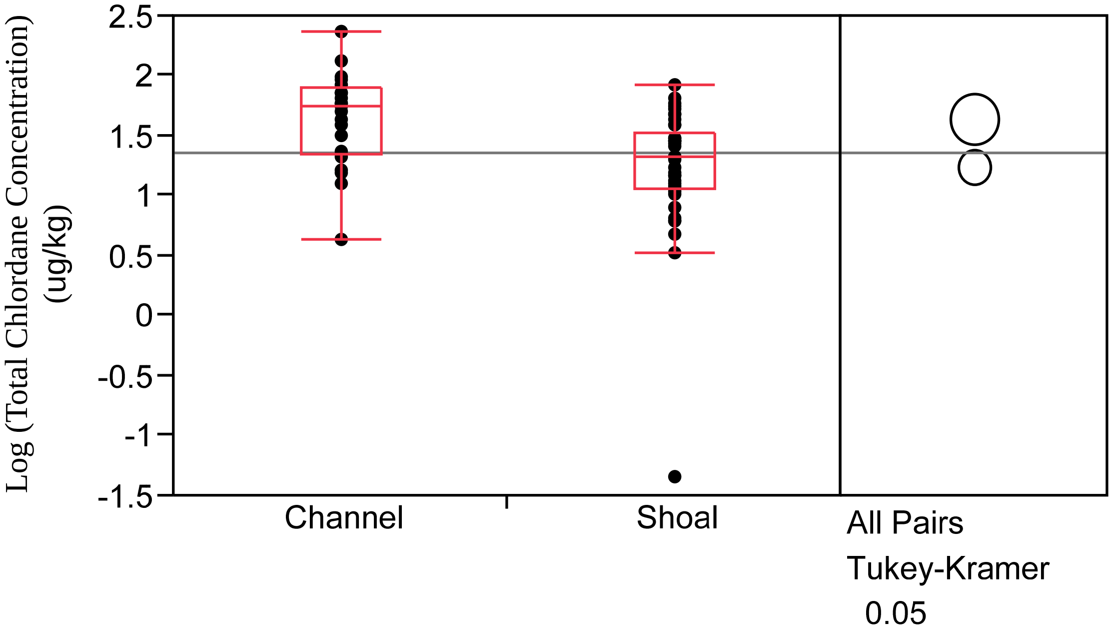
Comparison of Total Chlordane Surface Concentration (0-6 inches)
RM1 to RM7 *vs.* RM8 to 12

Lower Eight Miles of the Lower Passaic River

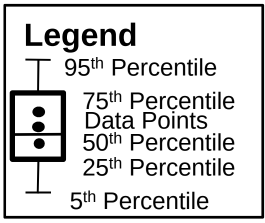
Figure 3.2-24

2014

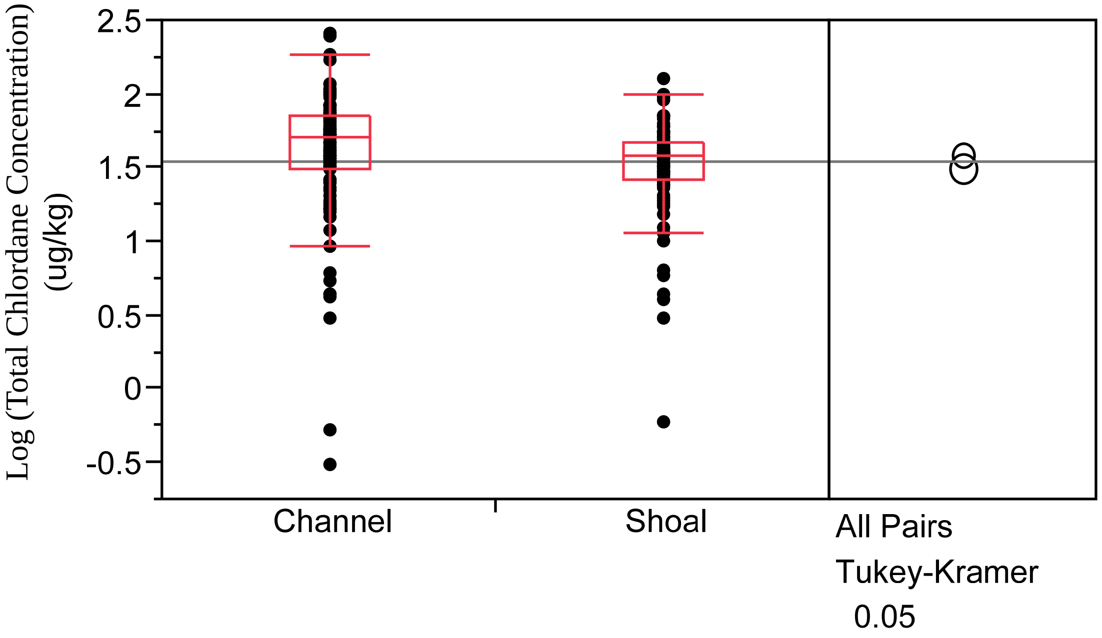
RM0 to RM2



Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



RM2 to RM8



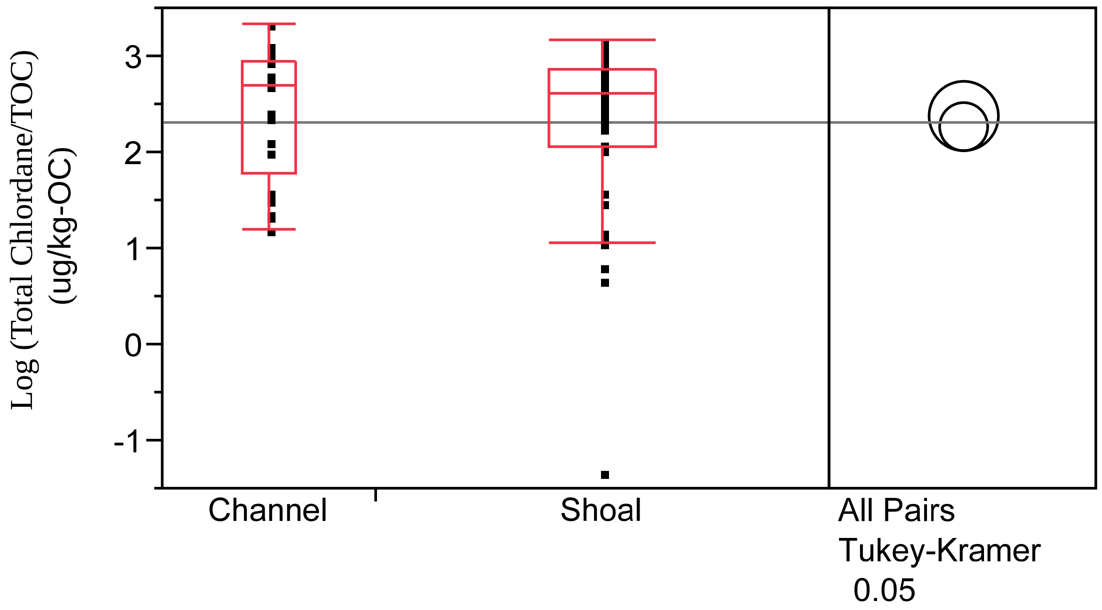
Total Chlordane (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

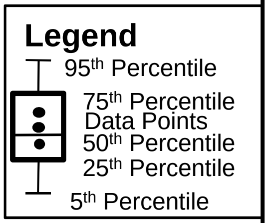
Figure 3.2-25a

2014

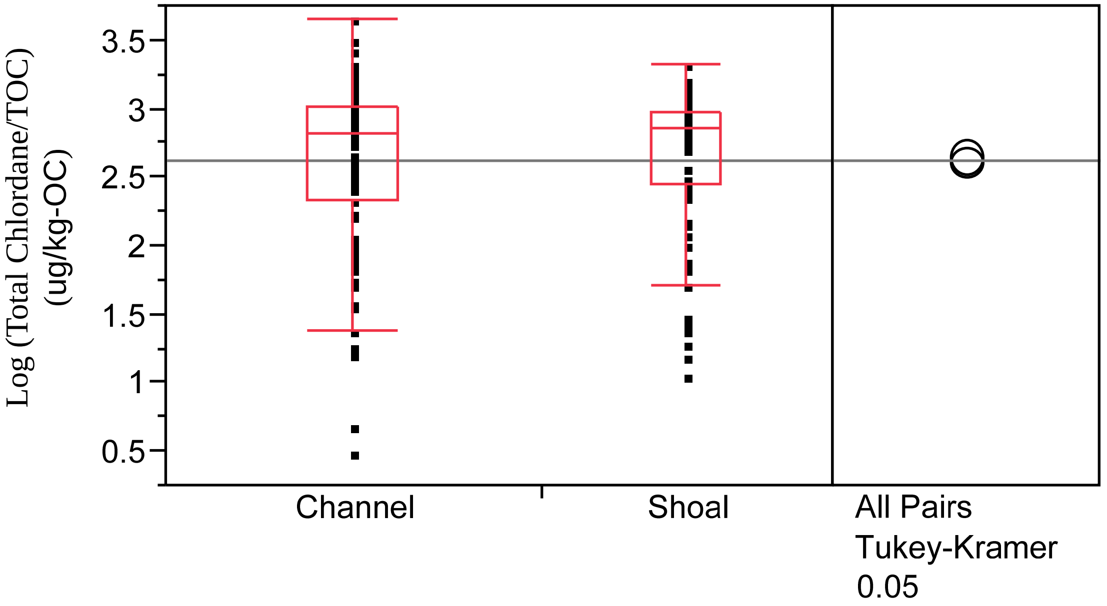
RM0 to RM2



Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



RM2 to RM8

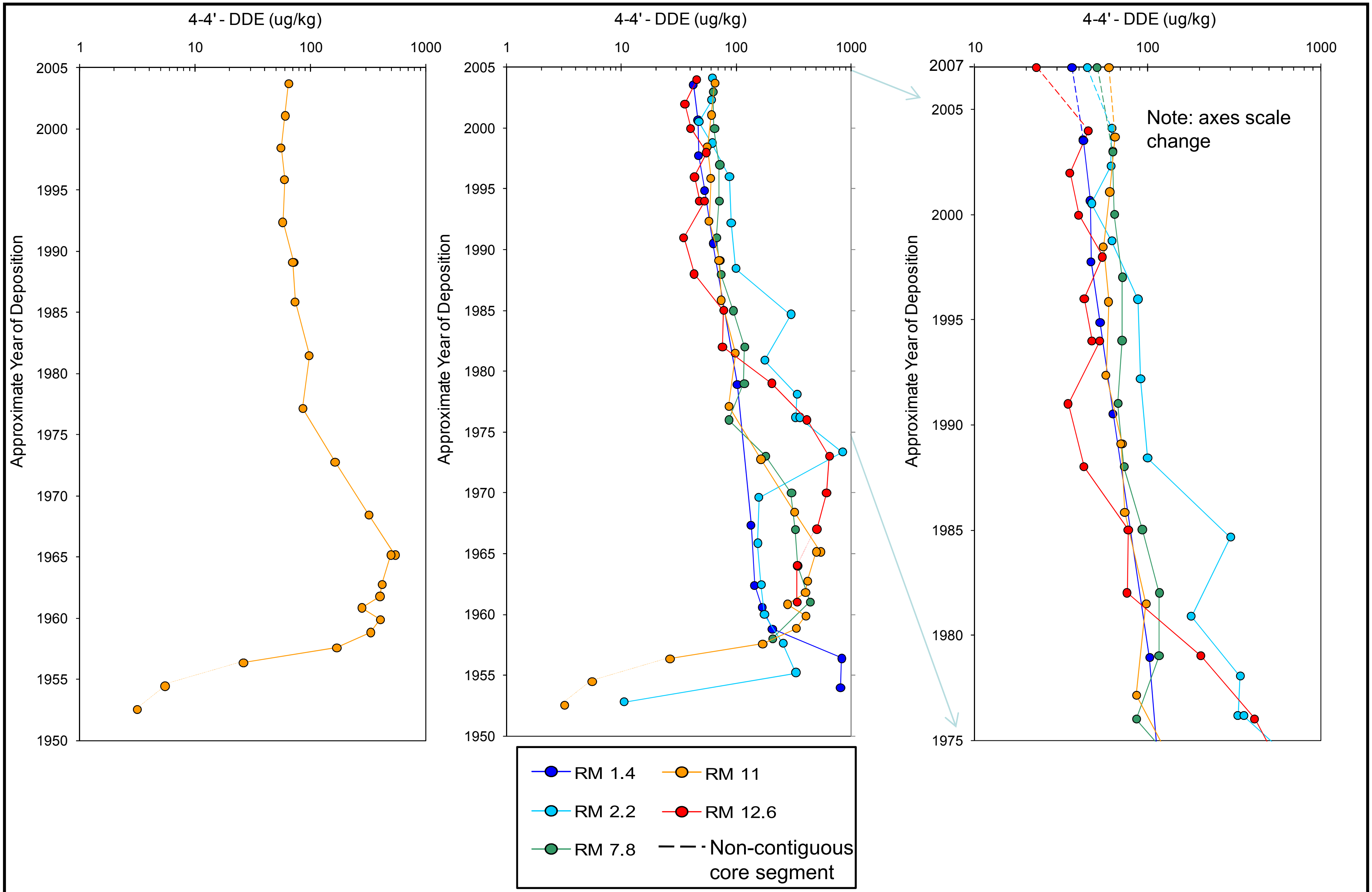


TOC Normalized Total Chlordane (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 3.2-25b

2014

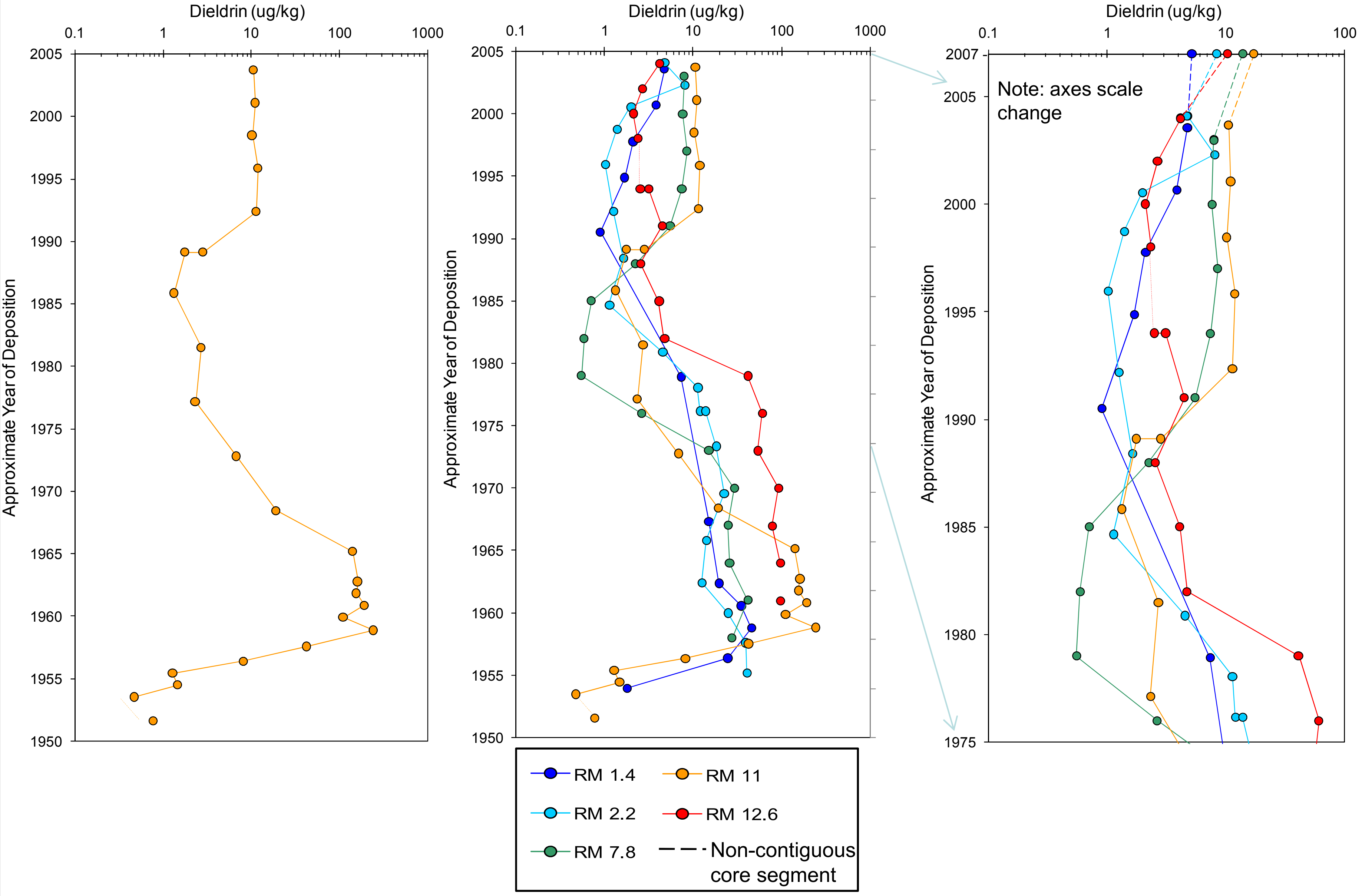


Dated Sediment Core Profile for 4,4'-DDE: 2005 High Resolution Cores and 2007 Surface Samples

Lower Eight Miles of the Lower Passaic River

Figure 3.2-26

2014



Dated Sediment Core Profile for Dieldrin:
2005 High Resolution Cores and 2007 Surface Samples

Lower Eight Miles of the Lower Passaic River

Figure 3.2-27

2014

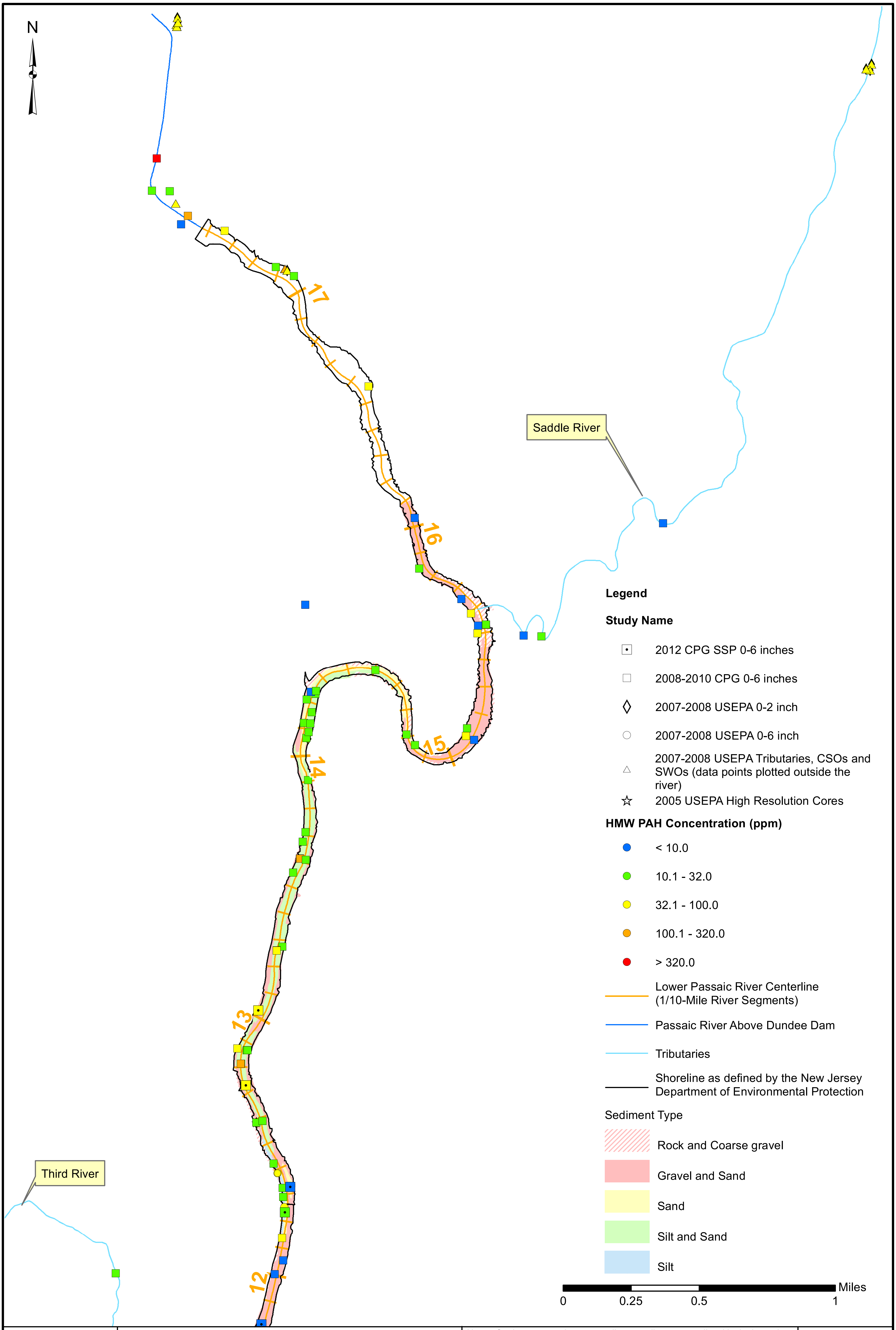
Total HMW PAH Surface Sediment Samples from 1991 to 2000

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.3-1

2014



Total HMW PAH Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.3-2a

2014

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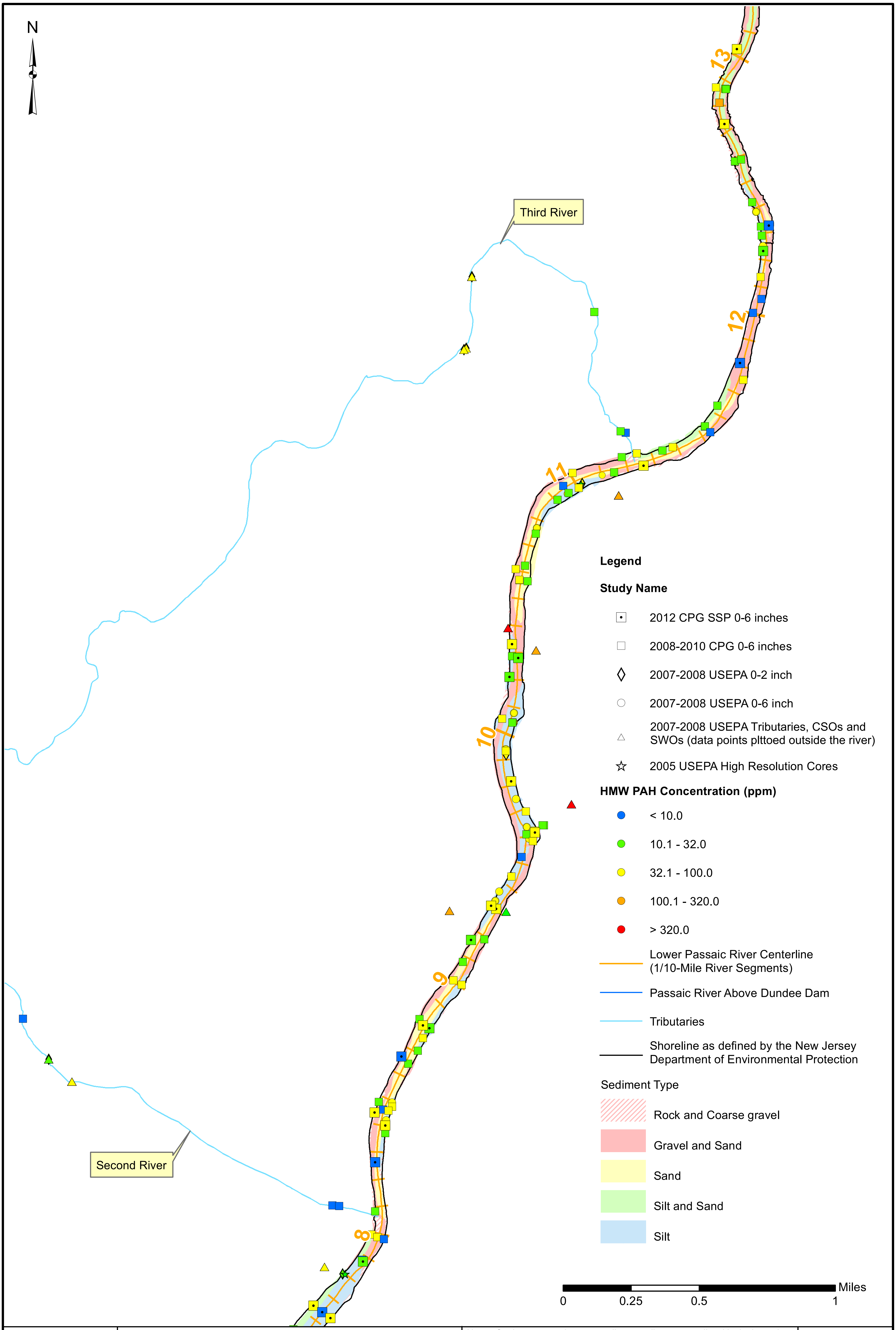

Total HMW PAH Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.3-2b

2014

Path: Z:\Projects\NNJ\0285924\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\HMW_PAH_Surficial_Sed_2005_2012.mxd

Total HMW PAH Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.3-2c

2014

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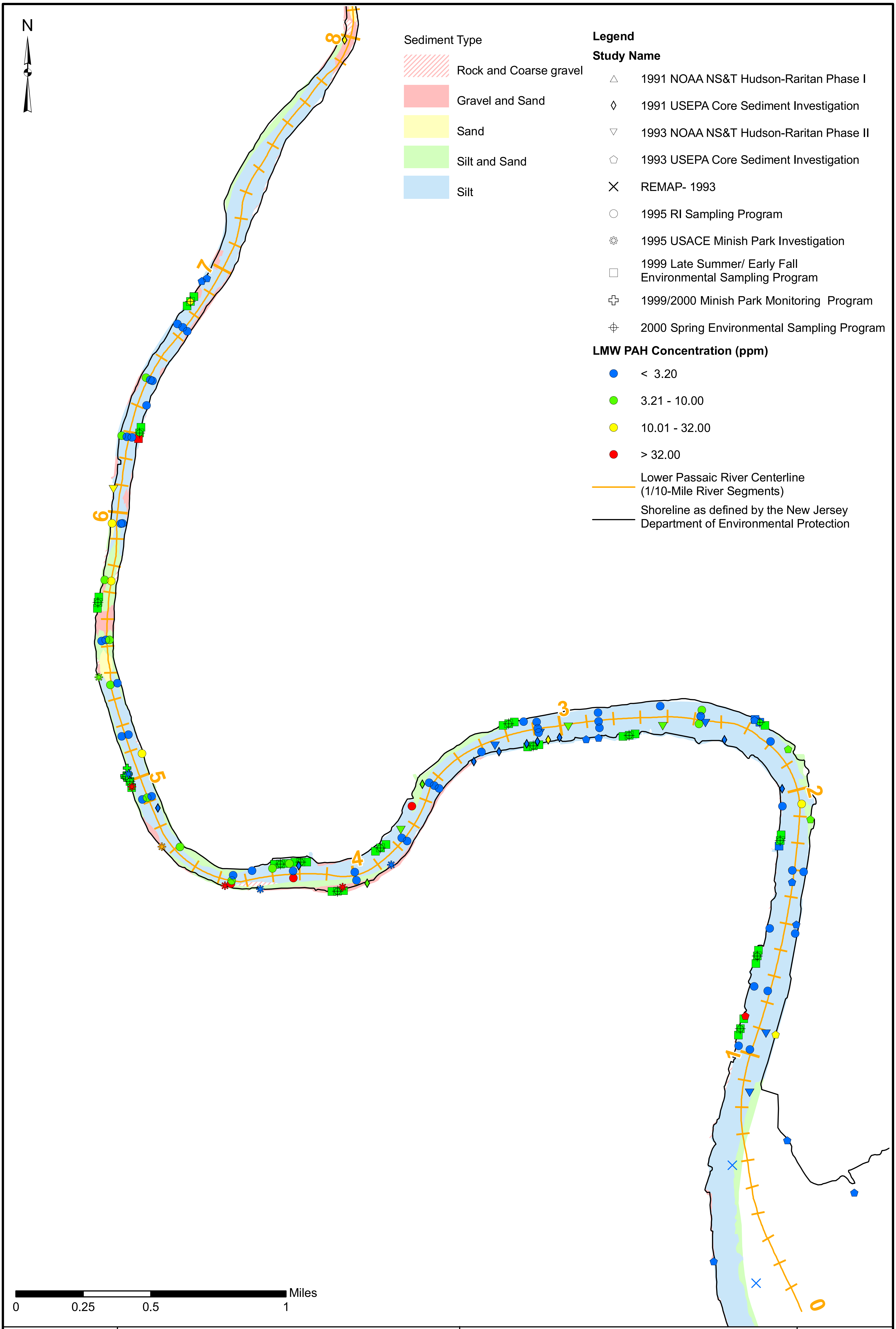


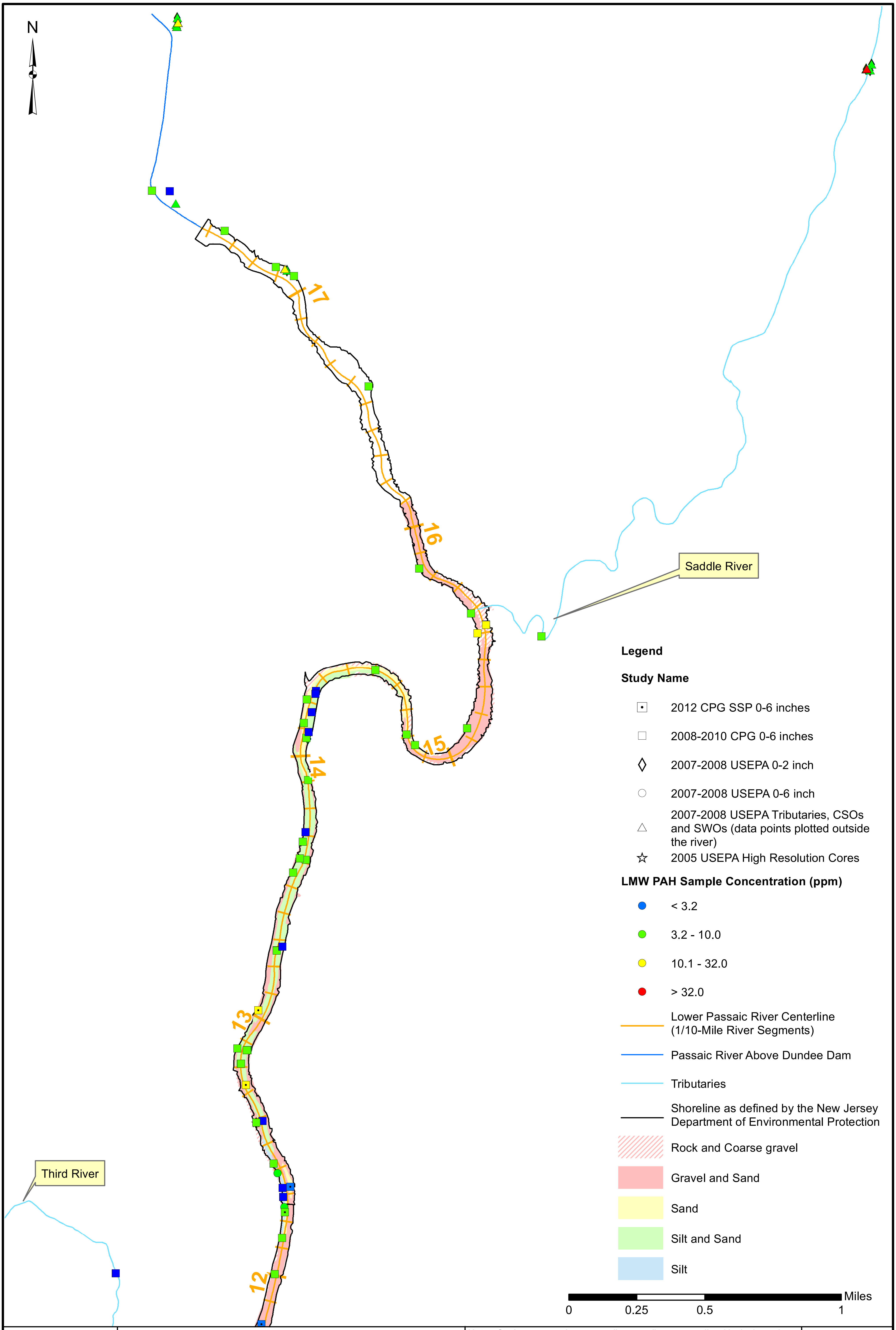
Total LMW PAH Surface Sediment Samples from 1991 to 2000

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.3-3

2014



Total LMW PAH Surface Sediment Samples from 2005 to 2012

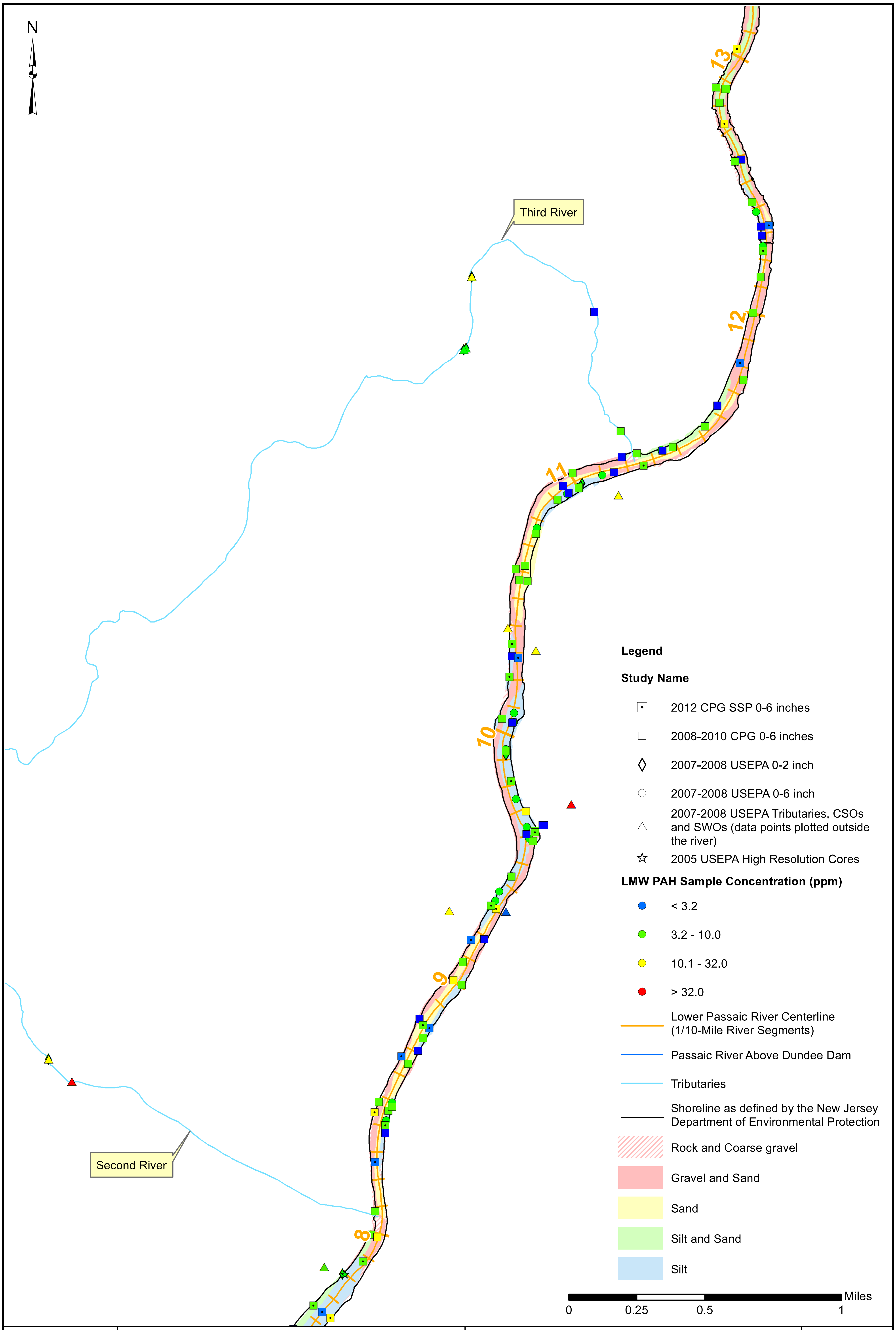
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.3-4a

2014

Path: P:\0285924\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\LMW_PAH_Surficial_Sed_2005_2012.mxd



Total LMW PAH Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.3-4b

2014

Path: P:\02855924\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\LMW_PAH_Surficial_Sed_2005_2012.mxd

Total LMW PAH Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.3-4c

2014

Path: P:\0285924\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\LMW_PAH_Surficial_Sed_2005_2012.mxd

Total PAH Surface Sediment Samples from 1991 to 2000

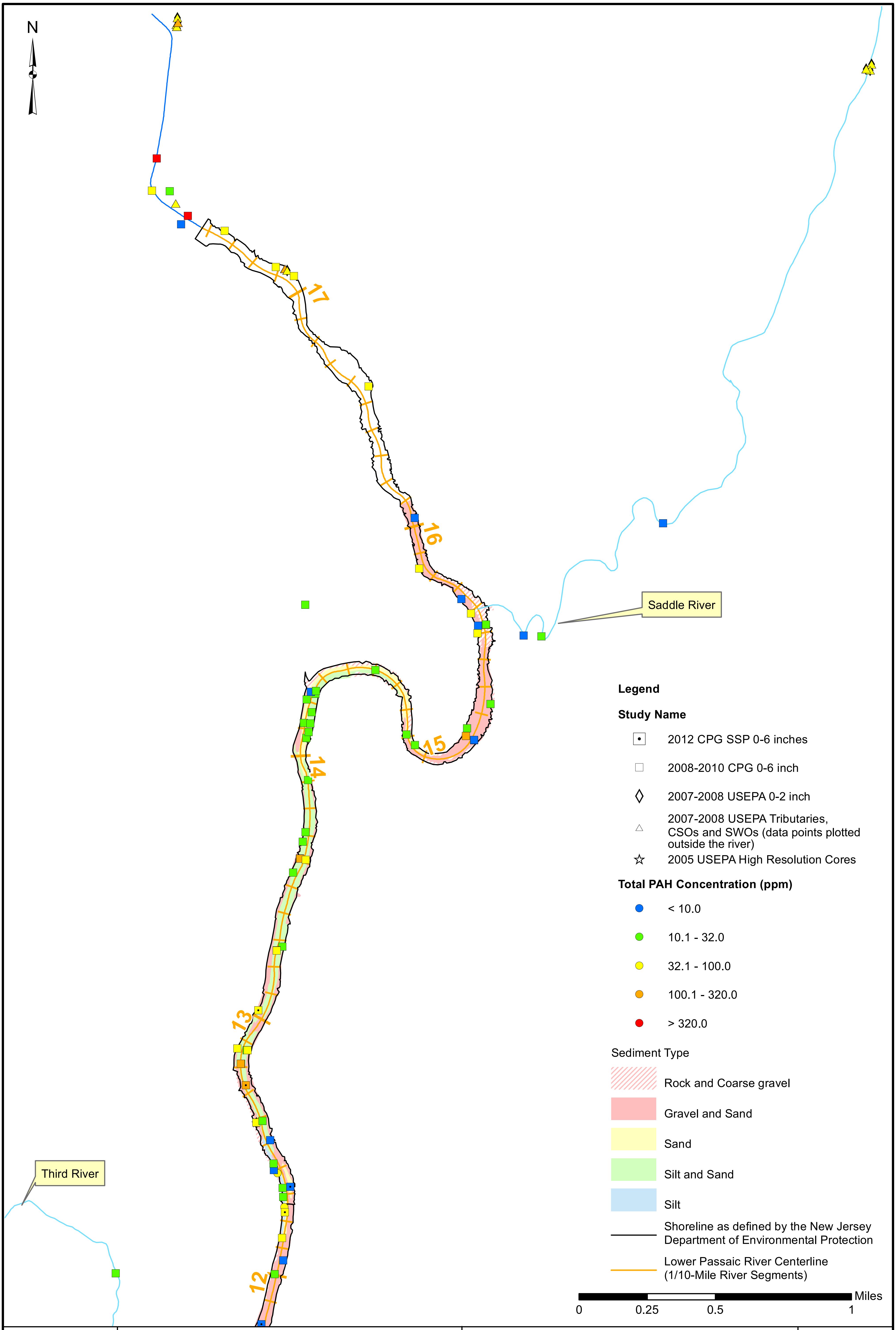
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.3-5

2014

S:\Projects\passaic\MapDocuments\4553001-CERCLA\2012_Update\Total_PAH_Surficial_Sed_1991_2000



Total PAH Surface Sediment Samples from 2005 to 2012

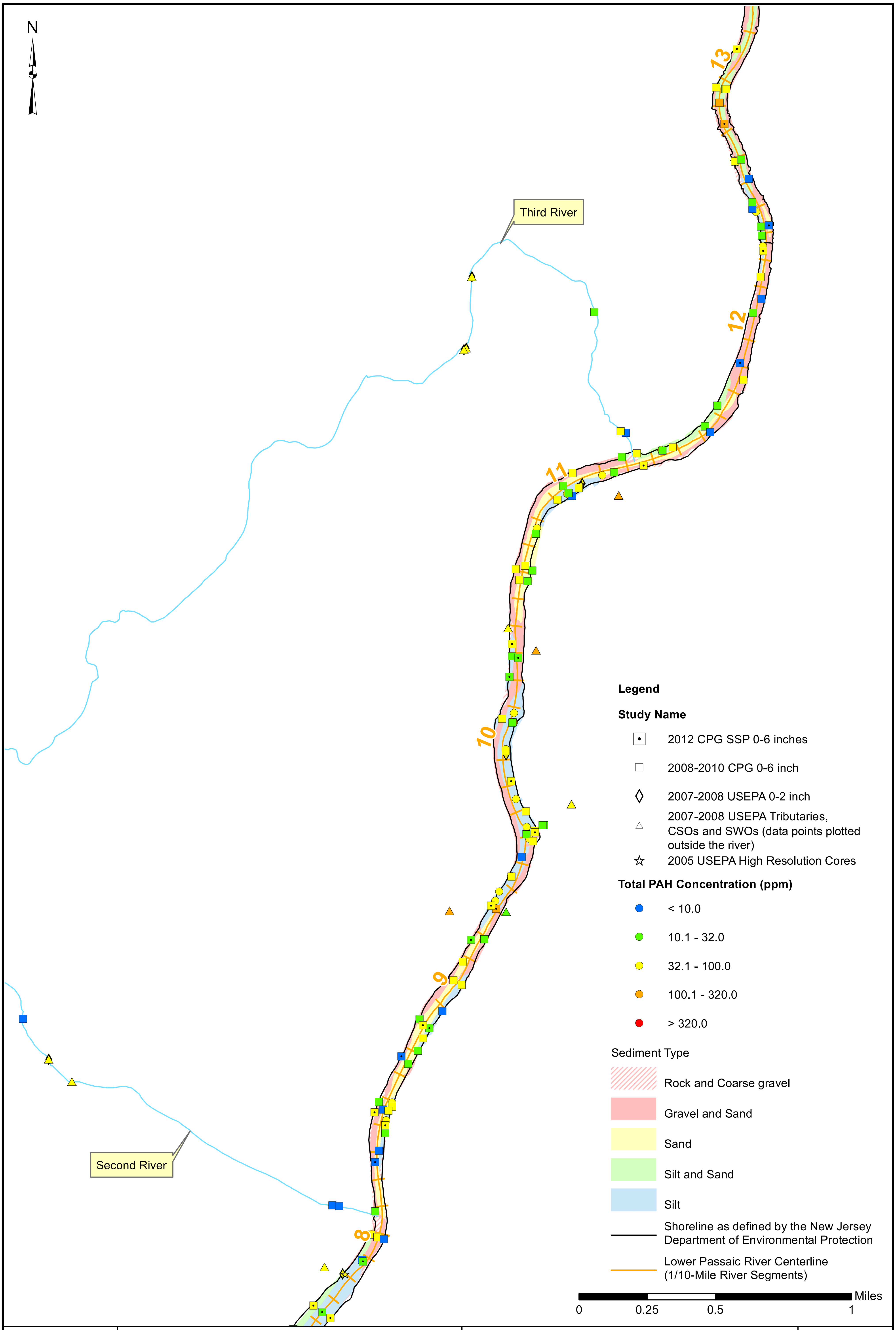
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.3-6a

2014

Path: P:\0285924\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\Total_PAH_Surficial_Sed_2005_2012.mxd



Total PAH Surface Sediment Samples from 2005 to 2012

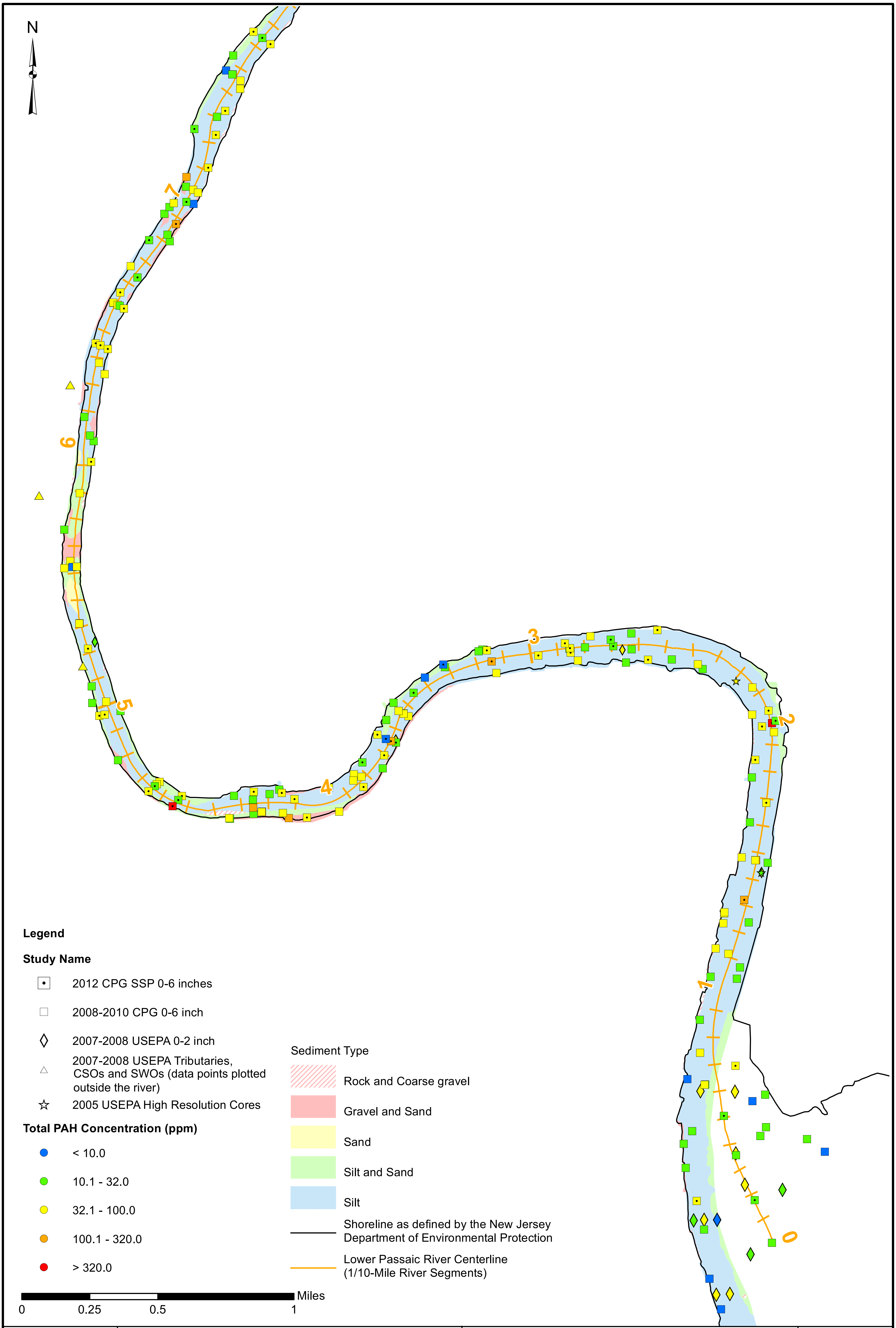
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.3-6b

2014

Path: P:\0285924\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\Total_PAH_Surficial_Sed_2005_2012.mxd



Total PAH Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.3-6c

2014

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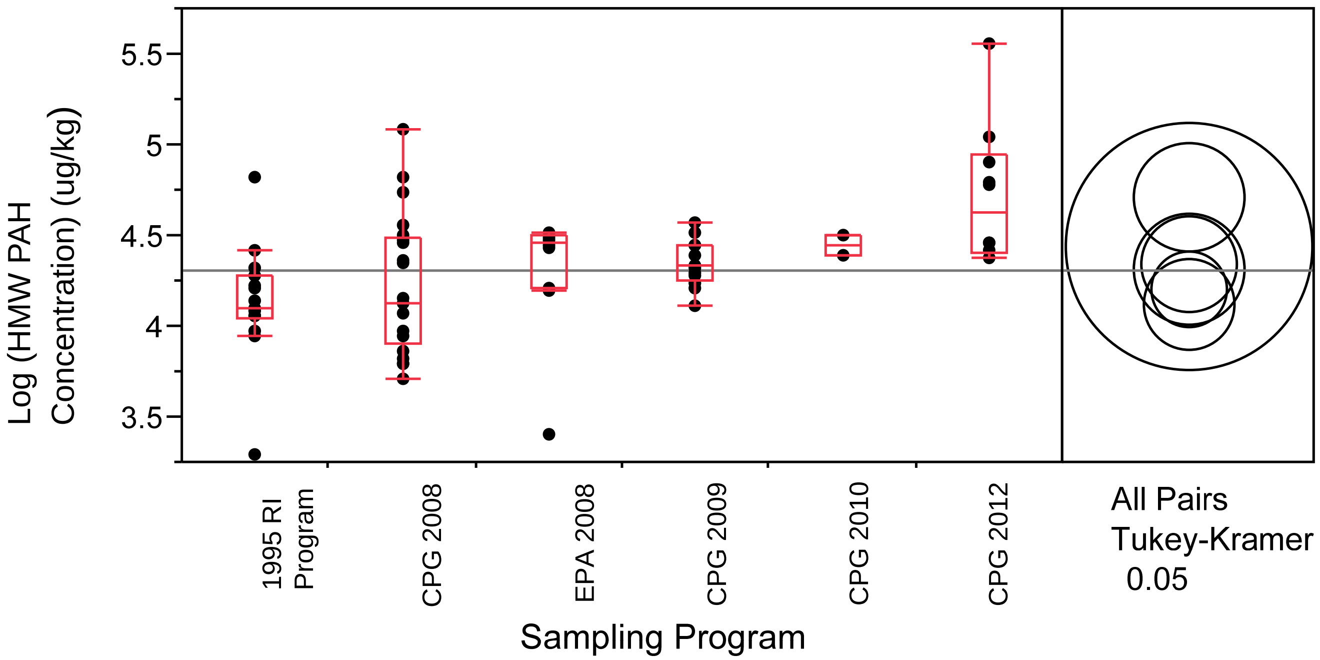
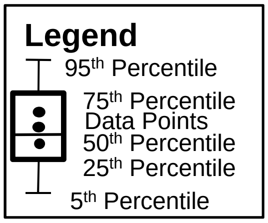
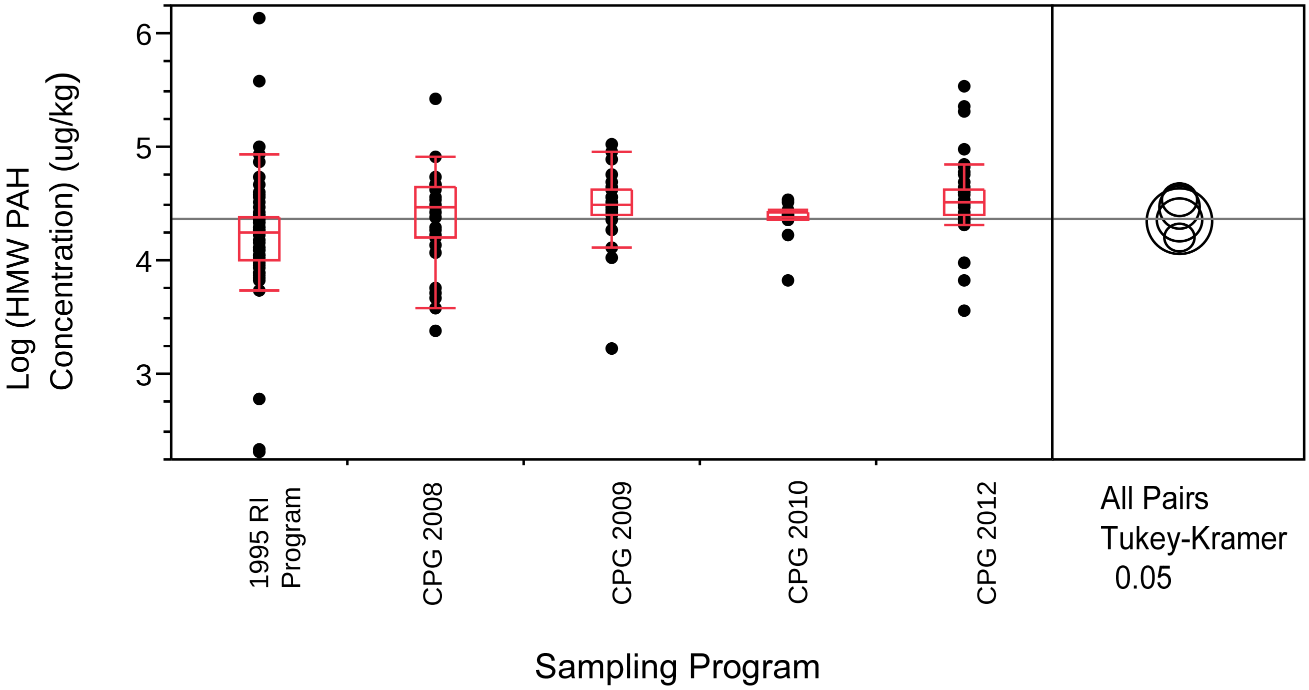


RM0 to RM2

Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.





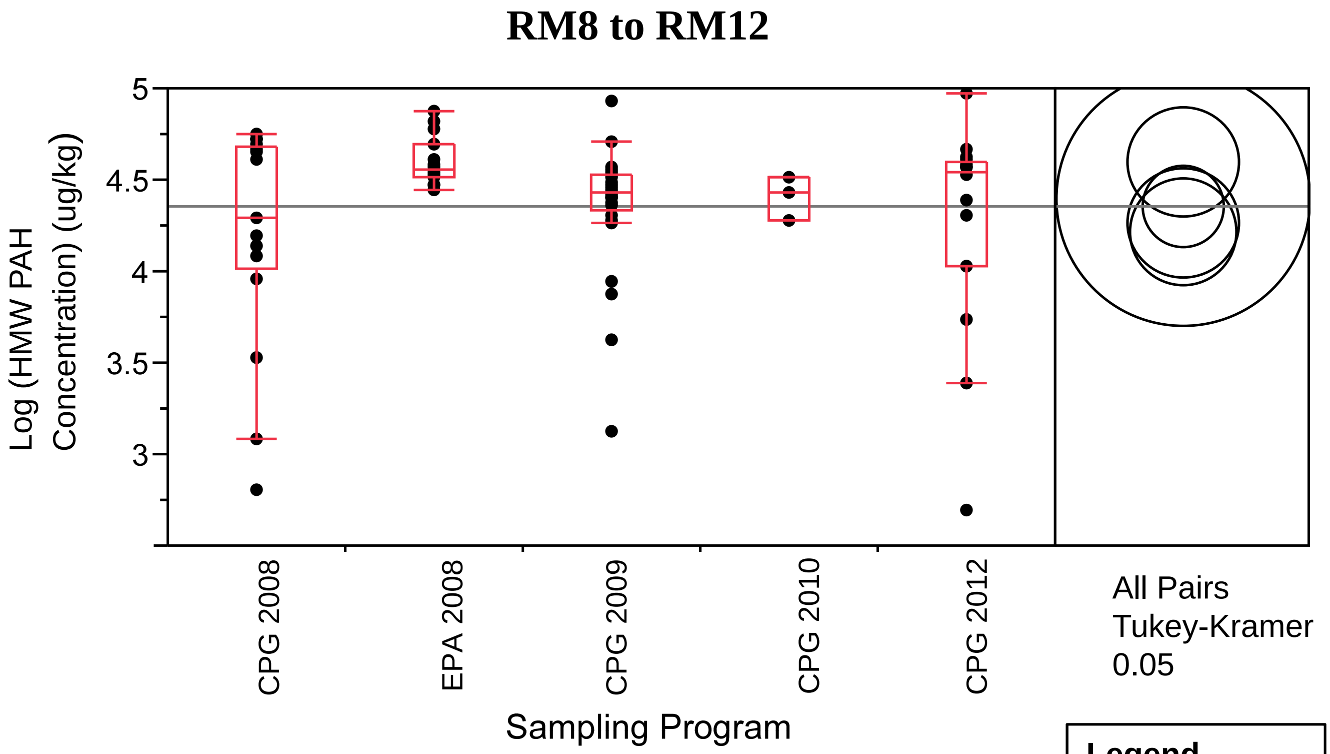
RM2 to RM8

HMW PAH (0-6 inch) by Sampling Program at RM0 to RM2 and RM2 to RM8

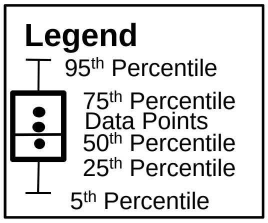
Lower Eight Miles of the Lower Passaic River

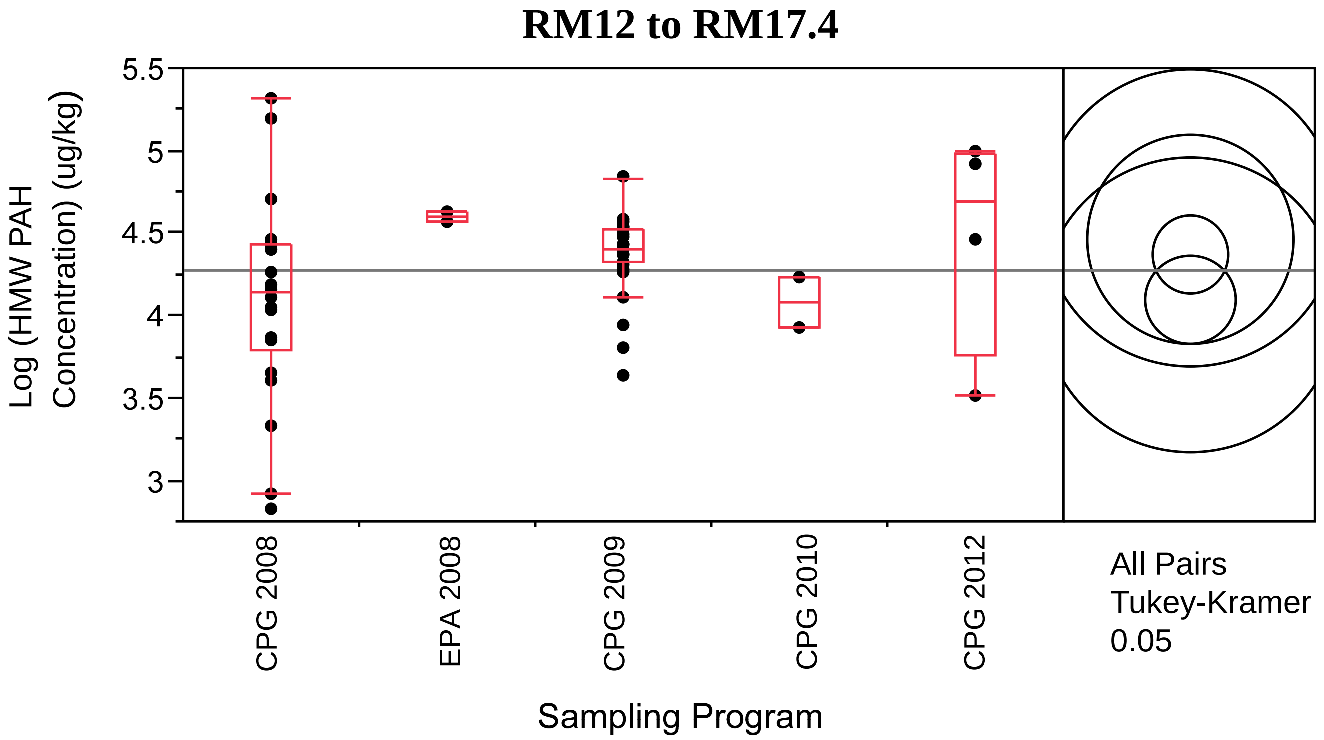
Figure 3.3-7a

2014


RM8 to RM12

Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.



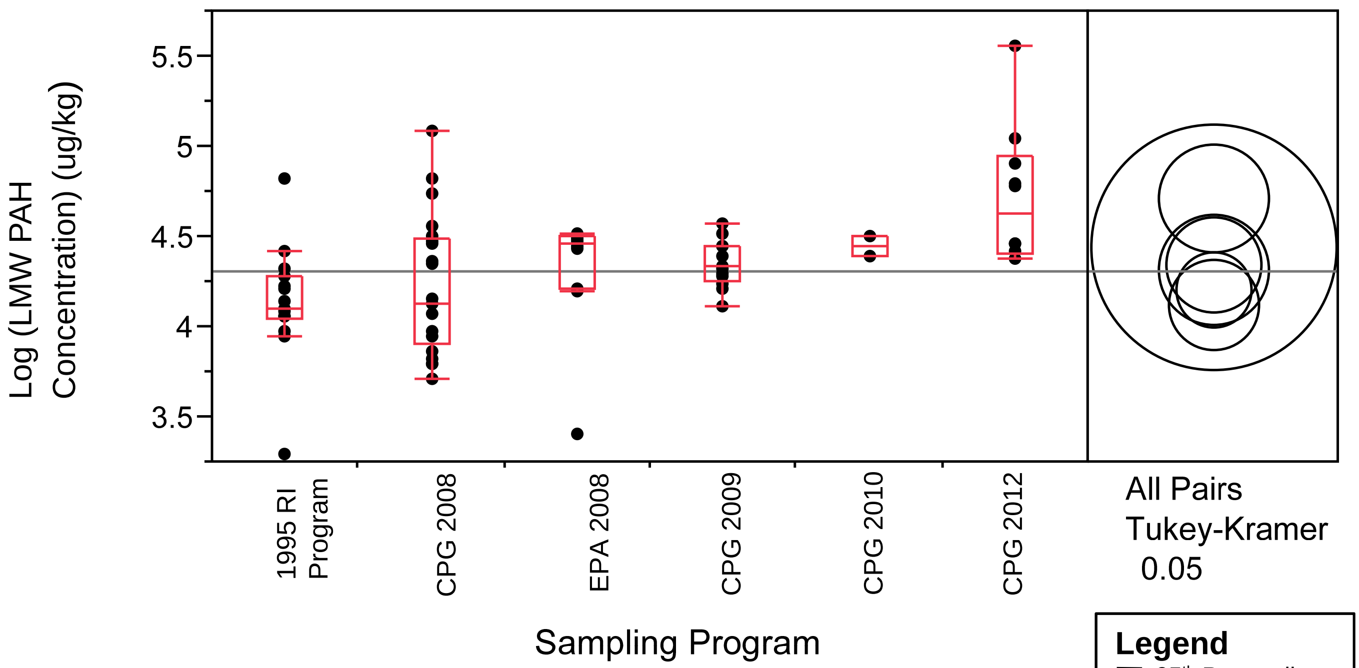

RM12 to RM17.4

HMW PAH (0-6 inch) by Sampling Program at RM8 to RM12 and RM12 to RM17.4

Lower Eight Miles of the Lower Passaic River

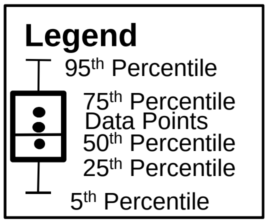
Figure 3.3-7b

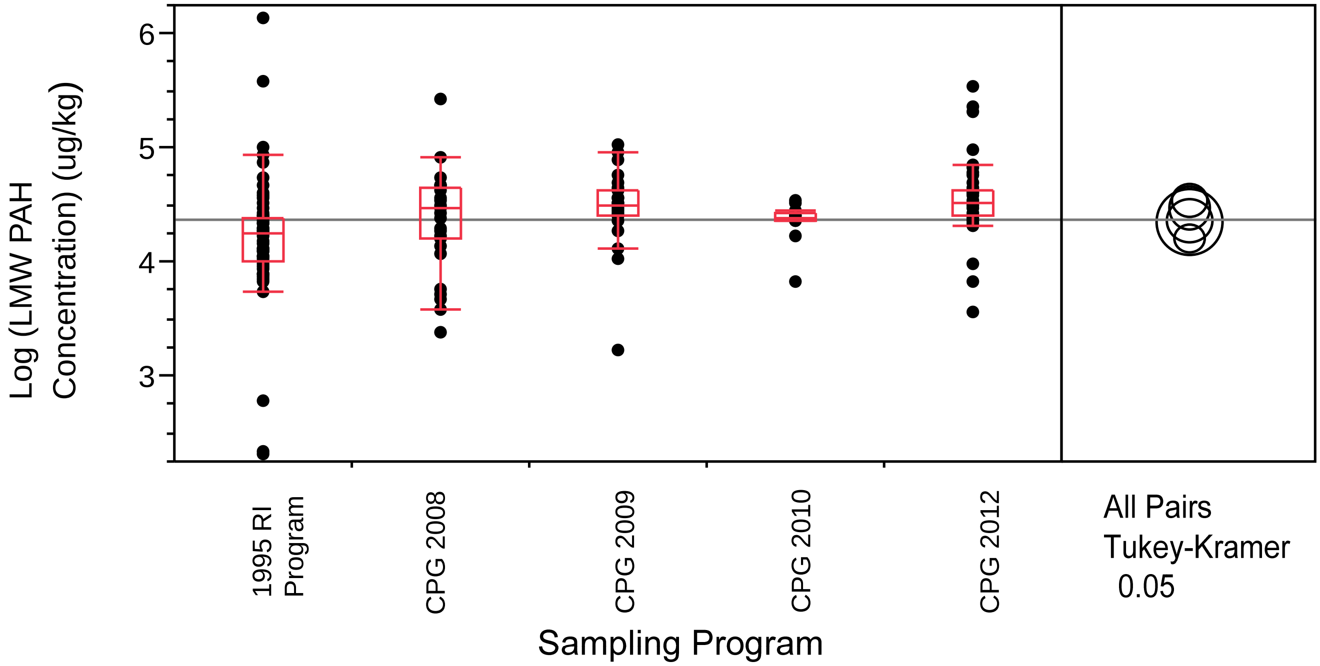
2014



RM0 to RM2

Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.





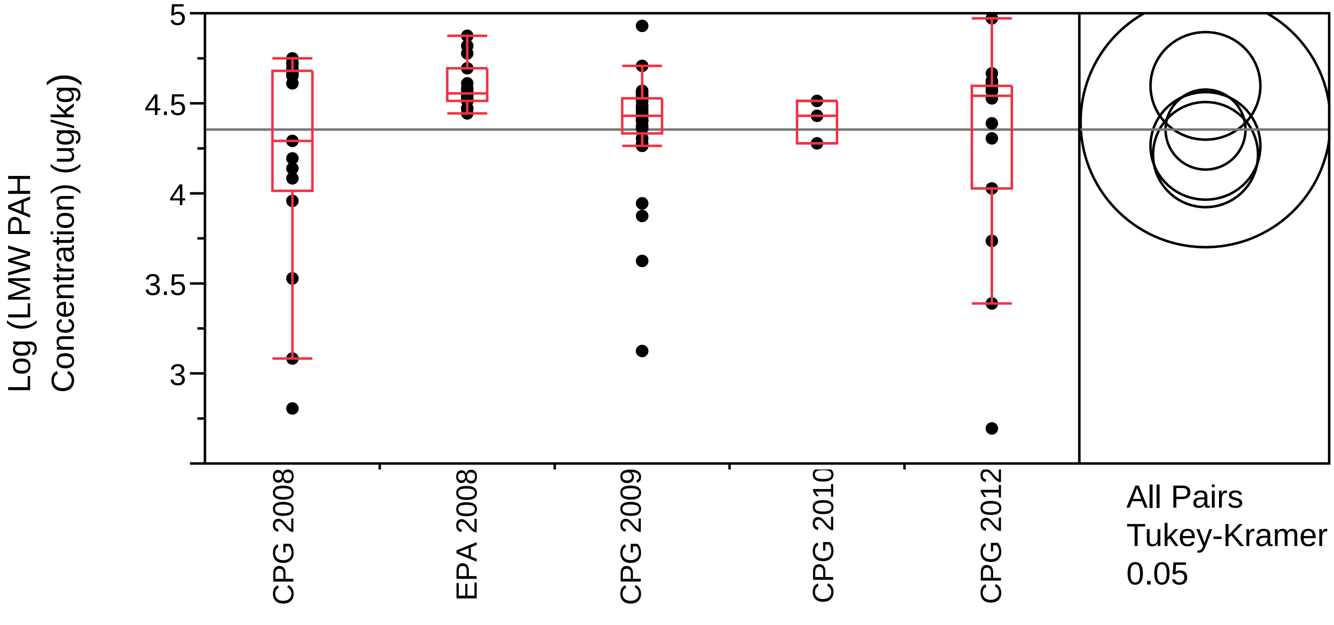
RM2 to RM8

LMW PAH (0-6 inch) by Sampling Program
at RM0 to RM2 and RM2 to RM8
Lower Eight Miles of the Lower Passaic River

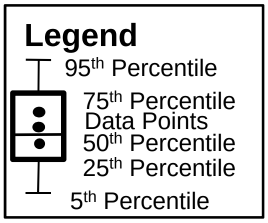
Figure 3.3-8a

2014

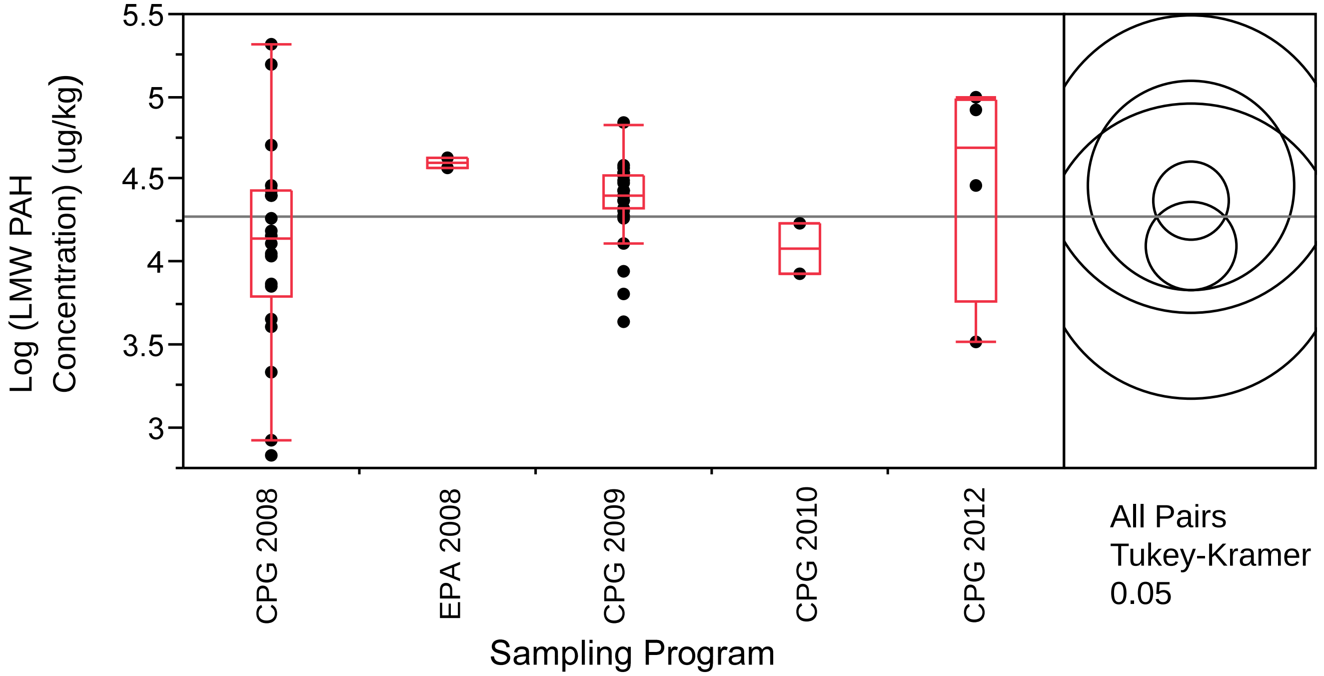
RM8 to RM12



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.



RM12 to RM17.4



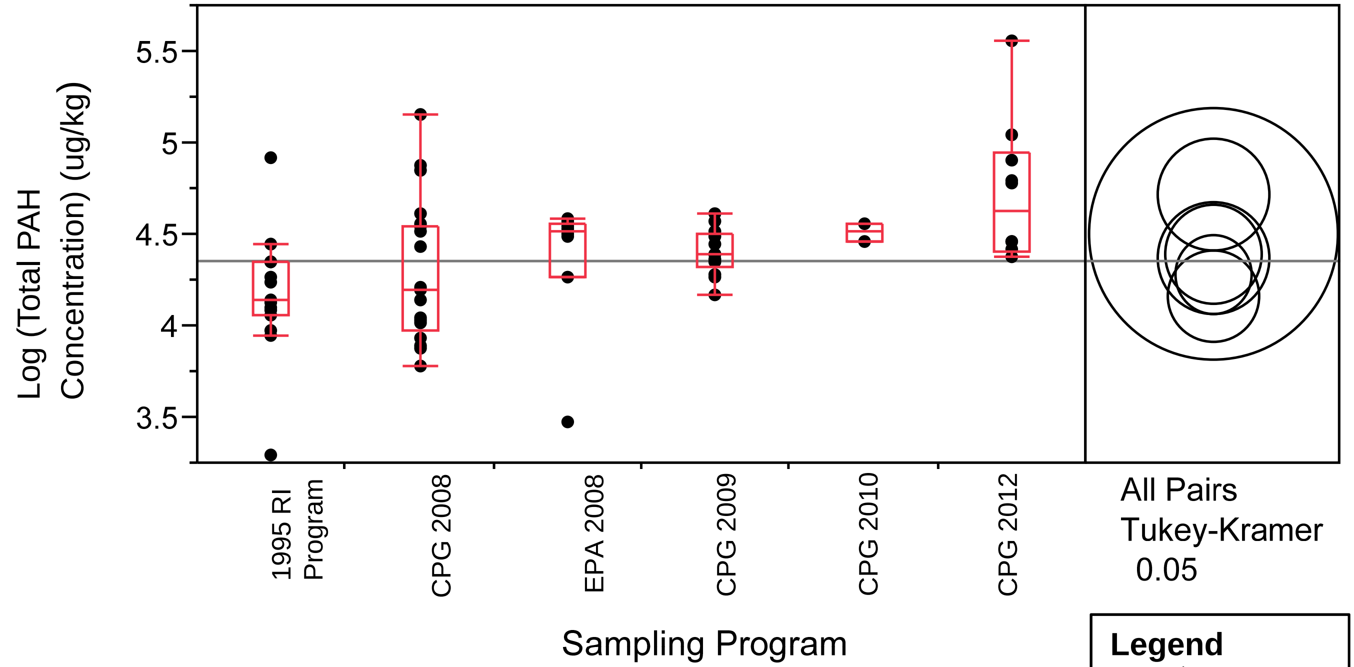
LMW PAH (0-6 inch) by Sampling Program at RM8 to RM12 and RM12 to RM17.4

Lower Eight Miles of the Lower Passaic River

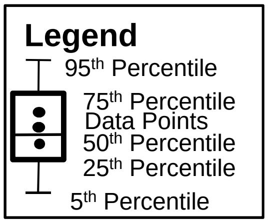
Figure 3.3-8b

2014

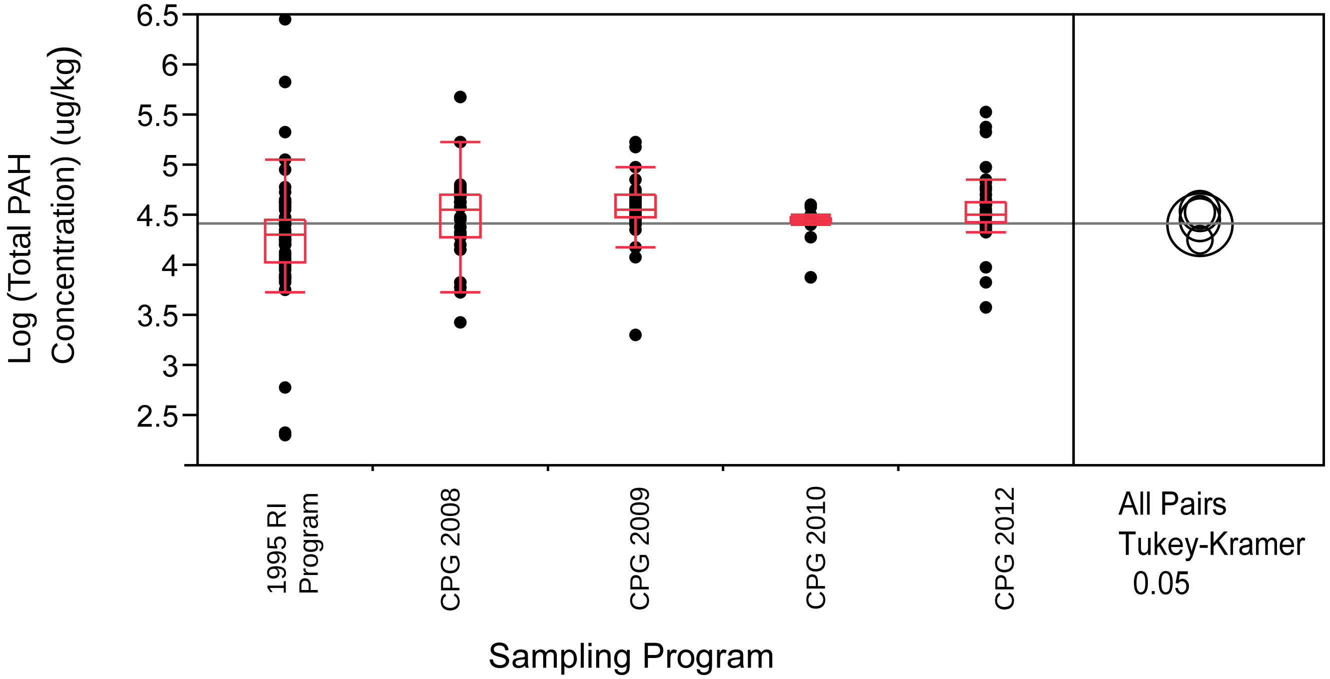
RM0 to RM2



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.



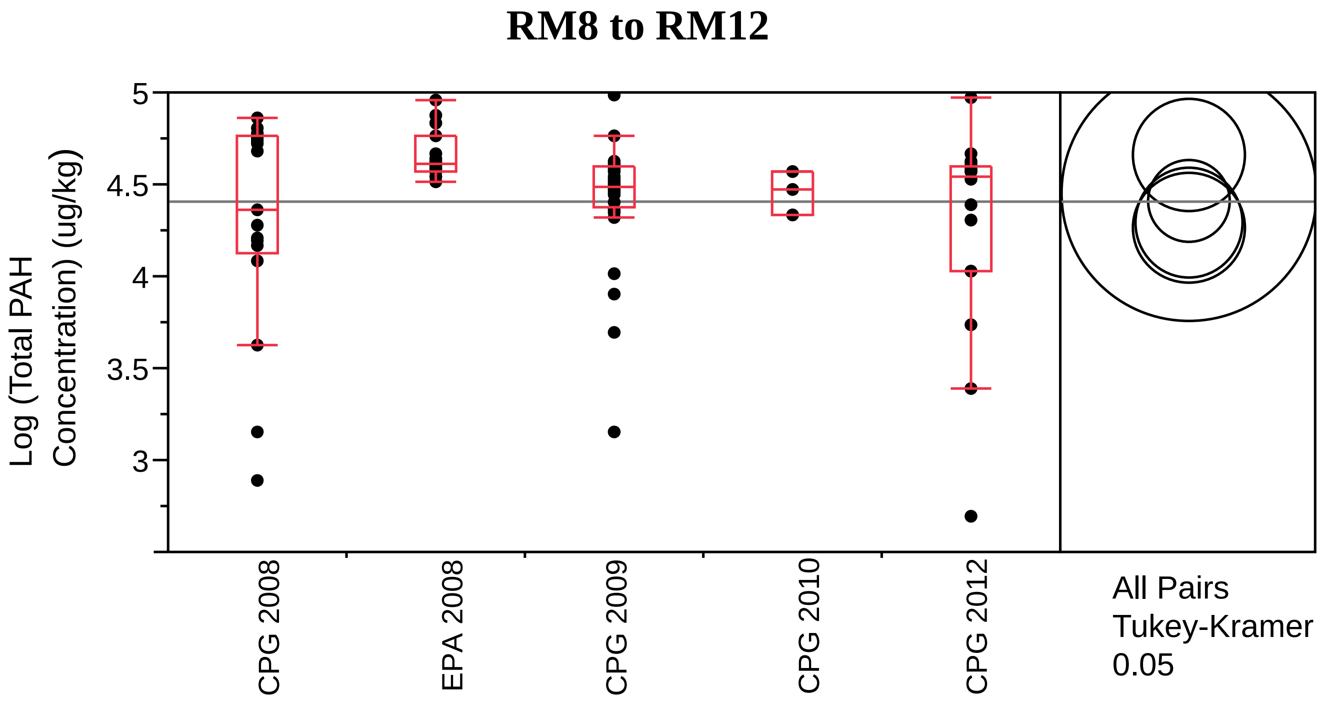
RM2 to RM8



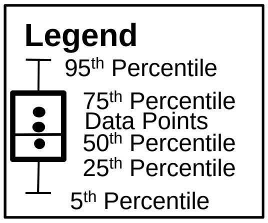
Total PAH (0-6 inch) by Sampling Program
at RM0 to RM2 and RM2 to RM8
Lower Eight Miles of the Lower Passaic River

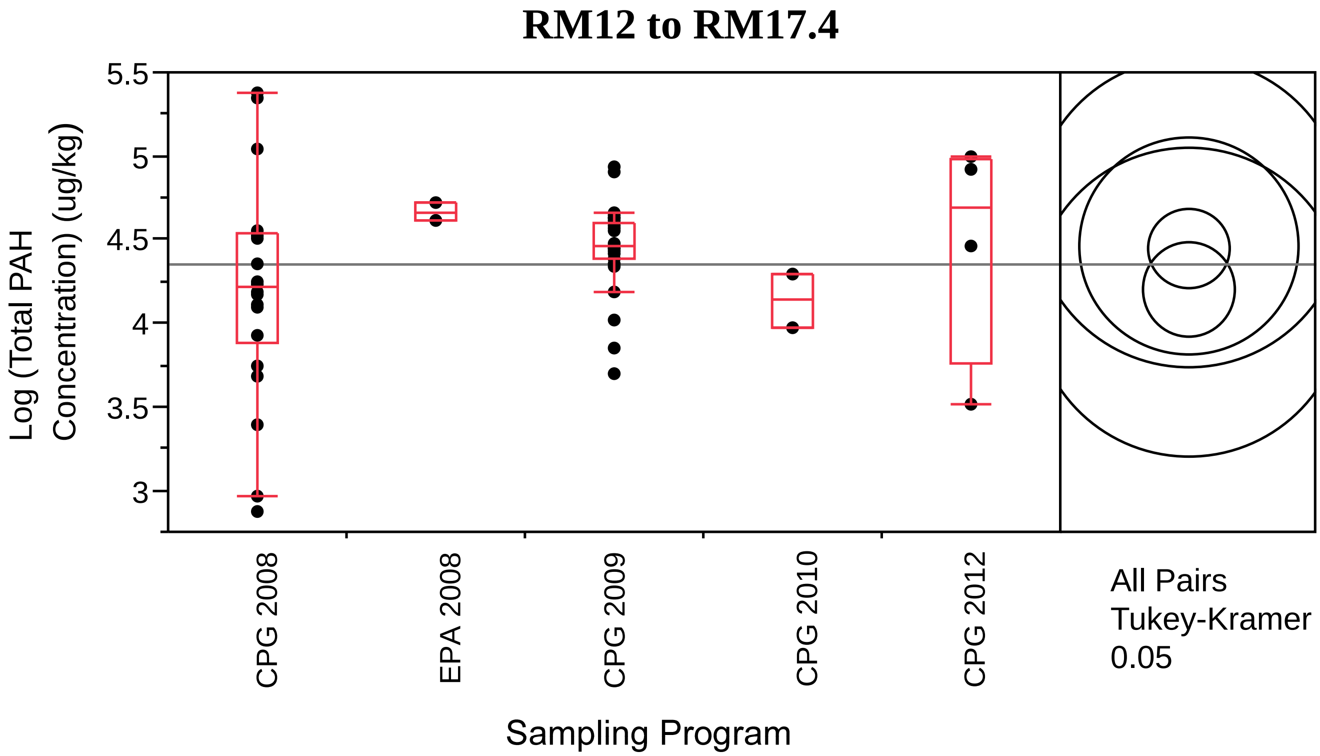
Figure 3.3-9a

2014



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.



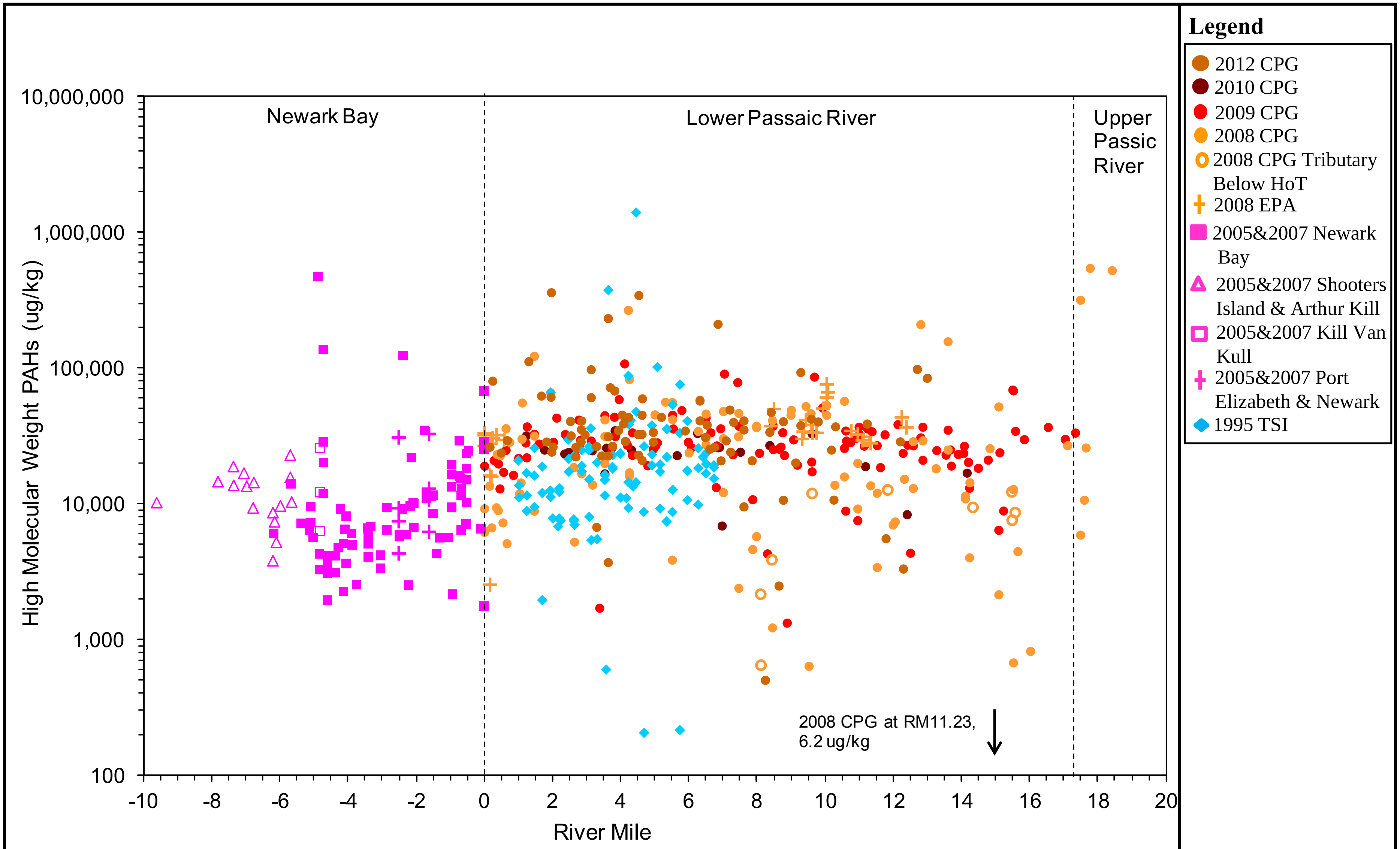


Total PAH (0-6 inch) by Sampling Program at RM8 to RM12 and RM12 to RM17.4

Lower Eight Miles of the Lower Passaic River

Figure 3.3-9b

2014

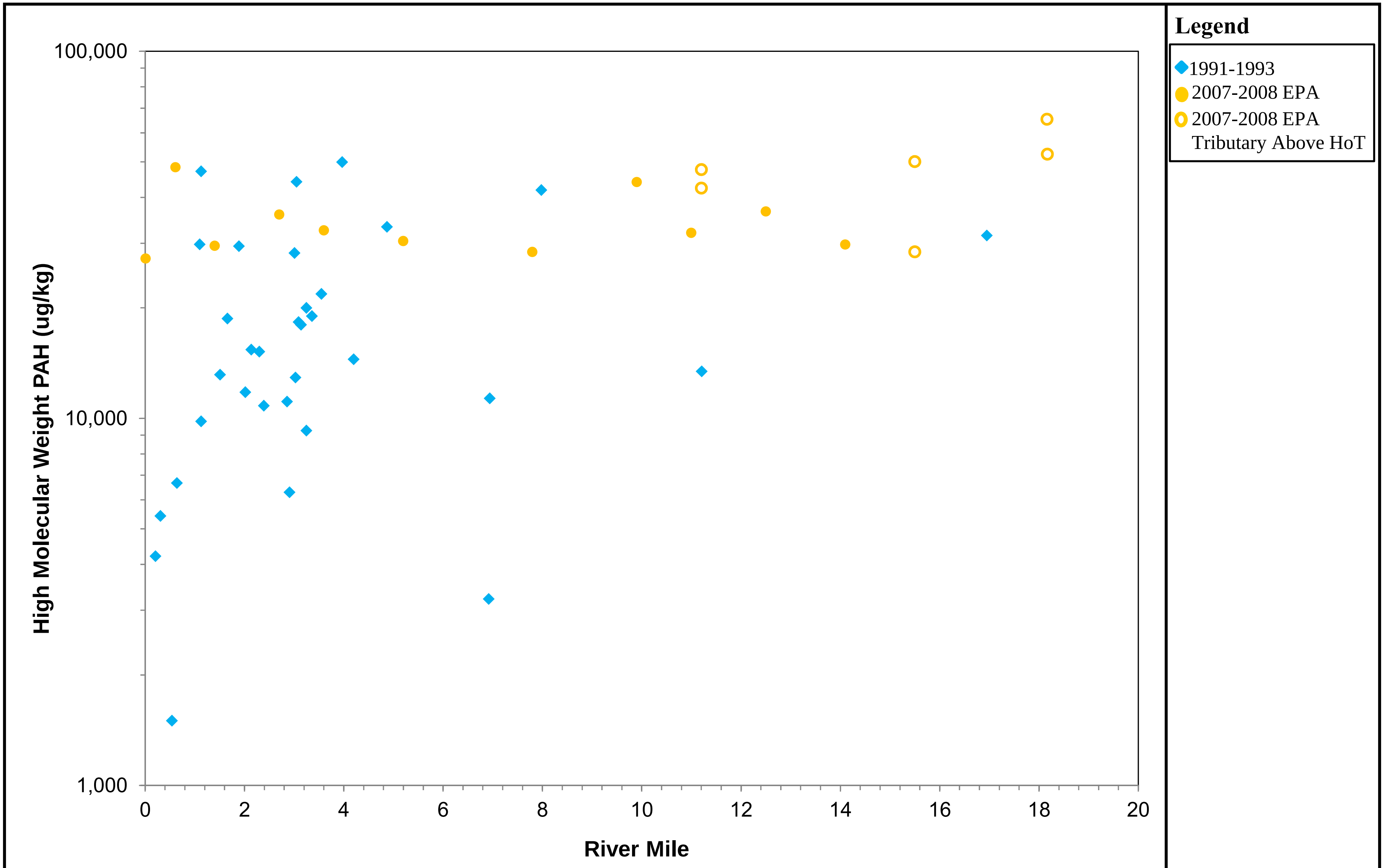


HMW PAH Concentration (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.3-10

2014

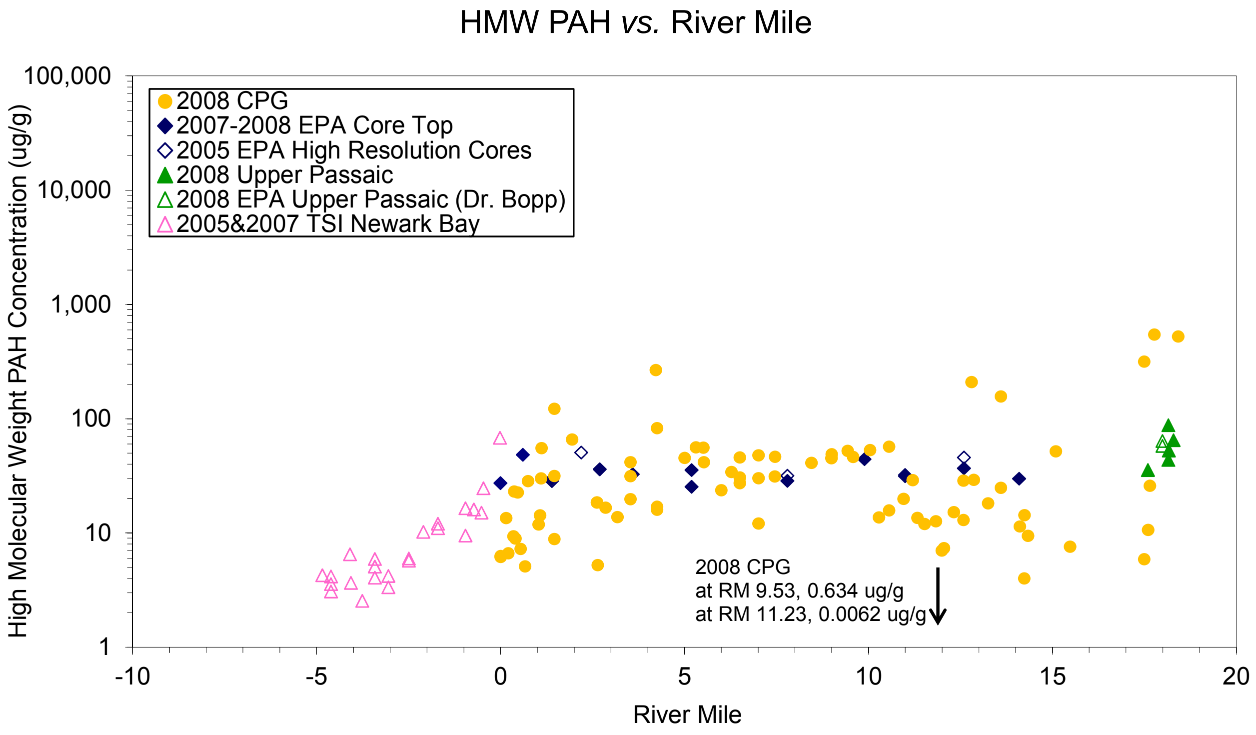


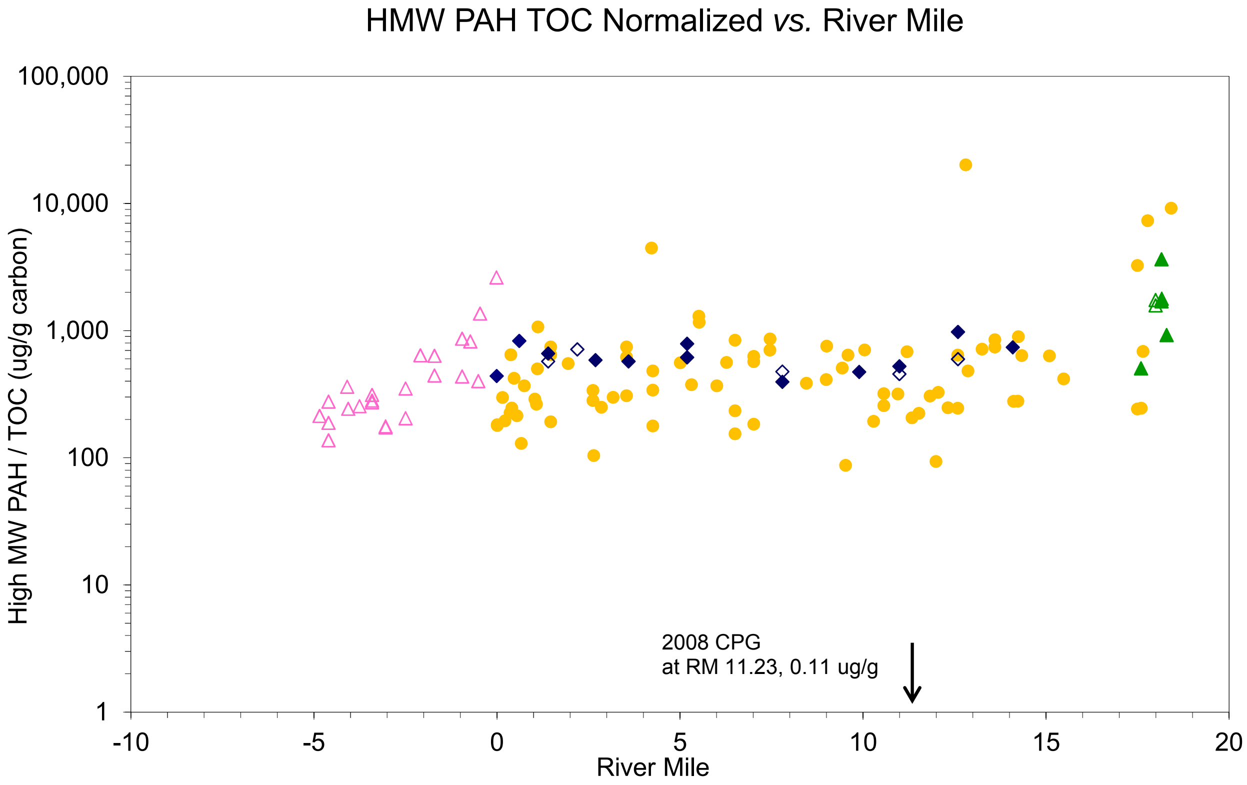
HMW PAH Concentration (0 - ≤2 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.3-11

2014



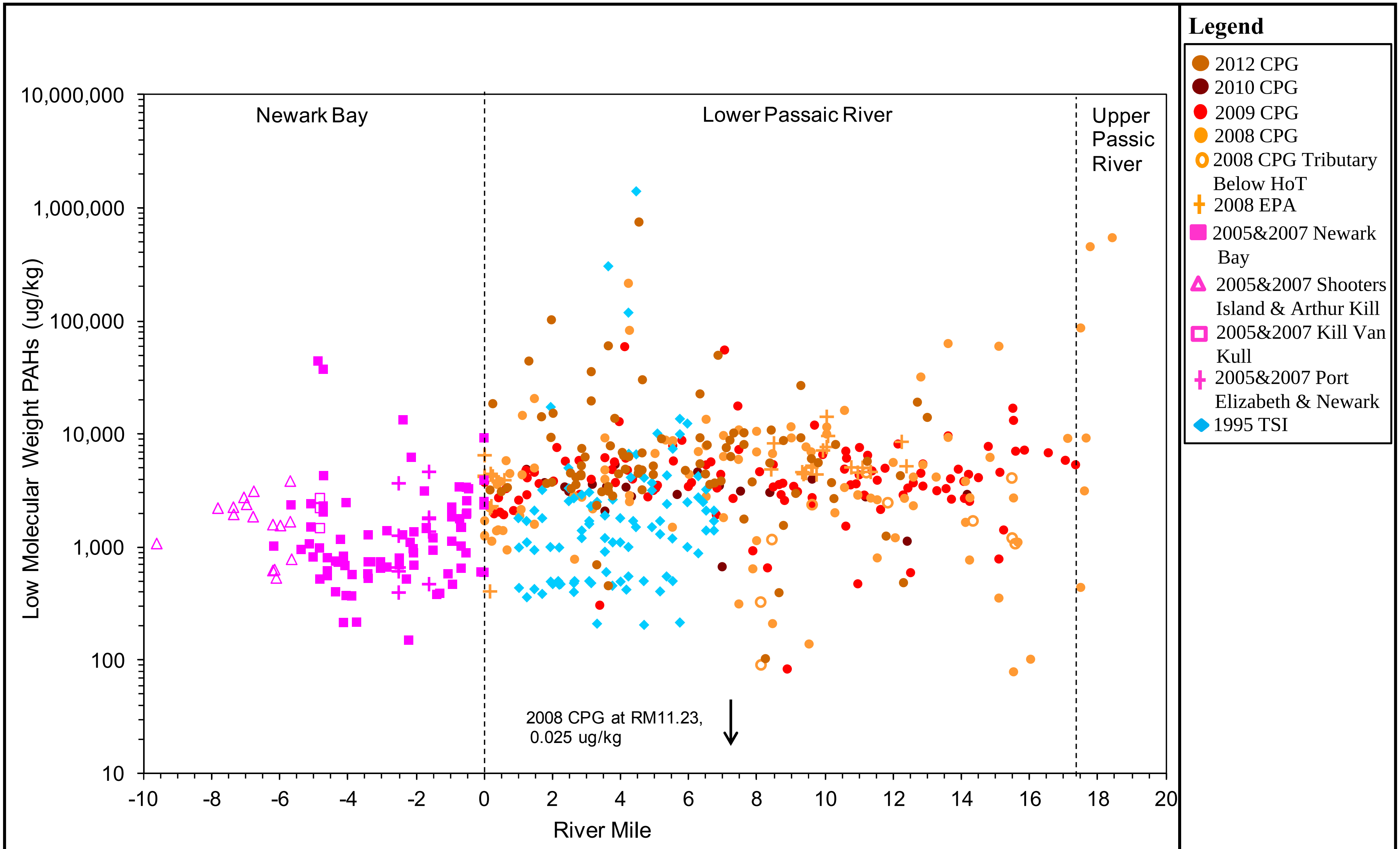


HMW PAH in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Passaic River

Figure 3.3-12

2014

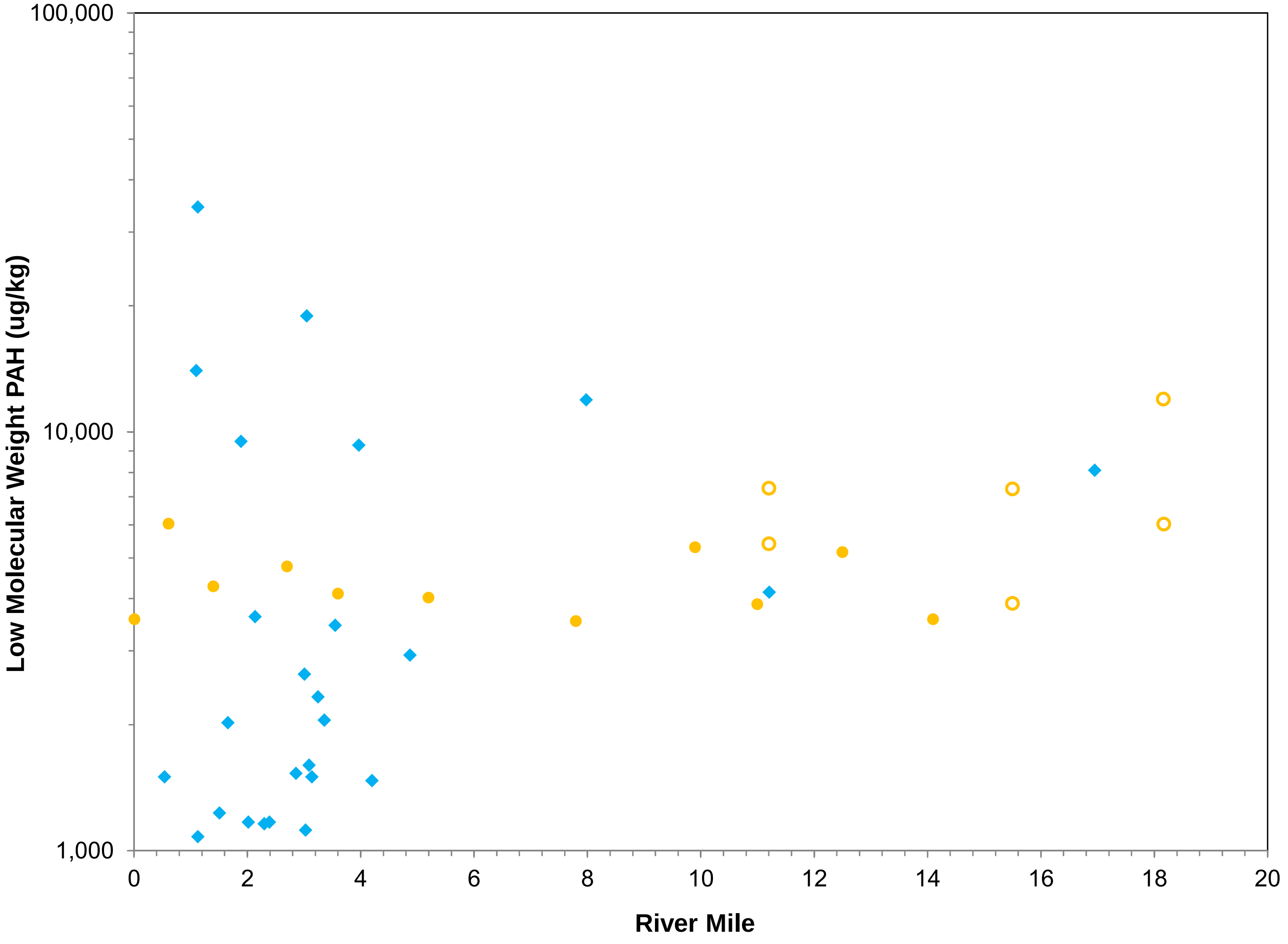


LMW PAH Concentration (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.3-13

2014



Legend

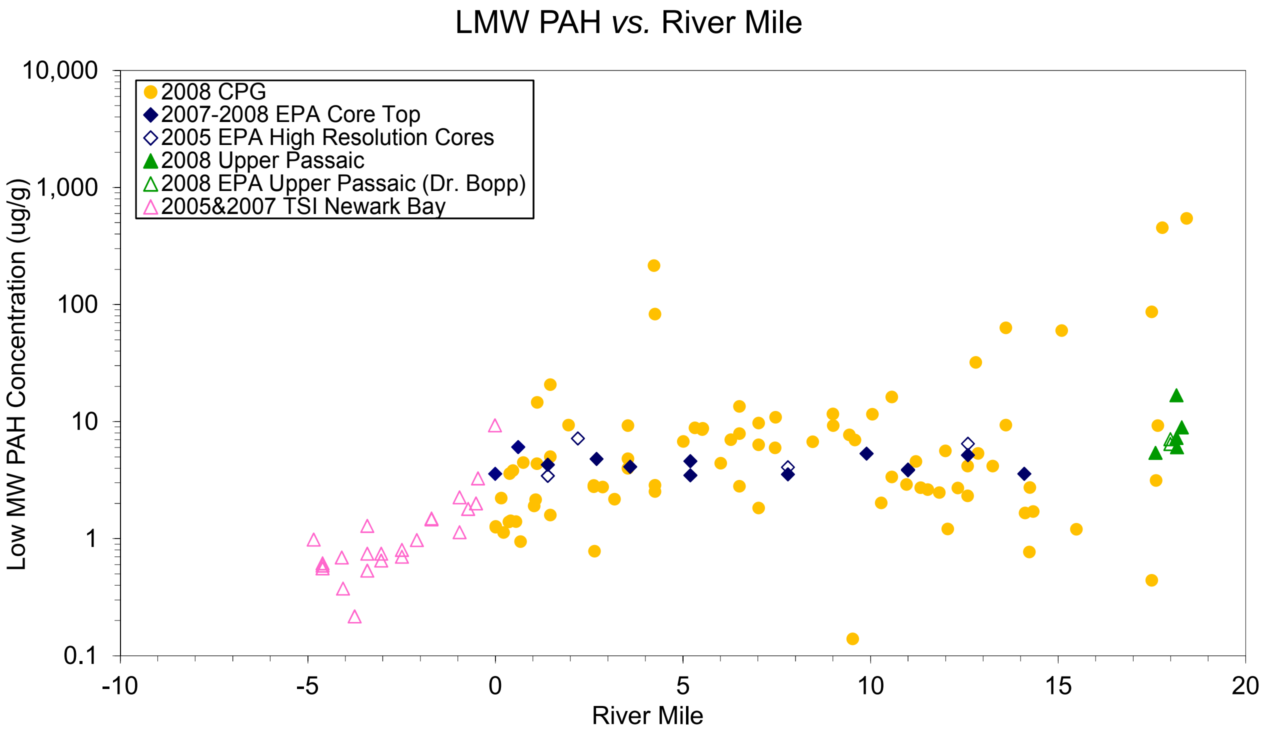
- ◆ 1991-1993
- ● 2007-2008 EPA
- ○ 2007-2008 EPA Tributary Above HoT

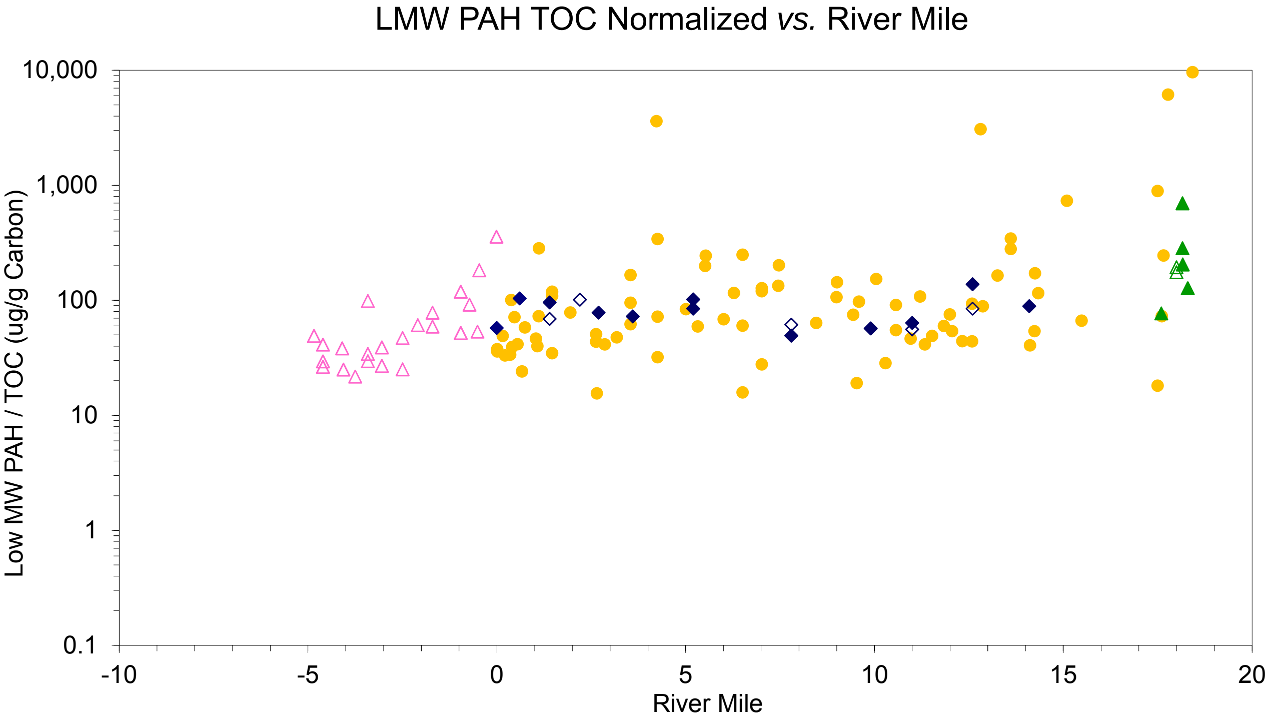
LMW PAH Concentration (0 - ≤2 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.3-14

2014



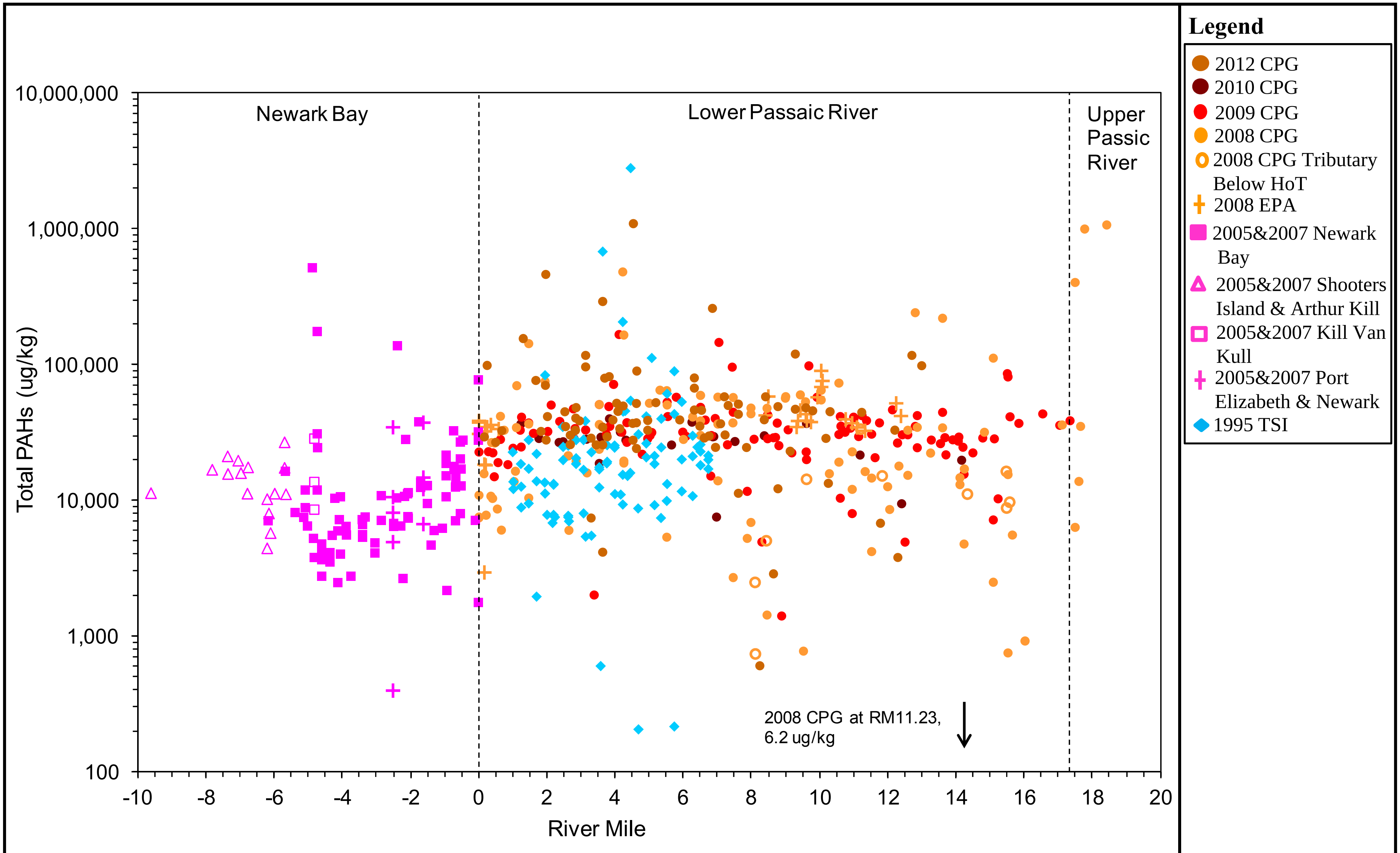


LMW PAH in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Passaic River

Figure 3.3-15

2014

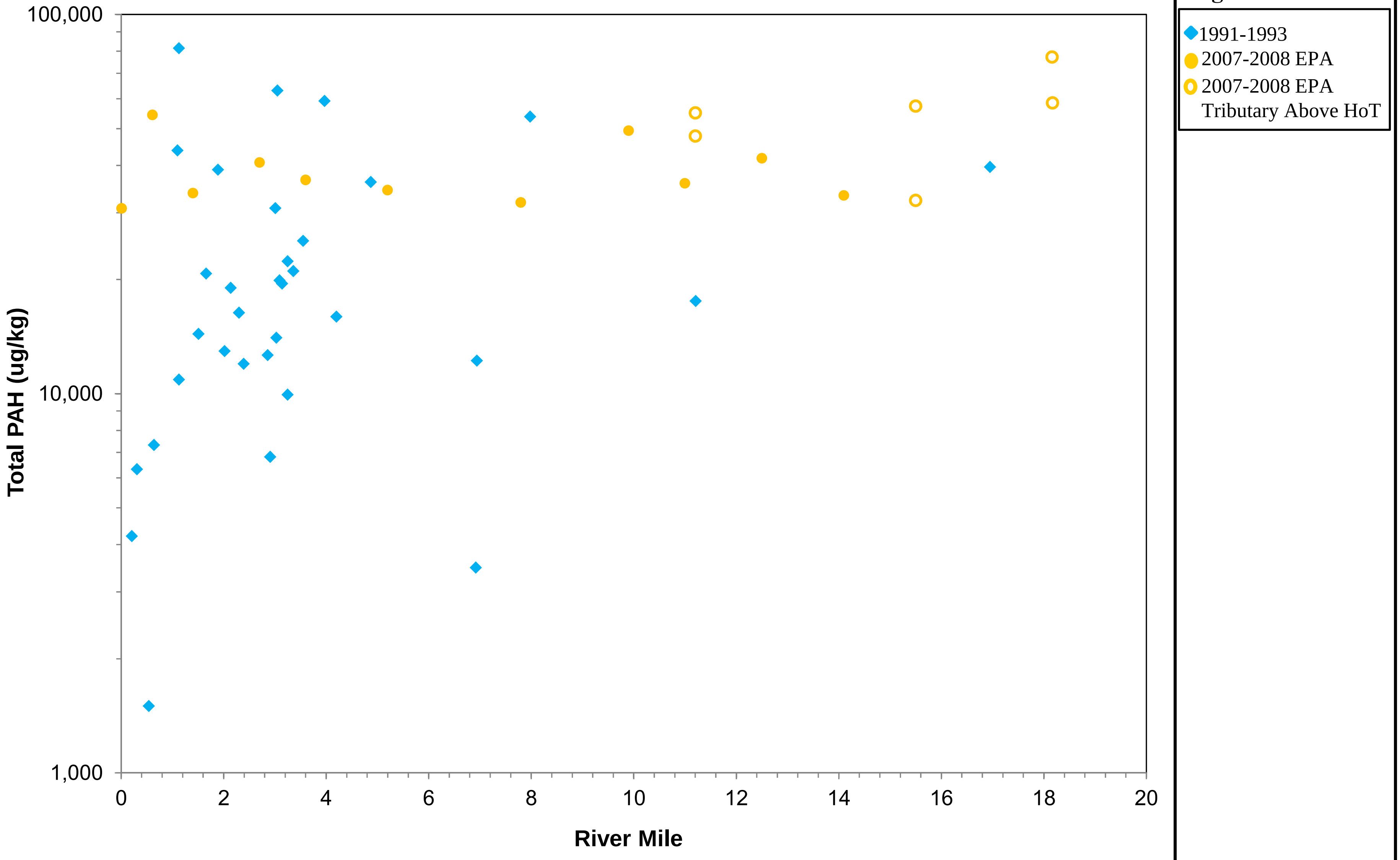


Total PAH Concentration (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.3-16

2014

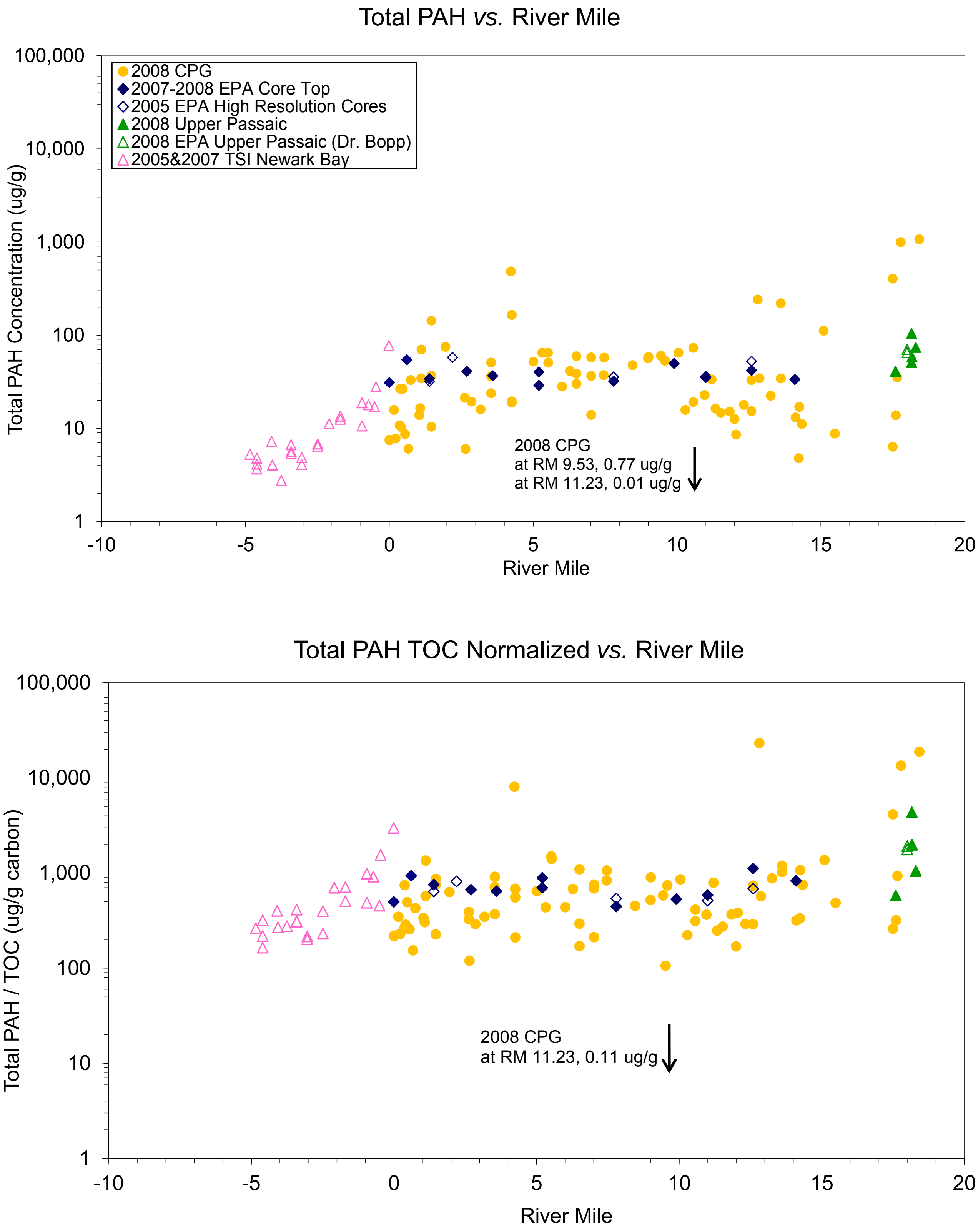


Total PAH Concentration (0 - ≤2 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.3-17

2014

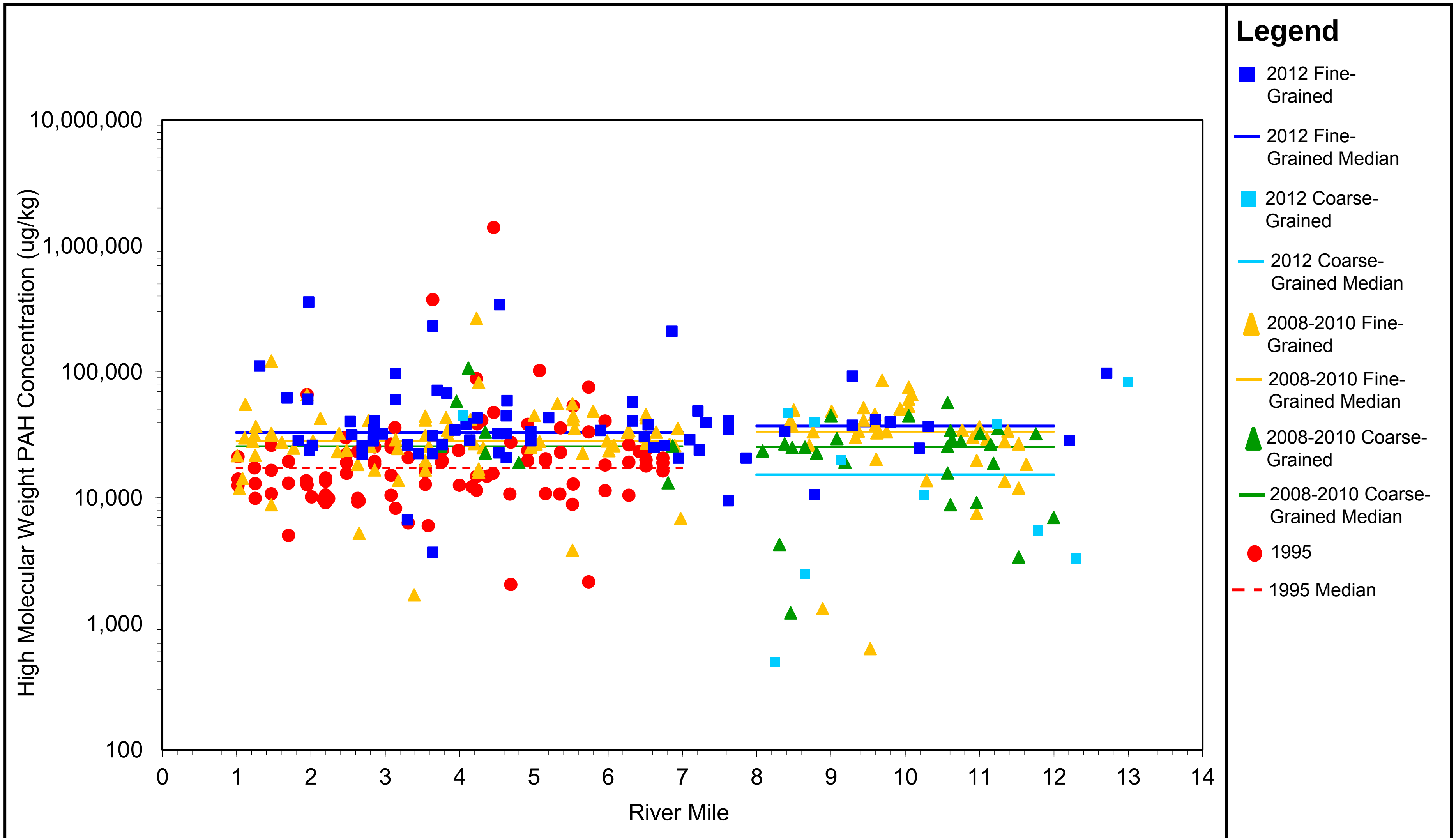


Total PAH in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Passaic River

Figure 3.3-18

2014



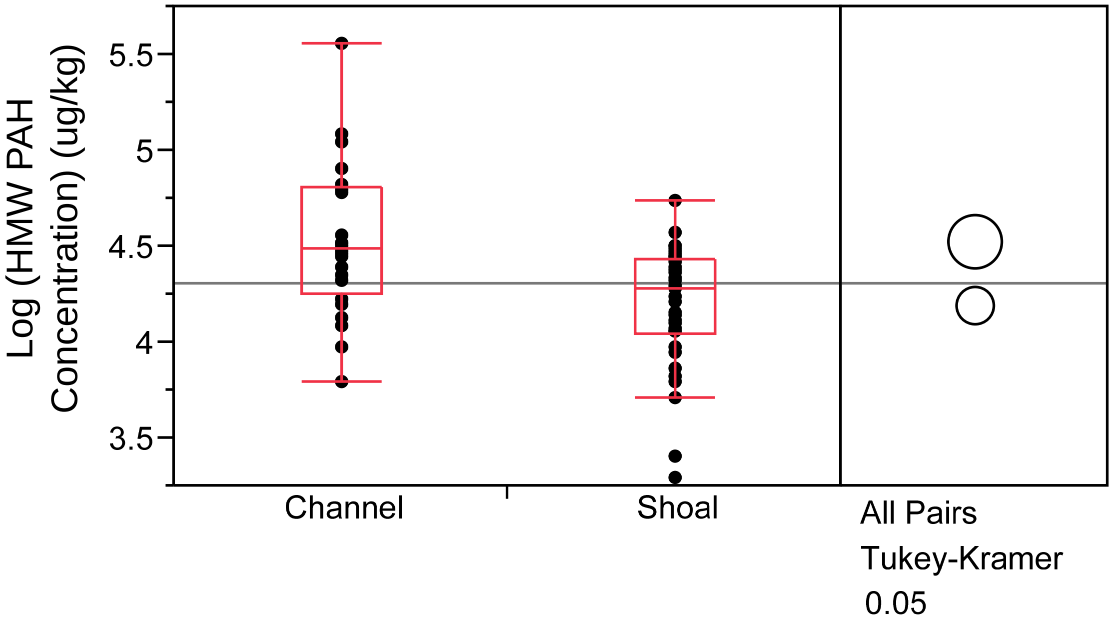
Comparison of HMW PAH Surface Concentration (0-6 inches)
RM1 to RM7 *vs.* RM8 to RM12

Lower Eight Miles of the Lower Passaic River

Figure 3.3-19

2014

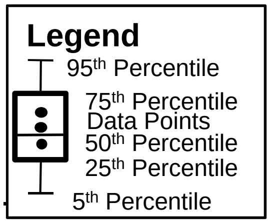
RM0 to RM2



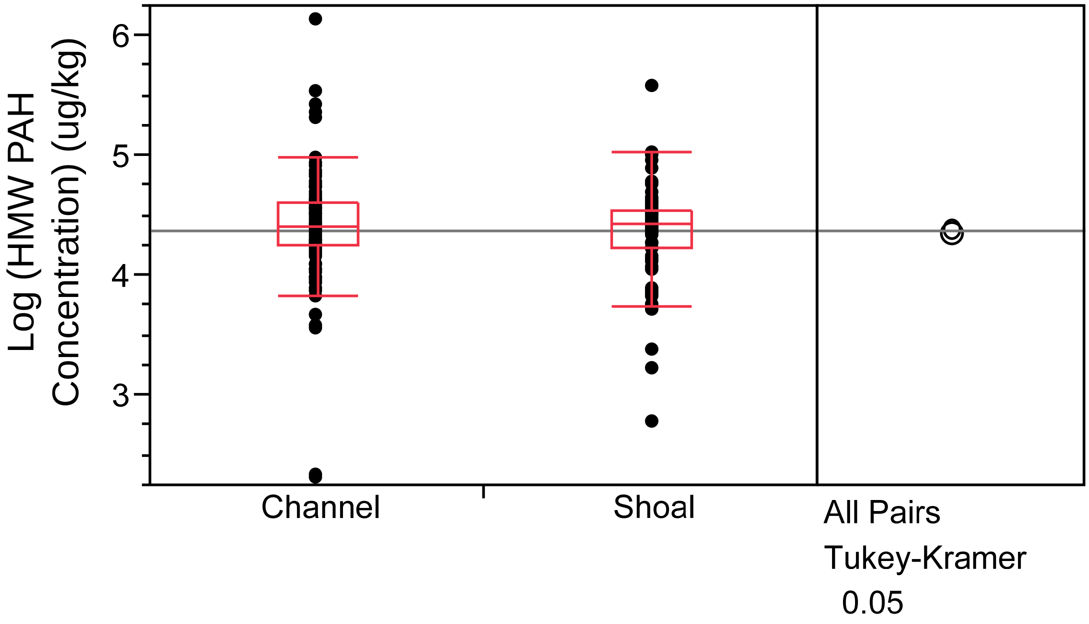
Notes:

1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.

2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



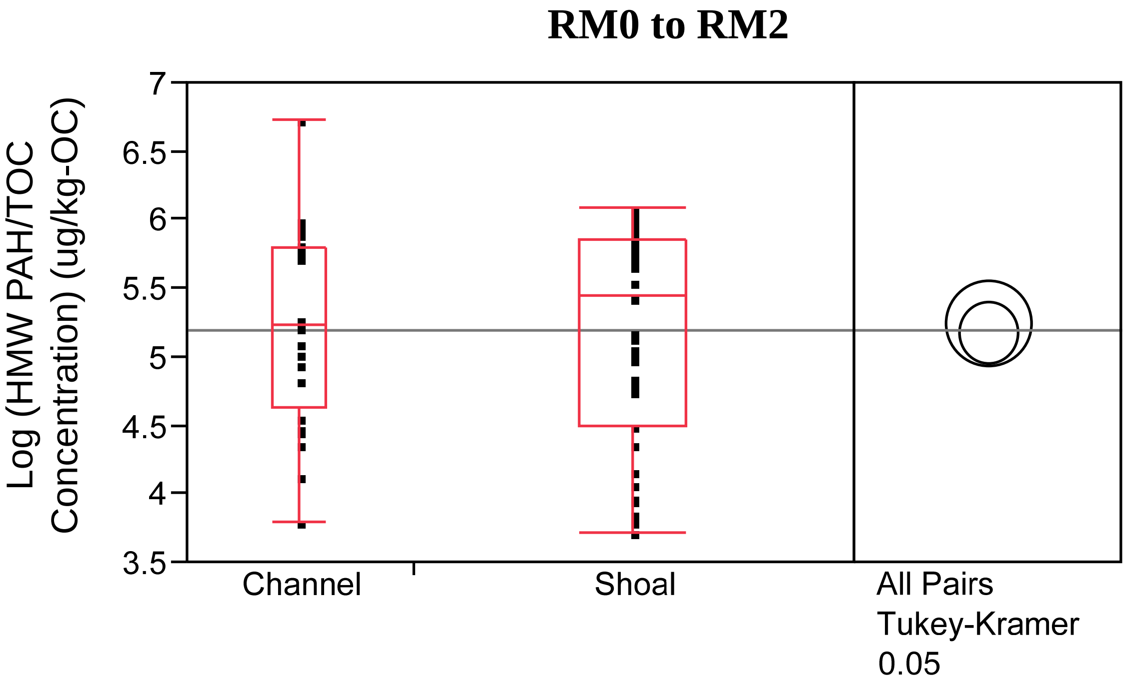
RM2 to RM8



HMW PAH (0-6 inch) by Channel and Shoal
at RM0 to RM2 and RM2 to RM8
Lower Eight Miles of the Lower Passaic River

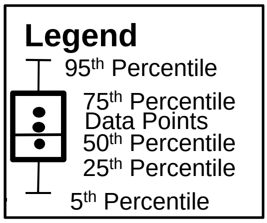
Figure 3.3-20a

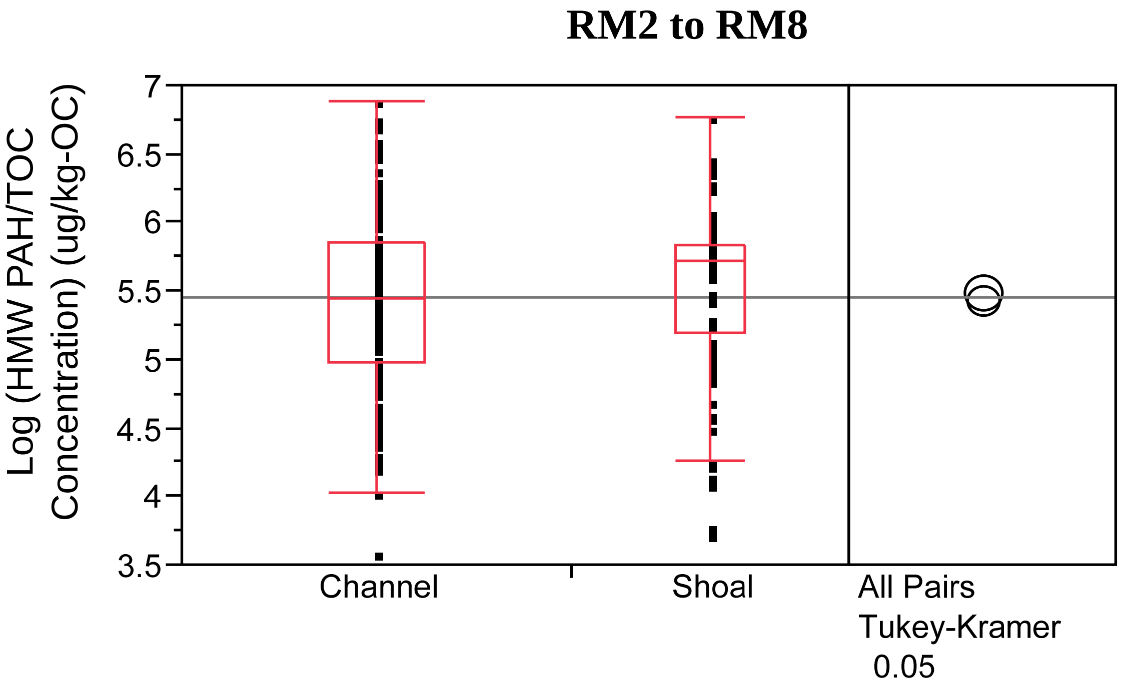
2014



Notes:

1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



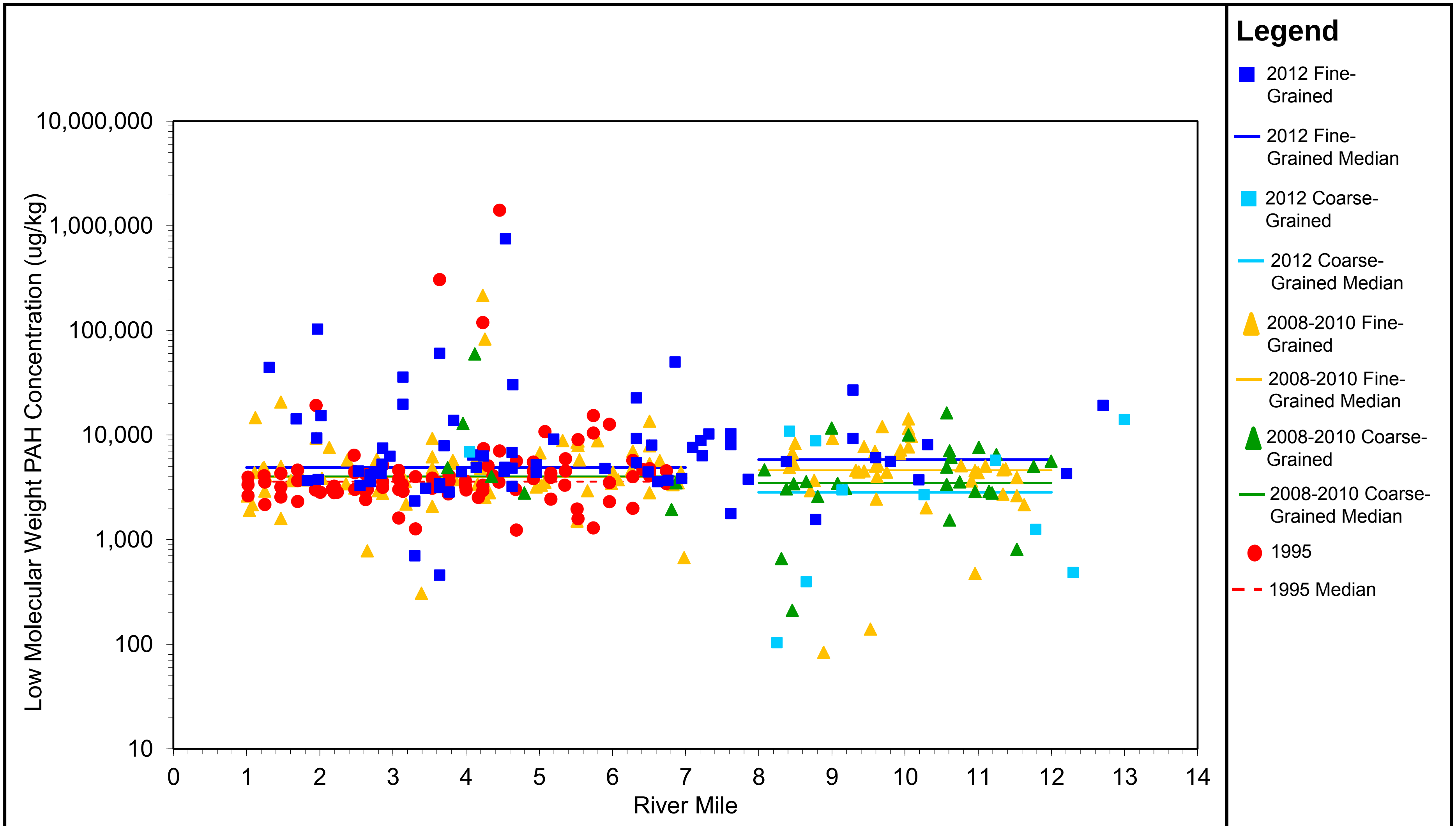


TOC Normalized HMW PAH (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 3.3-20b

2014

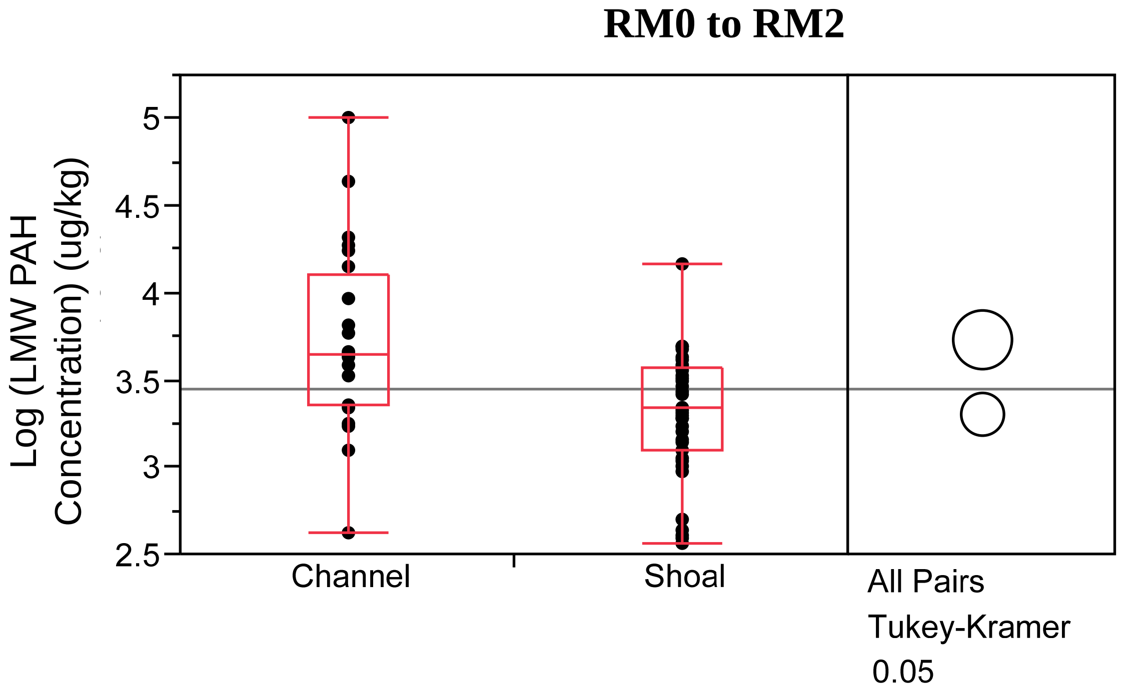


Comparison of LMW PAH Surface Concentration (0-6 inches)
RM1 to RM7 *vs.* RM8 to RM12

Lower Eight Miles of the Lower Passaic River

Figure 3.3-21

2014

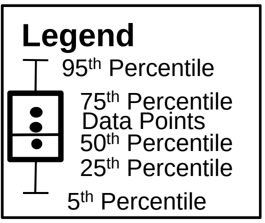


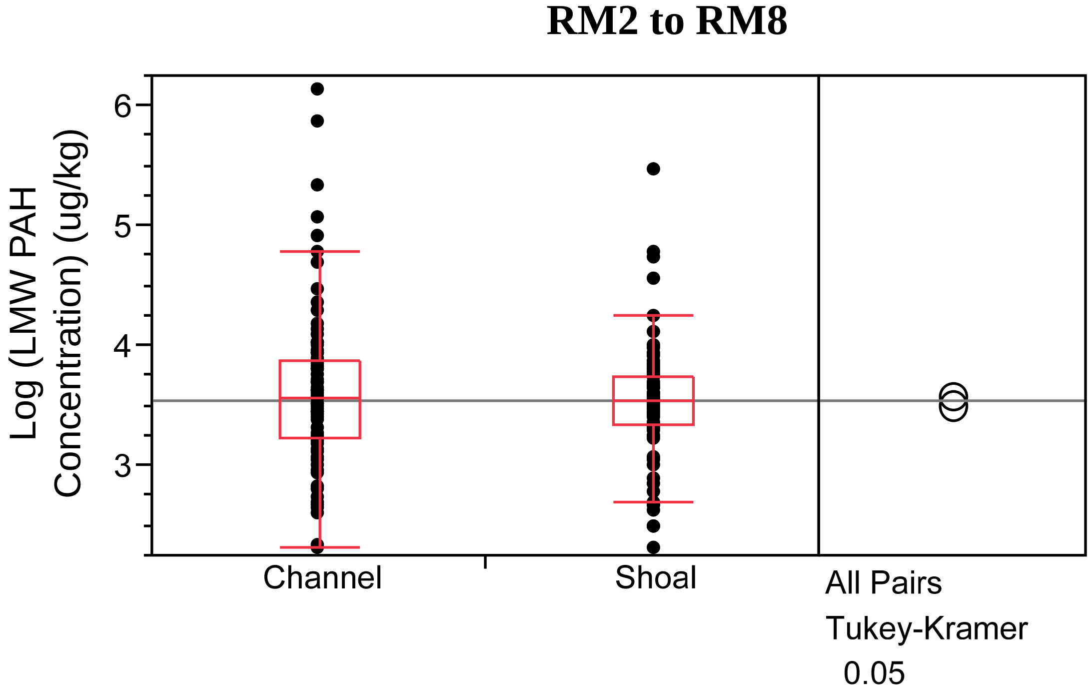
RM0 to RM2

Notes:

1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.

2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.





RM2 to RM8

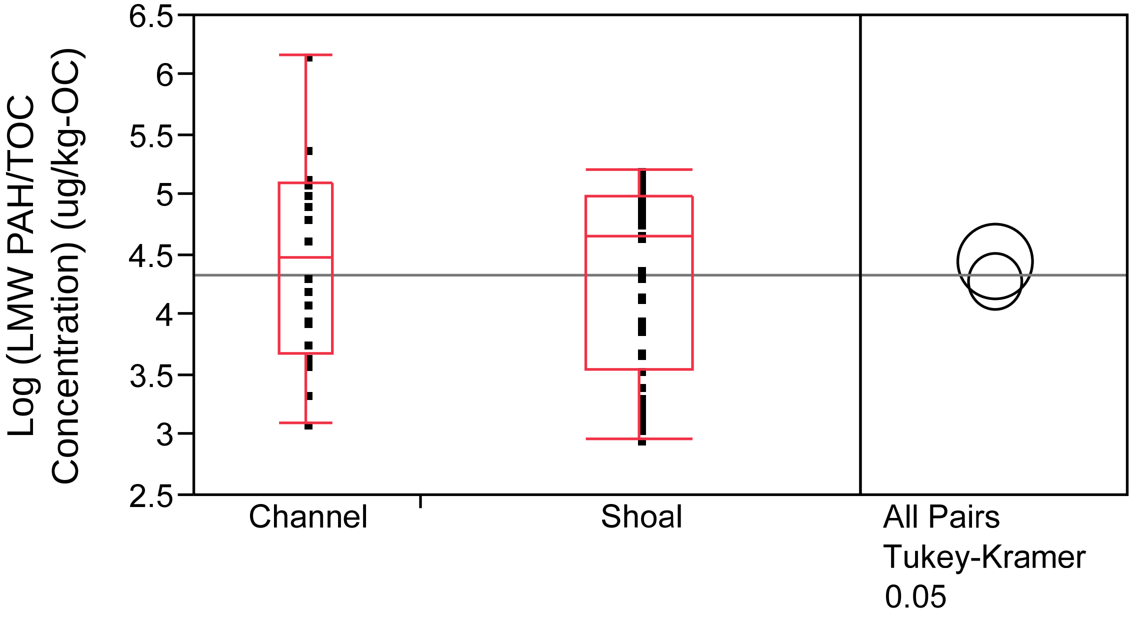
LMW PAH (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 3.3-22a

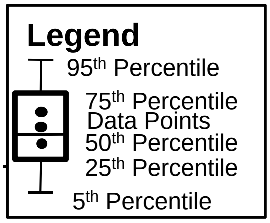
2014

RM0 to RM2

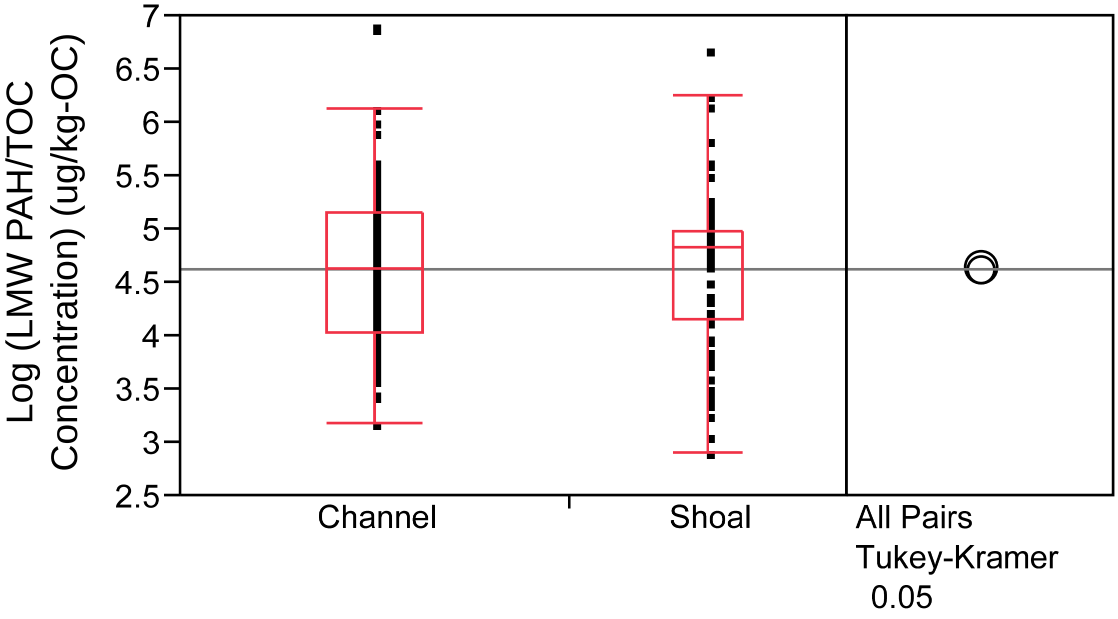


Notes:

1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



RM2 to RM8

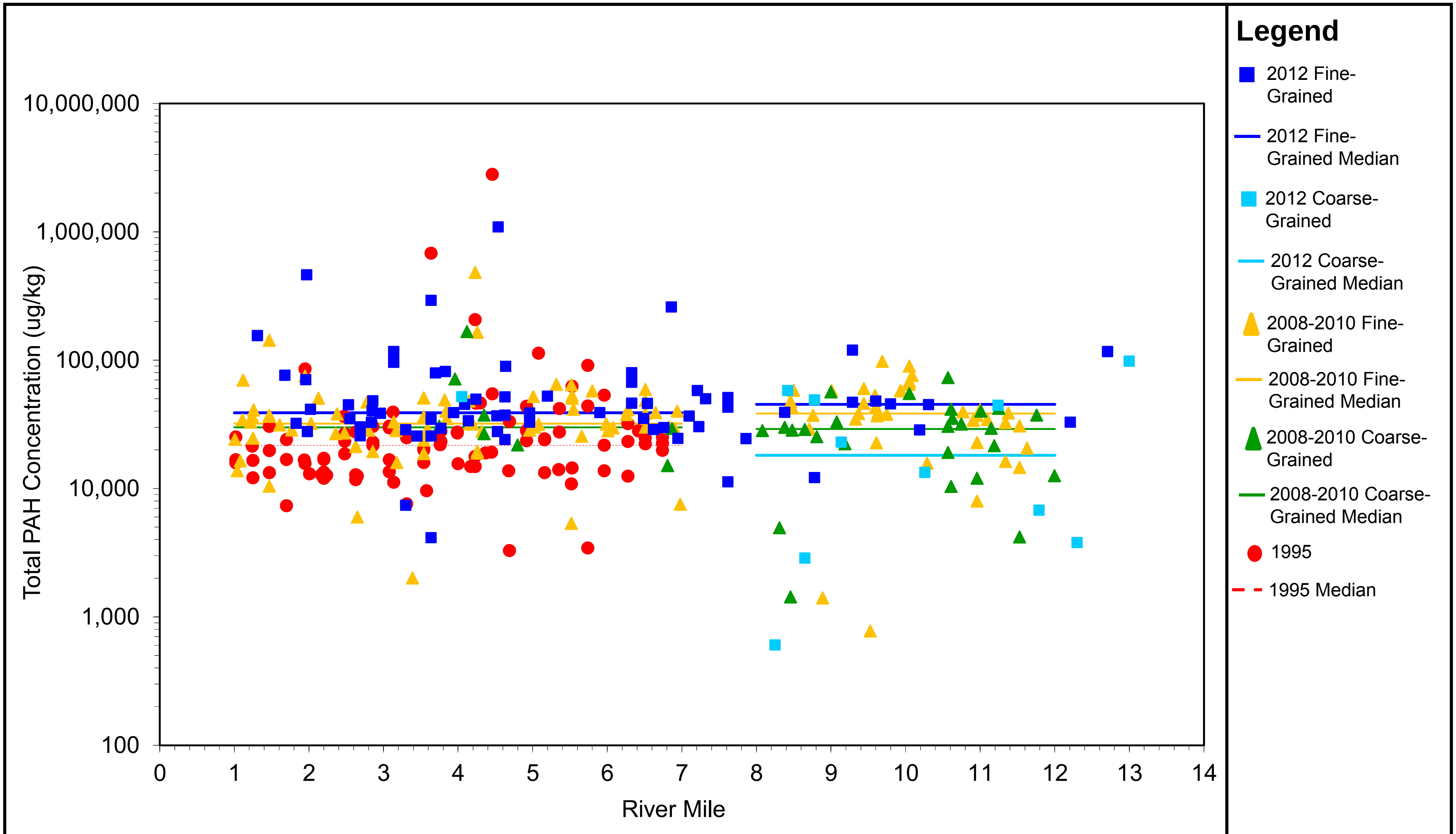


TOC Normalized LMW PAH (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 3.3-22b

2014

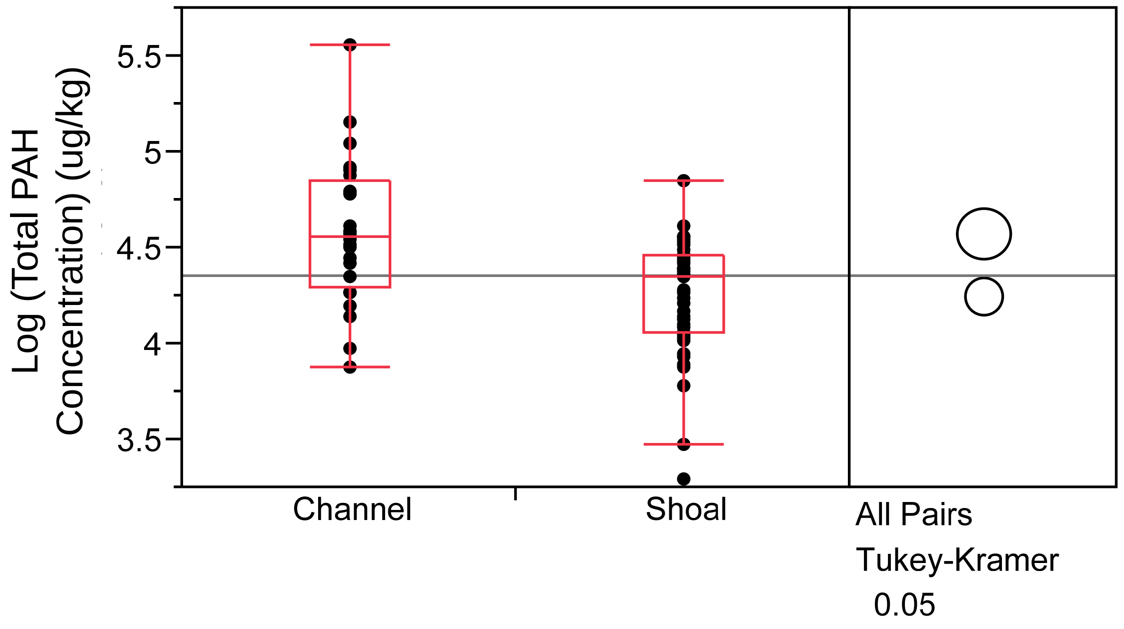


Comparison of Total PAH Surface Concentration (0-6 inches)
RM1 to RM7 *vs.* RM8 to RM12

Lower Eight Miles of the Lower Passaic River

Figure 3.3-23

2014

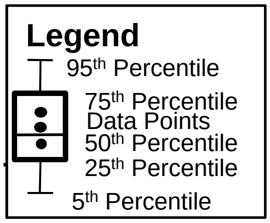


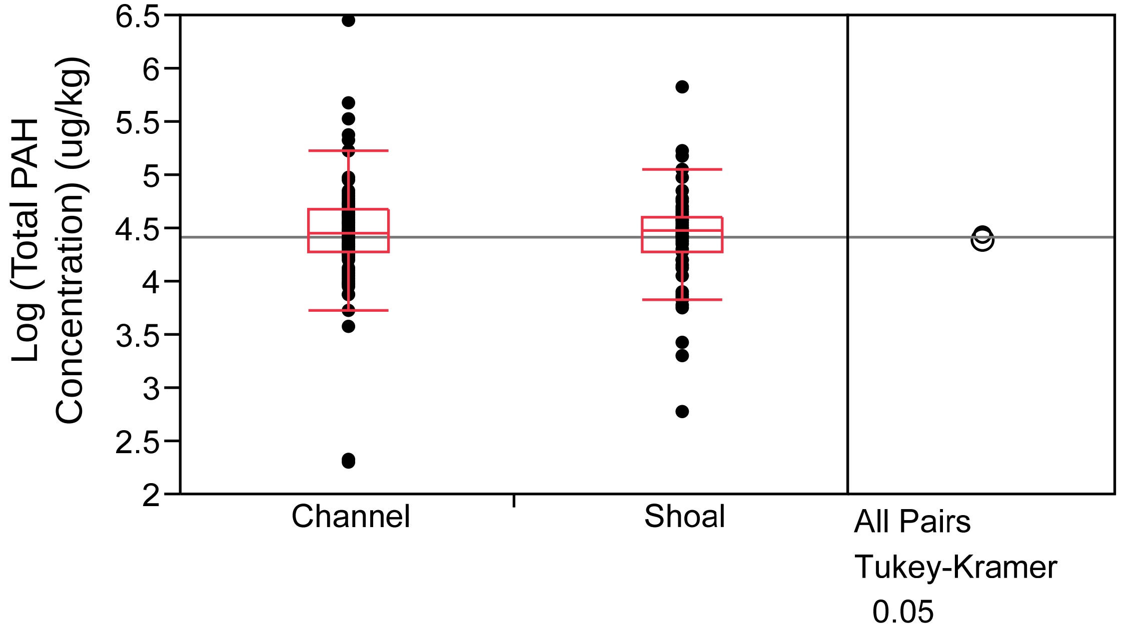
RM0 to RM2

Notes:

1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.

2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.





RM2 to RM8

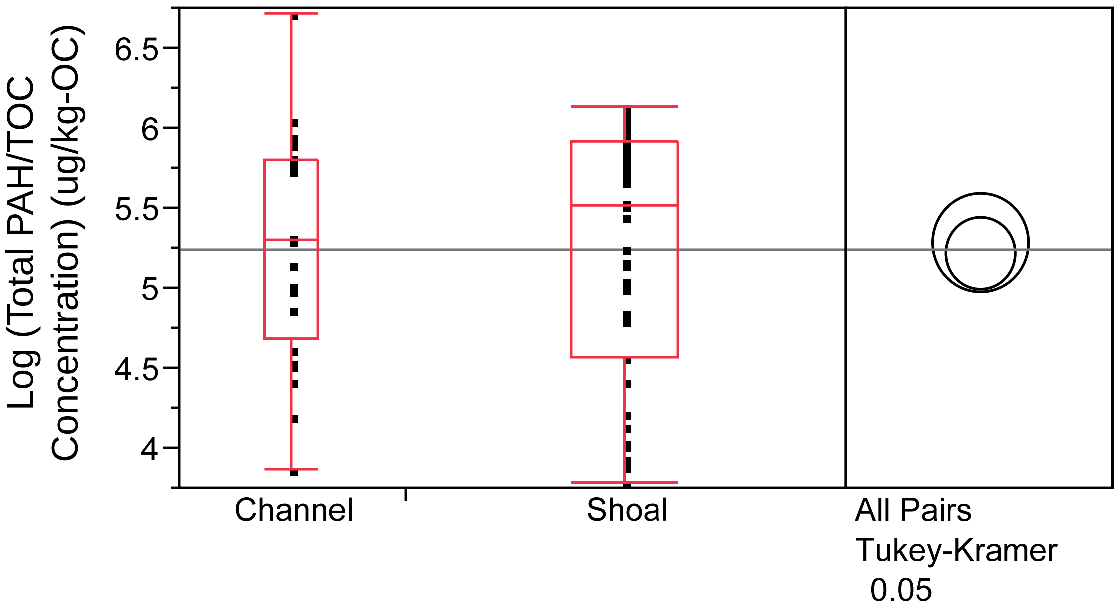
Total PAHs (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 3.3-24a

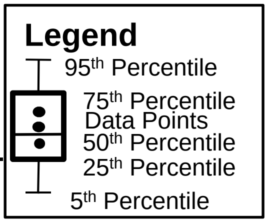
2014

RM0 to RM2

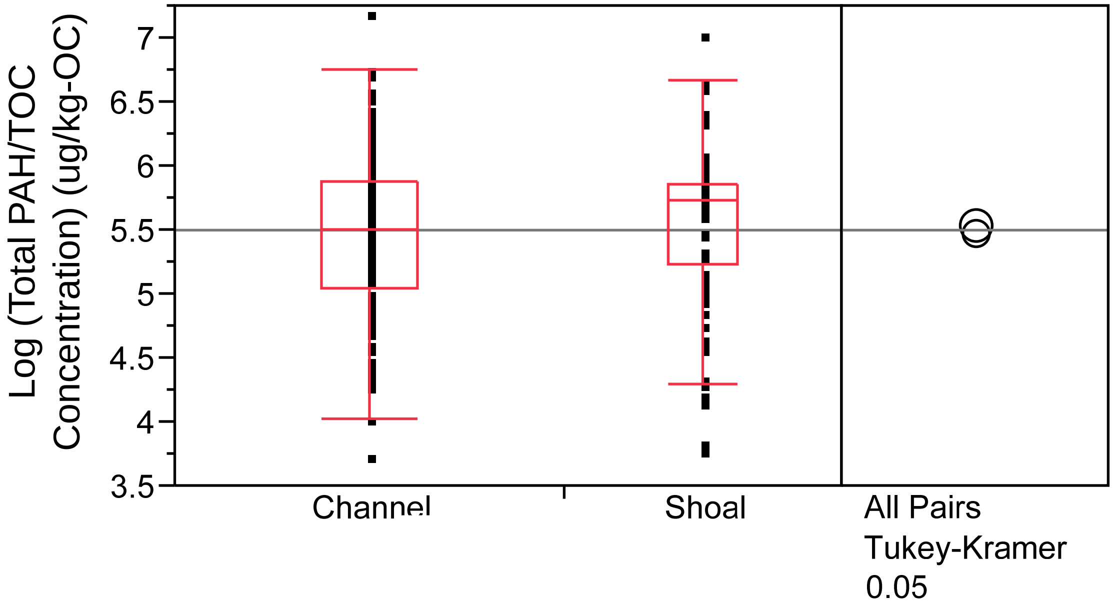


Notes:

1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



RM2 to RM8



TOC Normalized Total PAHs (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 3.3-24b

2014

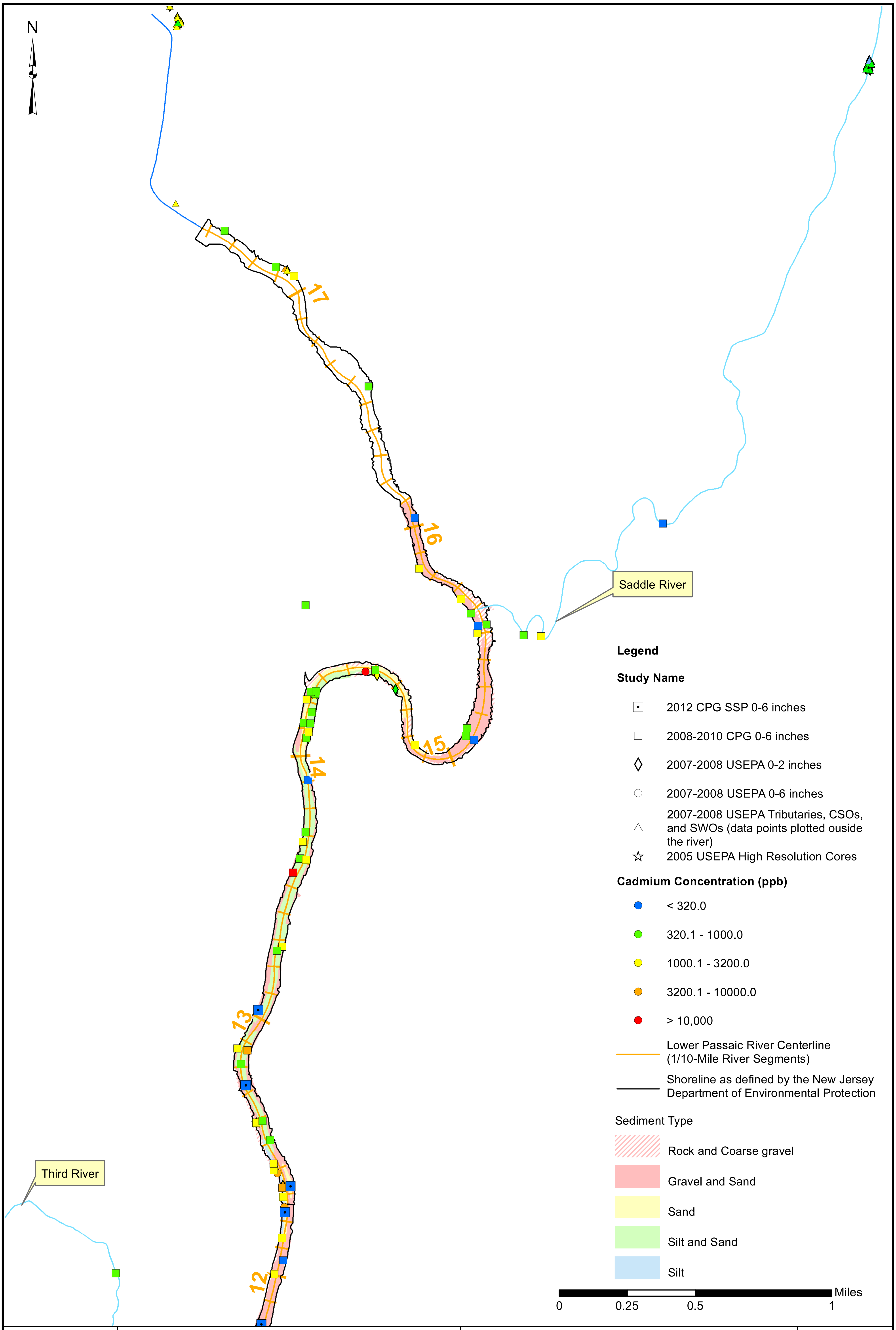
Cadmium Surface Sediment Samples from 1991 to 2000

Lower Eight Miles of the Lower Passaic Rivert

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting. No nondetect values were reported.

Figure 3.4-1

2014



Cadmium Surface Sediment Samples from 2005 to 2012

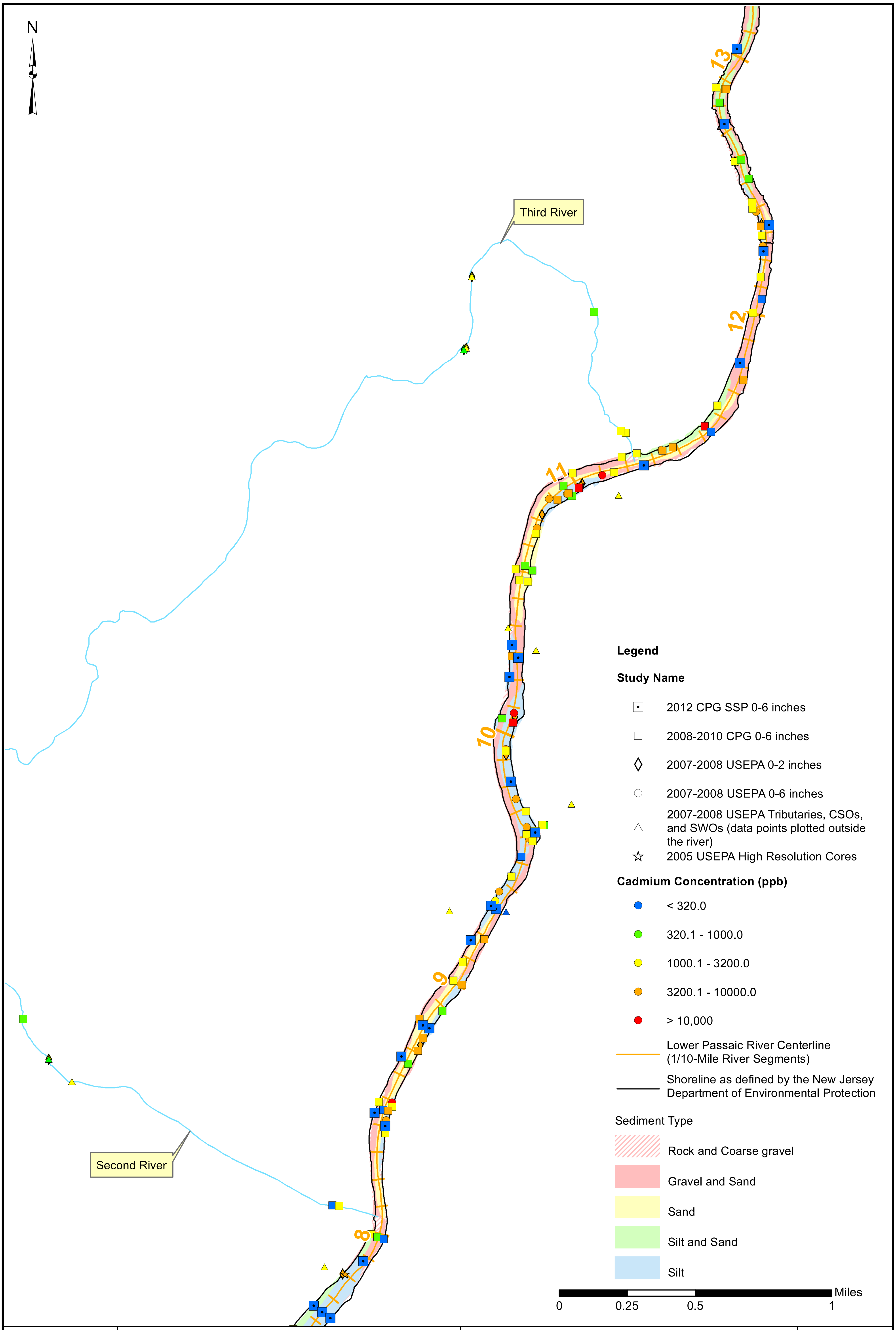
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-2a

2014

Path: P:\02859241\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\Cd_Surficial_Sed_2007_2010_SamplesRM12-DD_Fig14-3h1.mxd



Cadmium Surface Sediment Samples from 2005 to 2012

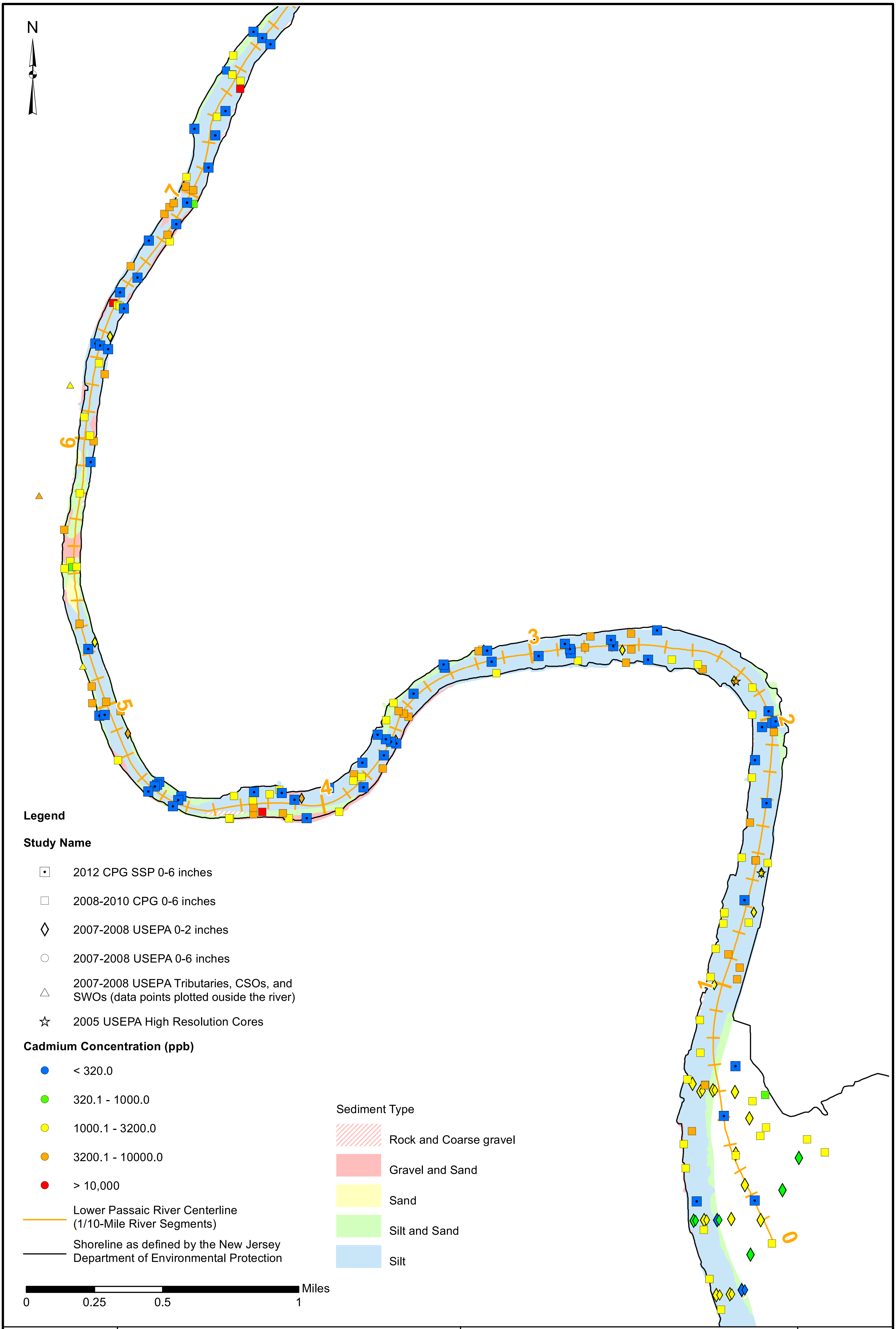
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-2b

2014

Path: P:\0285924\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\Cd_Surficial_Sed_2007_2010_SamplesRM12-DD_Fig14-3h1.mxd



Cadmium Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-2c

2014

Path: P:\0285924\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\Cd_Surficial_Sed_2007_2010_SamplesRM12-DD_Fig14-3h1.mxd

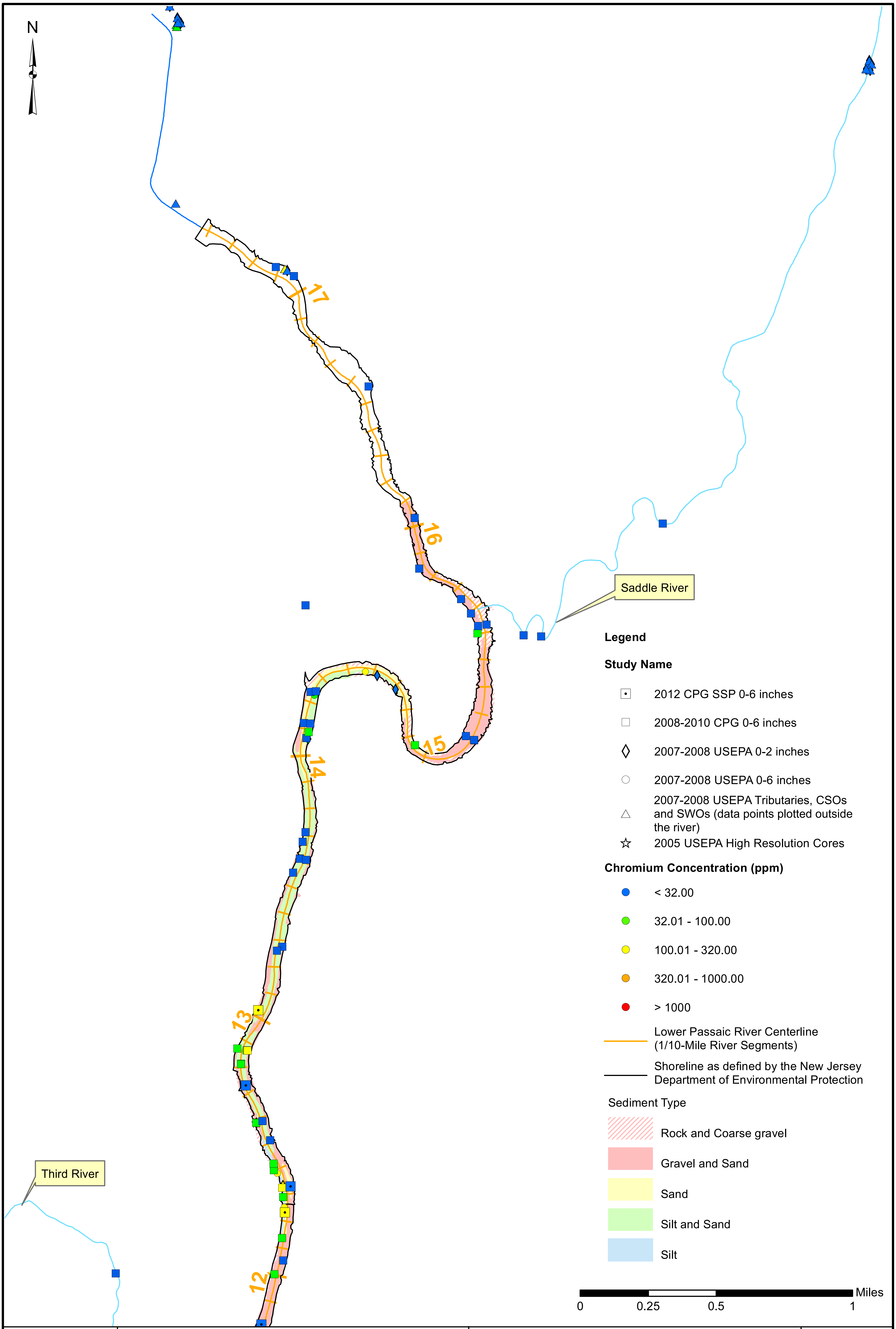
Chromium Surface Sediment Samples from 1991 to 2000

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting. No nondetect values were reported.

Figure 3.4-3

2014



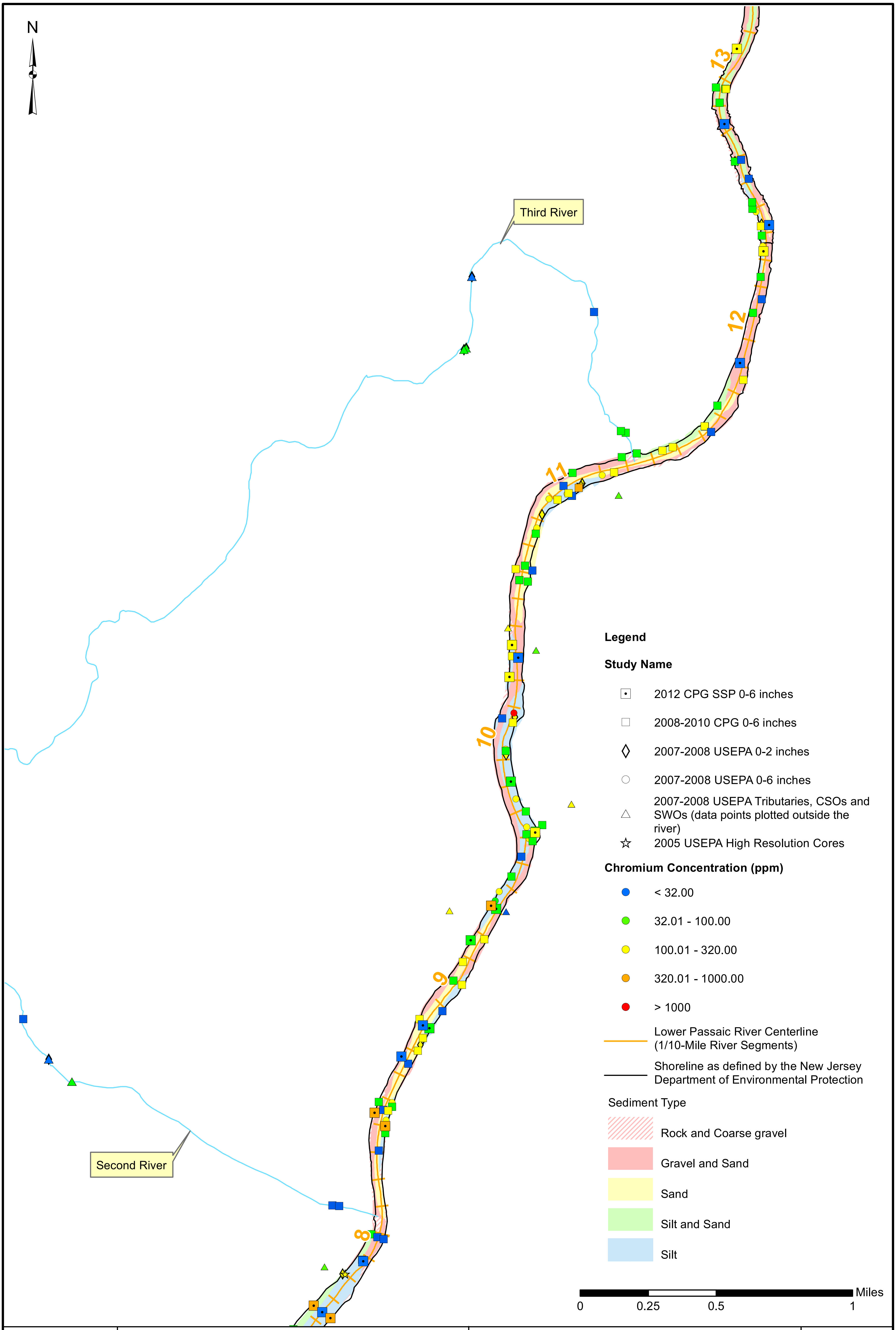
Chromium Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-4a

2014



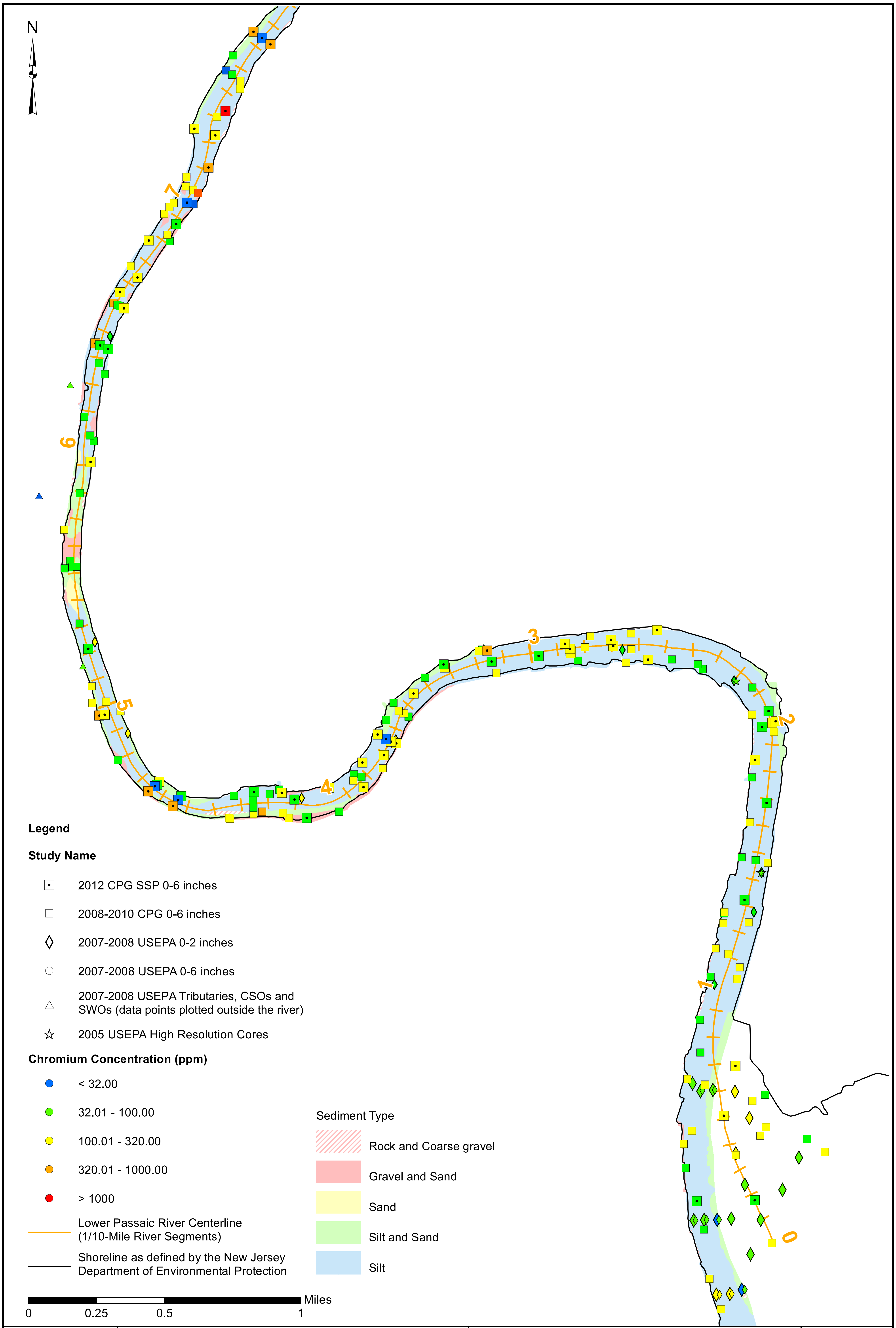
Chromium Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-4b

2014



Chromium Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-4c

2014

Copper Surface Sediment Samples from 1991 to 2000

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting. No nondetect values were reported.

Figure 3.4-5

2014

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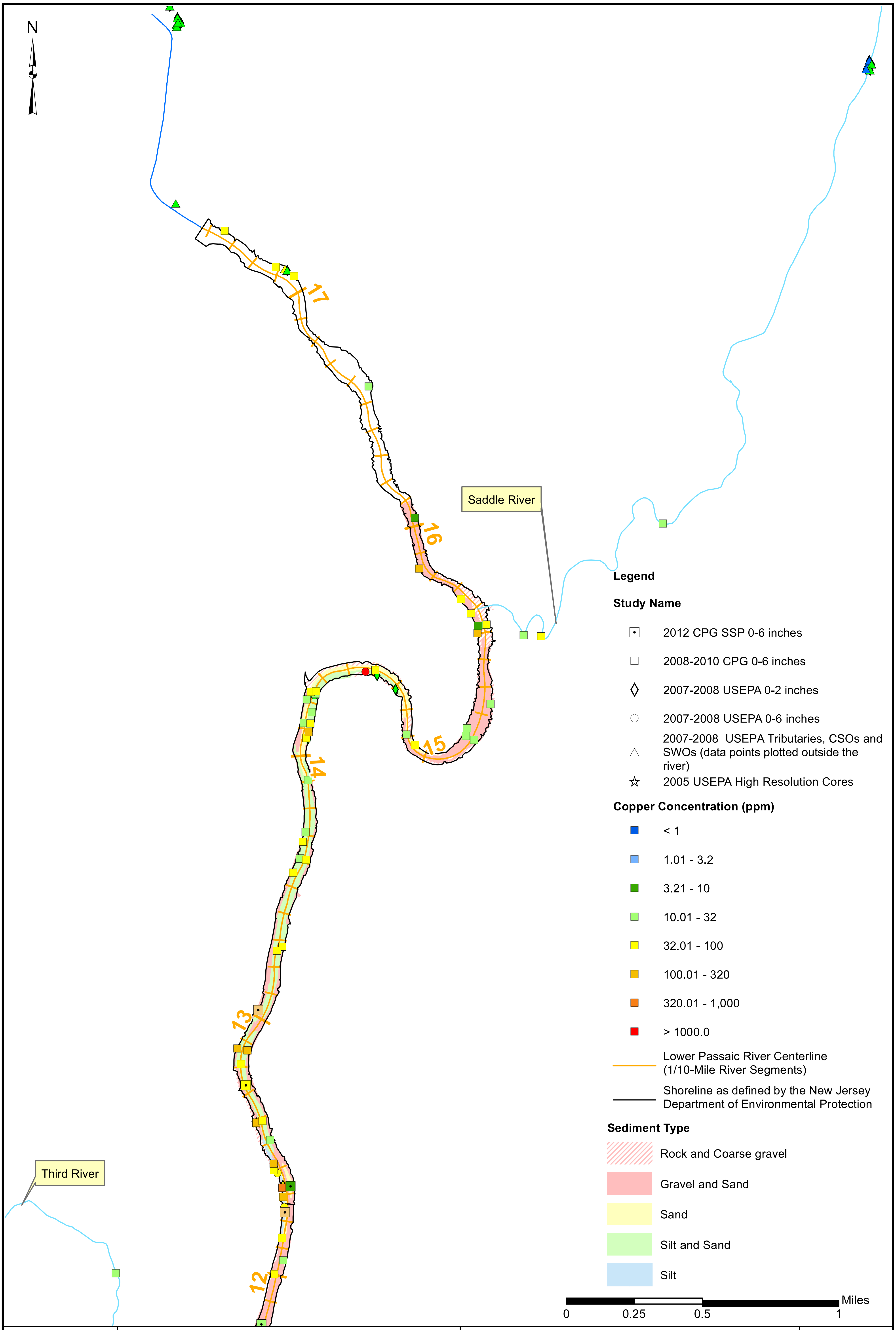


S:\Projects\passaic\MapDocuments\4553001-CERCLA\Cu_Surficial_Sed_2007_2010_Samples_RM12-DD_Fig14-3j1.mxd

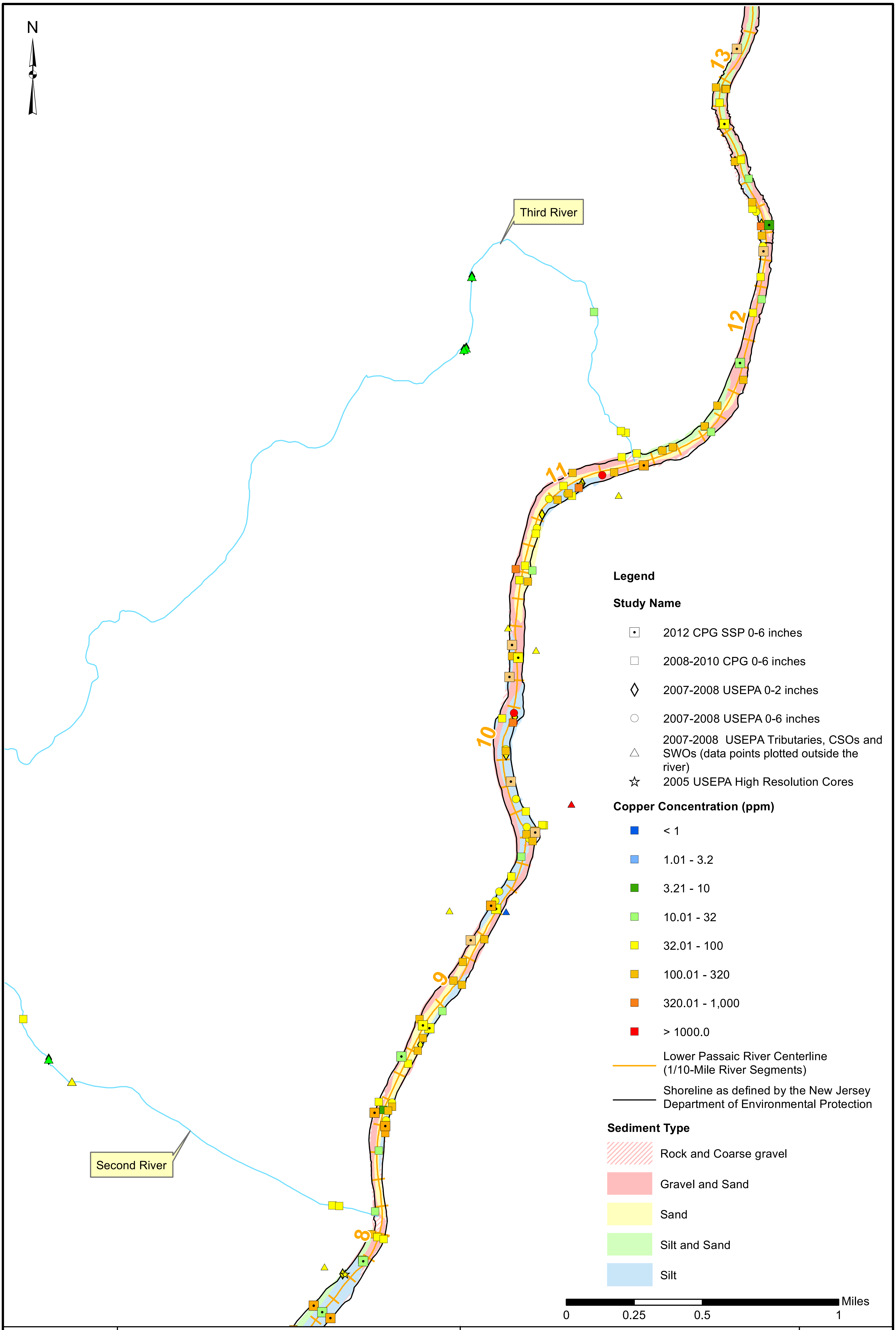
Copper Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-6a

2014



S:\Projects\passaic\MapDocuments\4553001-CERCLA\Cu_Surficial_Sed_2007_2010_Samples_RM12-DD_Fig14-3j1.mxd

Copper Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-6b

2014

S:\Projects\passaic\MapDocuments\4553001-CERCLA\Cu_Surficial_Sed_2007_2010_Samples_RM12-DD_Fig14-3j1.mxd

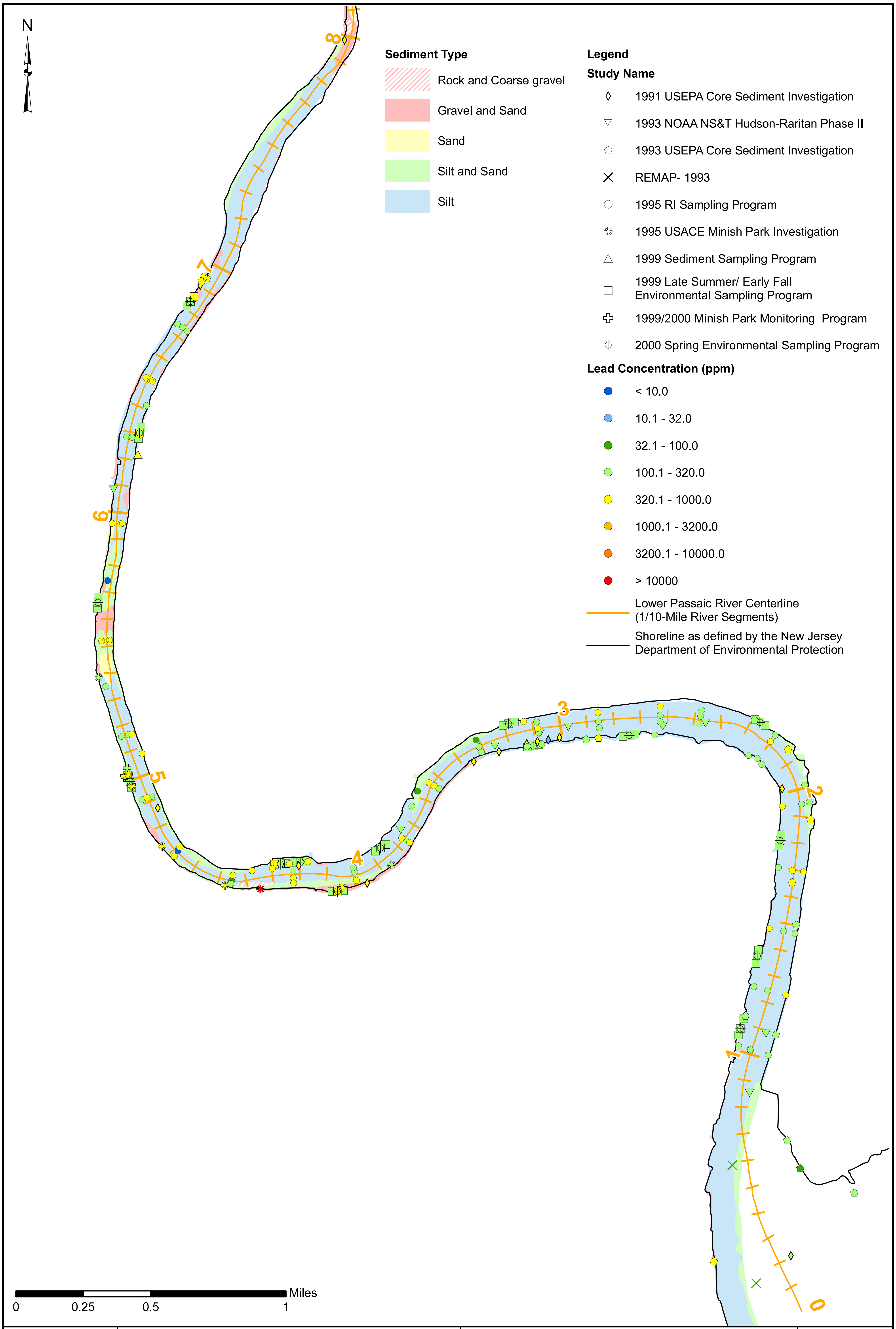
Copper Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-6c

2014



Lead Surface Sediment Samples from 1991 to 2000

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-7

2014

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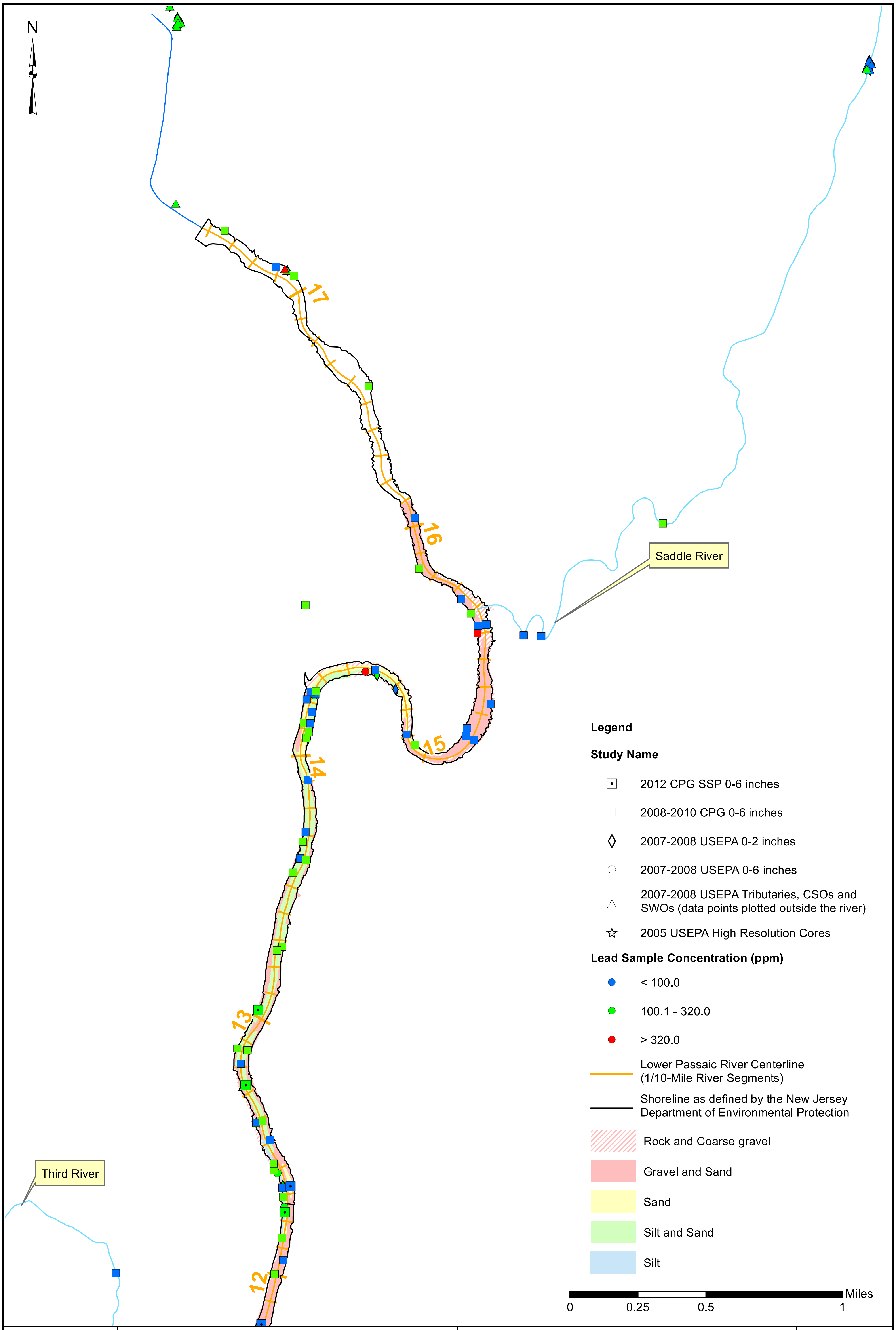

Lead Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-8a

2014

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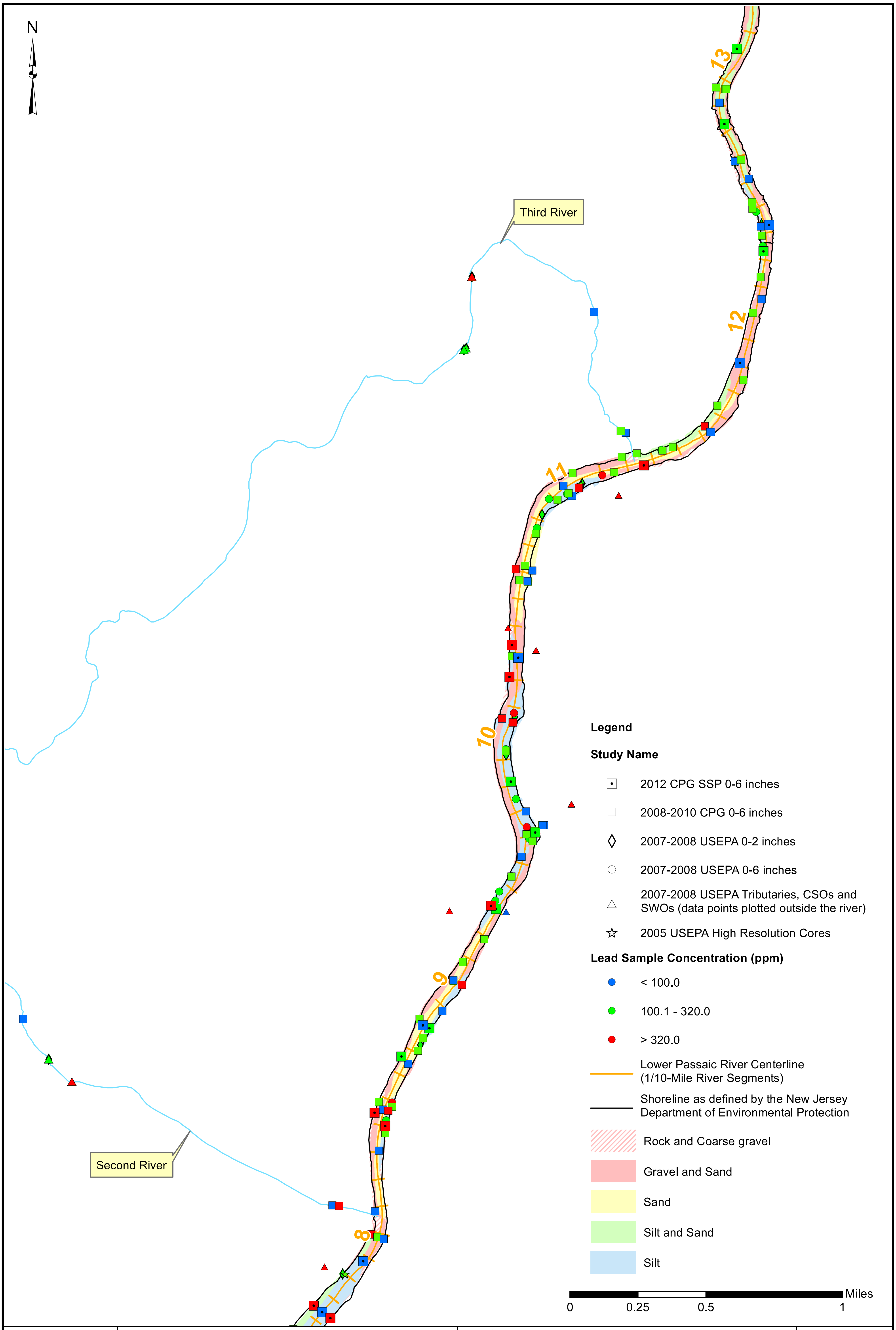


Lead Surface Sediment Samples from 2005 to 2012

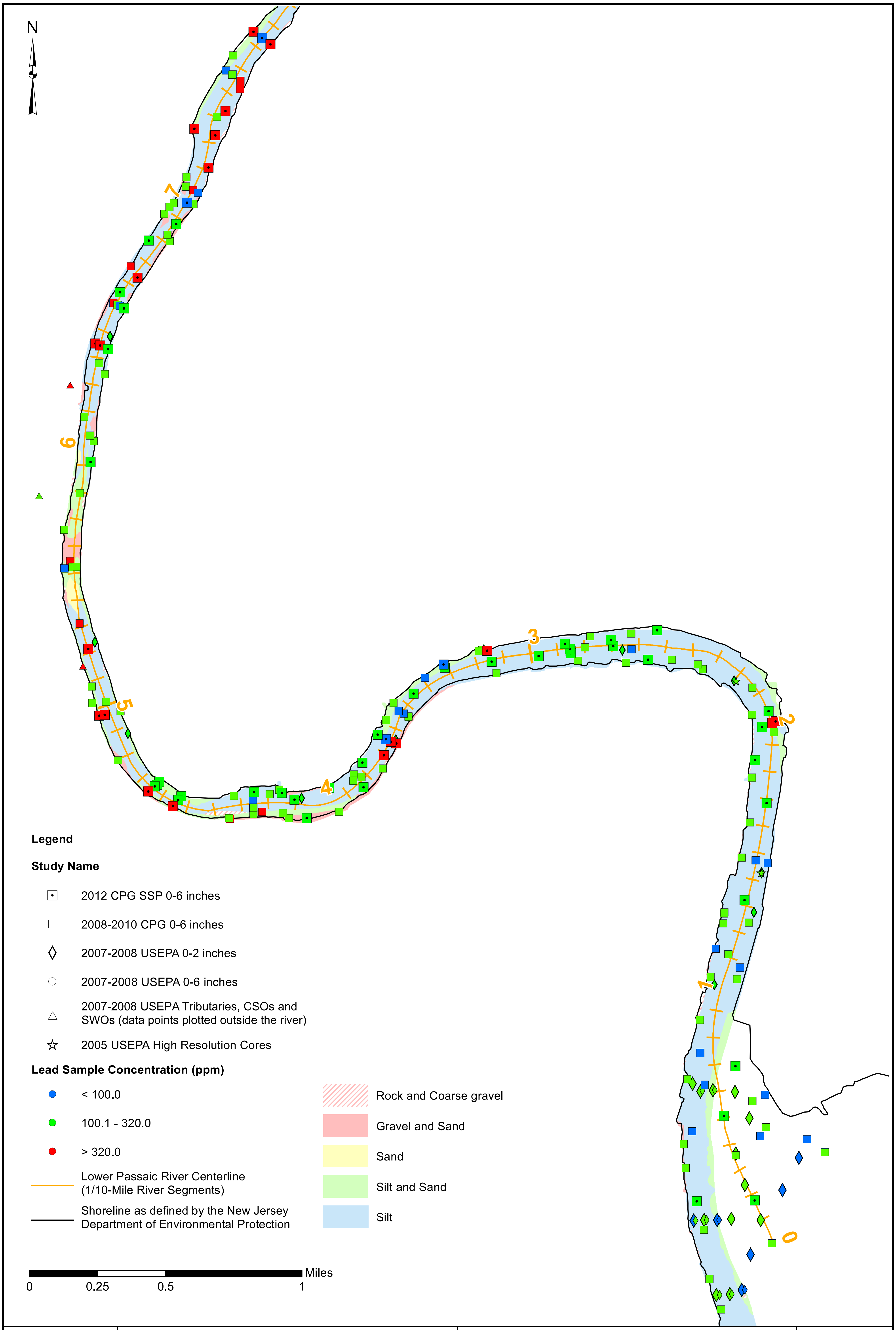
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-8b

2014

Path: P:\0285924\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\Pb_Surficial_Sed_2007_2010_SamplesRM12-DD_fig14-3k1.mxd



Lead Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-8c

2014

Path: P:\02859241\Mapping\CSM_MassBalance\SurfaceSed_Maps\HS mxd\Pb_Surficial_Sed_2007_2010_SamplesRM12-DD_fig14-3k1.mxd

Mercury Surface Sediment Samples from 1991 to 2000

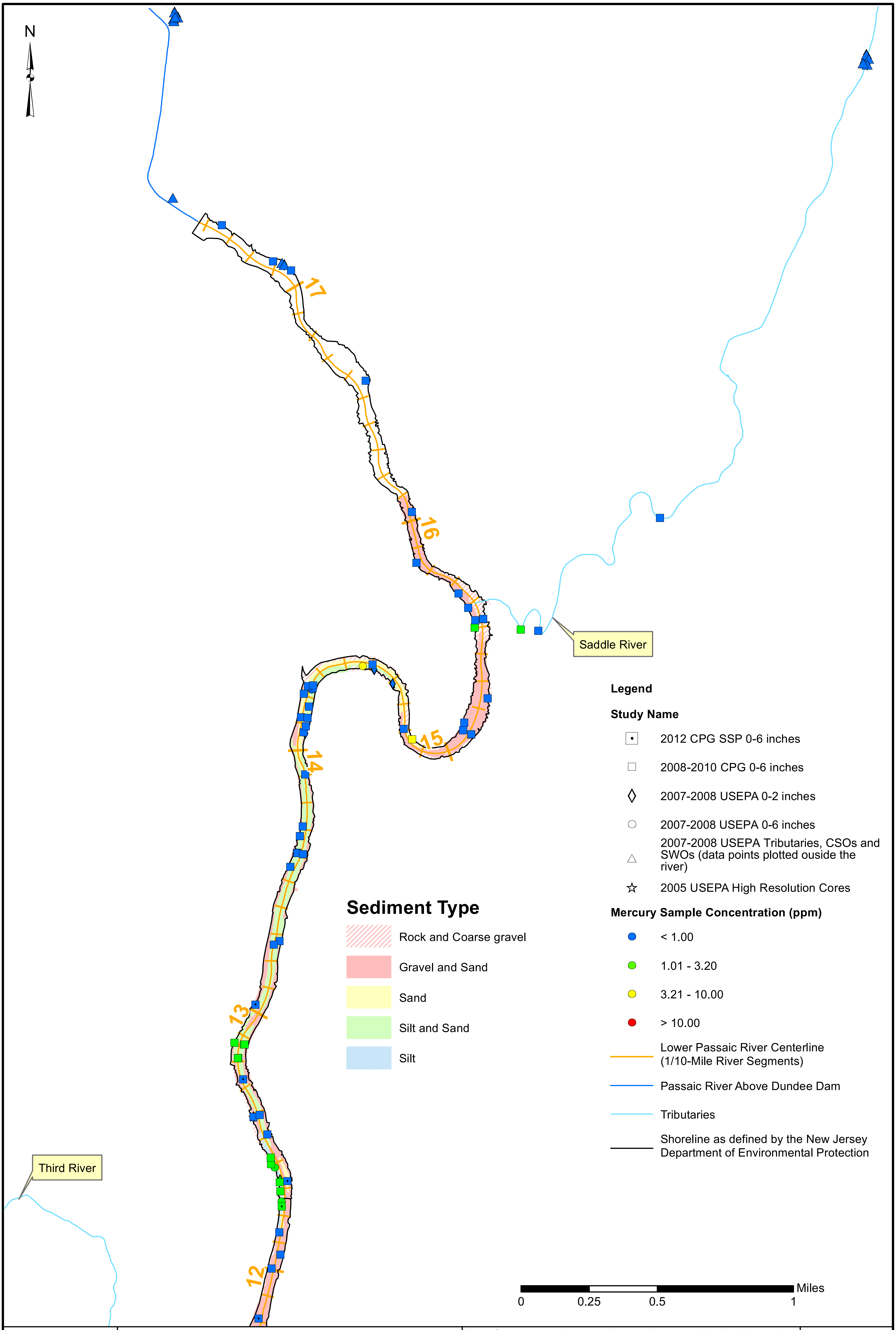
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-9

2014

Path: S:\Projects\Passaic\MapDocuments\4553001-CERCLA\2012_Update\Hg_Surficial_Sed_1991_2000_ArcMap93



Mercury Surface Sediment Samples from 2005 to 2012

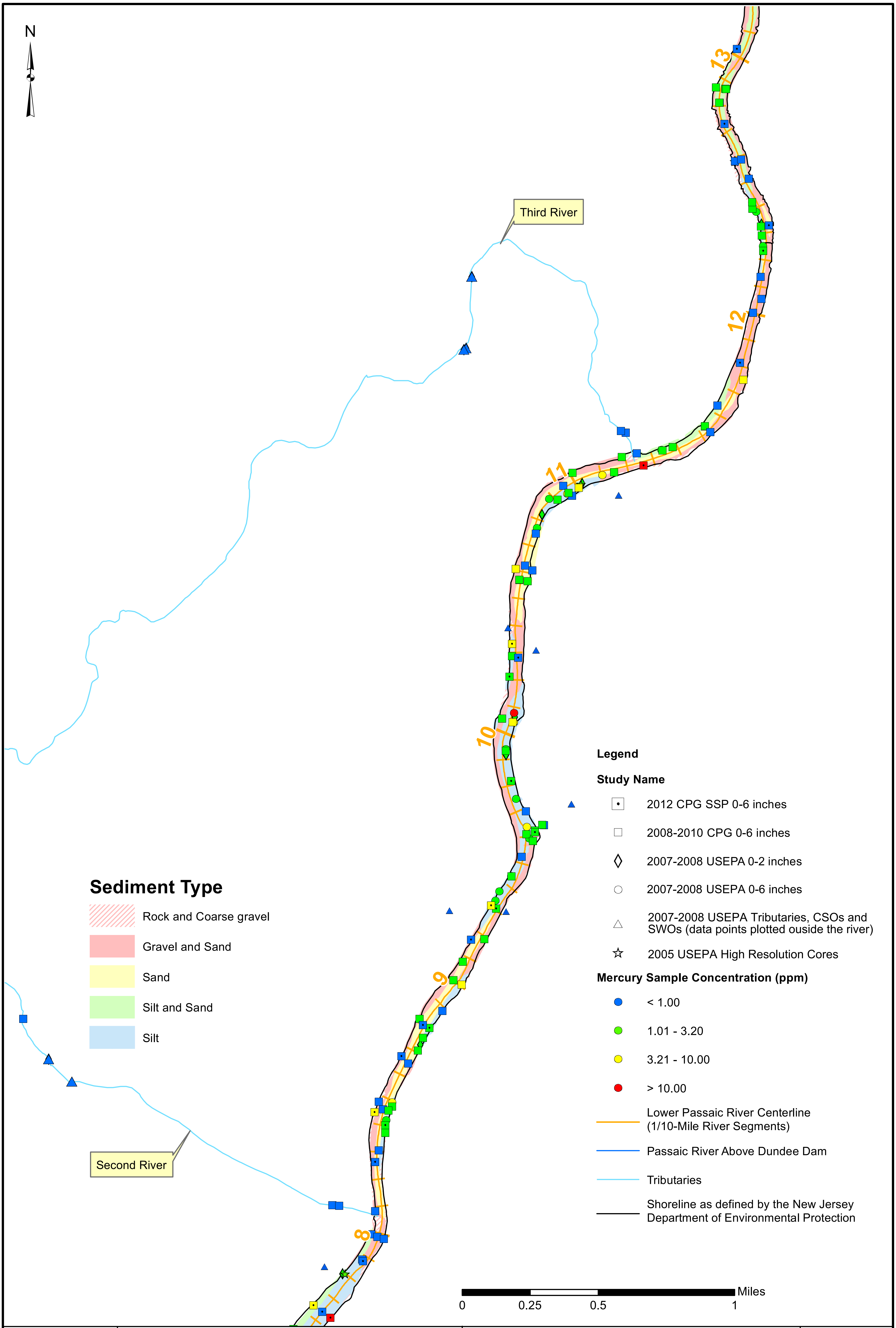
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-10a

2014

Path: P:\02859241\Mapping\CSM_MassBalance\SurfaceSed\SurfaceSed_Maps\Hg_Surficial_Sed_2005_2012.mxd



Mercury Surface Sediment Samples from 2005 to 2012

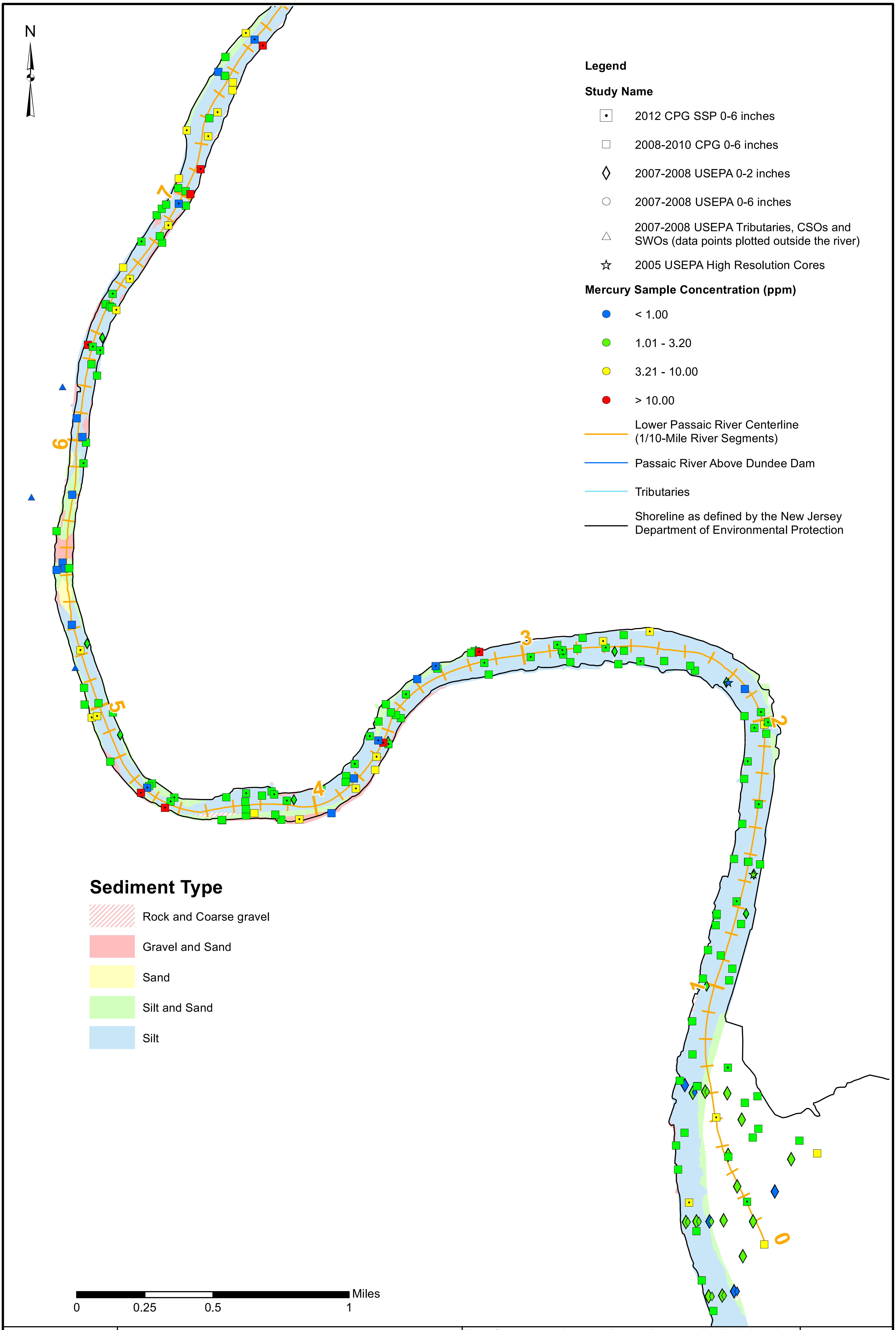
Lower Eight Miles of the Lower Passaic River

Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

Figure 3.4-10b

2014

Path: P:\02859241\Mapping\CSM_MassBalance\SurfaceSed_Maps\Hg_Surficial_Sed_2005_2012.mxd



Mercury Surface Sediment Samples from 2005 to 2012

Lower Eight Miles of the Lower Passaic River

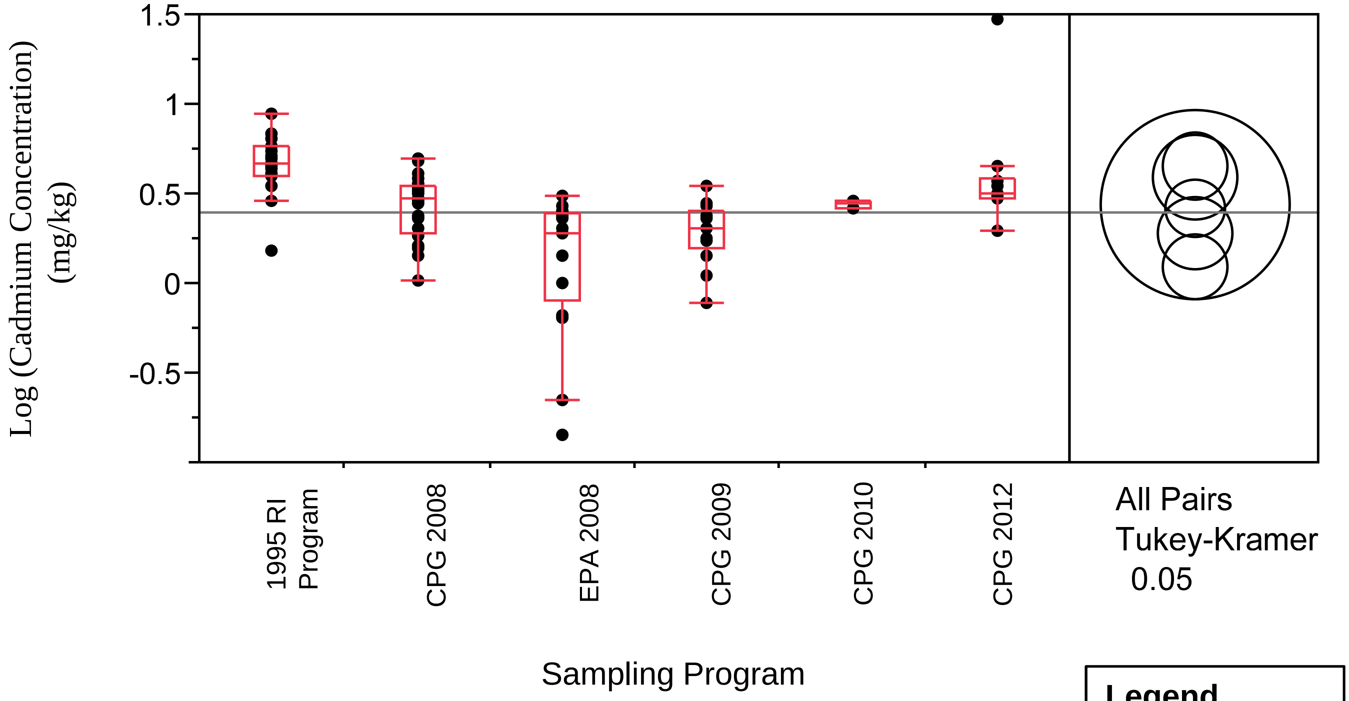
Note : Study names and corresponding sampling year are listed in the legend. Samples represent either sediment grab samples or the top segment of a sediment core. Because each study provided a different definition for "surface sediments," the samples plotted on this figure generally represent sediments from a depth of 0 foot to less than 1 foot. If samples are plotted at the same location, samples from the latest sampling event were plotted on top. Duplicate samples were averaged before plotting.

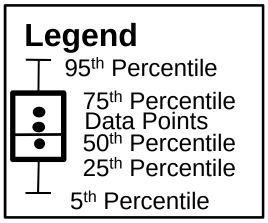
Figure 3.4-10c

2014

Path: P:\0285924\Mapping\CSM_MassBalance\SurfaceSed_Maps\Hg_Surficial_Sed_2005_2012.mxd

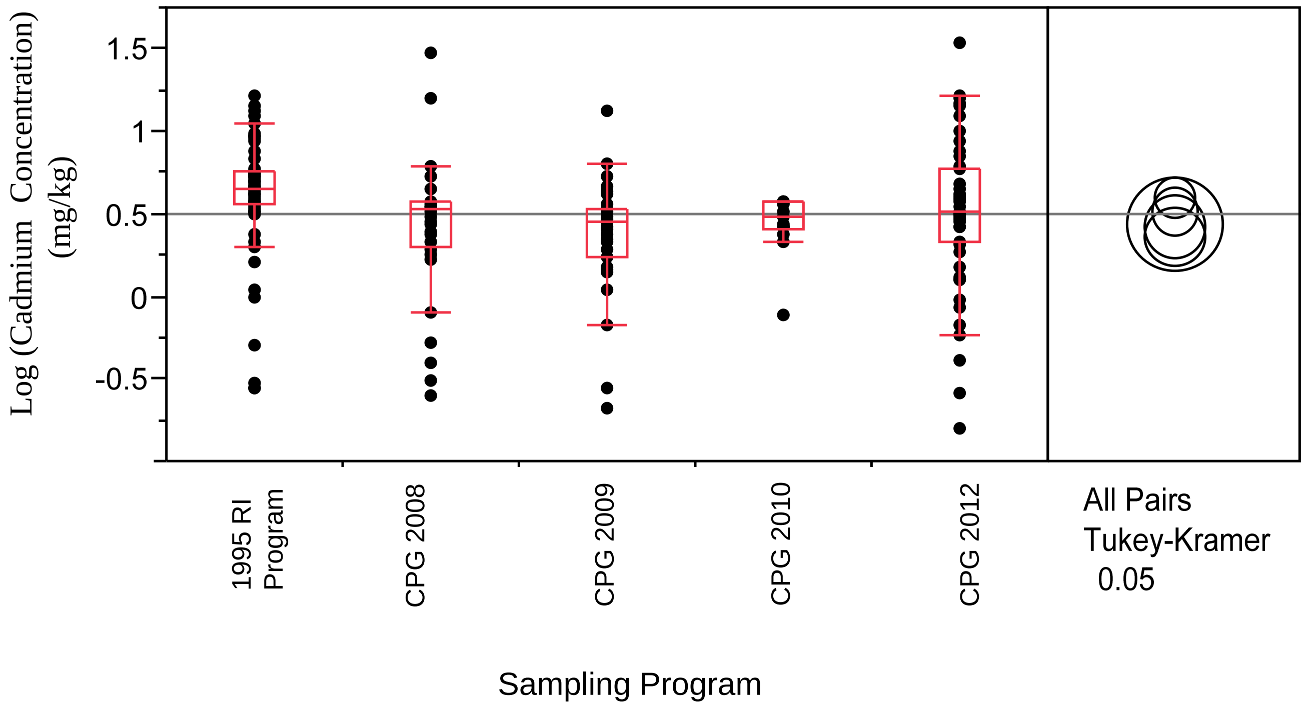
RM0 to RM2





Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles..

RM2 to RM8

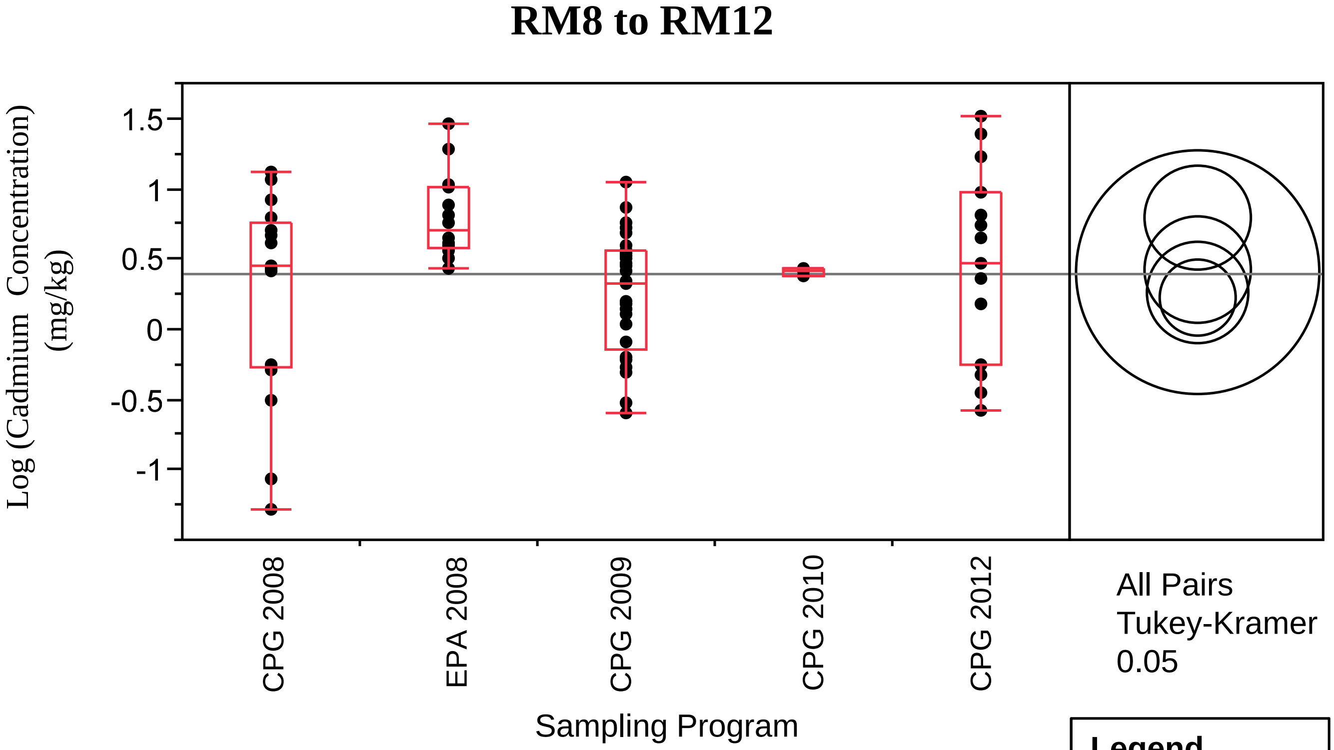


Cadmium (0-6 inch) by Sampling Program at RM0 to RM2 and RM2 to RM8

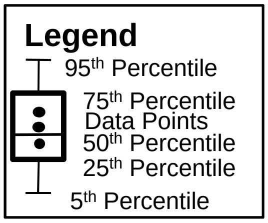
Lower Eight Miles of the Lower Passaic River

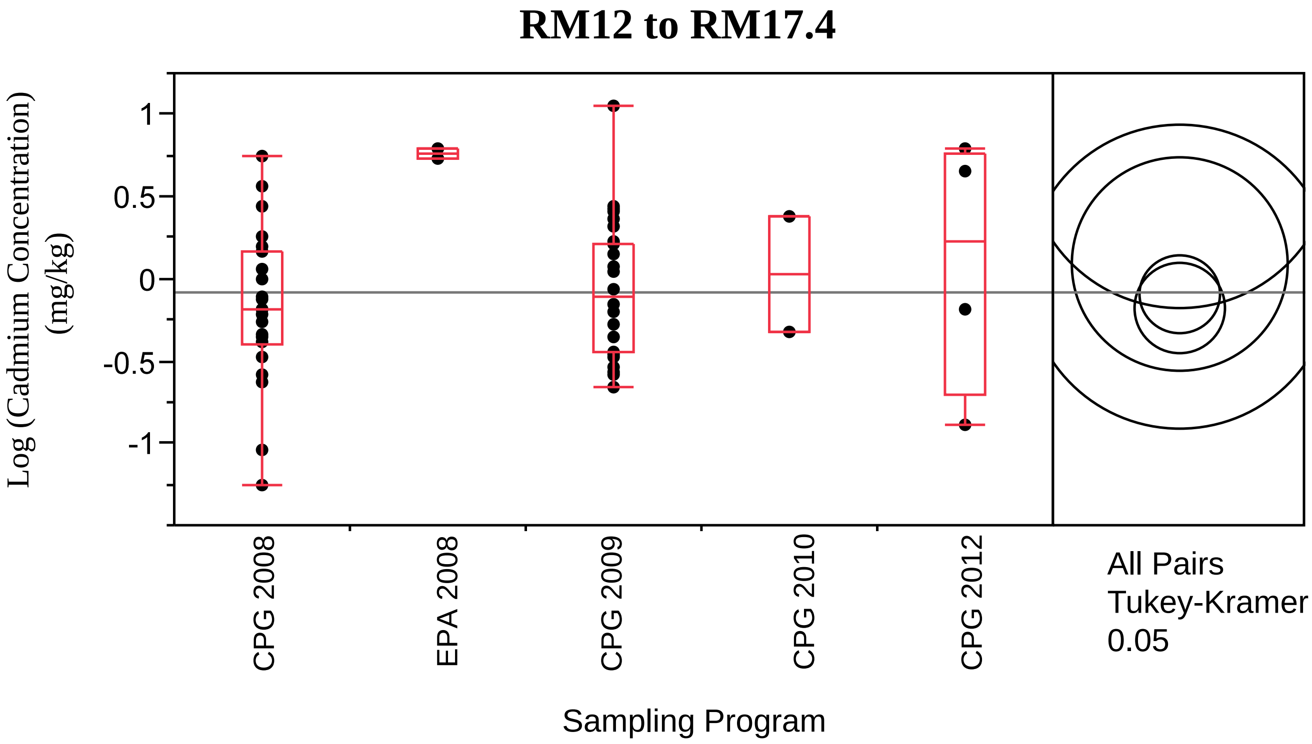
Figure 3.4-11a

2014


RM8 to RM12

Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles..



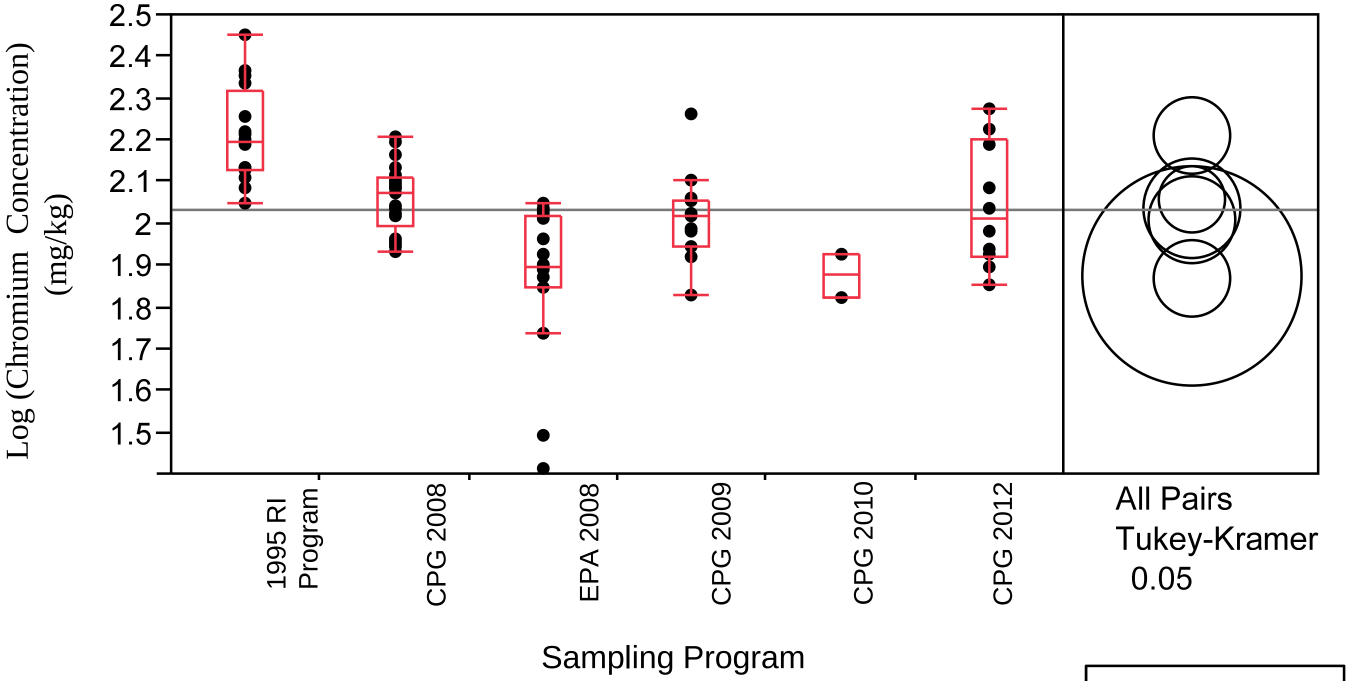

RM12 to RM17.4

Cadmium (0-6 inch) by Sampling Program
at RM8 to RM12 and RM12 to RM17.4
Lower Eight Miles of the Lower Passaic River

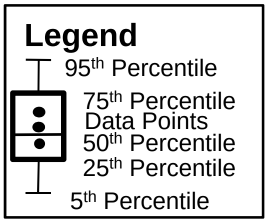
Figure 3.4-11b

2014

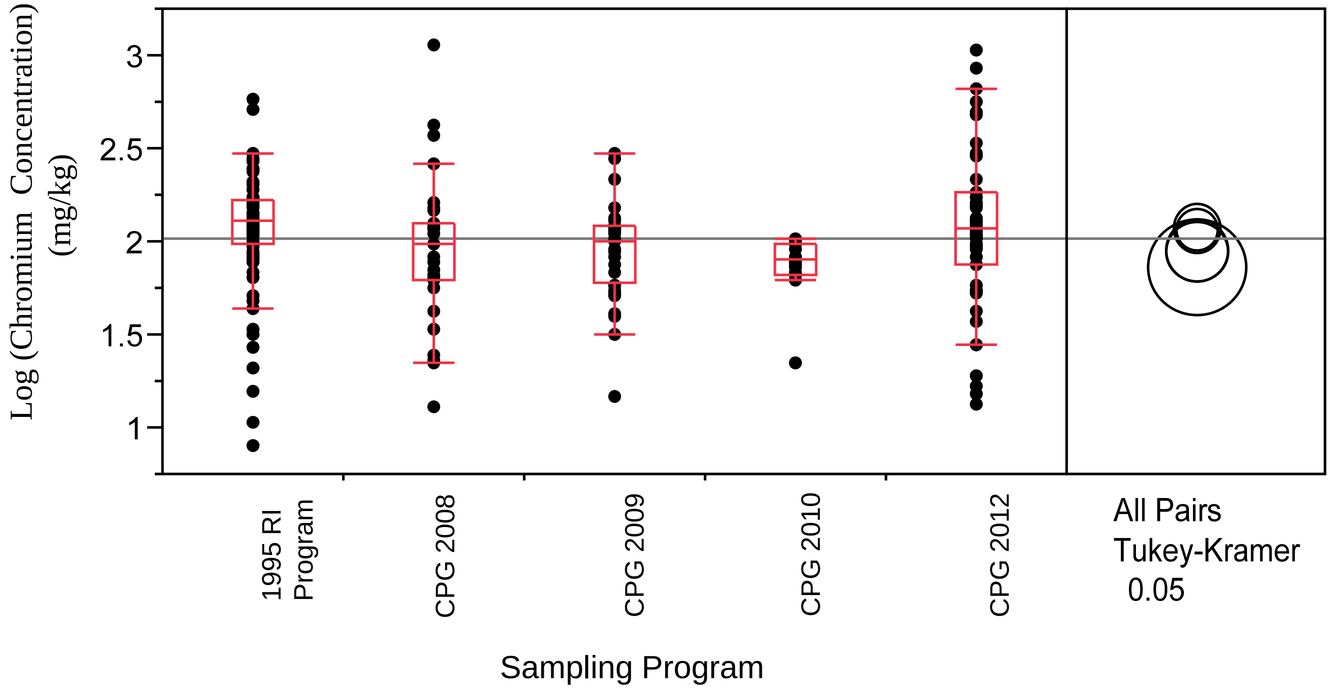
RM0 to RM2



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles..



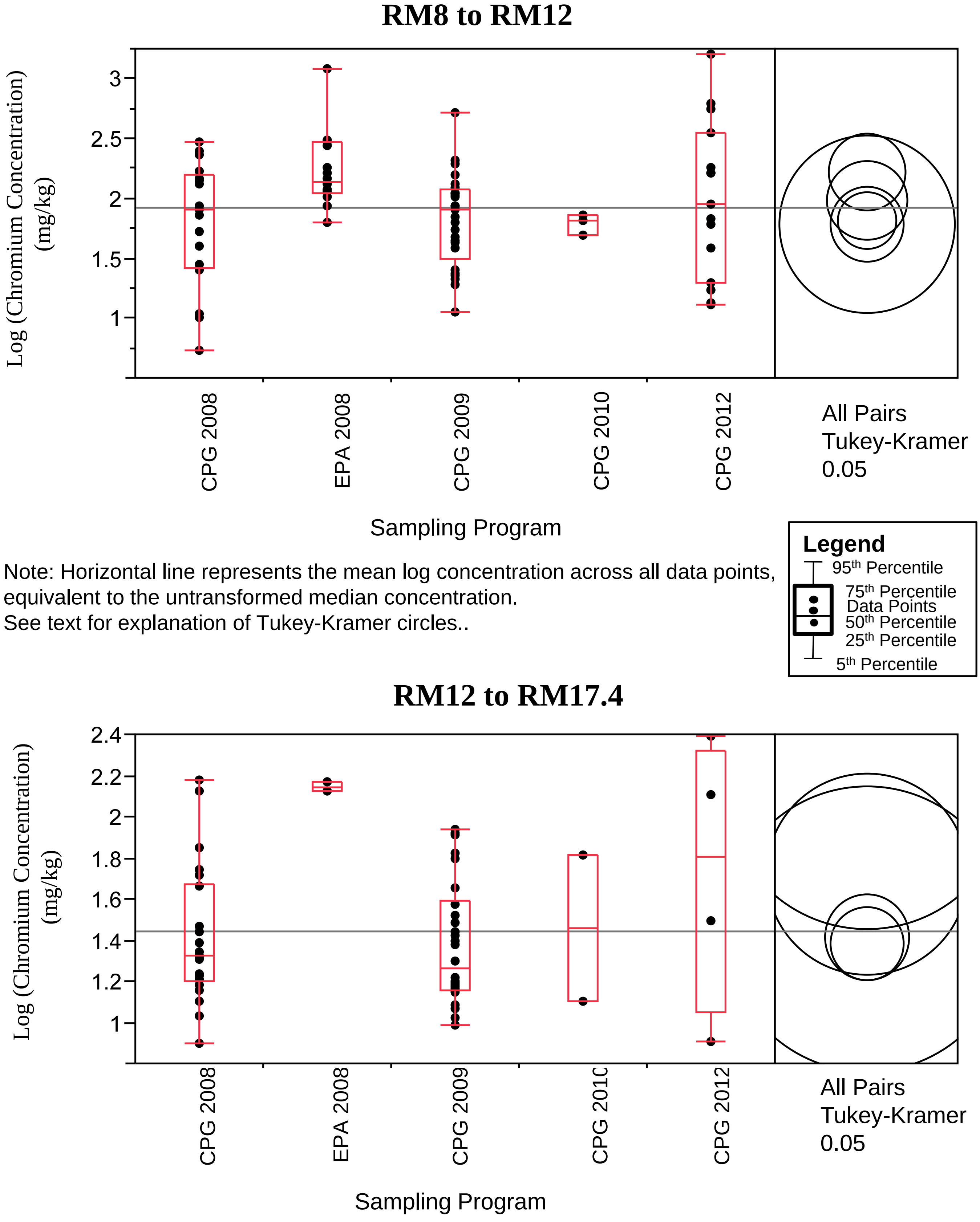
RM2 to RM8



Chromium (0-6 inch) by Sampling Program
at RM0 to RM2 and RM2 to RM8
Lower Eight Miles of the Lower Passaic River

Figure 3.4-12a

2014


RM8 to RM12

RM12 to RM17.4

Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles..

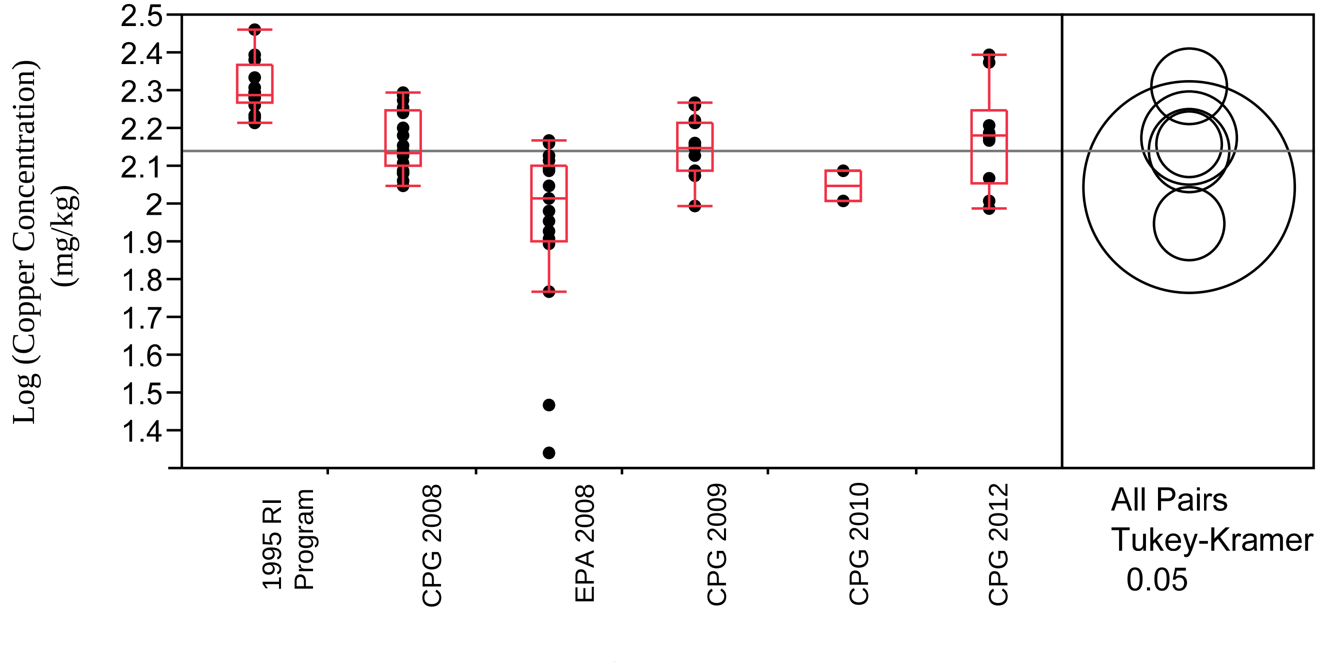
Chromium (0-6 inch) by Sampling Program at RM8 to RM12 and RM12 to RM17.4

Lower Eight Miles of the Lower Passaic River

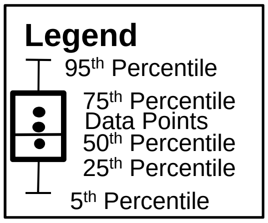
Figure 3.4-12b

2014

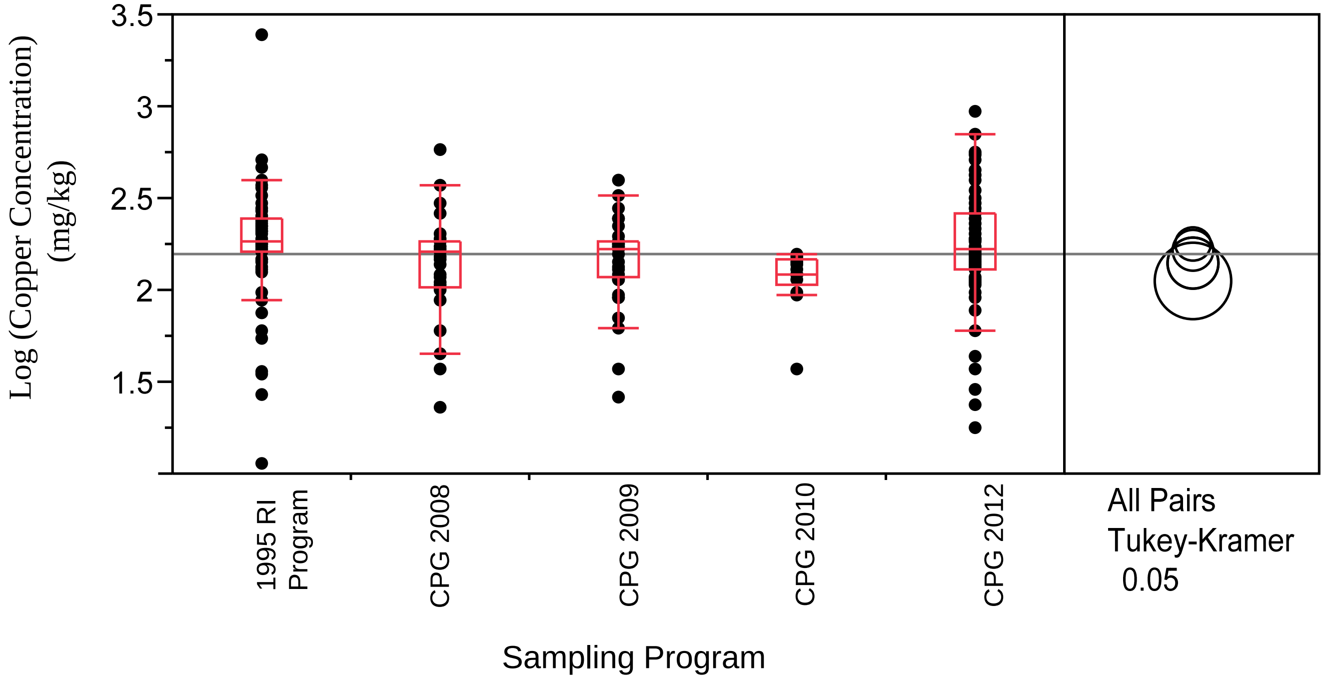
RM0 to RM2



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles..



RM2 to RM8



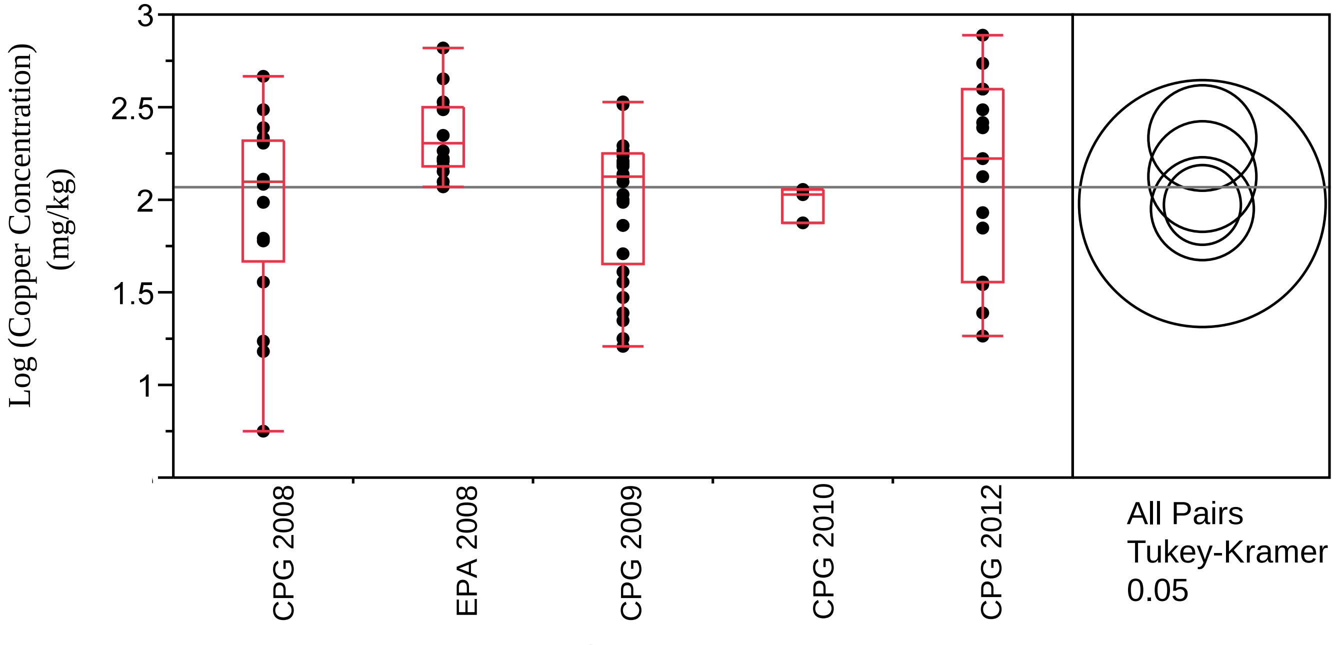
Copper (0-6 inch) by Sampling Program at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

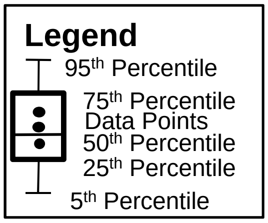
Figure 3.4-13a

2014

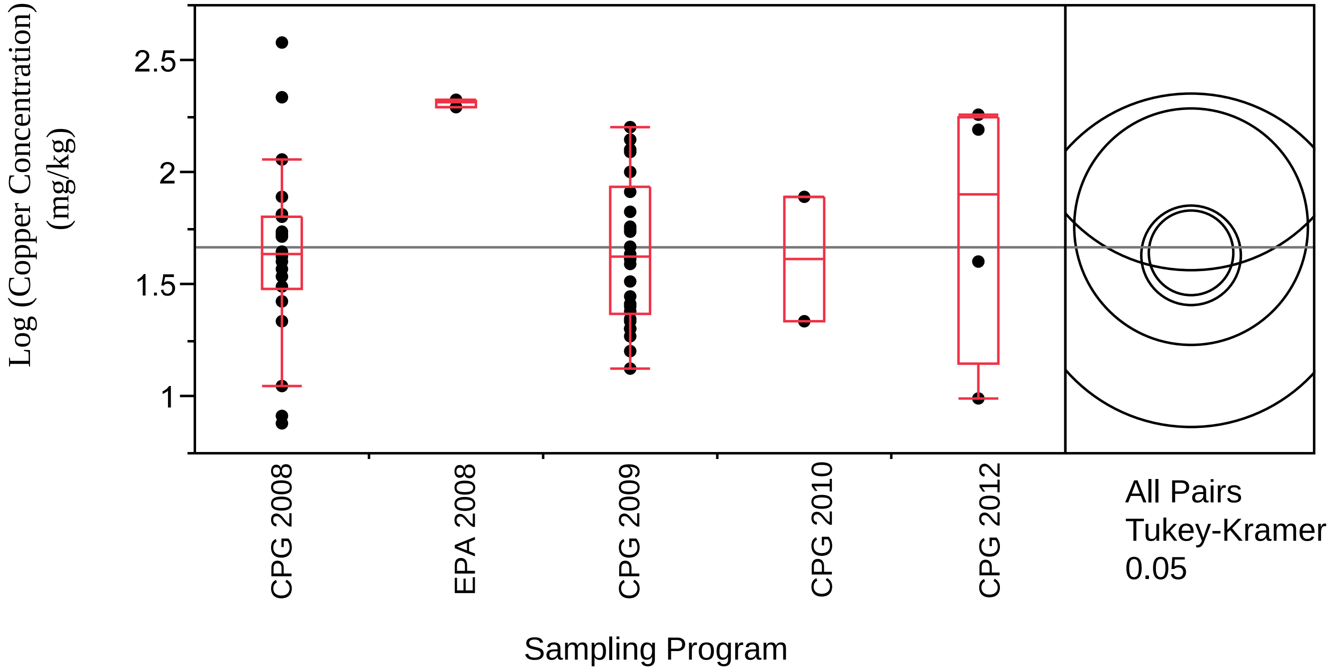
RM8 to RM12



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles..



RM12 to RM17.4



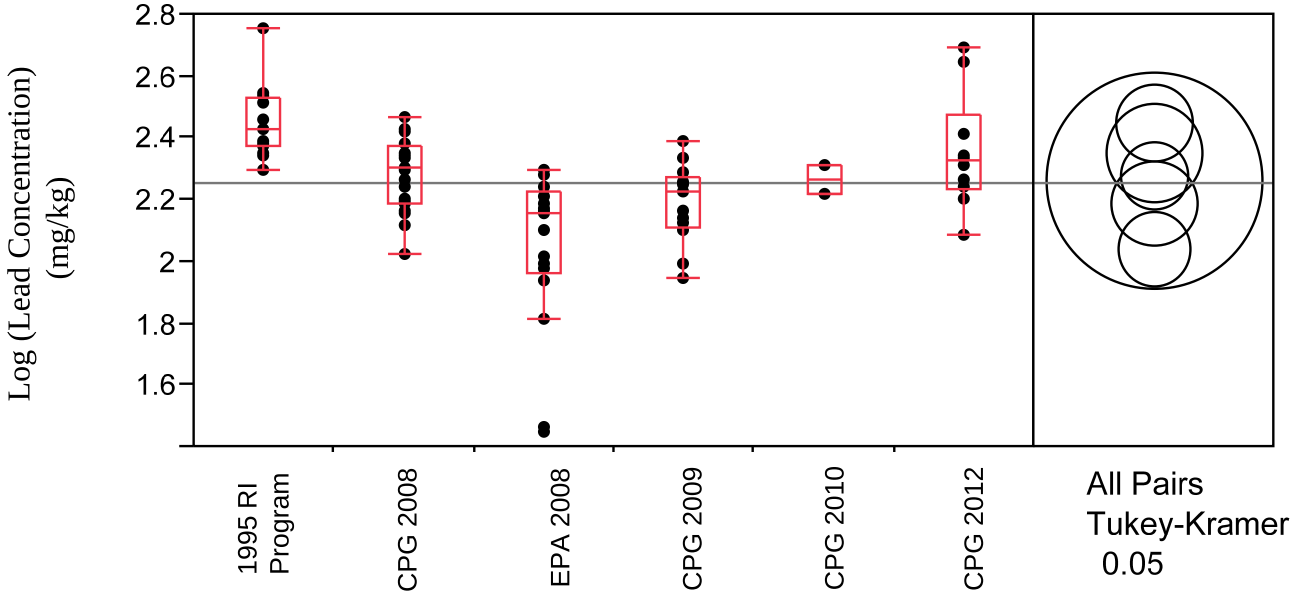
Copper (0-6 inch) by Sampling Program at RM8 to RM12 and RM12 to RM17.4

Lower Eight Miles of the Lower Passaic River

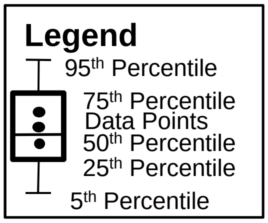
Figure 3.4-13b

2014

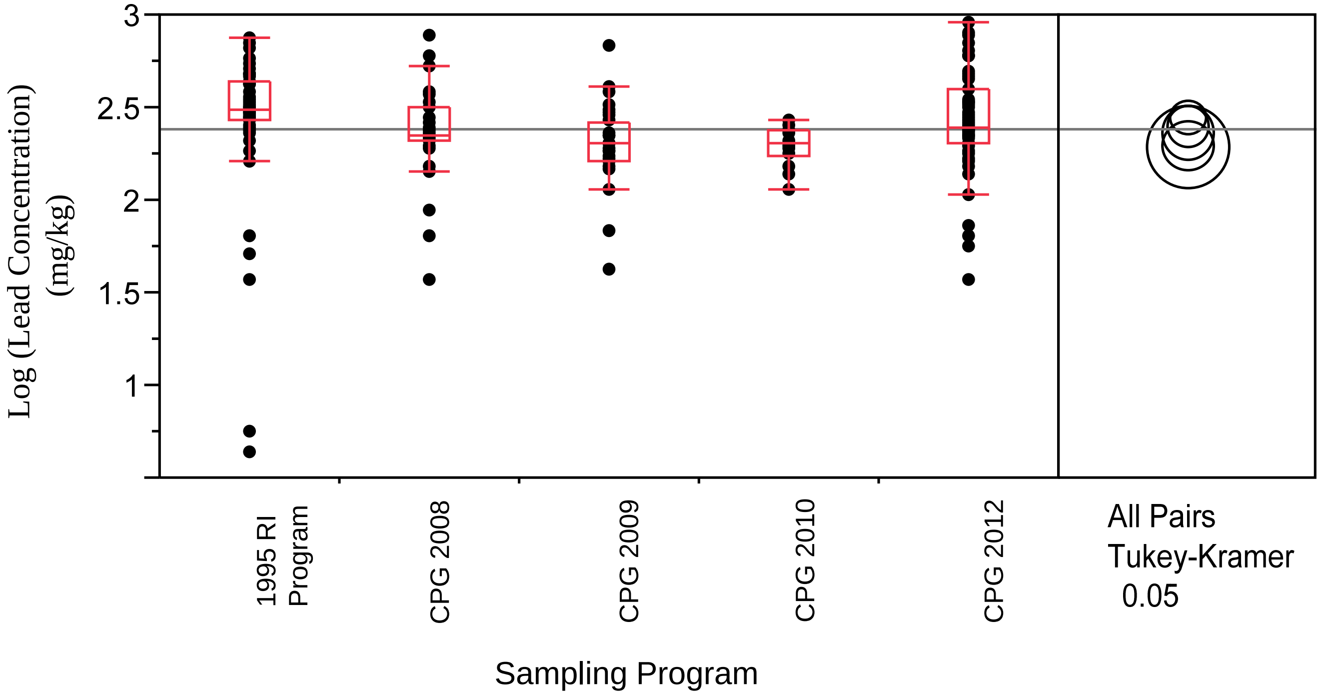
RM0 to RM2



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles..



RM2 to RM8

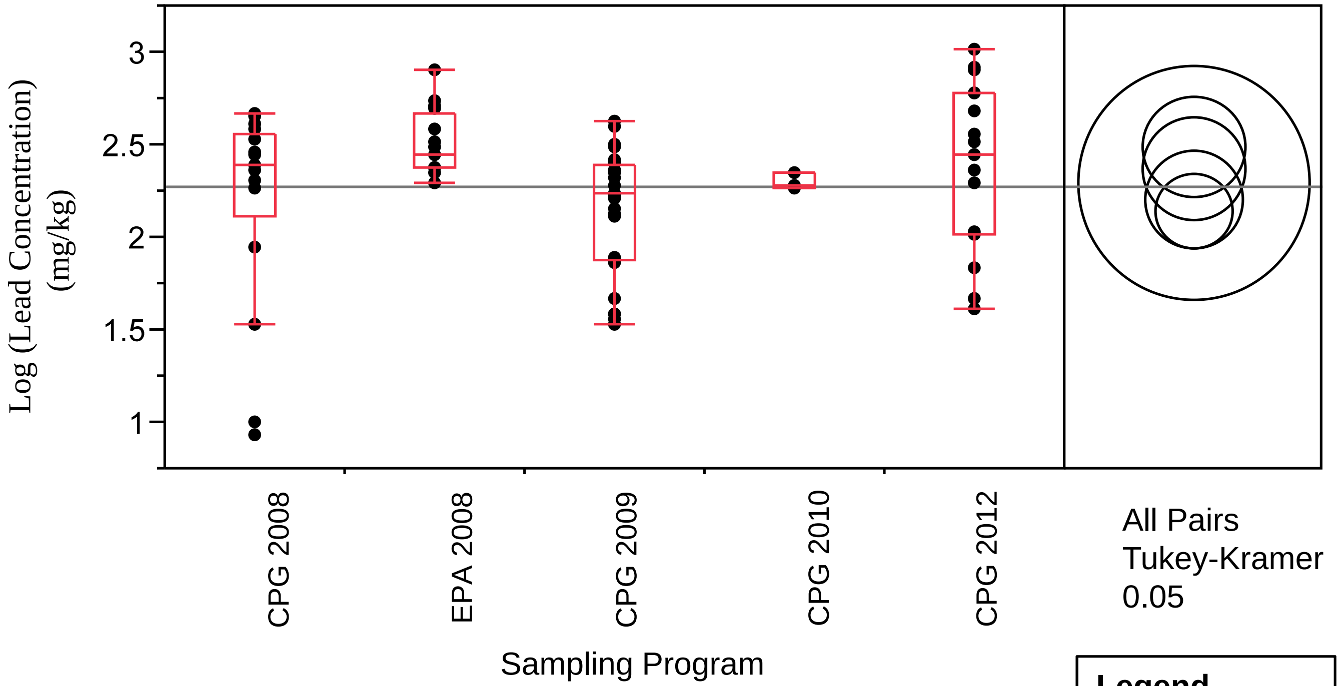


Lead (0-6 inch) by Sampling Program
at RM0 to RM2 and RM2 to RM8
Lower Eight Miles of the Lower Passaic River

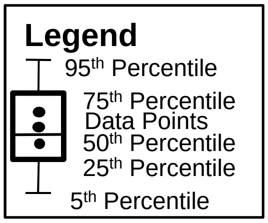
Figure 3.4-14a

2014

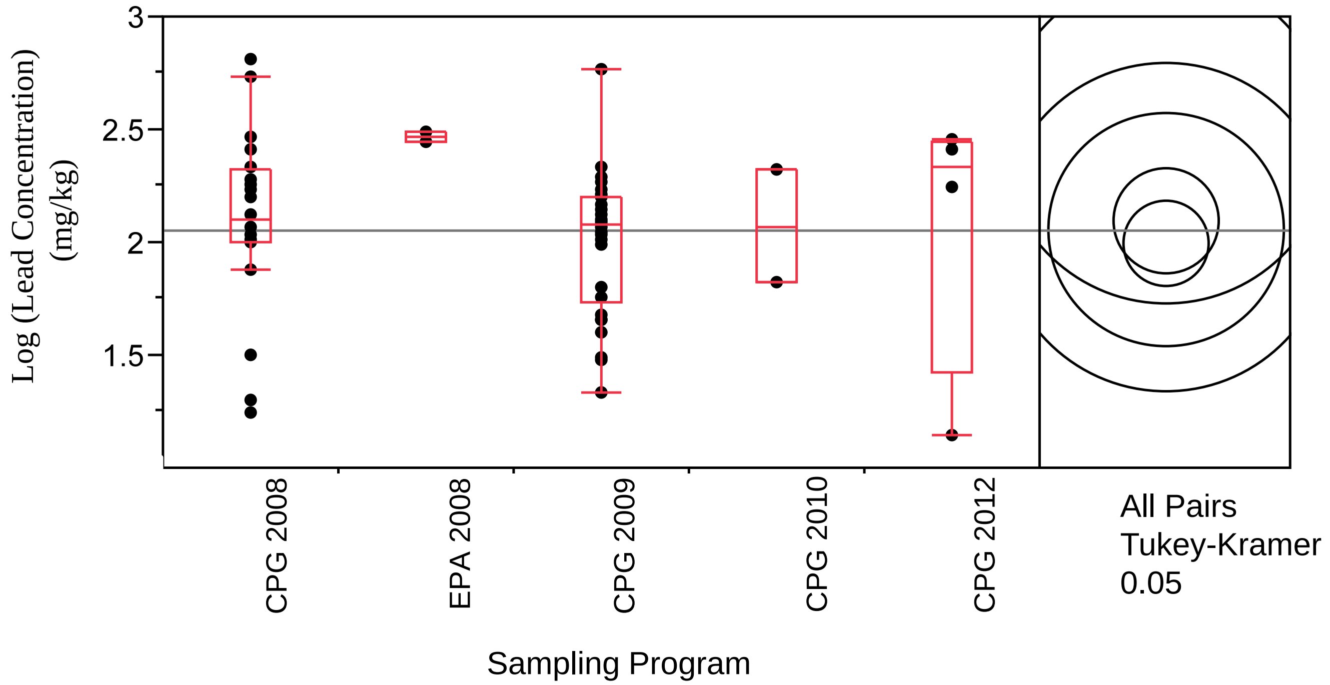
RM8 to RM12



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles..



RM12 to RM17.4

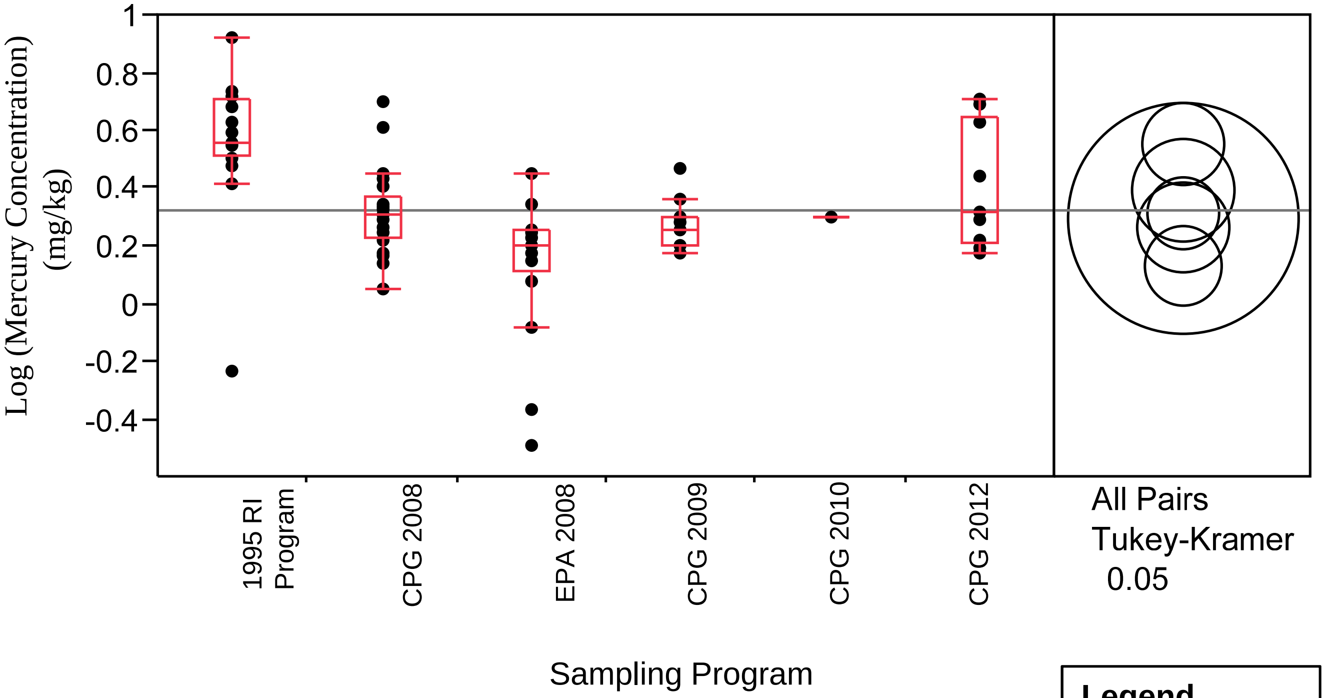


Lead (0-6 inch) by Sampling Program
at RM8 to RM12 and RM12 to RM17.4
Lower Eight Miles of the Lower Passaic River

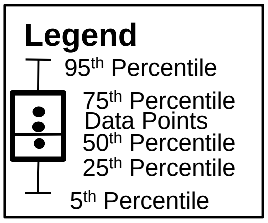
Figure 3.4-14b

2014

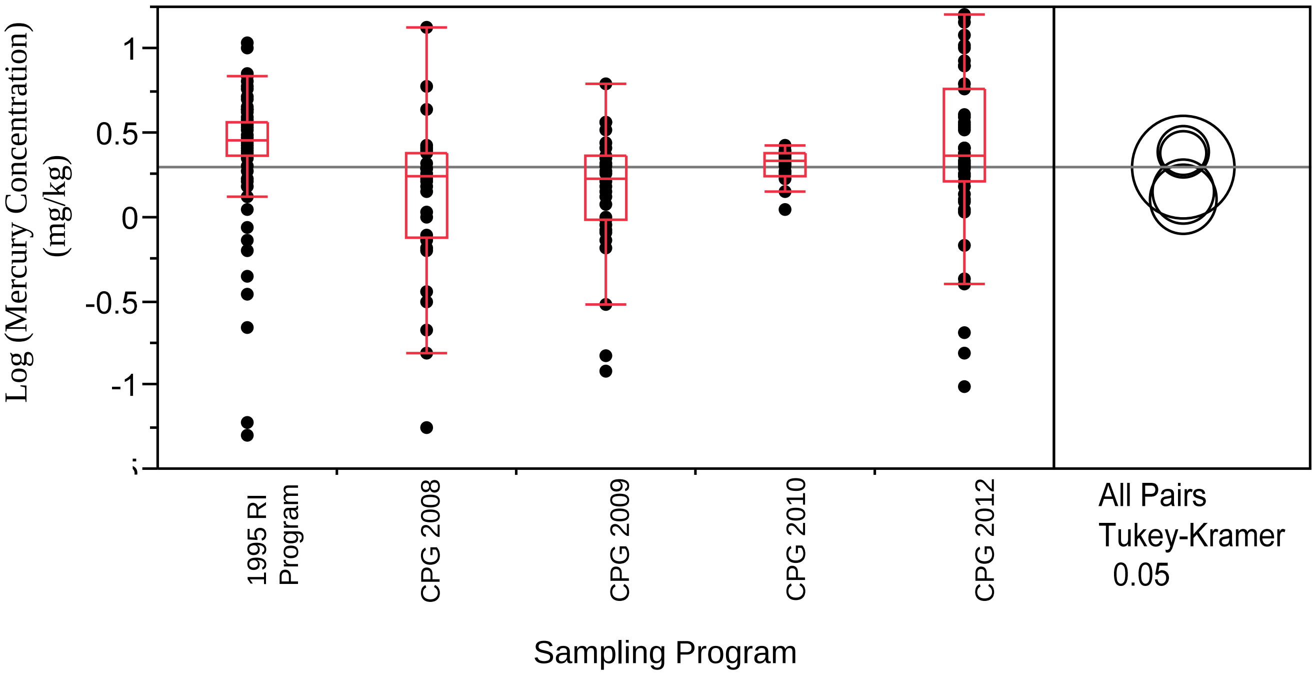
RM0 to RM2



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles..



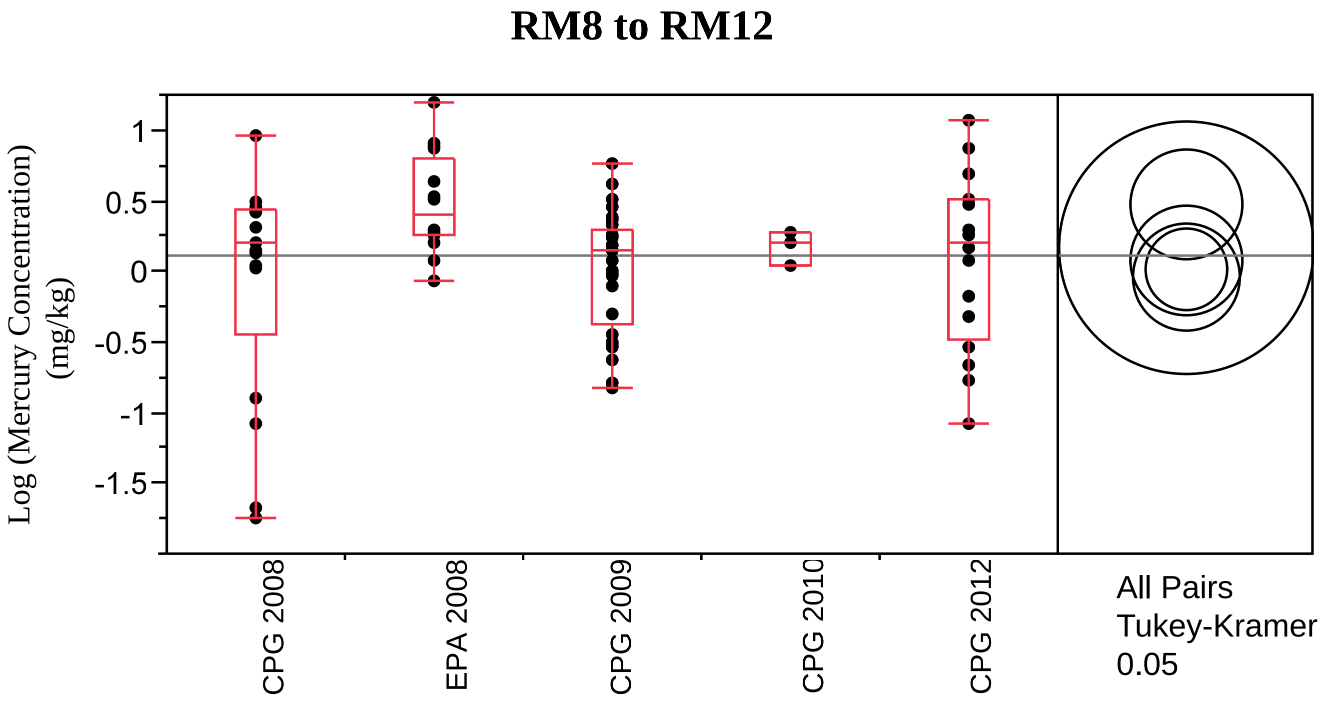
RM2 to RM8



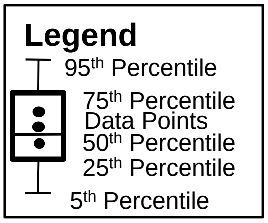
Mercury (0-6 inch) by Sampling Program
at RM0 to RM2 and RM2 to RM8
Lower Eight Miles of the Lower Passaic River

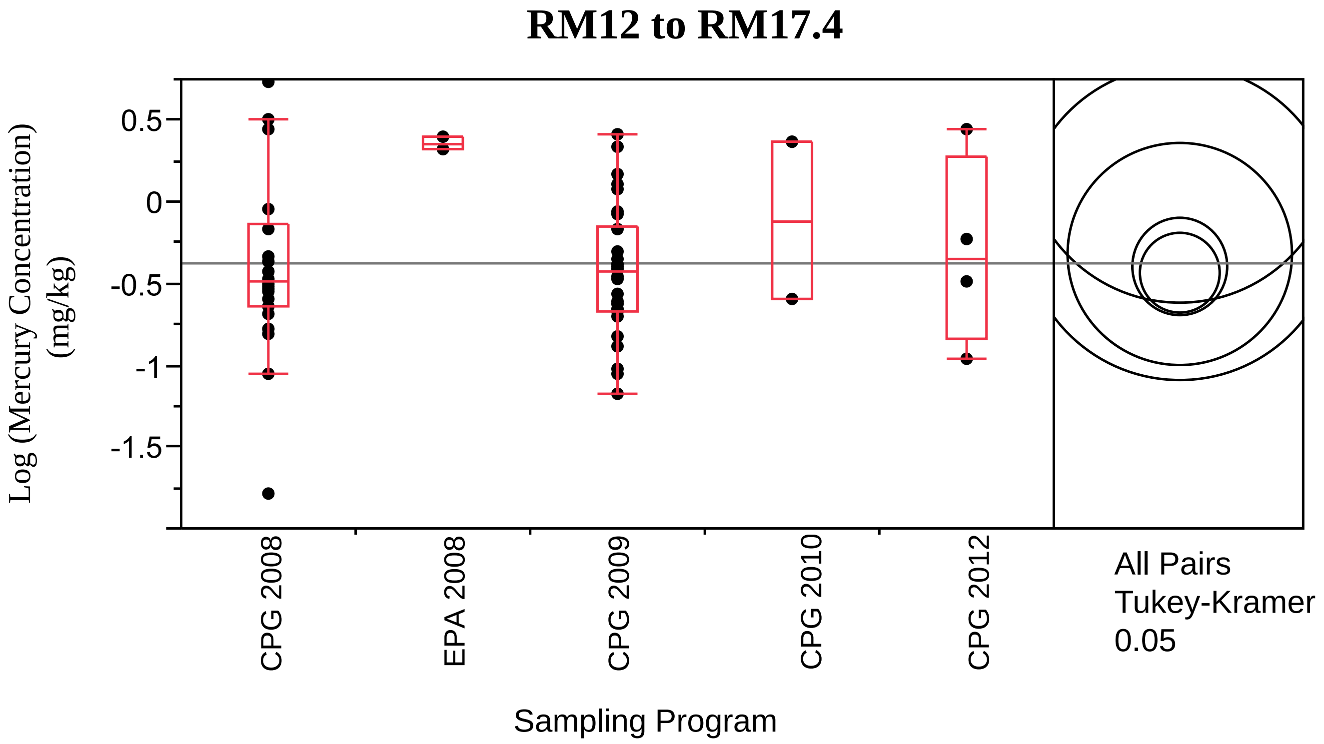
Figure 3.4-15a

2014



Note: Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles..



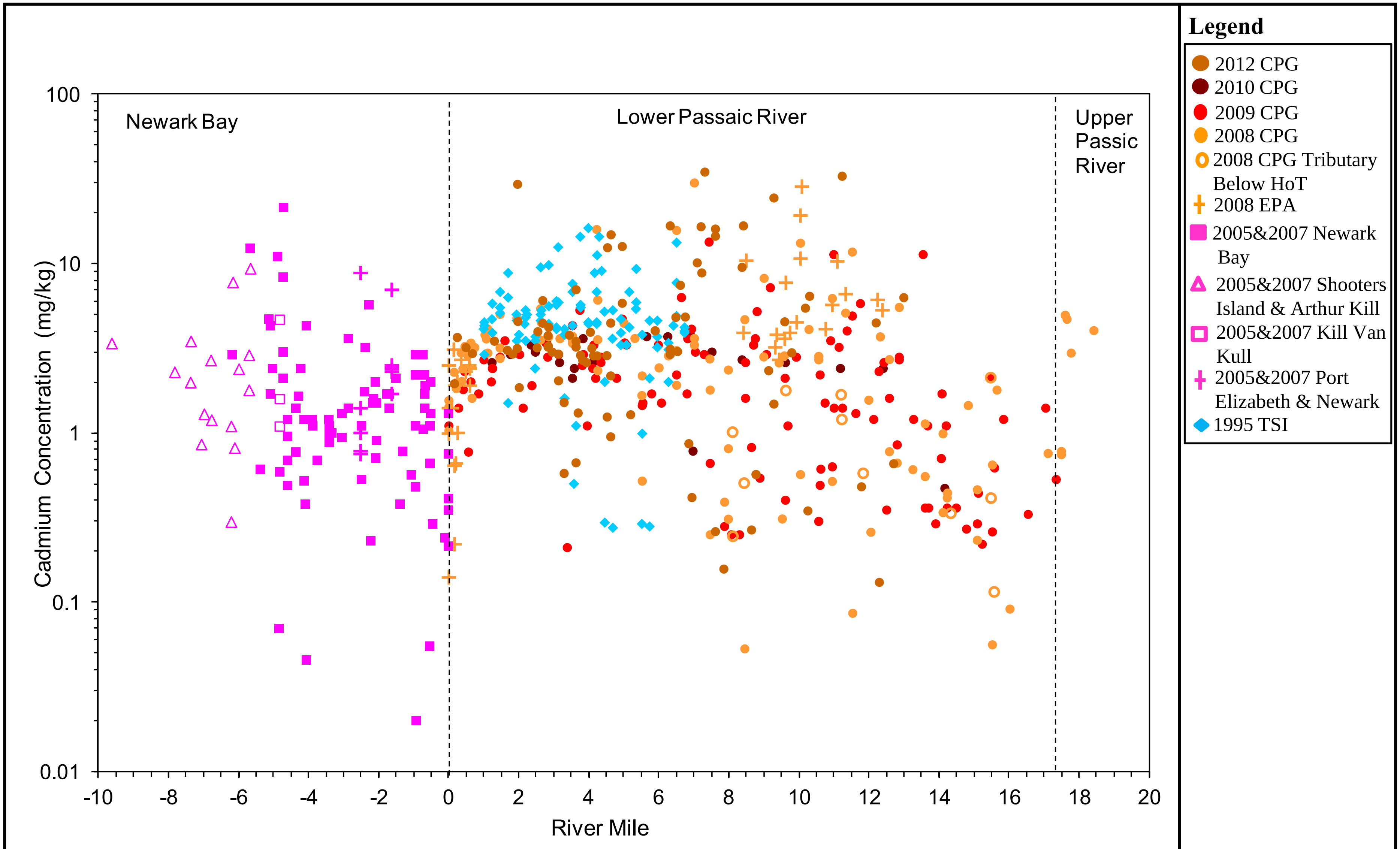


Mercury (0-6 inch) by Sampling Program at RM8 to RM12 and RM12 to RM17.4

Lower Eight Miles of the Lower Passaic River

Figure 3.4-15b

2014

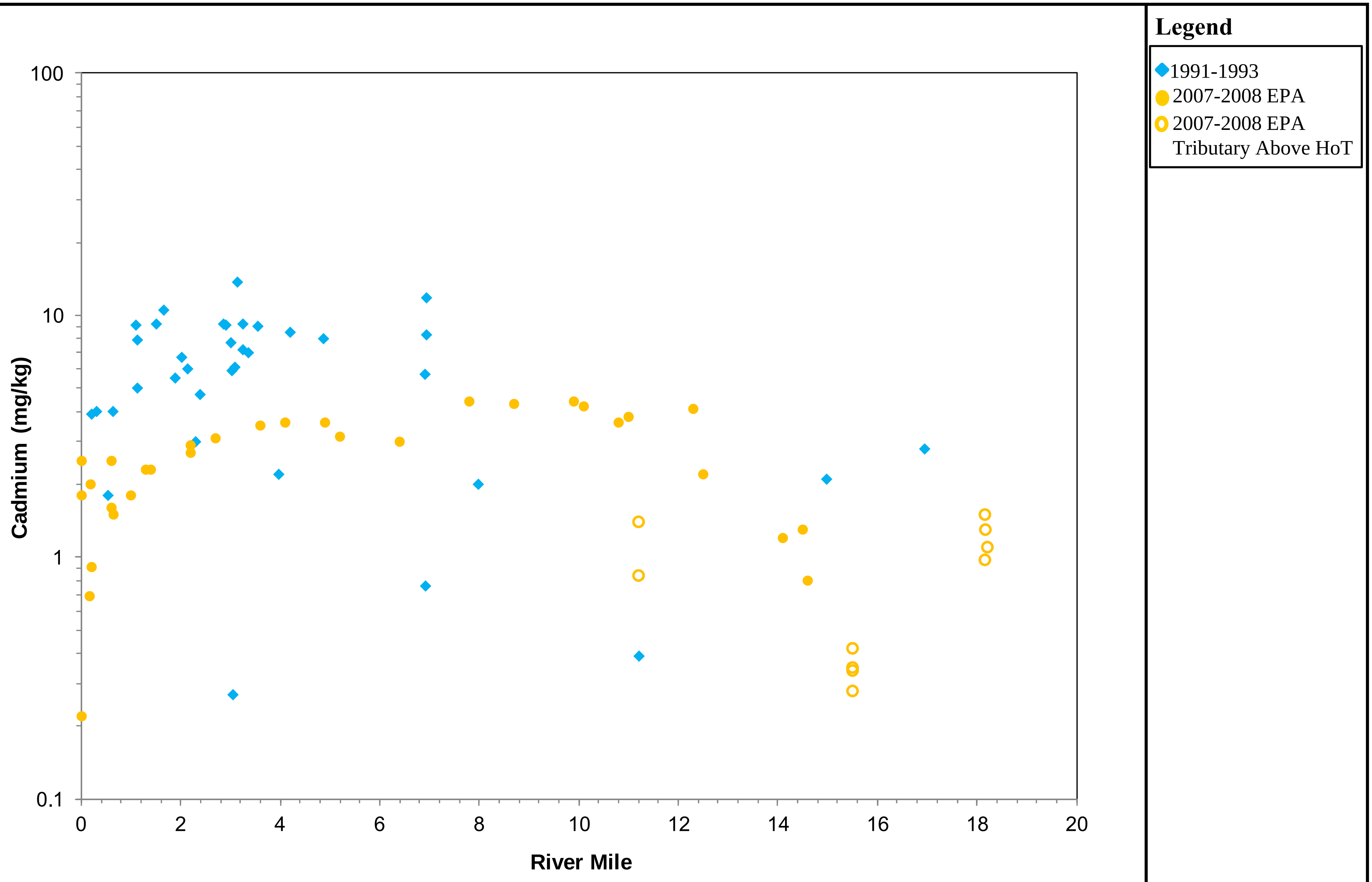


Cadmium Concentration (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.4-16

2014

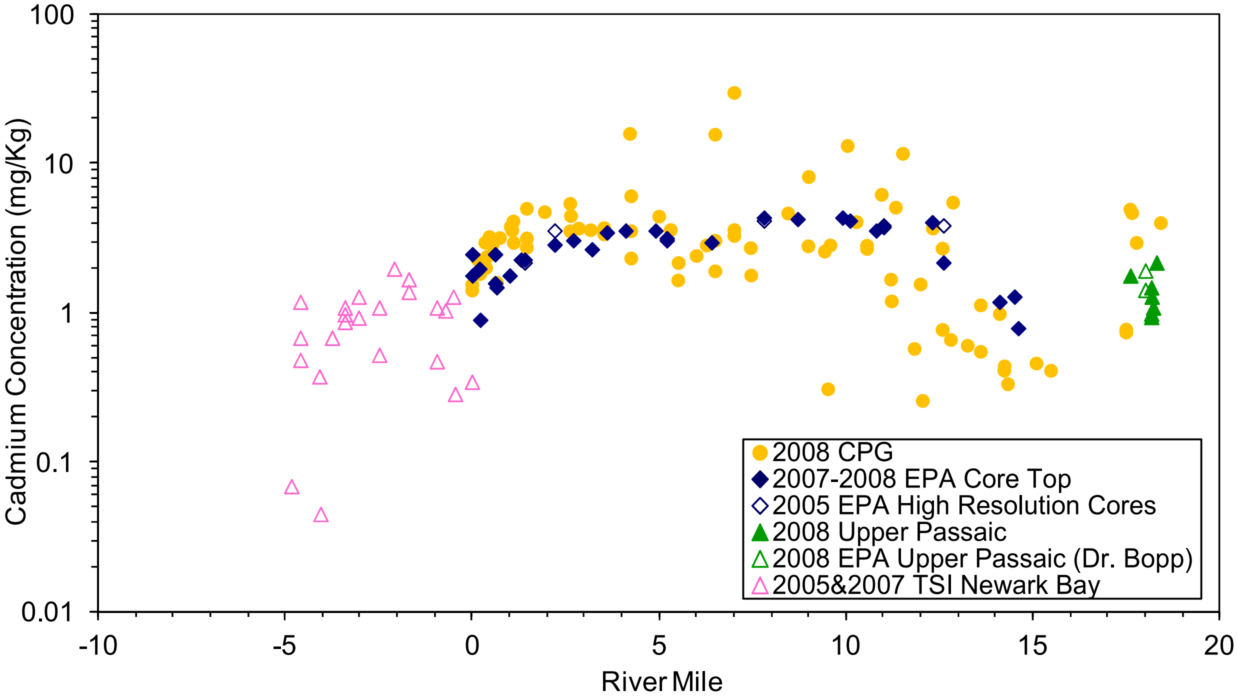


Cadmium Concentration (0 - ≤2 inches) *vs.* River Mile

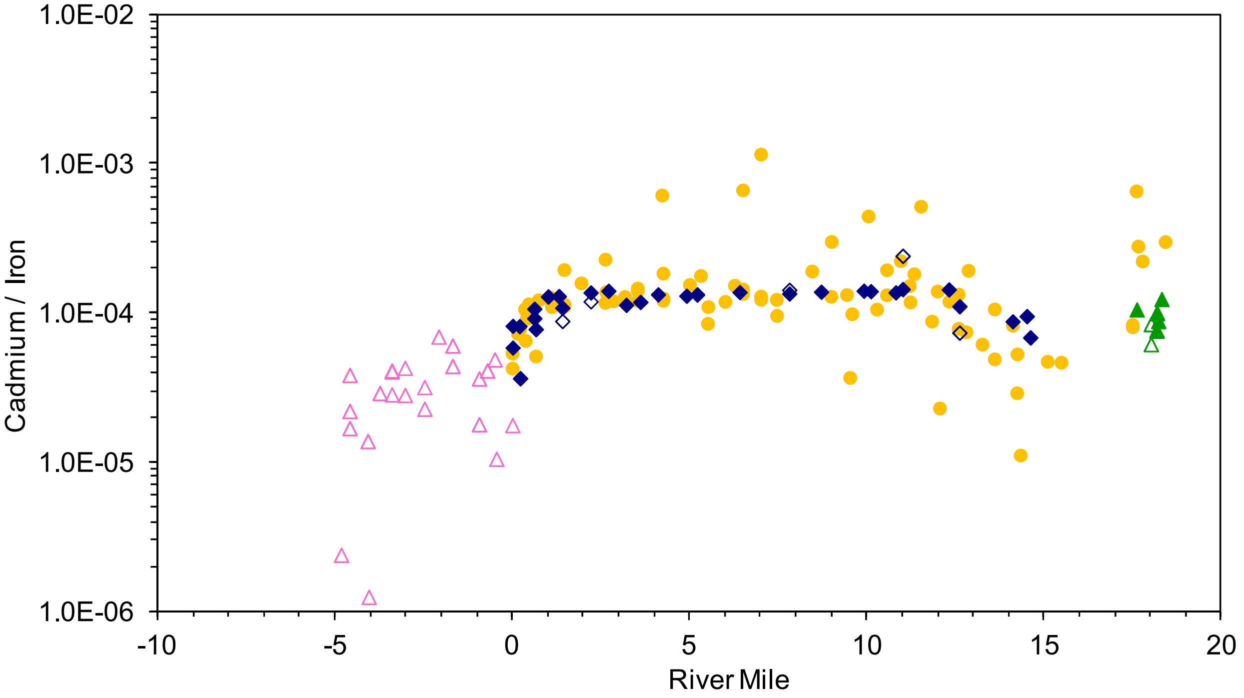
Lower Eight Miles of the Lower Passaic River

Figure 3.4-17

2014



Cadmium *vs.* River Mile



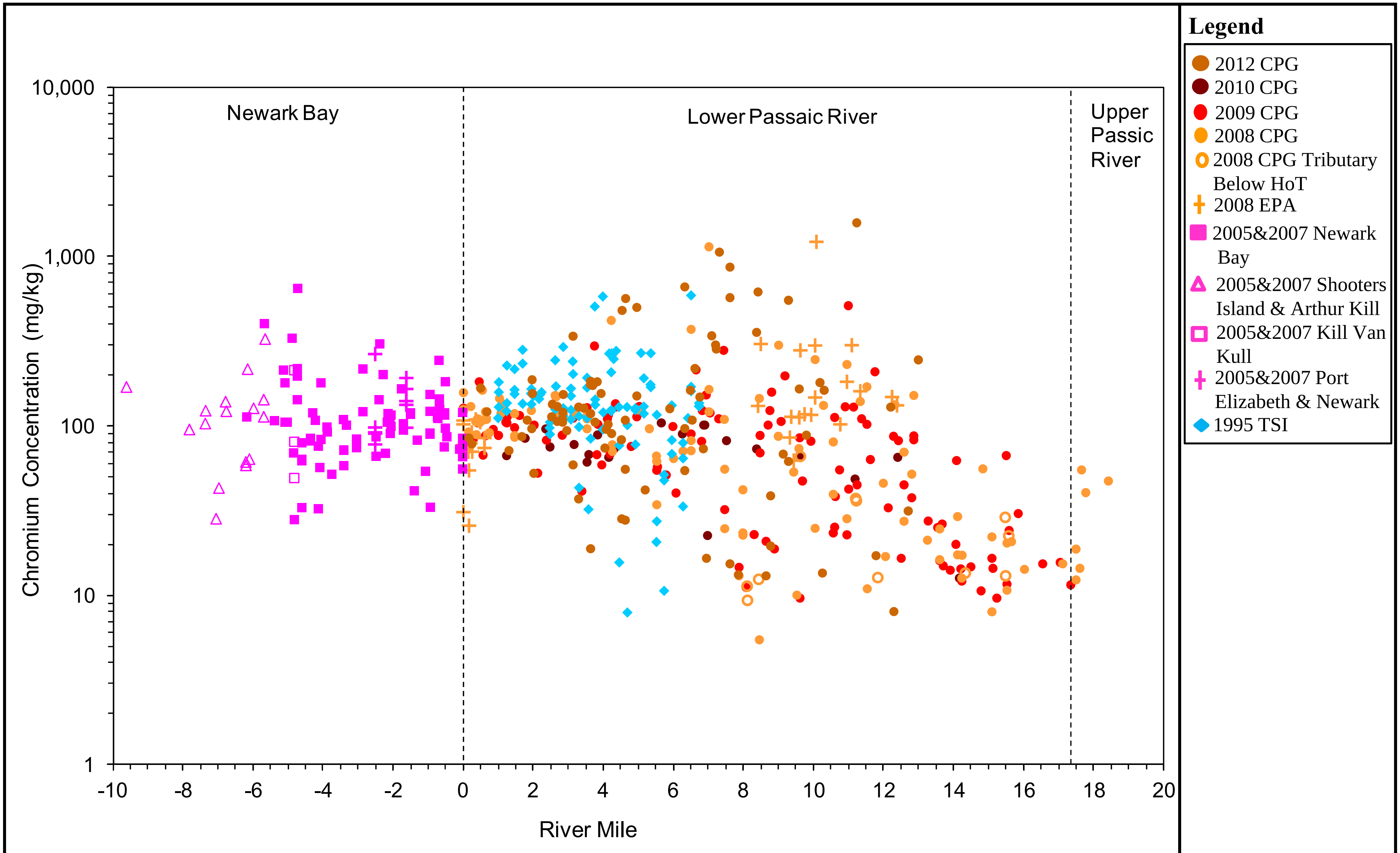
Cadmium Iron Normalized *vs.* River Mile

Cadmium in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Lower Passaic River

Figure 3.4-18

2014

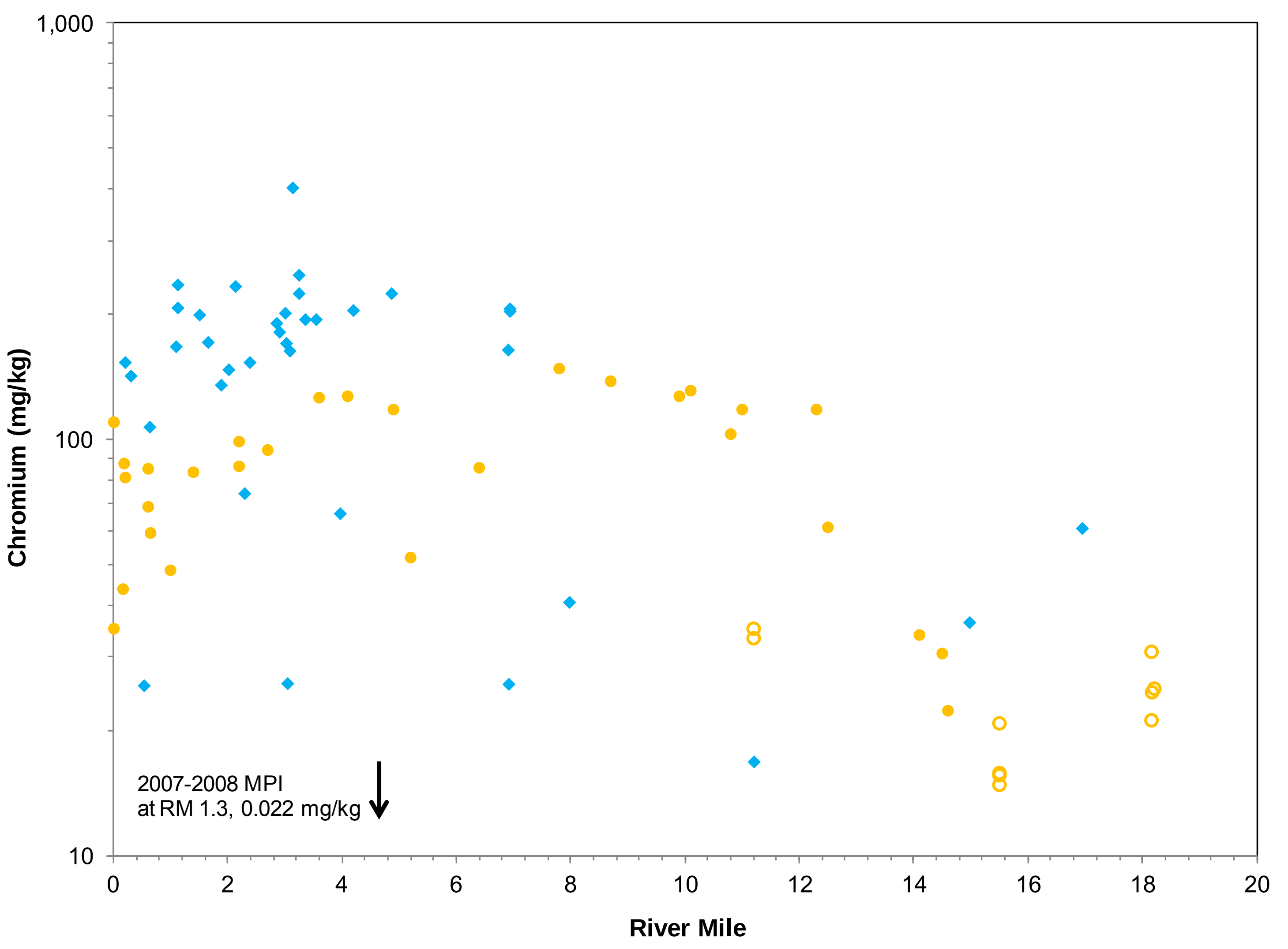


Chromium Concentration (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.4-19

2014



Legend

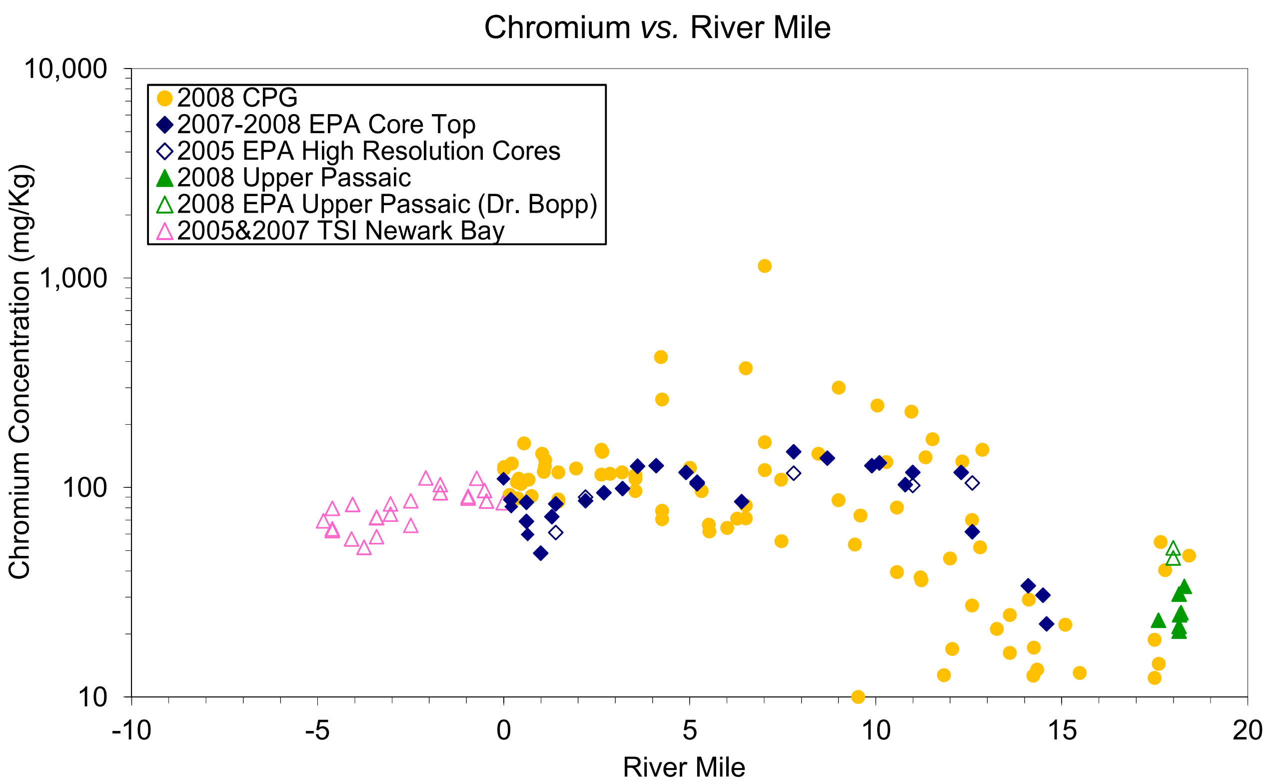
- ◆ 1991-1993
- ● 2007-2008 EPA
- ○ 2007-2008 EPA Tributary Above HoT

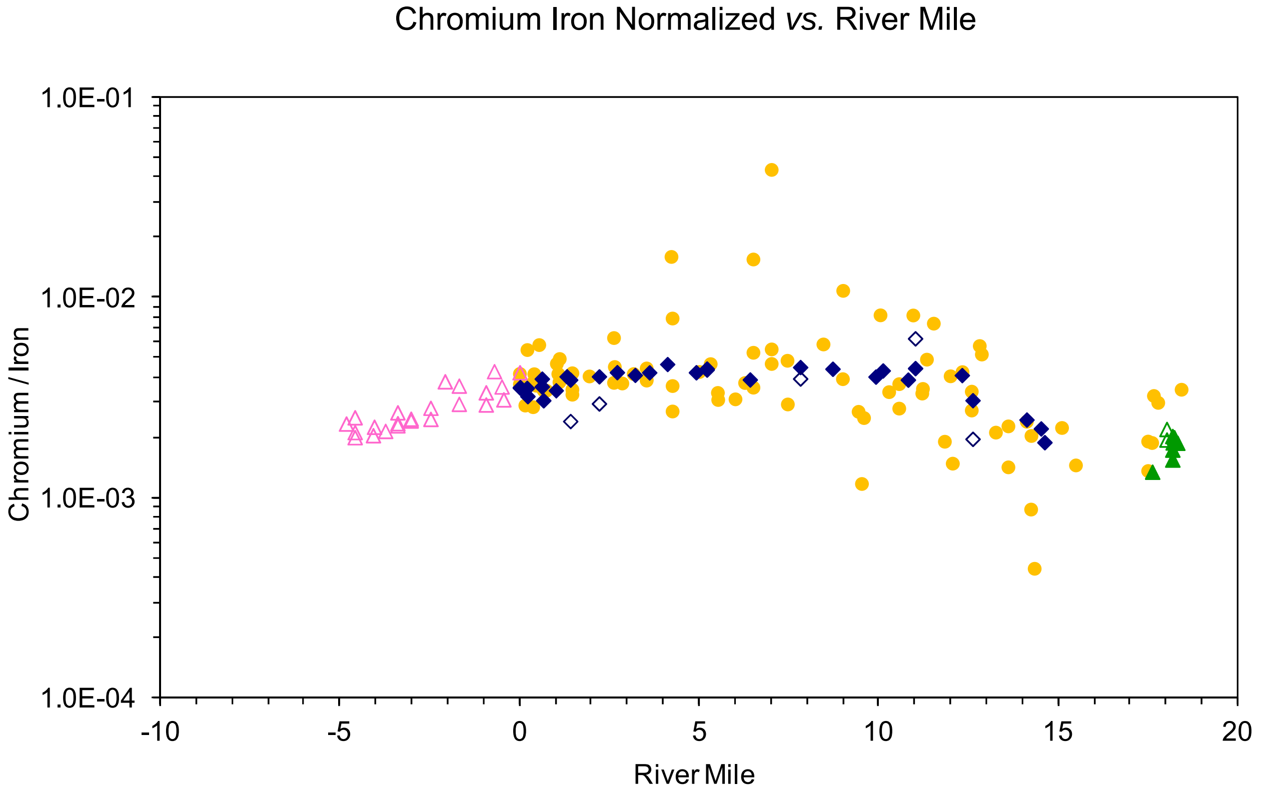
Chromium Concentration (0 - ≤2 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.4-20

2014



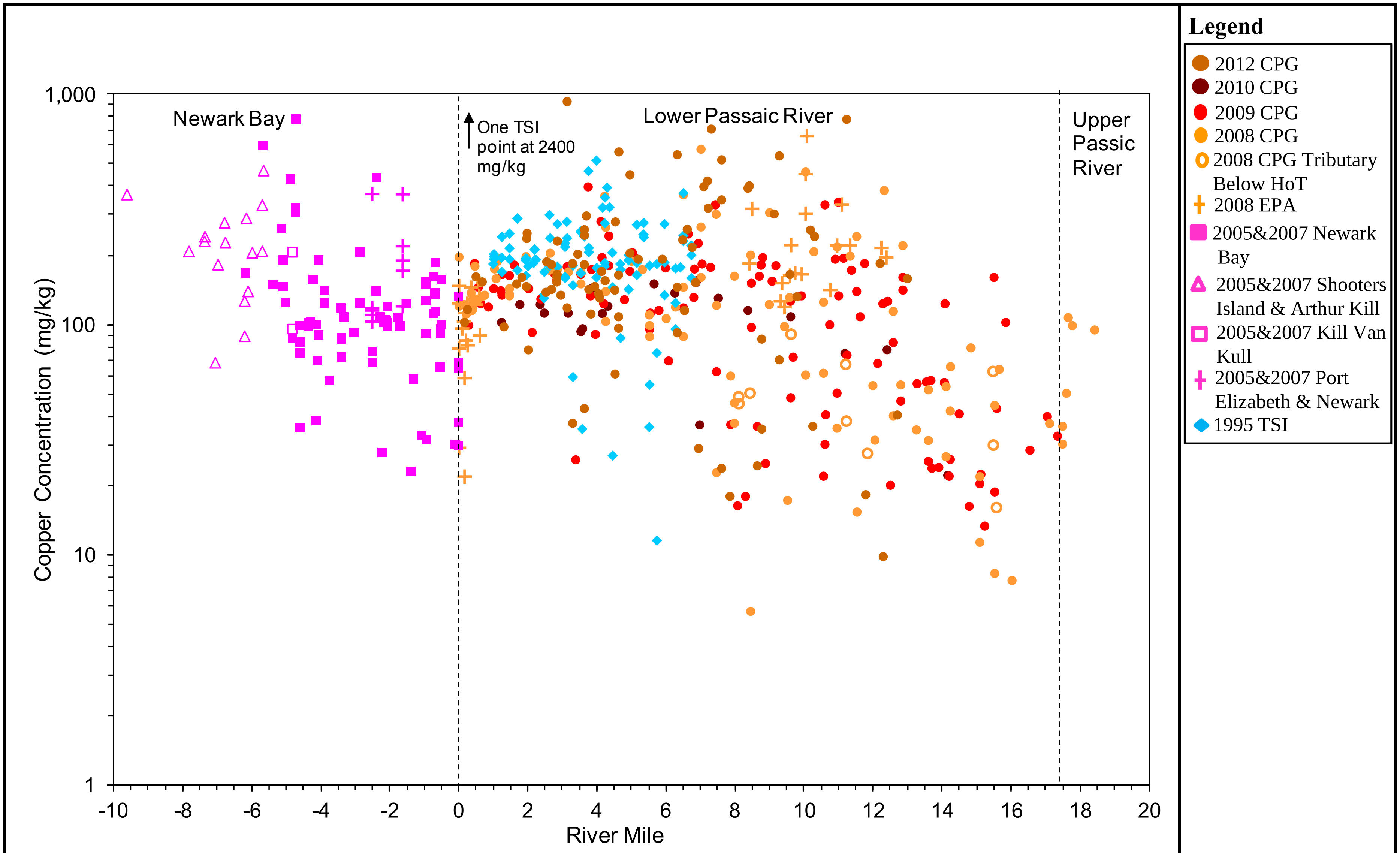


Chromium in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Lower Passaic River

Figure 3.4-21

2014

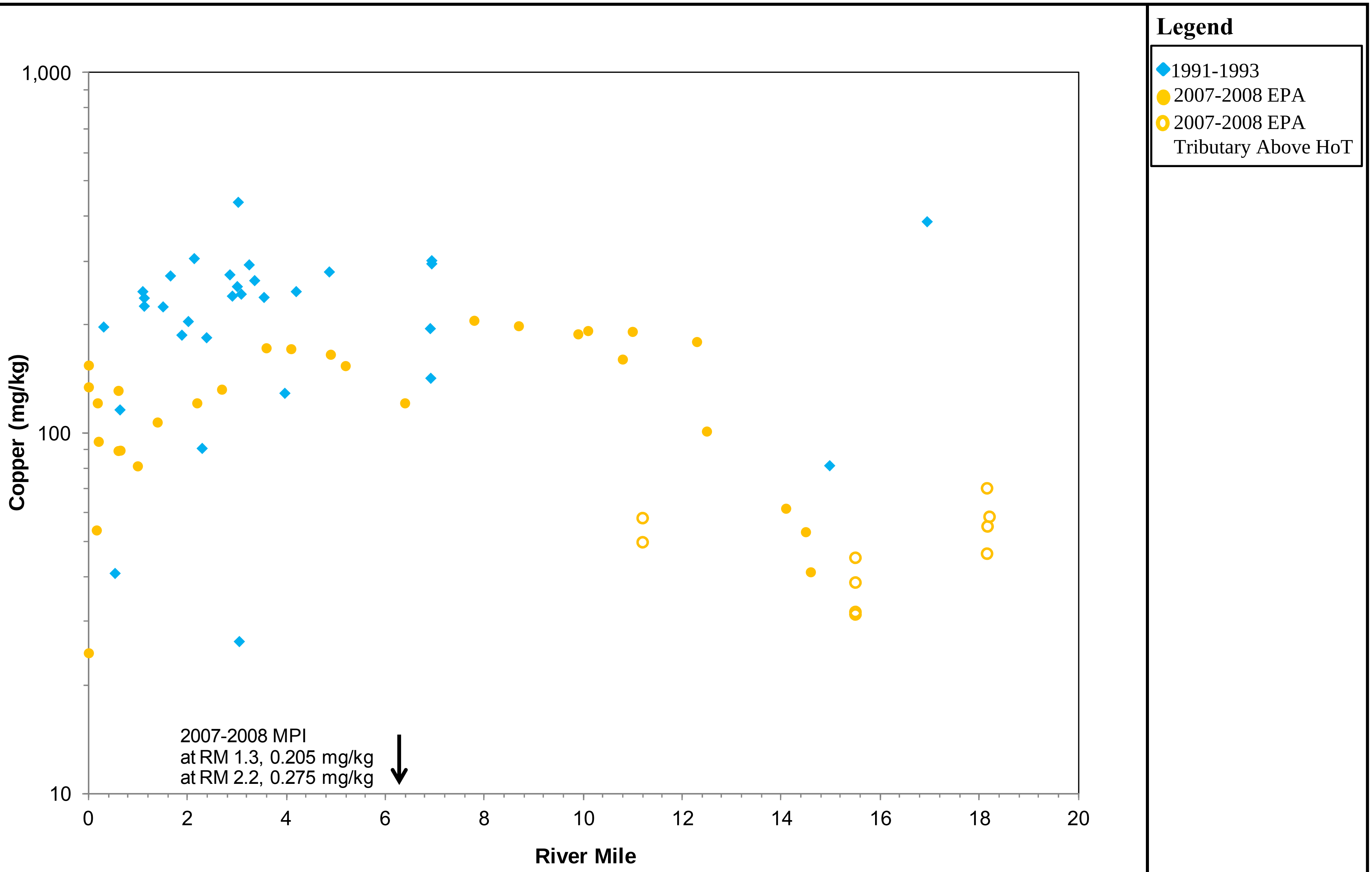


Copper Concentration (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.4-22

2014

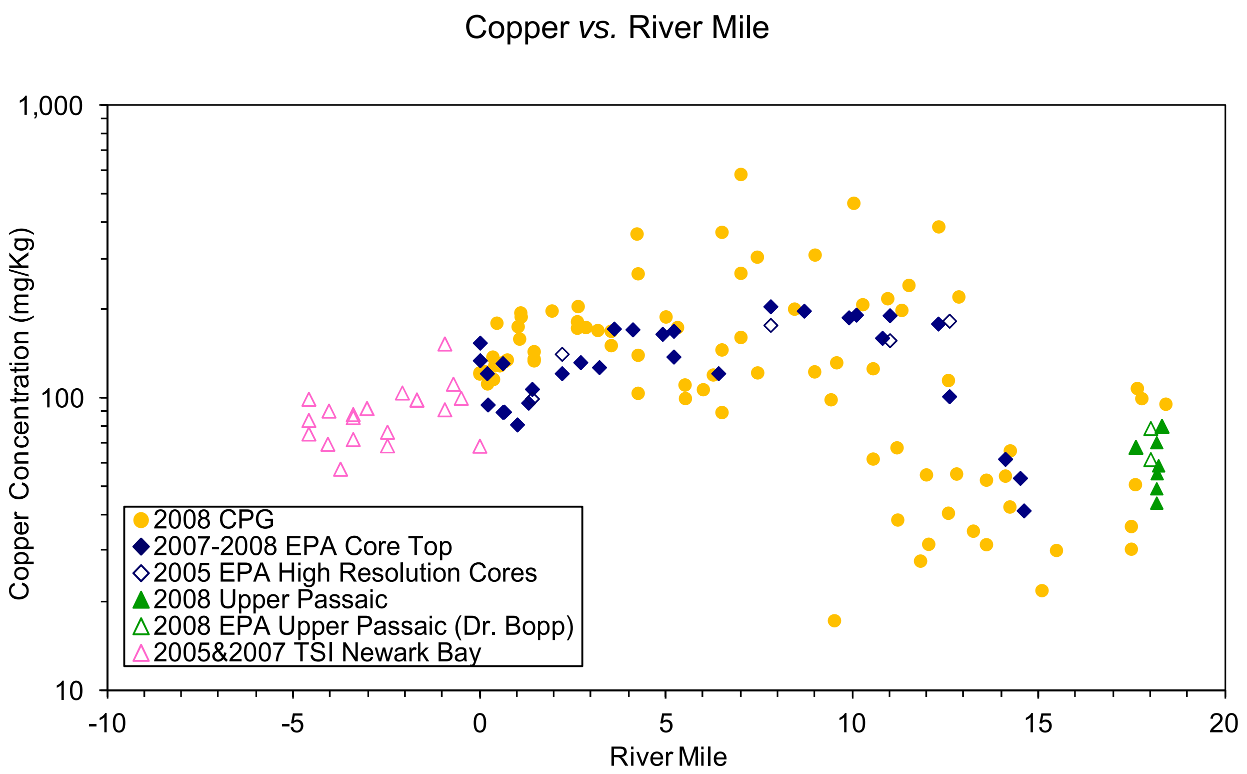


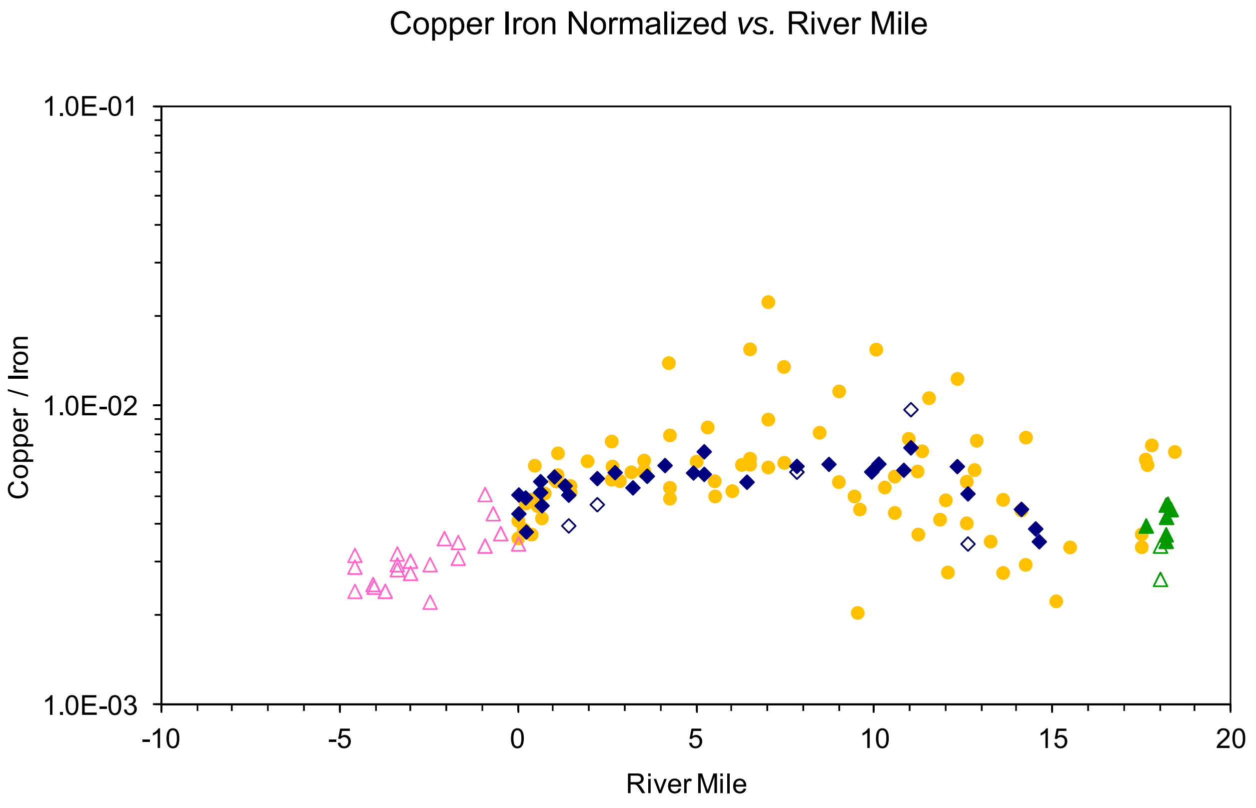
Copper Concentration (0 - ≤2 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.4-23

2014



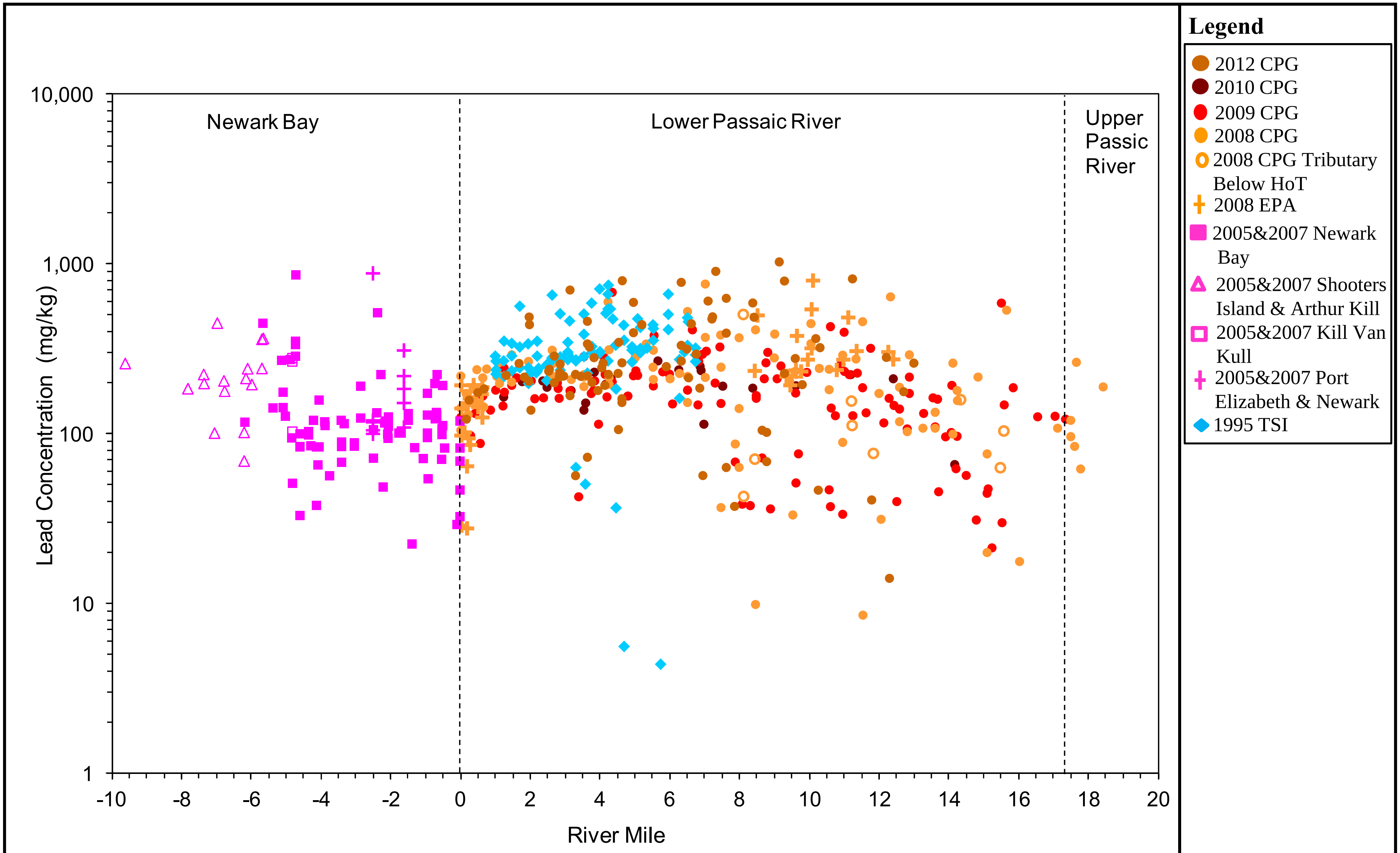


Copper in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Lower Passaic River

Figure 3.4-24

2014

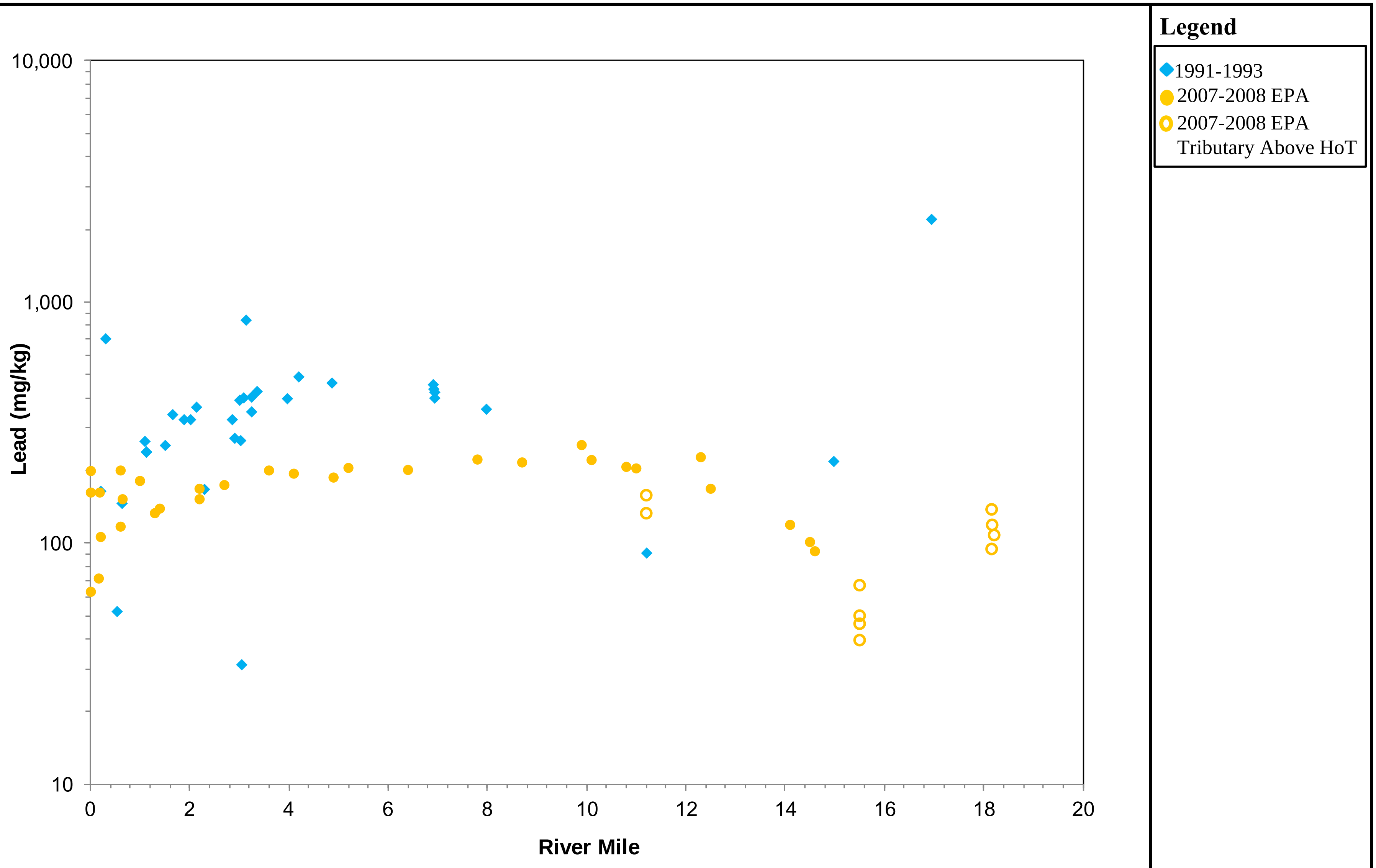


Lead Concentration (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.4-25

2014

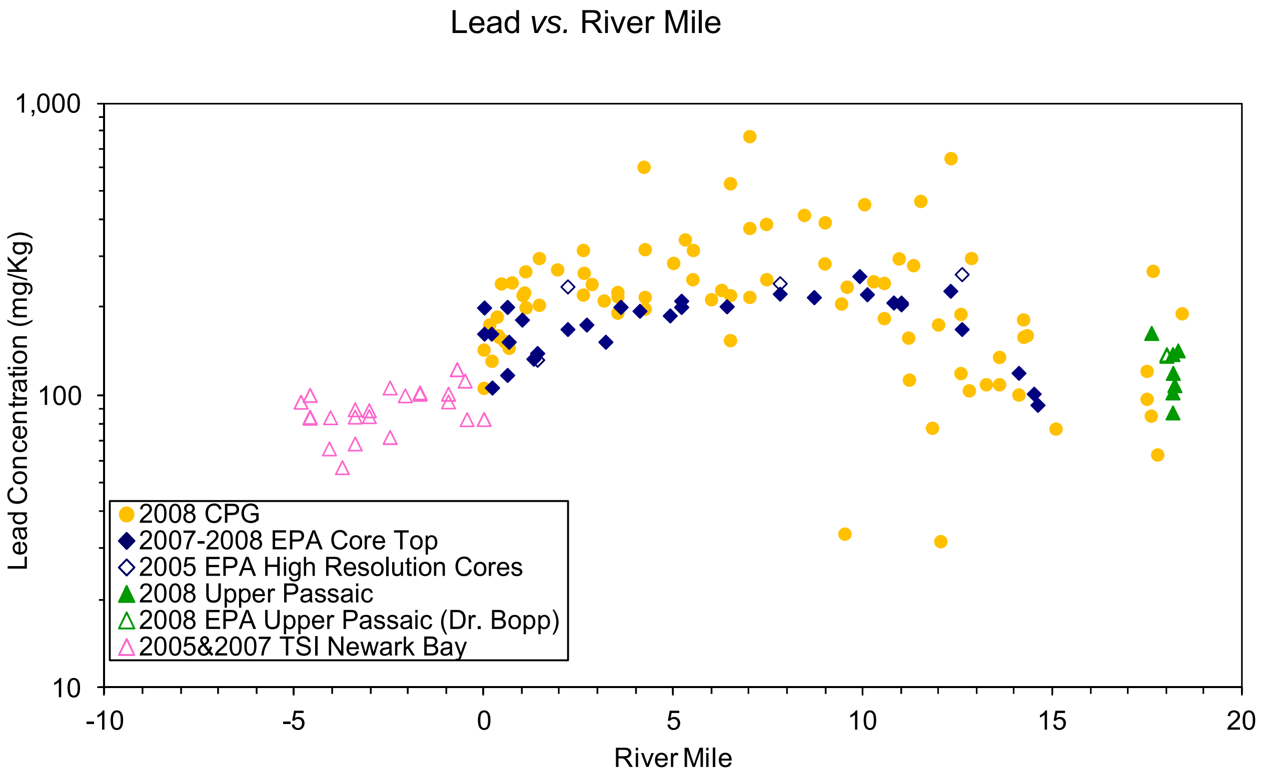


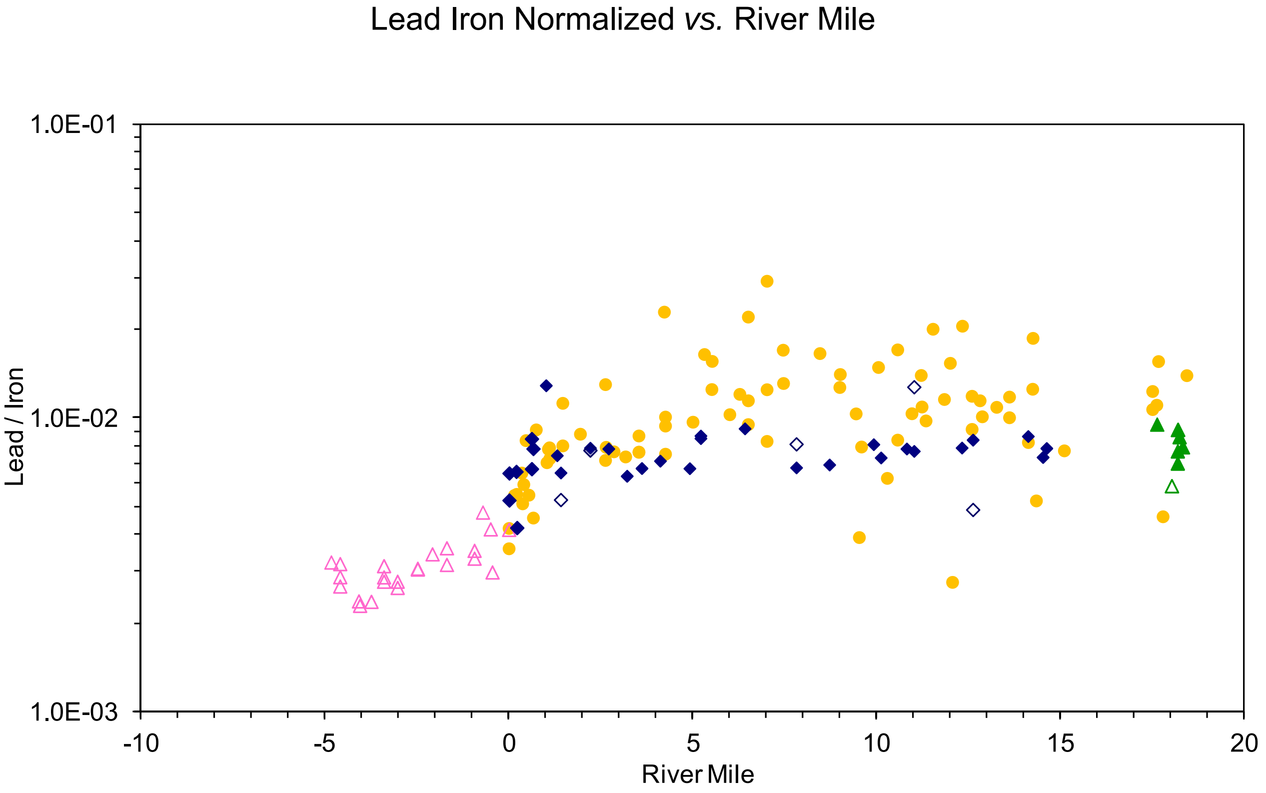
Lead Concentration (0 - ≤2 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.4-26

2014



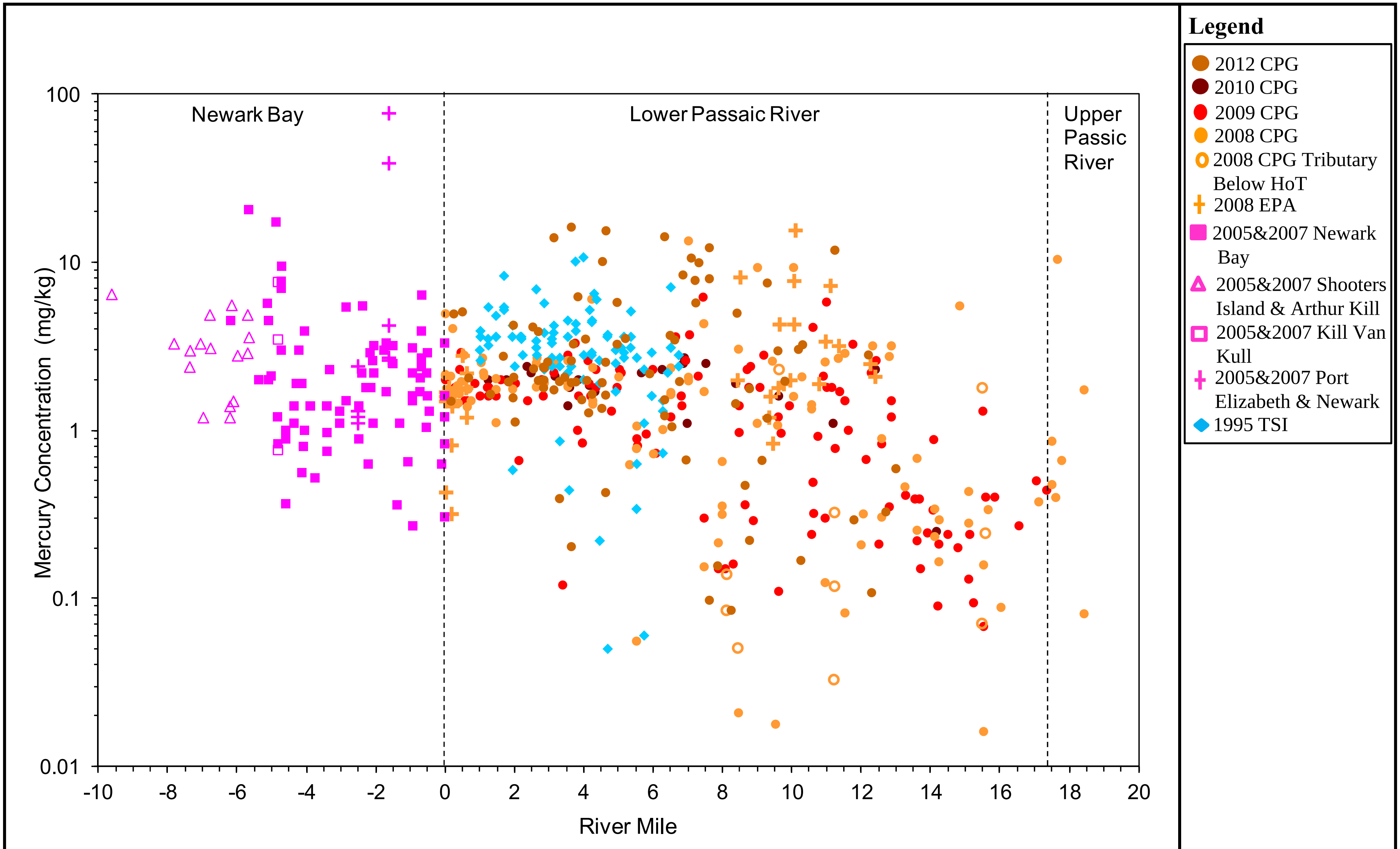


Lead in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Lower Passaic River

Figure 3.4-27

2014

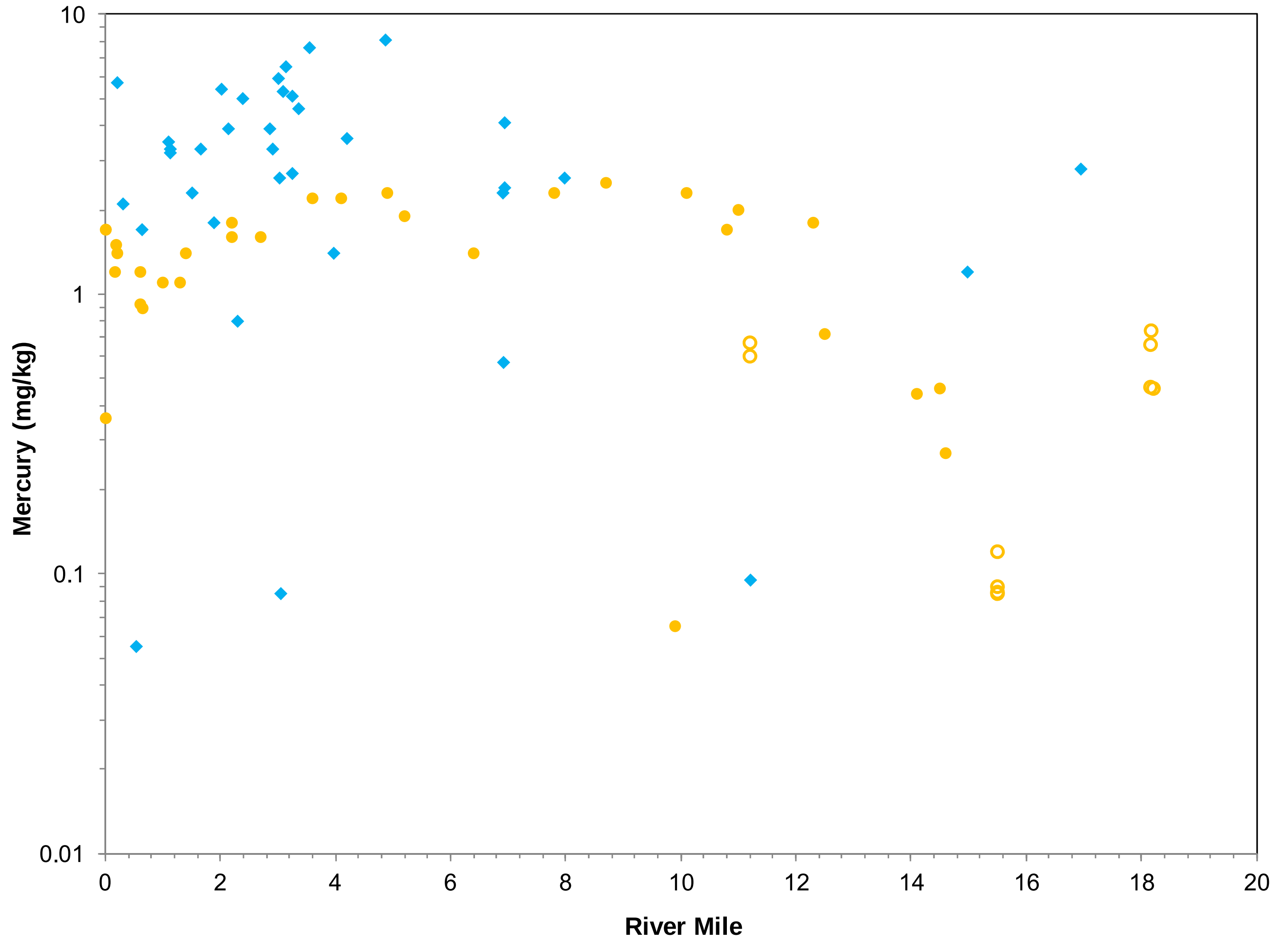


Mercury Concentration (0-6 inches) *vs.* River Mile

Lower Eight Miles of the Lower Passaic River

Figure 3.4-28

2014



Legend

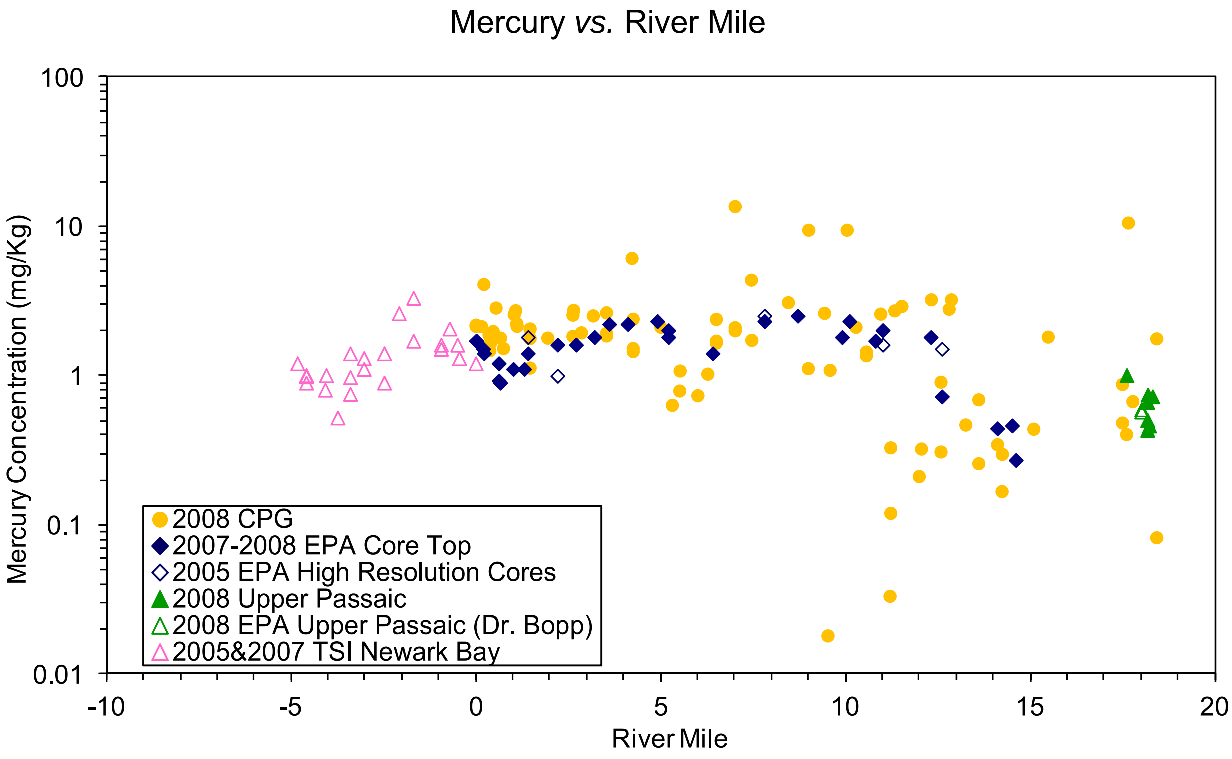
◆ 1991-1993
● 2007-2008 EPA
○ 2007-2008 EPA Tributary Above HoT

Mercury Concentration (0 - ≤2 inches) *vs.* River Mile

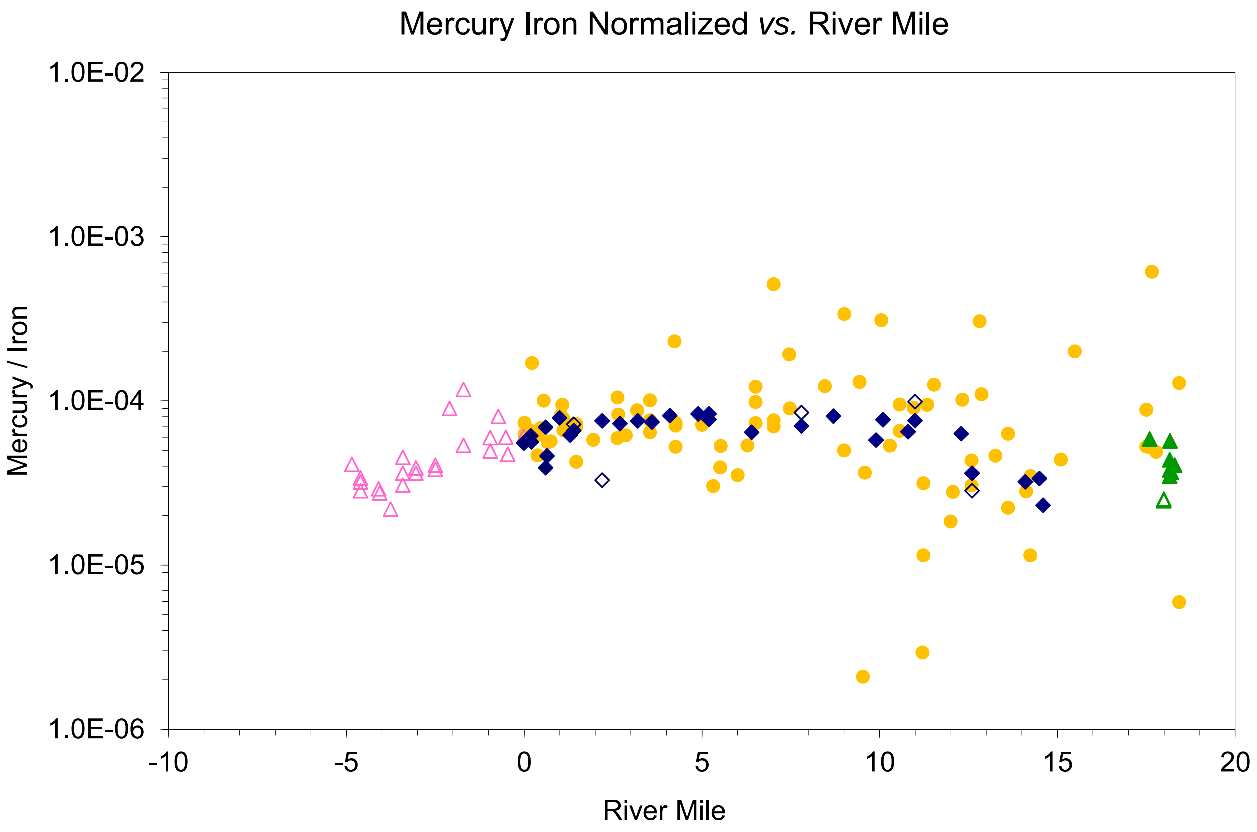
Lower Eight Miles of the Lower Passaic River

Figure 3.4-29

2014



Mercury *vs.* River Mile



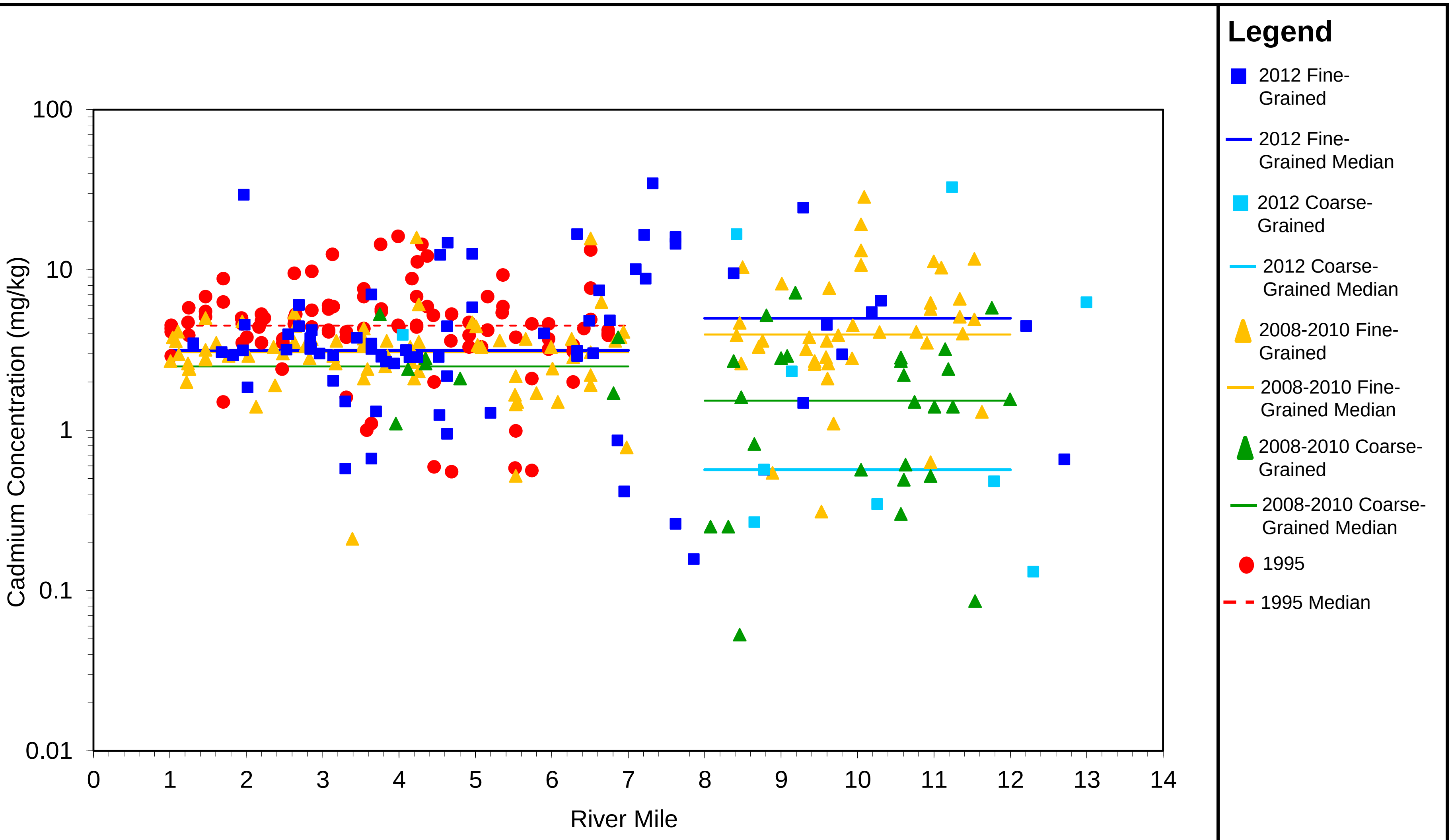
Mercury Iron Normalized *vs.* River Mile

Mercury in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River

Lower Eight Miles of the Lower Passaic River

Figure 3.4-30

2014



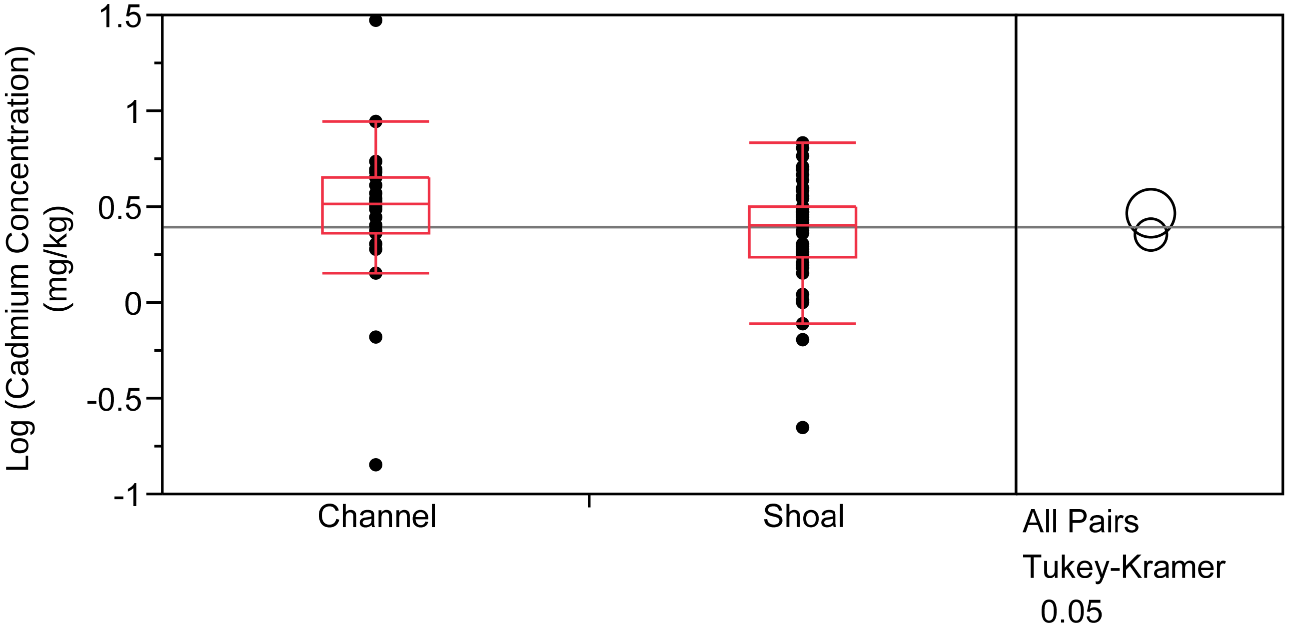
Comparison of Cadmium Surface Concentration (0-6 inches)
RM1 to RM7 *vs.* RM8 to RM12

Lower Eight Miles of the Lower Passaic River

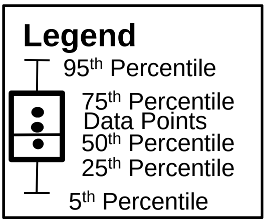
Figure 3.4-31

2014

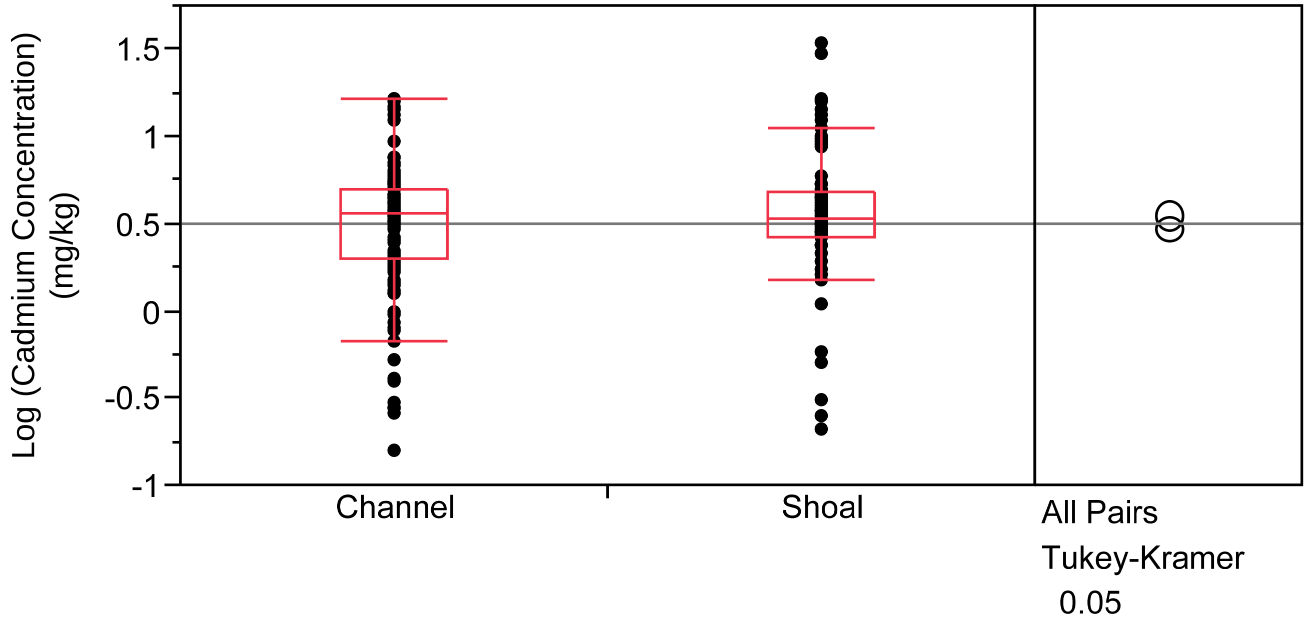
RM0 to RM2



Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



RM2 to RM8



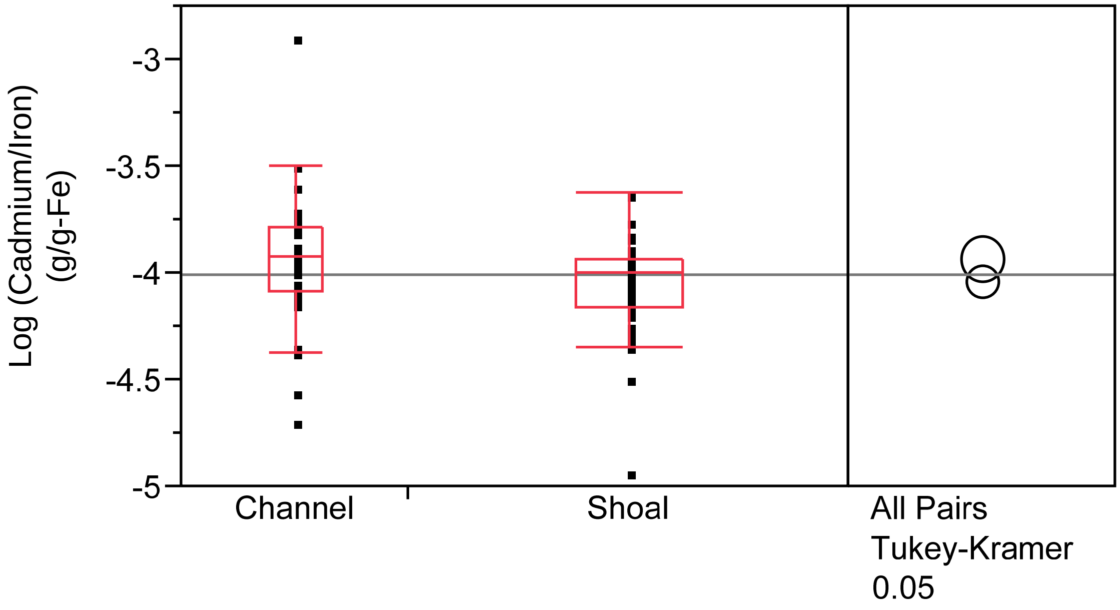
Cadmium (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

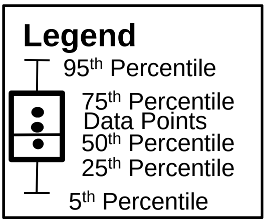
Figure 3.4-32a

2014

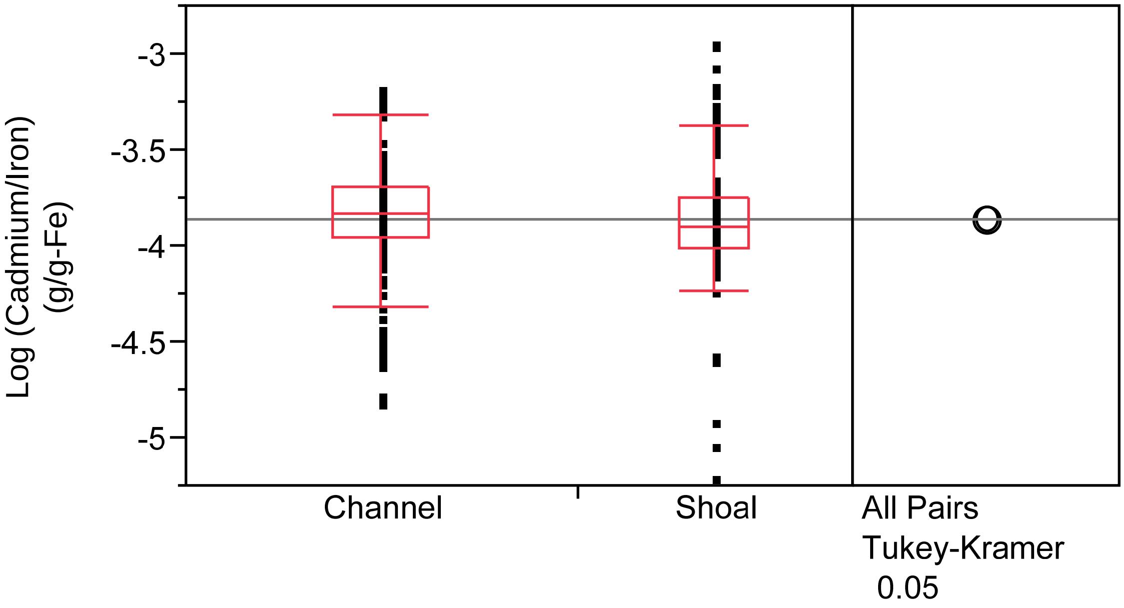
RM0 to RM2



Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



RM2 to RM8

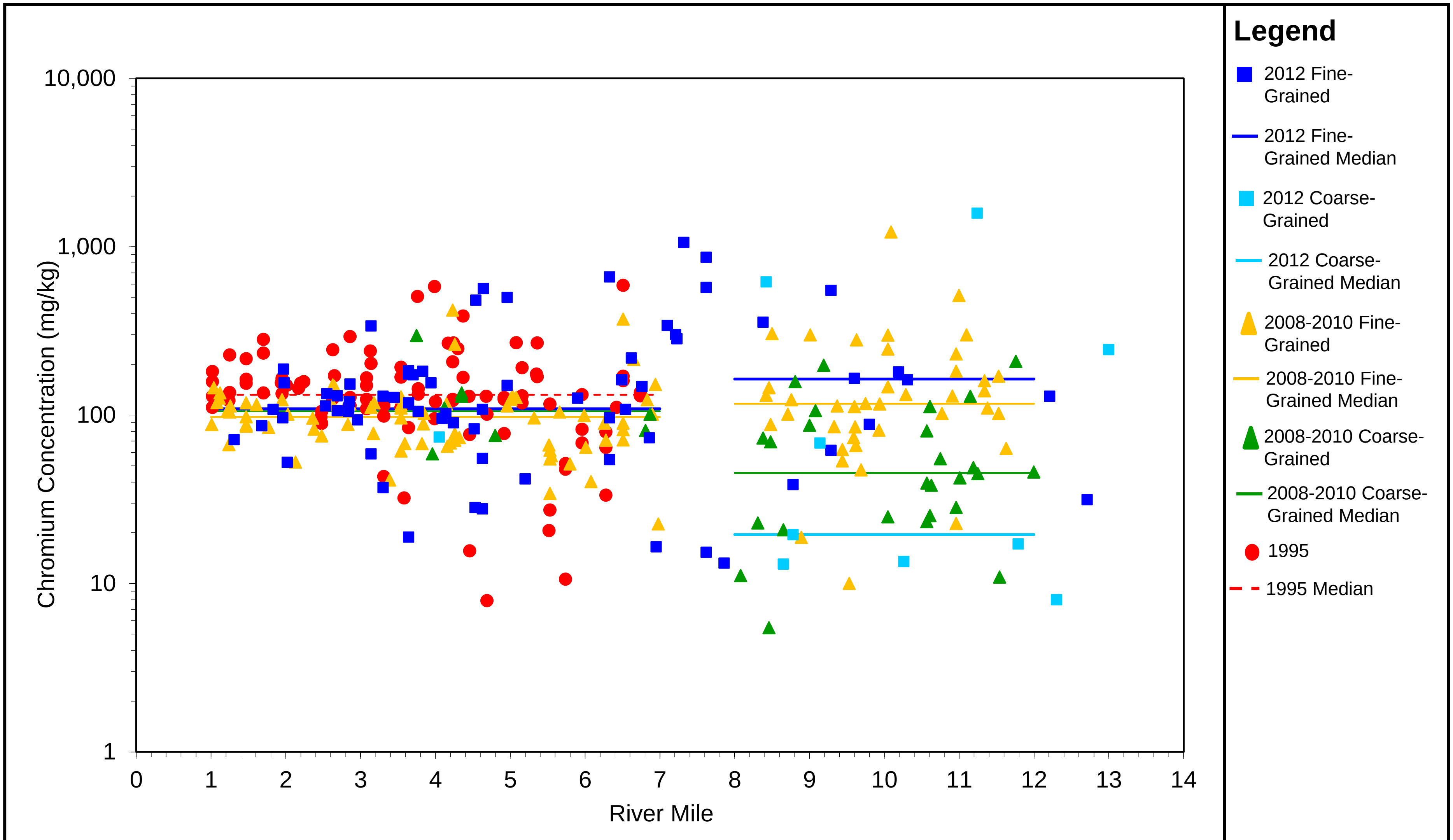


Iron Normalized Cadmium (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 3.4-32b

2014



Legend

- 🟦 2012 Fine-Grained
- — 2012 Fine-Grained Median
- 🟦 2012 Coarse-Grained
- — 2012 Coarse-Grained Median
- ▲ 2008-2010 Fine-Grained
- — 2008-2010 Fine-Grained Median
- ▲ 2008-2010 Coarse-Grained
- — 2008-2010 Coarse-Grained Median
- ● 1995
- - - 1995 Median

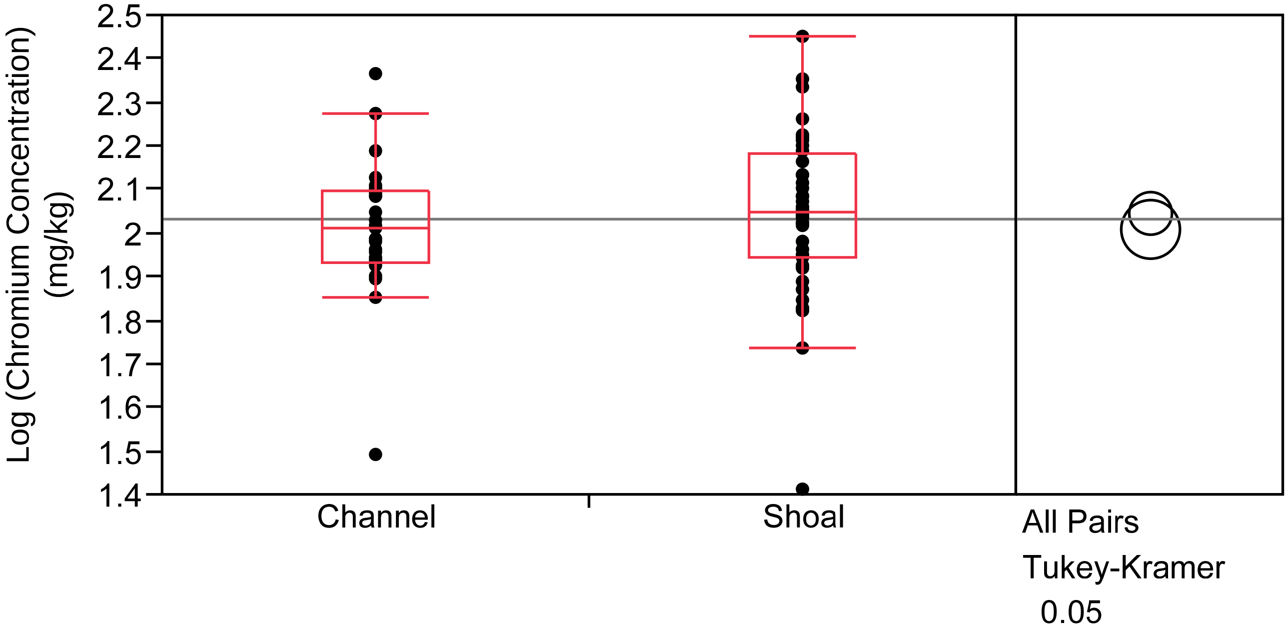
Comparison of Chromium Surface Concentration (0-6 inches) RM1 to RM7 *vs.* RM8 to RM12

Lower Eight Miles of the Lower Passaic River

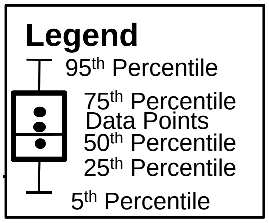
Figure 3.4-33

2014

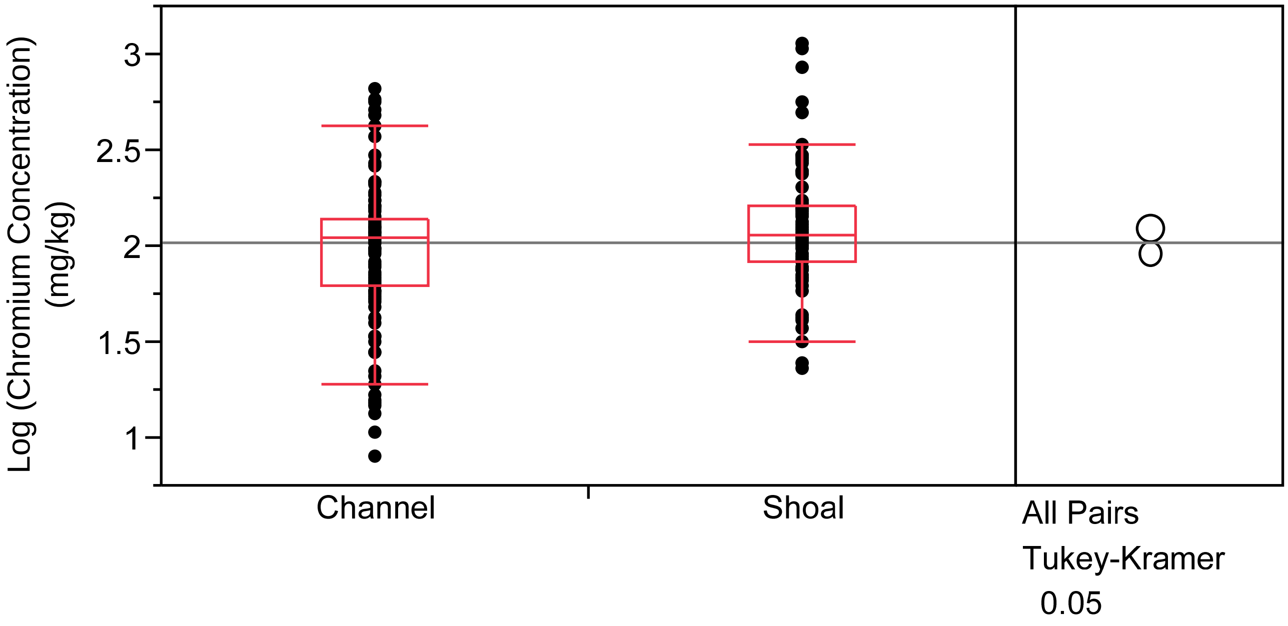
RM0 to RM2



Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



RM2 to RM8

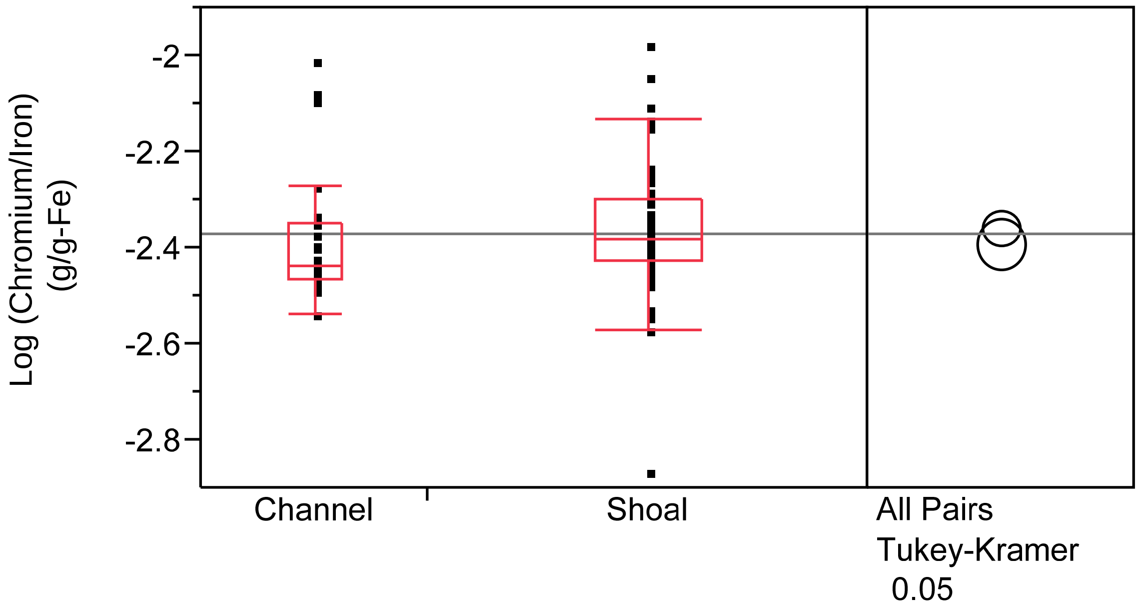


Chromium (0-6 inch) by Channel and Shoal
at RM0 to RM2 and RM2 to RM8
Lower Eight Miles of the Lower Passaic River

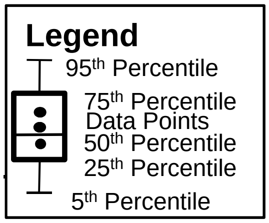
Figure 3.4-34a

2014

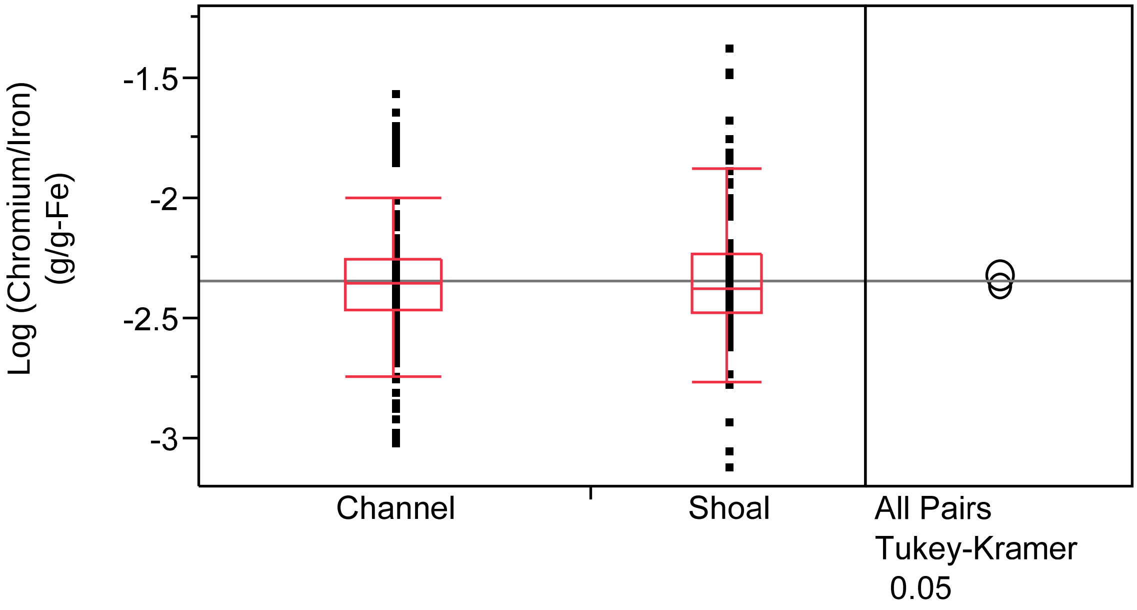
RM0 to RM2



Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



RM2 to RM8

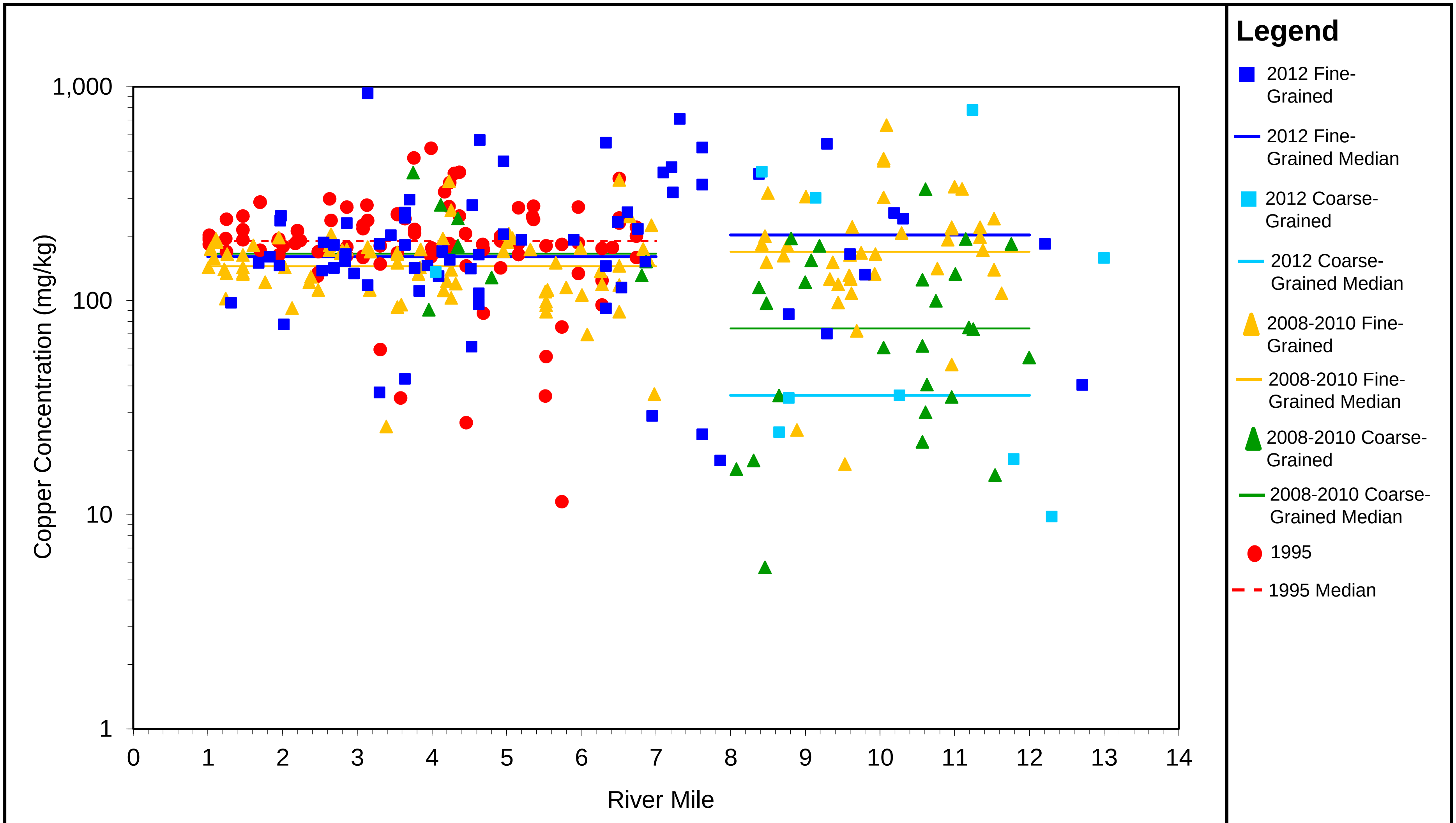


Iron Normalized Chromium (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 3.4-34b

2014



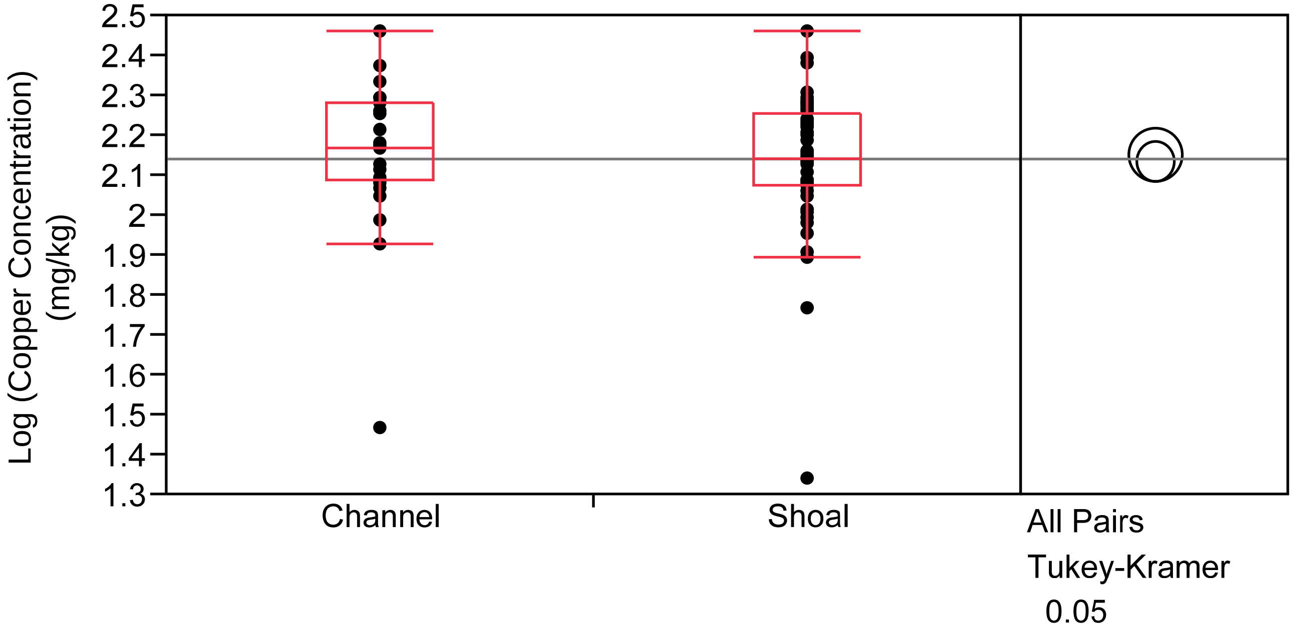
Comparison of Copper Surface Concentration (0-6 inches)
RM1 to RM7 *vs.* RM8 to RM12

Lower Eight Miles of the Lower Passaic River

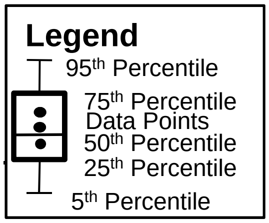
Figure 3.4-35

2014

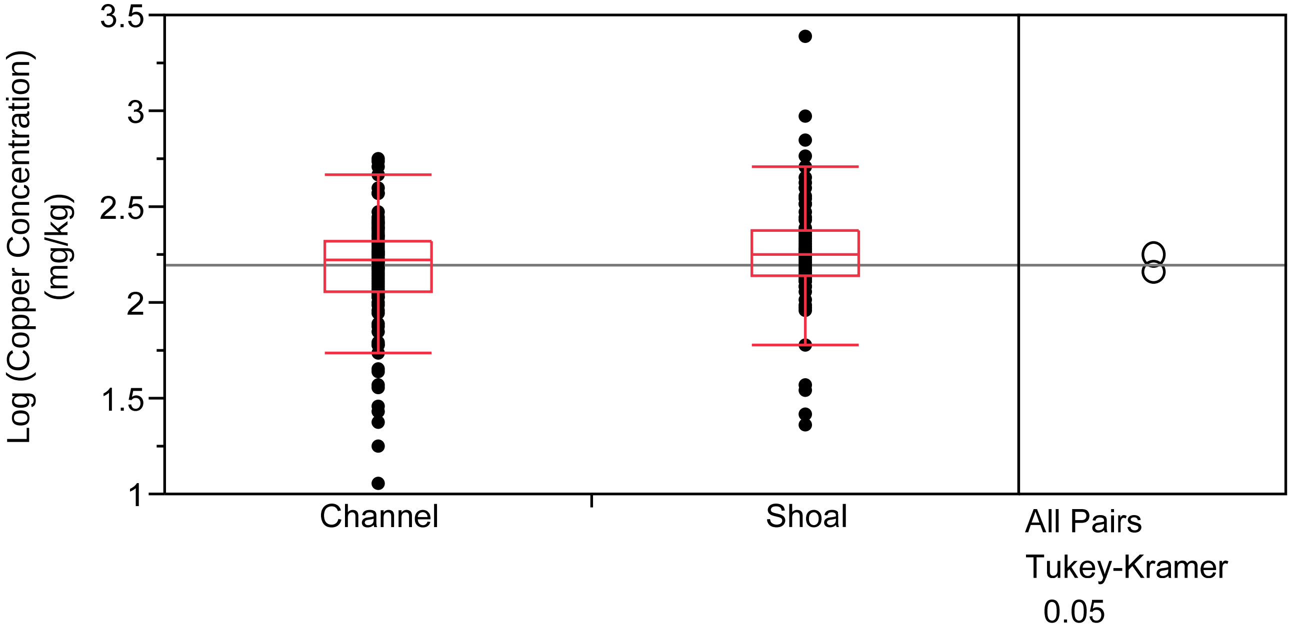
RM0 to RM2



Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



RM2 to RM8



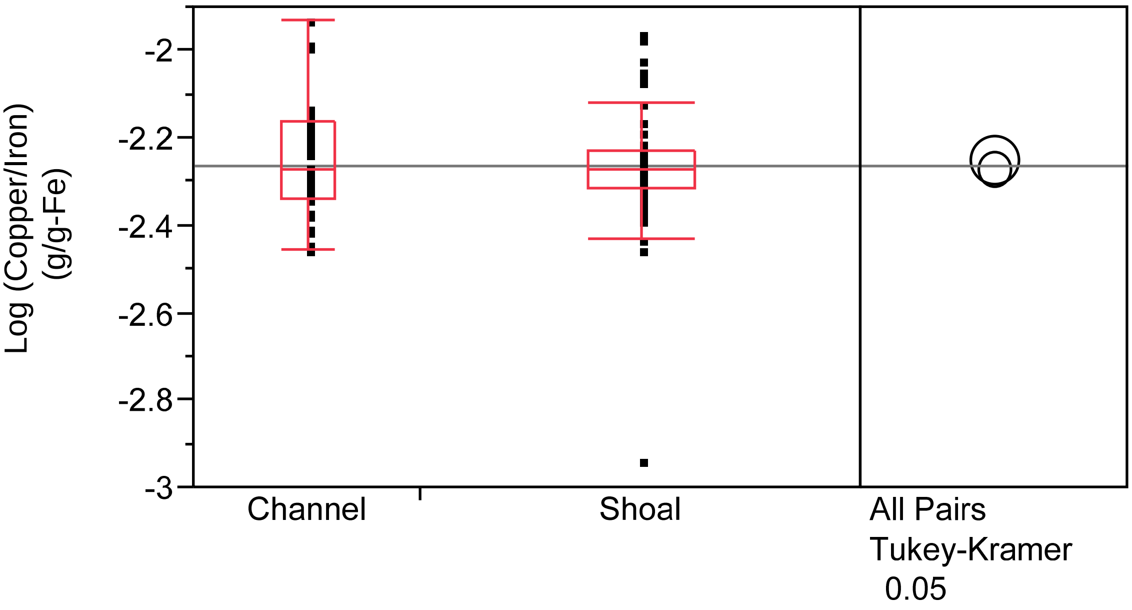
Copper (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

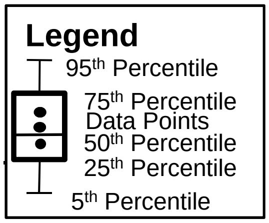
Figure 3.4-36a

2014

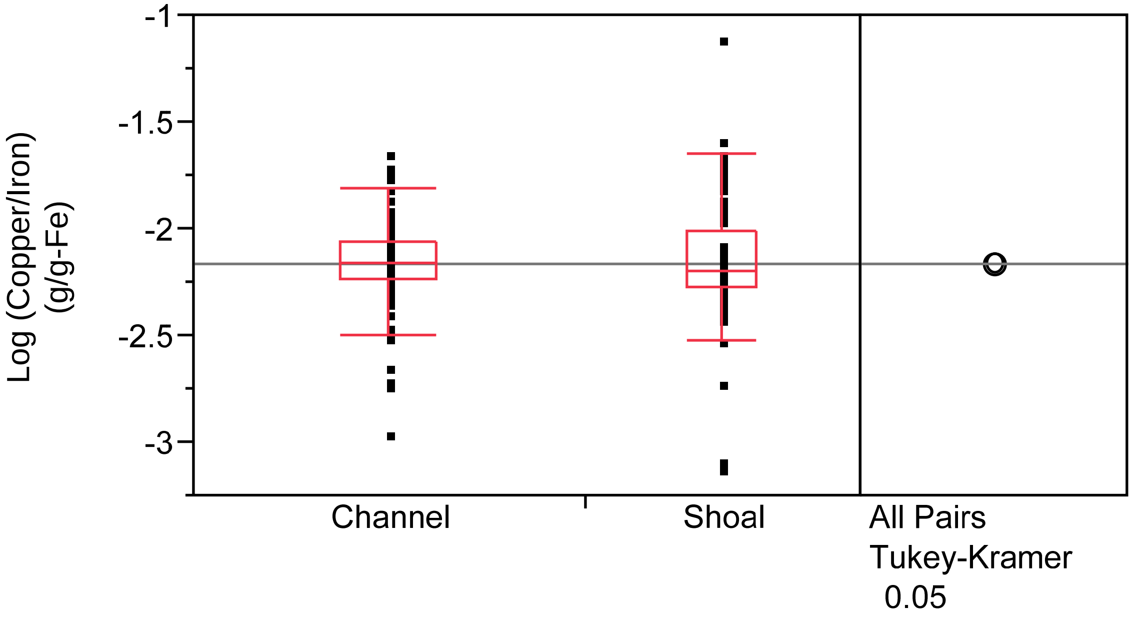
RM0 to RM2



Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



RM2 to RM8

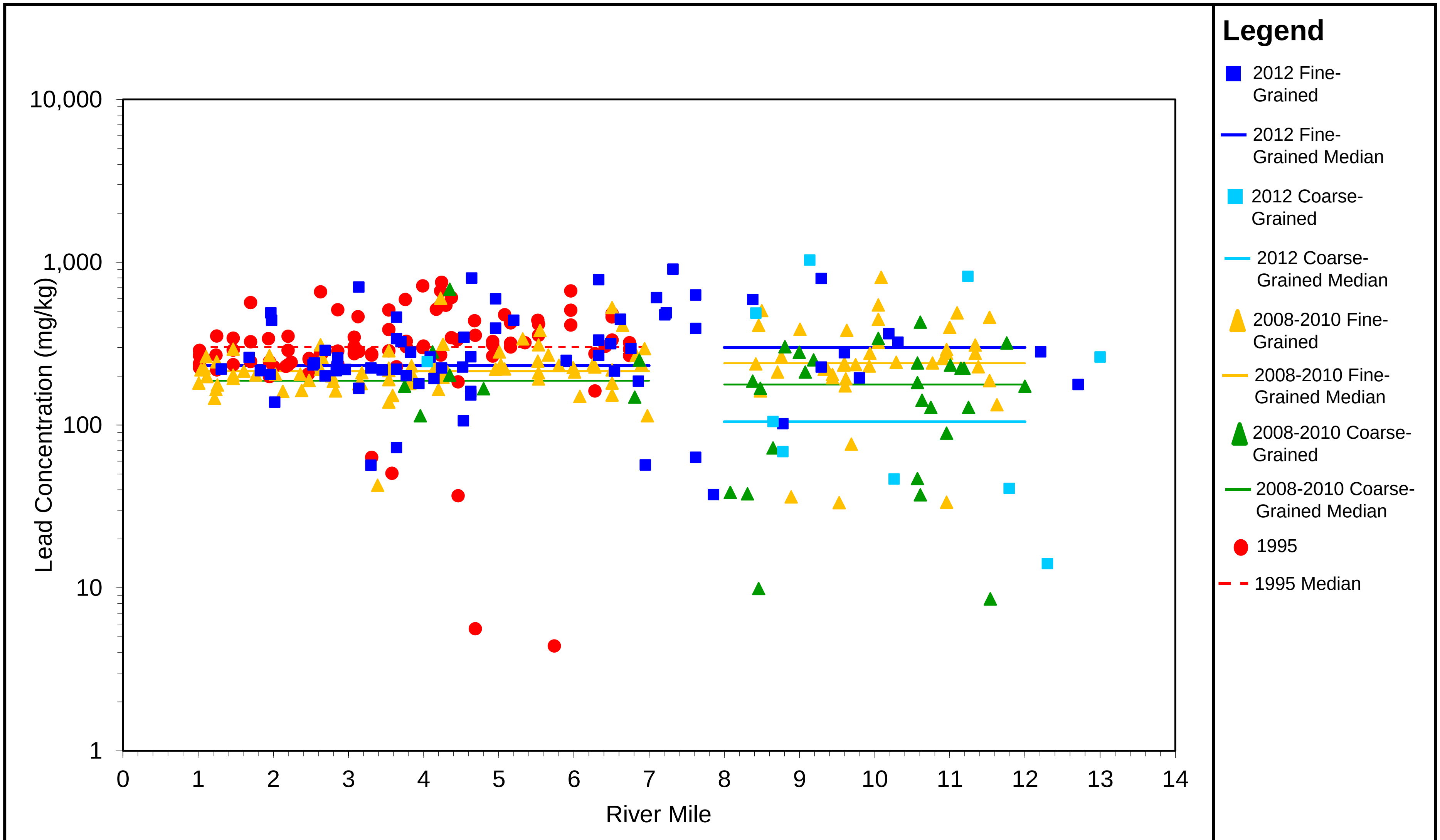


Iron Normalized Copper (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 3.4-36b

2014

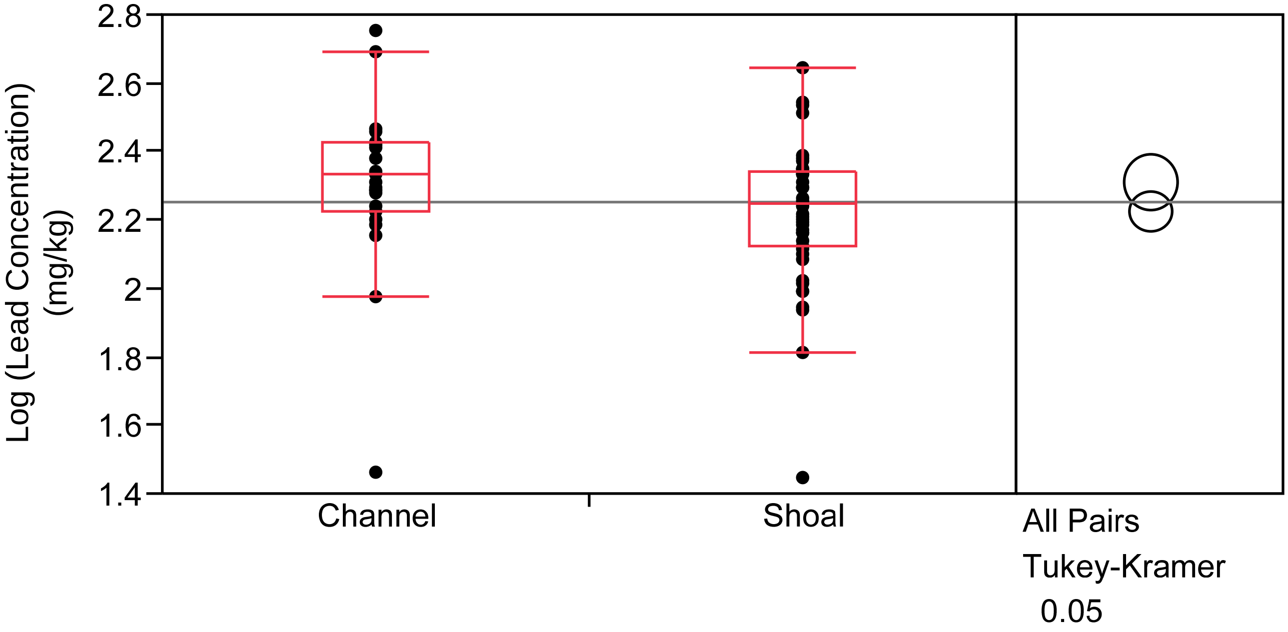


Comparison of Lead Surface Concentration (0-6 inches)
RM1 to RM7 *vs.* RM8 to RM12

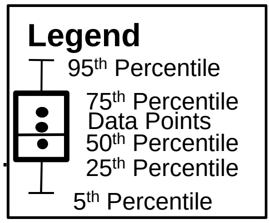
Lower Eight Miles of the Lower Passaic River

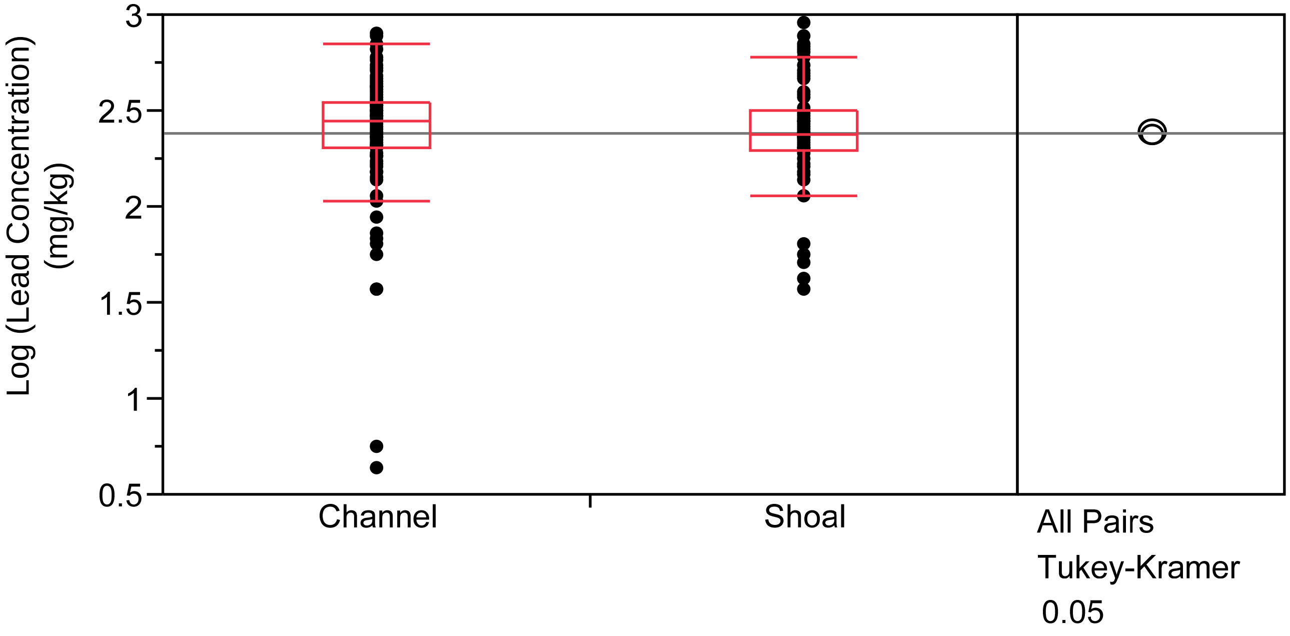
Figure 3.4-37

2014


RM0 to RM2

Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.




RM2 to RM8

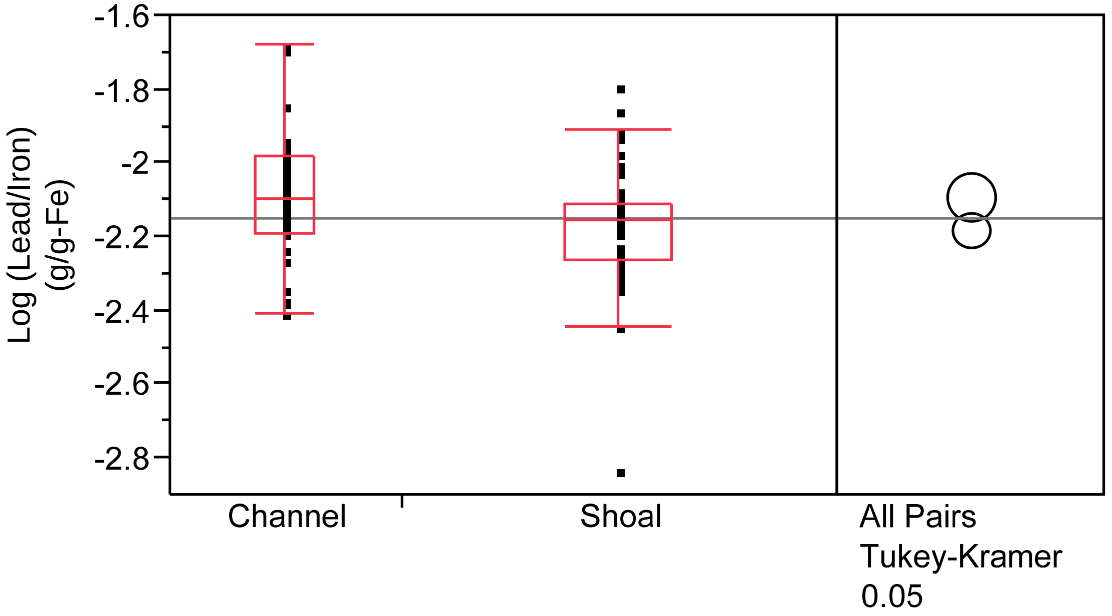
Lead (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

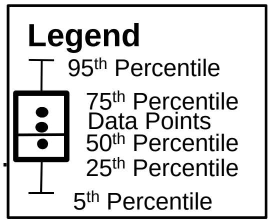
Figure 3.4-38a

2014

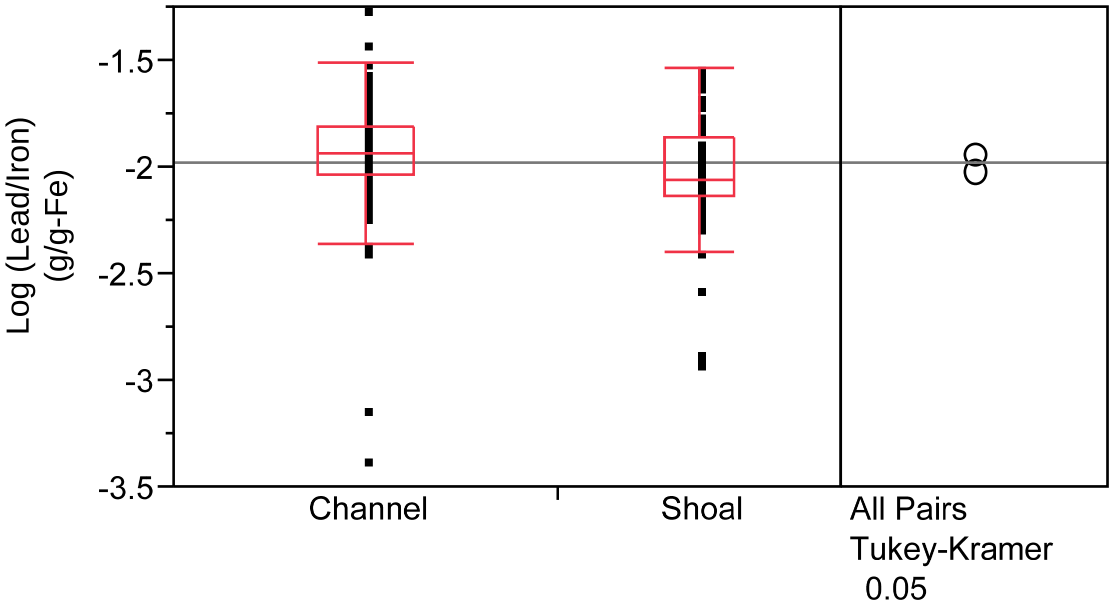
RM0 to RM2



Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



RM2 to RM8

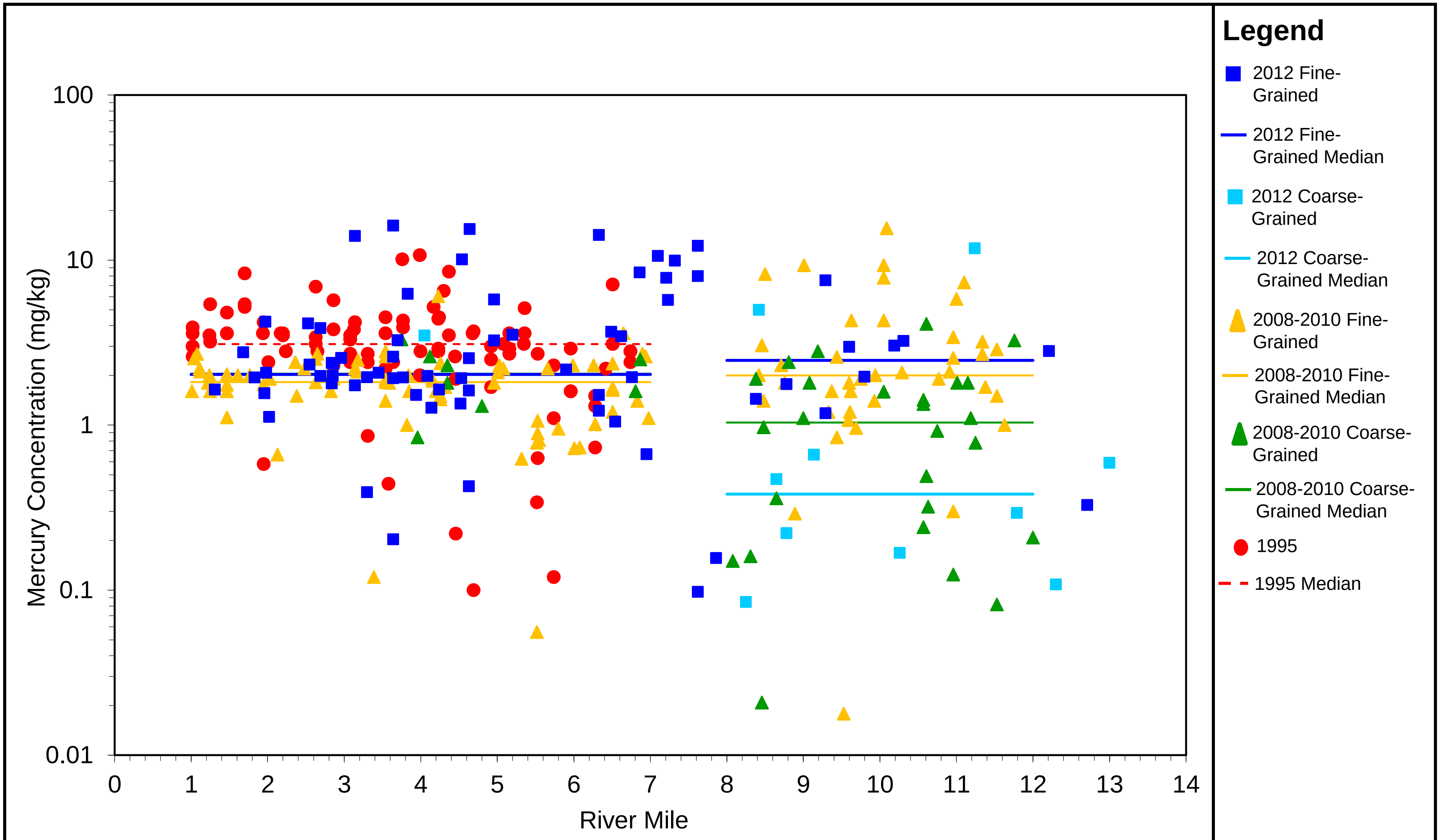


Iron Normalized Lead (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 3.4-38b

2014



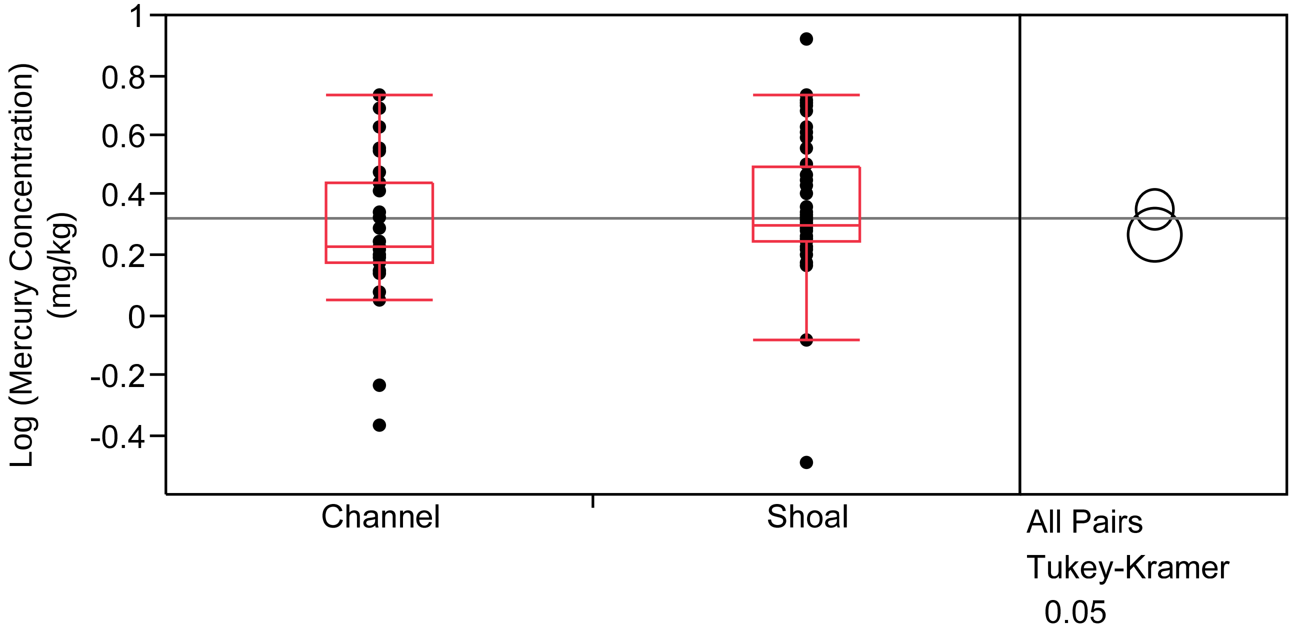
Comparison of Mercury Surface Concentration (0-6 inches)
RM1 to RM7 *vs.* RM8 to RM12

Lower Eight Miles of the Lower Passaic River

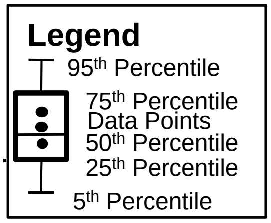
Figure 3.4-39

2014

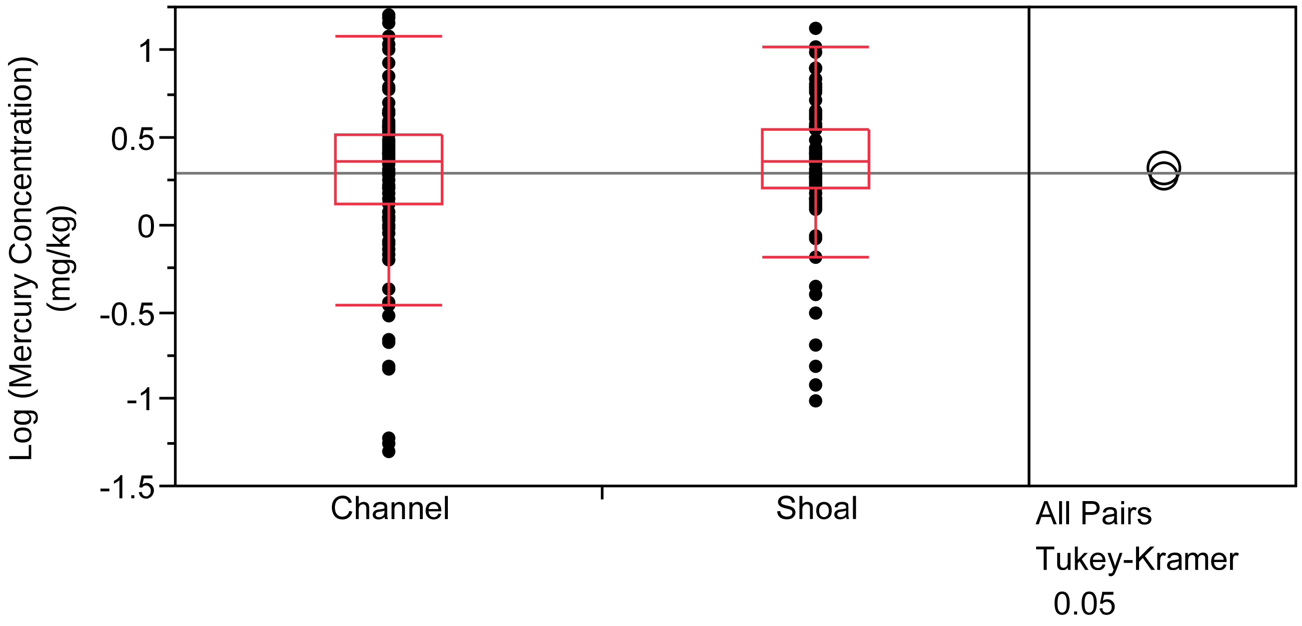
RM0 to RM2



Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



RM2 to RM8



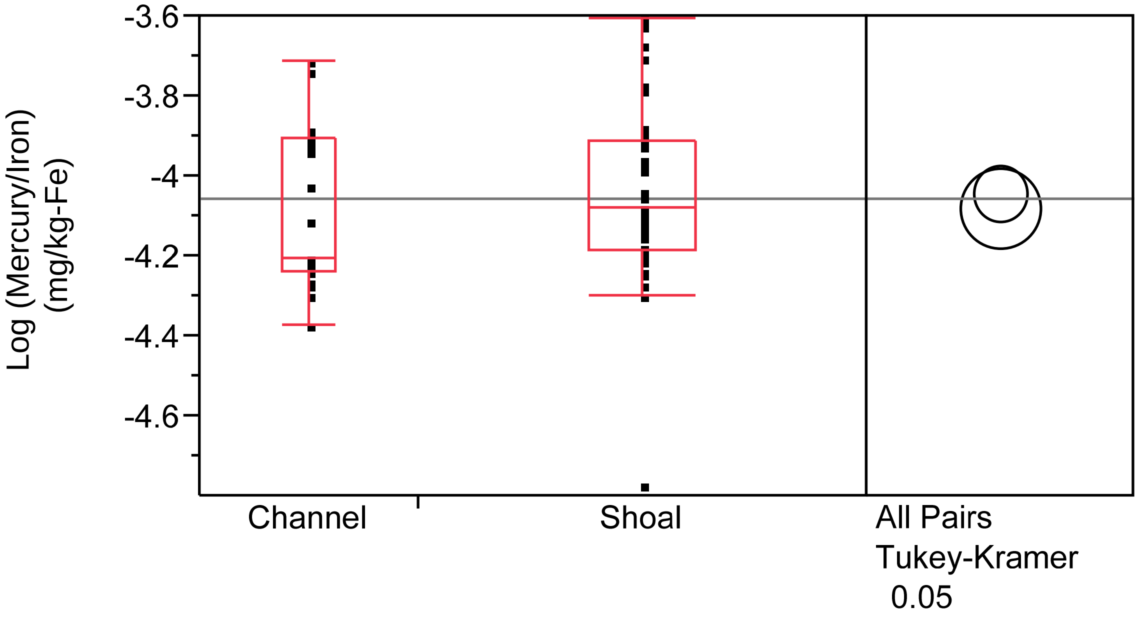
Mercury (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

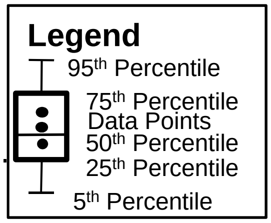
Figure 3.4-40a

2014

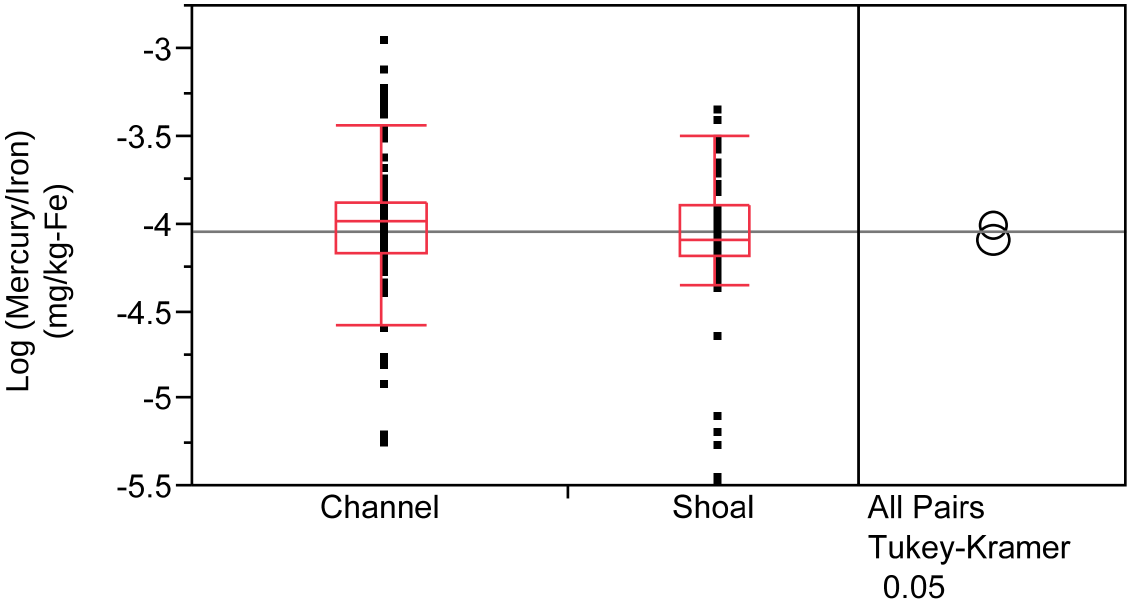
RM0 to RM2



Notes:
1) Horizontal line represents the mean log concentration across all data points, equivalent to the untransformed median concentration.
See text for explanation of Tukey-Kramer circles.
2) Data included 1995, 2008 EPA, 2008 CPG, 2009 CPG, 2010 CPG and 2012 CPG.



RM2 to RM8



Iron Normalized Mercury (0-6 inch) by Channel and Shoal at RM0 to RM2 and RM2 to RM8

Lower Eight Miles of the Lower Passaic River

Figure 3.4-40b

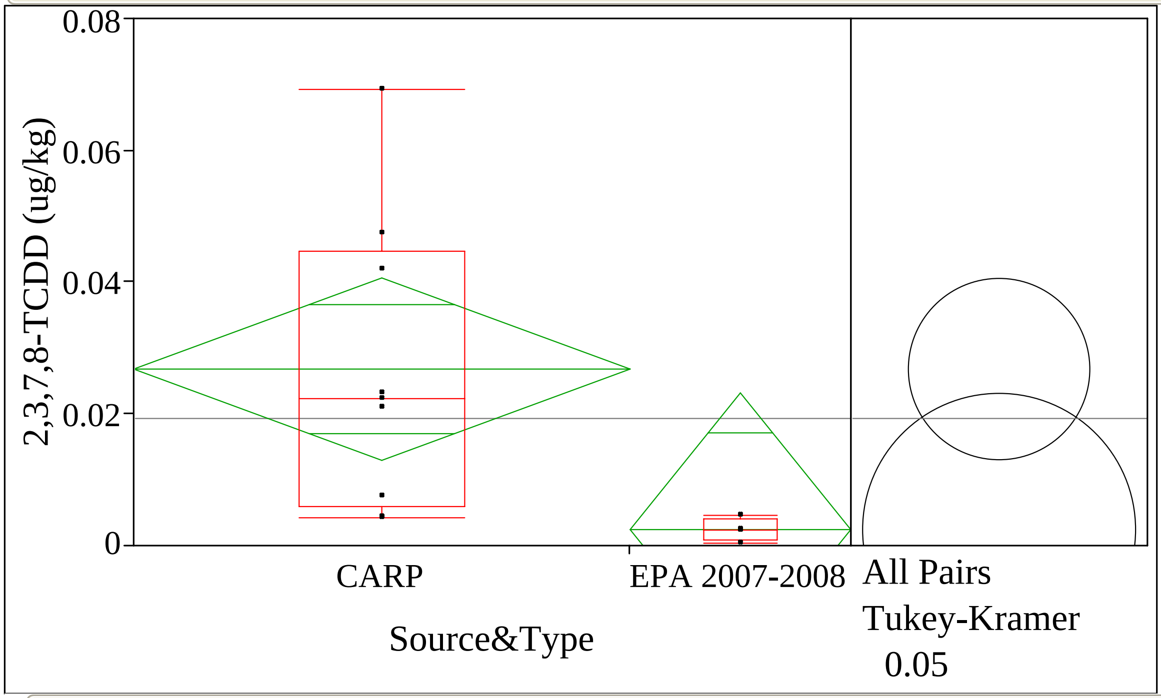
2014

ATTACHMENTS

ATTACHMENT A

Tukey-Kramer Honestly Significant Difference (HSD) Statistical Test for CSOs and SWOs Suspended Matter Concentrations for CARP and 2007-2008 USEPA Data

Oneway Analysis of 2,3,7,8-TCDD By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	0.004232	0.004232	0.005924	0.022295	0.044672	0.069231	0.069231
EPA 2007-2008	0.000357	0.000357	0.000838	0.002365	0.004058	0.004593	0.004593

Oneway Anova

Summary of Fit

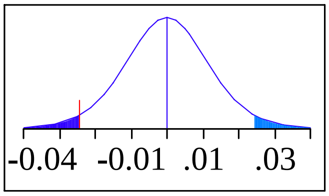
Rsquare	0.29565
Adj Rsquare	0.231618
Root Mean Square Error	0.018869
Mean of Response	0.019289
Observations (or Sum Wgts)	13

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-0.02437	t Ratio	-2.14877
Std Err Dif	0.01134	DF	11
Upper CL Dif	0.00059	Prob > |t|	0.0548
Lower CL Dif	-0.04932	Prob > t	0.9726
Confidence	0.95	Prob < t	0.0274*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	0.00164399	0.001644	4.6172	0.0548
Error	11	0.00391661	0.000356		
C. Total	12	0.00556059			

Oneway Analysis of 2,3,7,8-TCDD By Source&Type

Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	0.026786	0.00629	0.0129	0.04063
EPA 2007-2008	4	0.002420	0.00943	-0.0183	0.02319

Std Error uses a pooled estimate of error variance

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.20097	0.05

Abs(Dif)-LSD

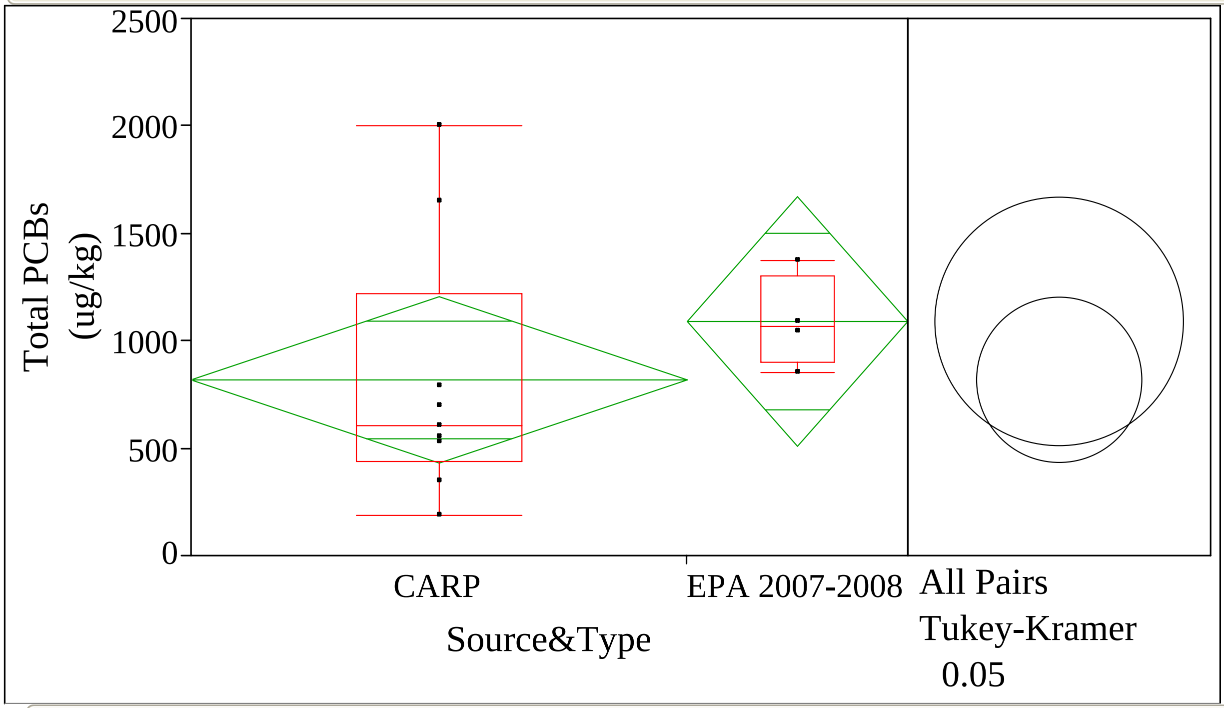
	CARP	EPA 2007-2008
CARP	-0.01958	-0.00059
EPA 2007-2008	-0.00059	-0.02937

Positive values show pairs of means that are significantly different.

Level		Mean
CARP	A	0.02678551
EPA 2007-2008	A	0.00242032

Levels not connected by same letter are significantly different.

Oneway Analysis of Total PCBs (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	186.7627	186.7627	437.9439	604.4065	1219.294	2001.053	2001.053
EPA 2007-2008	852.0415	852.0415	900.0061	1066.462	1301.997	1372.988	1372.988

Oneway Anova

Summary of Fit

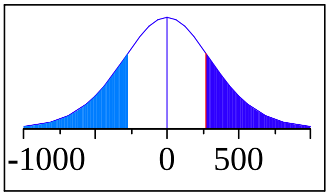
Rsquare	0.062709
Adj Rsquare	-0.0225
Root Mean Square Error	527.7826
Mean of Response	901.1236
Observations (or Sum Wgts)	13

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	272.08	t Ratio	0.857877
Std Err Dif	317.16	DF	11
Upper CL Dif	970.14	Prob > |t|	0.4093
Lower CL Dif	-425.98	Prob > t	0.2046
Confidence	0.95	Prob < t	0.7954



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	205003.0	205003	0.7360	0.4093
Error	11	3064099.7	278555		
C. Total	12	3269102.7			

Oneway Analysis of Total PCBs (ug/kg) By Source&Type

Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	817.41	175.93	430.19	1204.6
EPA 2007-2008	4	1089.49	263.89	508.67	1670.3

Std Error uses a pooled estimate of error variance

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.20097	0.05

Abs(Dif)-LSD

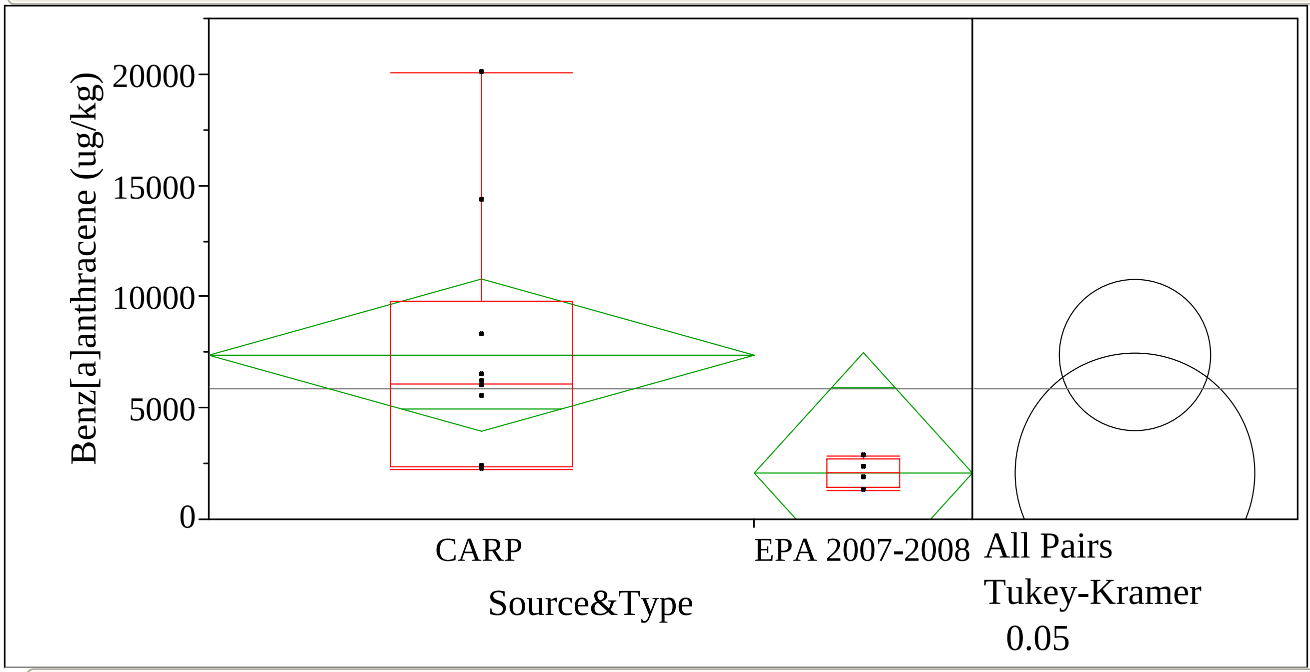
	EPA 2007-2008	CARP
EPA 2007-2008	-821.40	-425.97
CARP	-425.97	-547.60

Positive values show pairs of means that are significantly different.

Level		Mean
EPA 2007-2008	A	1089.4884
CARP	A	817.4059

Levels not connected by same letter are significantly different.

Oneway Analysis of Benz[a]anthracene (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	2234.328	2244.36	2358.459	6080.319	9794.059	19486.47	20060.05
EPA 2007-2008	1297.03	1297.03	1436.148	2091.587	2712.67	2840.336	2840.336

Oneway Anova

Summary of Fit

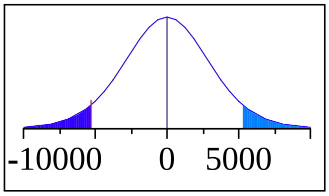
Rsquare	0.213109
Adj Rsquare	0.147534
Root Mean Square Error	4965.598
Mean of Response	5862.918
Observations (or Sum Wgts)	14

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-5296	t Ratio	-1.80274
Std Err Dif	2938	DF	12
Upper CL Dif	1105	Prob > |t|	0.0966
Lower CL Dif	-11697	Prob > t	0.9517
Confidence	0.95	Prob < t	0.0483*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	80132892	80132892	3.2499	0.0966
Error	12	295886020	24657168		
C. Total	13	376018912			

Oneway Analysis of Benz[a]anthracene (ug/kg) By Source&Type

Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	10	7376.03	1570.3	3955	10797
EPA 2007-2008	4	2080.13	2482.8	-3329	7490

Std Error uses a pooled estimate of error variance

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.17880	0.05

Abs(Dif)-LSD

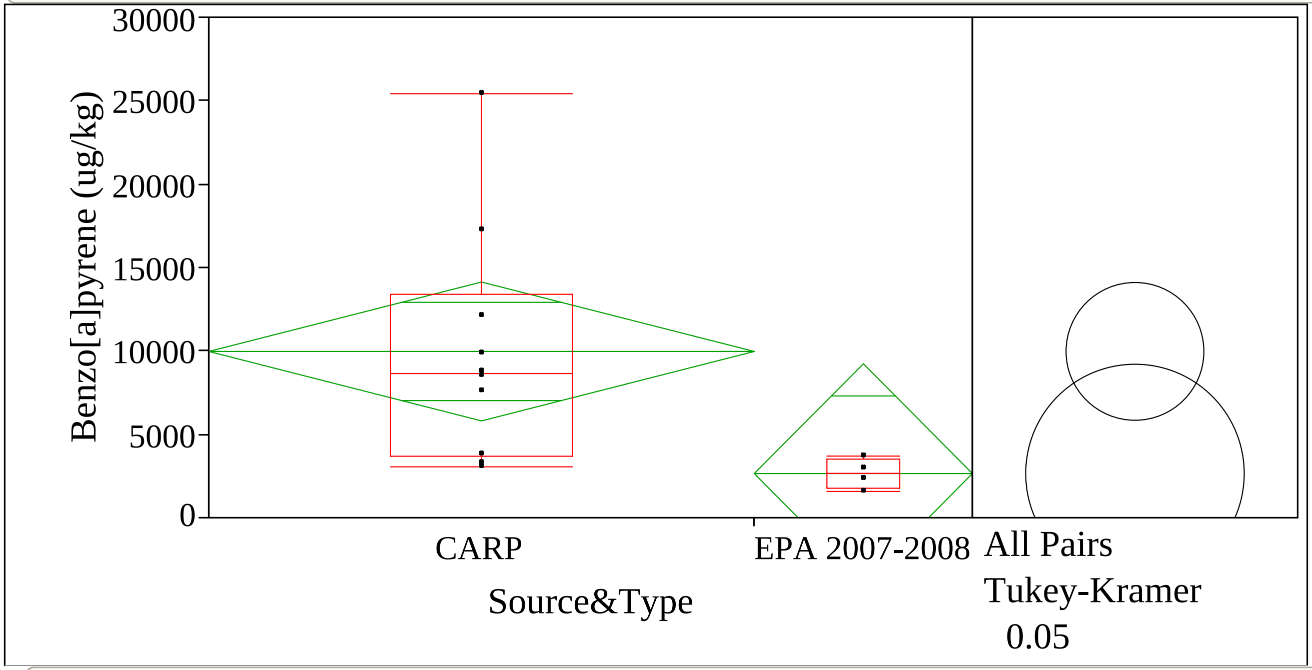
	CARP	EPA 2007-2008
CARP	-4838.4	-1104.7
EPA 2007-2008	-1104.7	-7650.2

Positive values show pairs of means that are significantly different.

Level		Mean
CARP	A	7376.0306
EPA 2007-2008	A	2080.1348

Levels not connected by same letter are significantly different.

Oneway Analysis of Benzo[a]pyrene (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	3047.38	3071.275	3680.379	8646.221	13390.4	24596.34	25412.95
EPA 2007-2008	1574.257	1574.257	1766.68	2655.491	3508.565	3689.076	3689.076

Oneway Anova

Summary of Fit

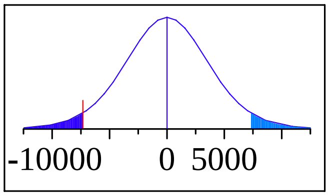
Rsquare	0.259058
Adj Rsquare	0.197313
Root Mean Square Error	6042.34
Mean of Response	7873.655
Observations (or Sum Wgts)	14

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-7322	t Ratio	-2.04832
Std Err Dif	3575	DF	12
Upper CL Dif	466	Prob > |t|	0.0631
Lower CL Dif	-15111	Prob > t	0.9685
Confidence	0.95	Prob < t	0.0315*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	153180684	153180684	4.1956	0.0631
Error	12	438118541	36509878		
C. Total	13	591299225			

Oneway Analysis of Benzo[a]pyrene (ug/kg) By Source&Type

Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	10	9965.68	1910.8	5803	14129
EPA 2007-2008	4	2643.58	3021.2	-3939	9226

Std Error uses a pooled estimate of error variance

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.17880	0.05

Abs(Dif)-LSD

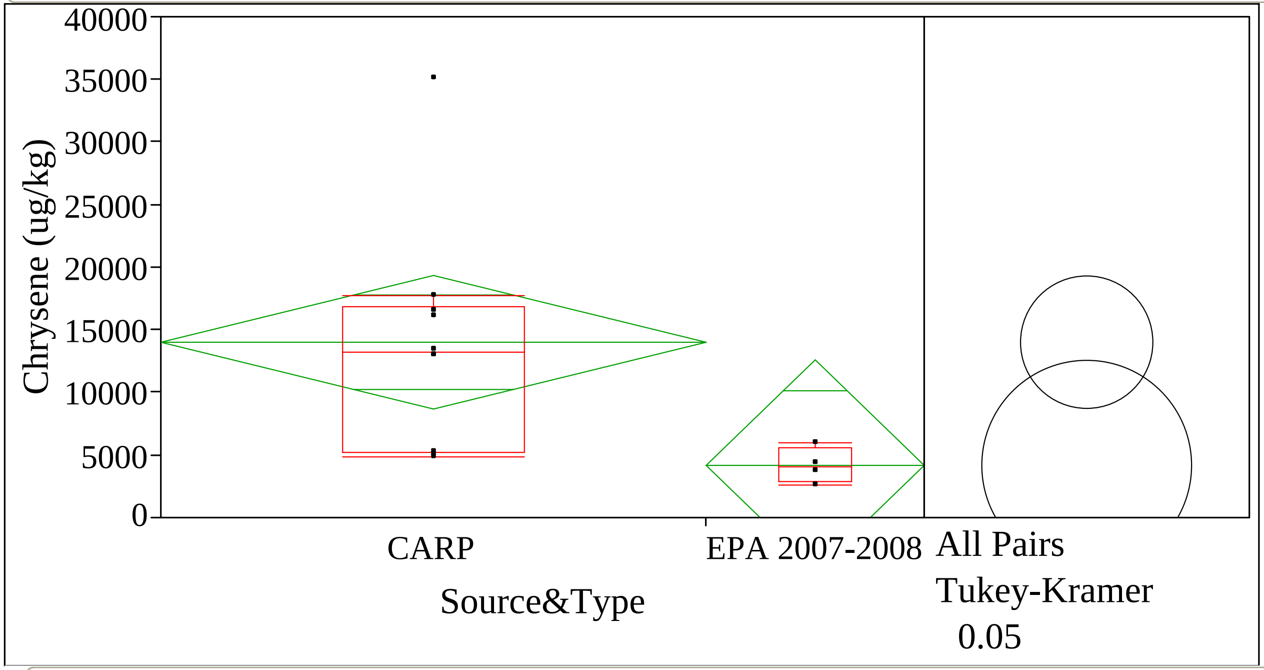
	CARP	EPA 2007-2008
CARP	-5887.6	-466.4
EPA 2007-2008	-466.4	-9309.1

Positive values show pairs of means that are significantly different.

Level		Mean
CARP	A	9965.6850
EPA 2007-2008	A	2643.5788

Levels not connected by same letter are significantly different.

Oneway Analysis of Chrysene (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	4850.132	4870.321	5205.9	13207.73	16835.59	33361.22	35098.66
EPA 2007-2008	2599.01	2599.01	2883.971	4056.24	5574.499	5974.79	5974.79

Oneway Anova

Summary of Fit

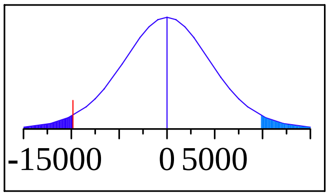
Rsquare	0.277627
Adj Rsquare	0.21743
Root Mean Square Error	7737.665
Mean of Response	11193.51
Observations (or Sum Wgts)	14

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-9831	t Ratio	-2.14754
Std Err Dif	4578	DF	12
Upper CL Dif	143	Prob > |t|	0.0529
Lower CL Dif	-19805	Prob > t	0.9736
Confidence	0.95	Prob < t	0.0264*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	276122812	276122812	4.6119	0.0529
Error	12	718457521	59871460		
C. Total	13	994580334			

Oneway Analysis of Chrysene (ug/kg) By Source&Type

Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	10	14002.3	2446.9	8671	19334
EPA 2007-2008	4	4171.6	3868.8	-4258	12601

Std Error uses a pooled estimate of error variance

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.17880	0.05

Abs(Dif)-LSD

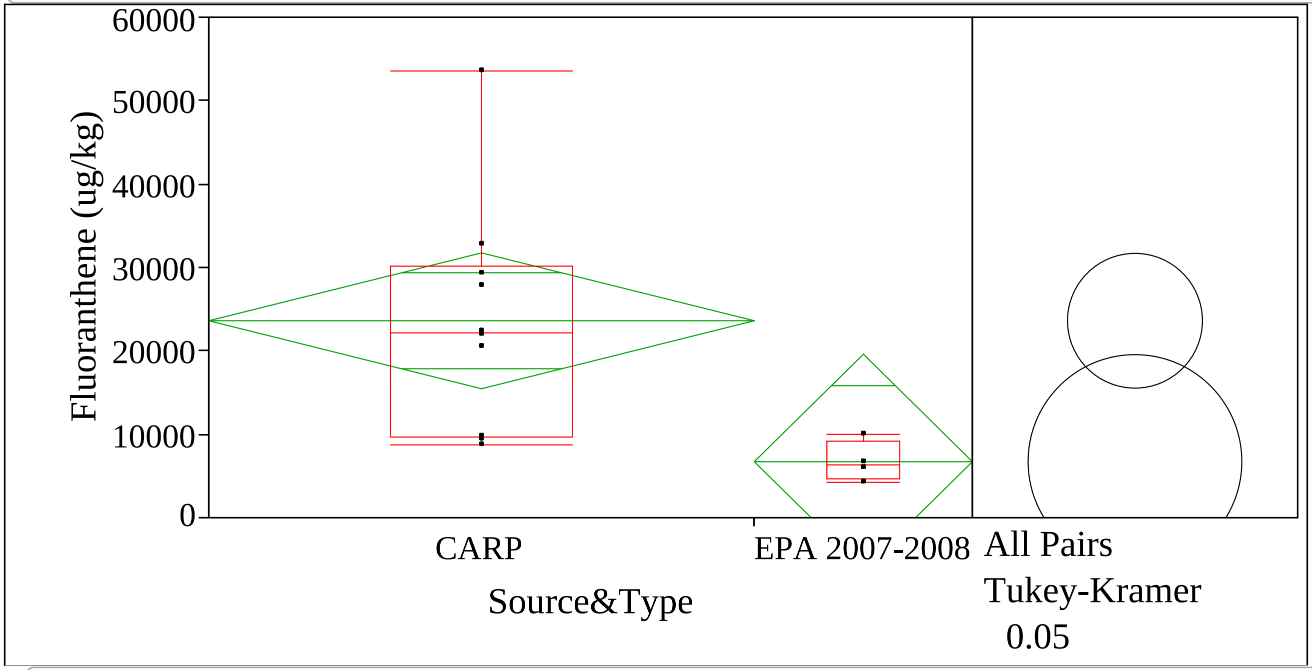
	CARP	EPA 2007-2008
CARP	-7539	-143
EPA 2007-2008	-143	-11921

Positive values show pairs of means that are significantly different.

Level		Mean
CARP	A	14002.286
EPA 2007-2008	A	4171.570

Levels not connected by same letter are significantly different.

Oneway Analysis of Fluoranthene (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	8719.551	8787.924	9660.618	22150.9	30149.99	51470.92	53550.18
EPA 2007-2008	4232.673	4232.673	4669.728	6331.105	9170.33	10000	10000

Oneway Anova

Summary of Fit

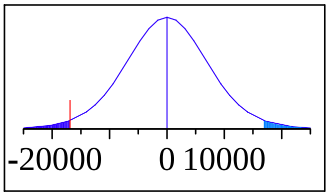
Rsquare	0.326873
Adj Rsquare	0.270779
Root Mean Square Error	11822.05
Mean of Response	18783.25
Observations (or Sum Wgts)	14

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-16883	t Ratio	-2.41397
Std Err Dif	6994	DF	12
Upper CL Dif	-1645	Prob > |t|	0.0327*
Lower CL Dif	-32122	Prob > t	0.9837
Confidence	0.95	Prob < t	0.0163*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	814419921	814419921	5.8272	0.0327*
Error	12	1677129450	139760788		
C. Total	13	2491549371			

Oneway Analysis of Fluoranthene (ug/kg) By Source&Type

Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	10	23607.1	3738.5	15462	31752
EPA 2007-2008	4	6723.7	5911.0	-6155	19603

Std Error uses a pooled estimate of error variance

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.17880	0.05

Abs(Dif)-LSD

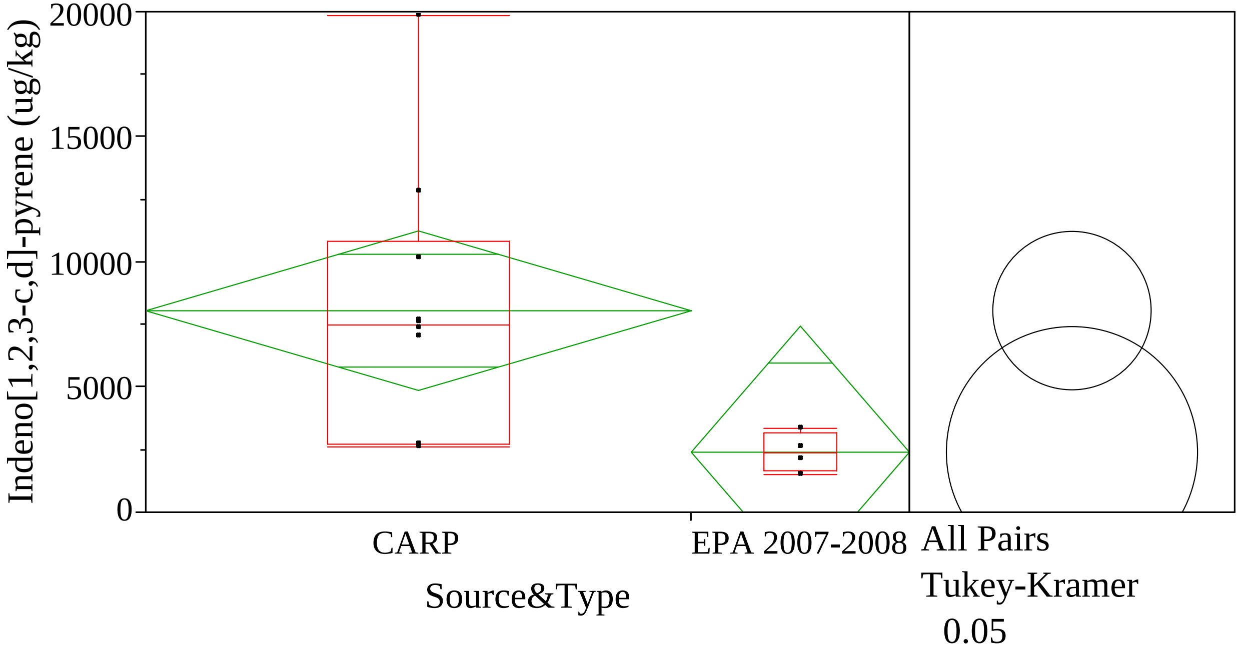
	CARP	EPA 2007-2008
CARP	-11519	1645
EPA 2007-2008	1645	-18214

Positive values show pairs of means that are significantly different.

Level		Mean
CARP	A	23607.055
EPA 2007-2008	B	6723.721

Levels not connected by same letter are significantly different.

Oneway Analysis of Indeno[1,2,3-c,d]-pyrene (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	2608.104	2616.592	2717.837	7484.601	10824.88	19141.31	19843.61
EPA 2007-2008	1502.475	1502.475	1658.704	2371.387	3168.552	3352.941	3352.941

Oneway Anova

Summary of Fit

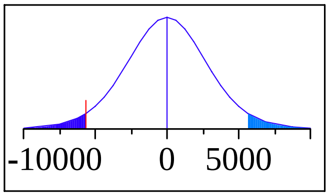
Rsquare	0.262455
Adj Rsquare	0.200993
Root Mean Square Error	4624.45
Mean of Response	6437.765
Observations (or Sum Wgts)	14

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-5654	t Ratio	-2.06644
Std Err Dif	2736	DF	12
Upper CL Dif	307	Prob > |t|	0.0611
Lower CL Dif	-11614	Prob > t	0.9695
Confidence	0.95	Prob < t	0.0305*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	91320343	91320343	4.2702	0.0611
Error	12	256626408	21385534		
C. Total	13	347946752			

Oneway Analysis of Indeno[1,2,3-c,d]-pyrene (ug/kg) By Source&Type

Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	10	8053.05	1462.4	4867	11239
EPA 2007-2008	4	2399.55	2312.2	-2638	7437

Std Error uses a pooled estimate of error variance

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.17880	0.05

Abs(Dif)-LSD

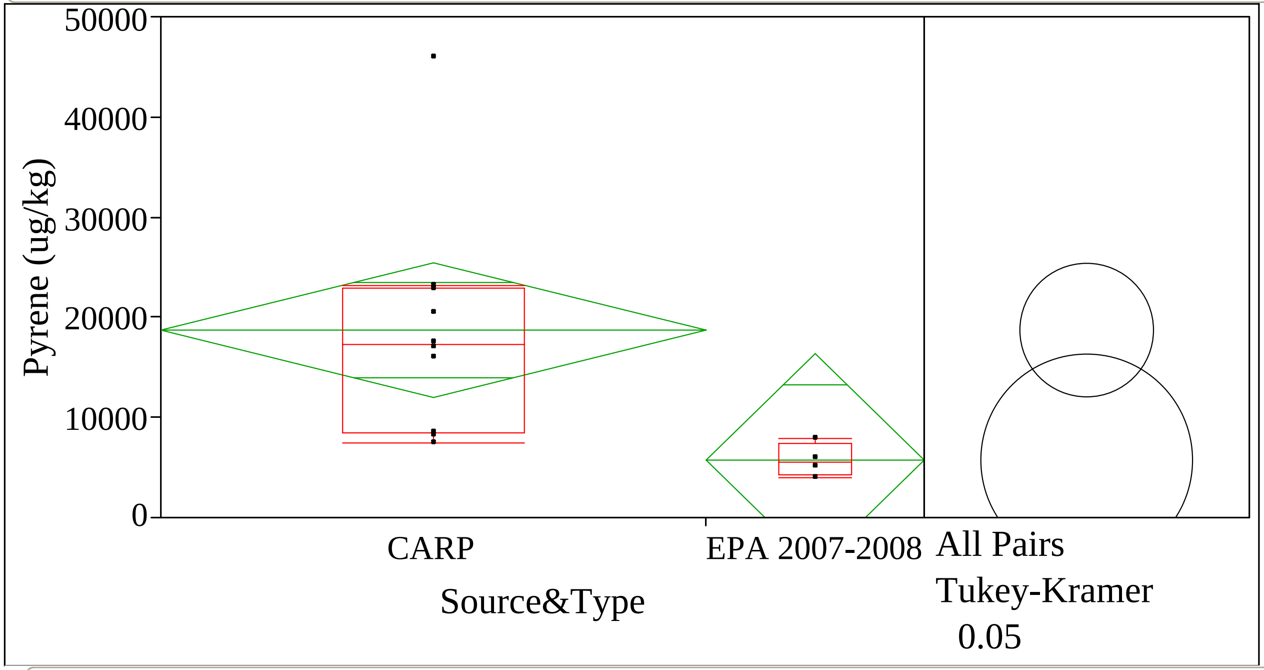
	CARP	EPA 2007-2008
CARP	-4506.0	-307.4
EPA 2007-2008	-307.4	-7124.6

Positive values show pairs of means that are significantly different.

Level		Mean
CARP	A	8053.0525
EPA 2007-2008	A	2399.5474

Levels not connected by same letter are significantly different.

Oneway Analysis of Pyrene (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	7453.165	7529.837	8453.129	17272.31	22913.61	43682.37	45962.91
EPA 2007-2008	3985.149	3985.149	4267.524	5535.347	7407.078	7890.756	7890.756

Oneway Anova

Summary of Fit

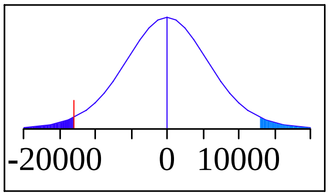
Rsquare	0.296392
Adj Rsquare	0.237758
Root Mean Square Error	9758.06
Mean of Response	15007.67
Observations (or Sum Wgts)	14

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-12979	t Ratio	-2.24832
Std Err Dif	5773	DF	12
Upper CL Dif	-401	Prob > |t|	0.0441*
Lower CL Dif	-25558	Prob > t	0.9779
Confidence	0.95	Prob < t	0.0221*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	481330491	481330491	5.0549	0.0441*
Error	12	1142636739	95219728		
C. Total	13	1623967230			

Oneway Analysis of Pyrene (ug/kg) By Source&Type

Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	10	18716.1	3085.8	11993	25439
EPA 2007-2008	4	5736.6	4879.0	-4894	16367

Std Error uses a pooled estimate of error variance

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.17880	0.05

Abs(Dif)-LSD

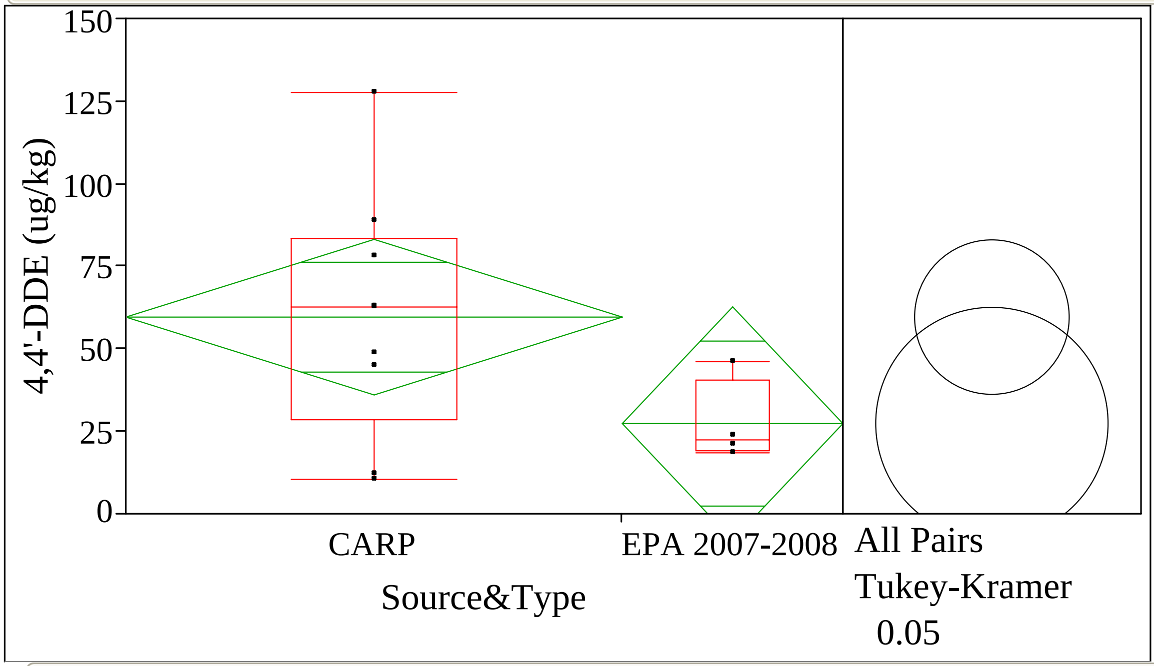
	CARP	EPA 2007-2008
CARP	-9508	401
EPA 2007-2008	401	-15034

Positive values show pairs of means that are significantly different.

Level			Mean
CARP	A		18716.082
EPA 2007-2008		B	5736.650

Levels not connected by same letter are significantly different.

Oneway Analysis of 4,4'-DDE (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	10.40581	10.40581	28.46039	62.61018	83.36657	127.6045	127.6045
EPA 2007-2008	18.43956	18.43956	19.08445	22.37837	40.47222	46.05042	46.05042

Oneway Anova

Summary of Fit

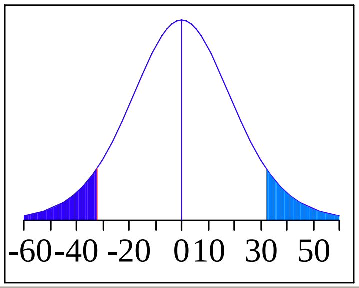
Rsquare	0.202389
Adj Rsquare	0.129879
Root Mean Square Error	32.09461
Mean of Response	49.61891
Observations (or Sum Wgts)	13

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-32.222	t Ratio	-1.67068
Std Err Dif	19.286	DF	11
Upper CL Dif	10.228	Prob > |t|	0.1230
Lower CL Dif	-74.671	Prob > t	0.9385
Confidence	0.95	Prob < t	0.0615



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	2875.096	2875.10	2.7912	0.1230
Error	11	11330.707	1030.06		
C. Total	12	14205.803			

Oneway Analysis of 4,4'-DDE (ug/kg) By Source&Type

Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	59.5332	10.698	35.99	83.080
EPA 2007-2008	4	27.3117	16.047	-8.01	62.632

Std Error uses a pooled estimate of error variance

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.20097	0.05

Abs(Dif)-LSD

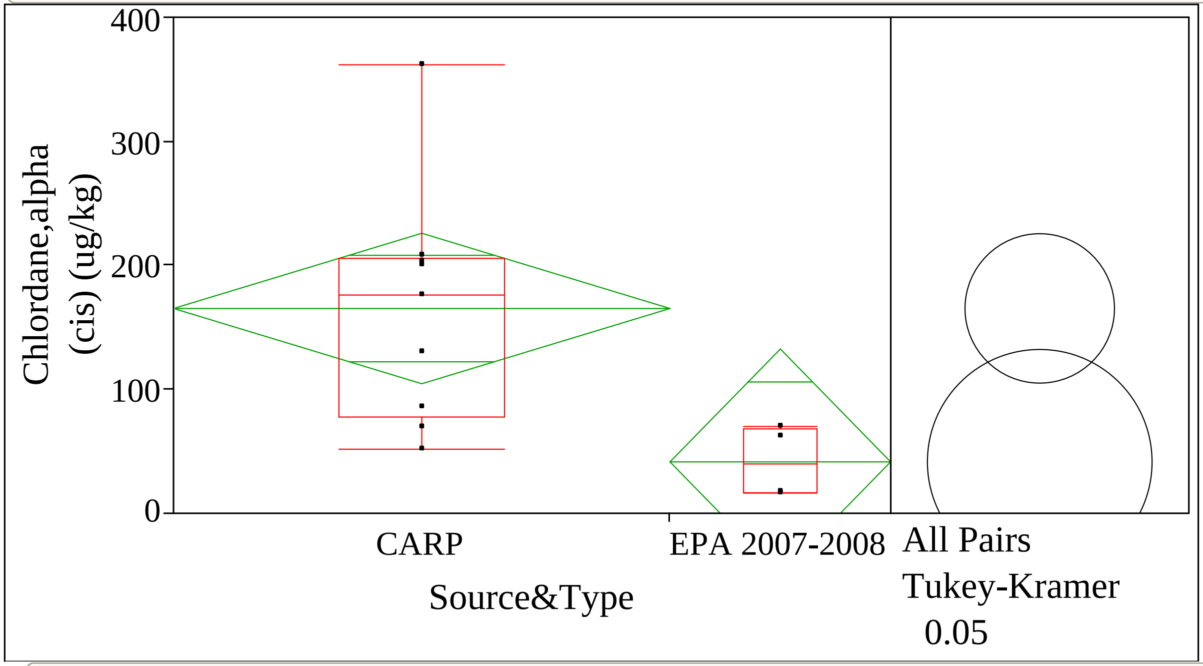
	CARP	EPA 2007-2008
CARP	-33.300	-10.227
EPA 2007-2008	-10.227	-49.950

Positive values show pairs of means that are significantly different.

Level		Mean
CARP	A	59.533241
EPA 2007-2008	A	27.311678

Levels not connected by same letter are significantly different.

Oneway Analysis of Chlordane,alpha (cis) (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	51.69861	51.69861	77.57327	175.979	205.5917	361.6798	361.6798
EPA 2007-2008	16.24204	16.24204	16.54417	39.78963	68.03218	70	70

Oneway Anova

Summary of Fit

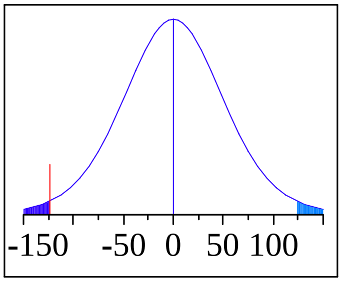
Rsquare	0.359981
Adj Rsquare	0.301798
Root Mean Square Error	82.72505
Mean of Response	127.0598
Observations (or Sum Wgts)	13

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-123.65	t Ratio	-2.48737
Std Err Dif	49.71	DF	11
Upper CL Dif	-14.24	Prob > |t|	0.0302*
Lower CL Dif	-233.07	Prob > t	0.9849
Confidence	0.95	Prob < t	0.0151*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	42340.30	42340.3	6.1870	0.0302*
Error	11	75277.78	6843.4		
C. Total	12	117618.08			

Oneway Analysis of Chlordane,alpha (cis) (ug/kg) By Source&Type

Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	165.106	27.575	104.4	225.80
EPA 2007-2008	4	41.455	41.363	-49.6	132.49

Std Error uses a pooled estimate of error variance

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.20097	0.05

Abs(Dif)-LSD

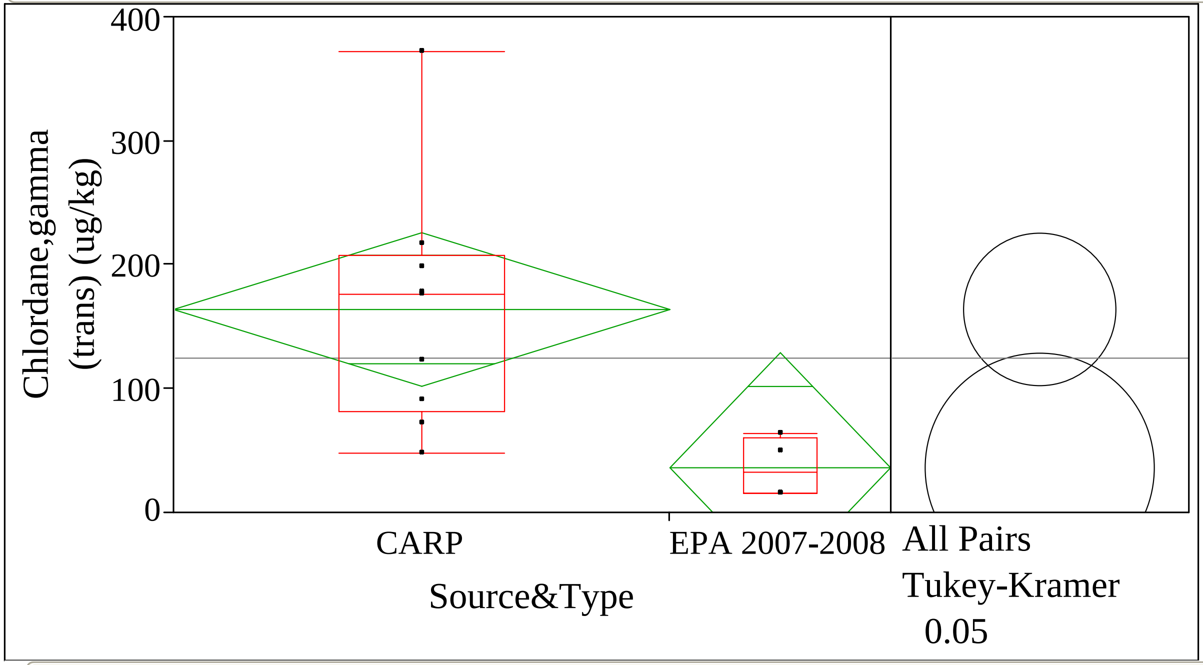
	CARP	EPA 2007-2008
CARP	-85.83	14.24
EPA 2007-2008	14.24	-128.75

Positive values show pairs of means that are significantly different.

Level		Mean
CARP	A	165.10626
EPA 2007-2008	B	41.45533

Levels not connected by same letter are significantly different.

Oneway Analysis of Chlordane,gamma (trans) (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	47.73093	47.73093	81.36116	176.0238	207.4211	371.8322	371.8322
EPA 2007-2008	15.36264	15.36264	15.37548	32.45948	60.14935	63.69748	63.69748

Oneway Anova

Summary of Fit

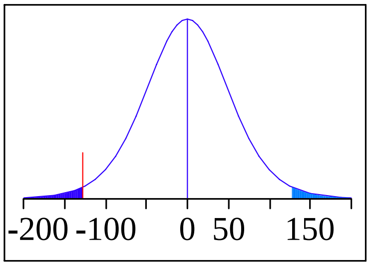
Rsquare	0.365752
Adj Rsquare	0.308093
Root Mean Square Error	84.38668
Mean of Response	124.4154
Observations (or Sum Wgts)	13

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-127.72	t Ratio	-2.5186
Std Err Dif	50.71	DF	11
Upper CL Dif	-16.11	Prob > |t|	0.0285*
Lower CL Dif	-239.33	Prob > t	0.9857
Confidence	0.95	Prob < t	0.0143*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	45171.84	45171.8	6.3434	0.0285*
Error	11	78332.23	7121.1		
C. Total	12	123504.07			

Oneway Analysis of Chlordane,gamma (trans) (ug/kg) By Source&Type

Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	163.713	28.129	101.8	225.62
EPA 2007-2008	4	35.995	42.193	-56.9	128.86

Std Error uses a pooled estimate of error variance

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.20097	0.05

Abs(Dif)-LSD

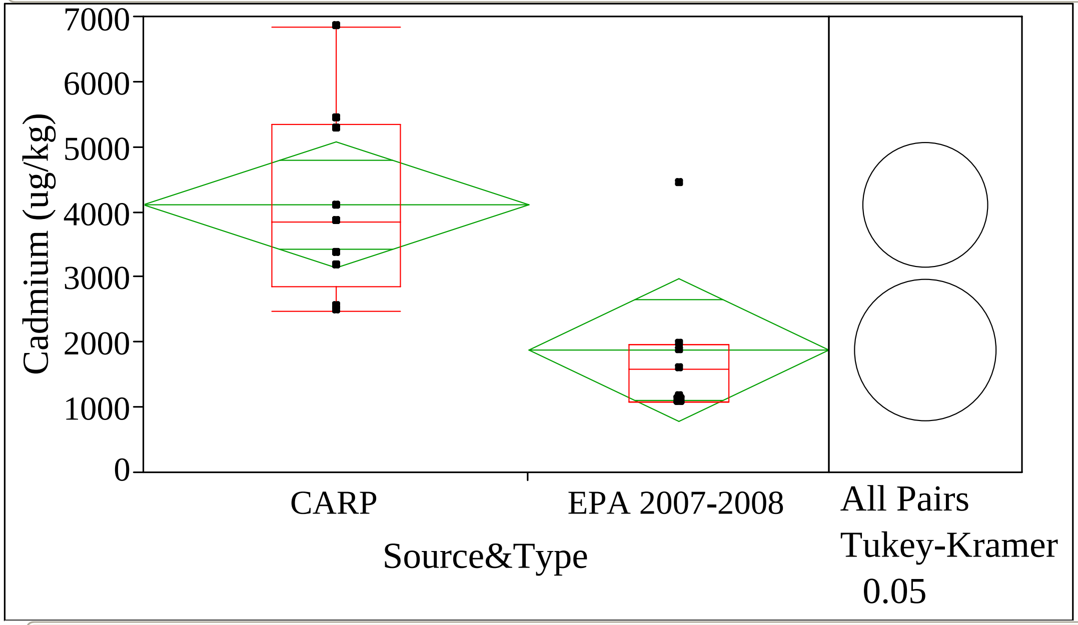
	CARP	EPA 2007-2008
CARP	-87.56	16.11
EPA 2007-2008	16.11	-131.33

Positive values show pairs of means that are significantly different.

Level		Mean
CARP	A	163.71342
EPA 2007-2008	B	35.99477

Levels not connected by same letter are significantly different.

Oneway Analysis of Cadmium (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	2471.17	2471.17	2849.144	3843.844	5342.001	6835.017	6835.017
EPA 2007-2008	1076.605	1076.605	1079.944	1583.333	1959.596	4425	4425

Oneway Anova

Summary of Fit

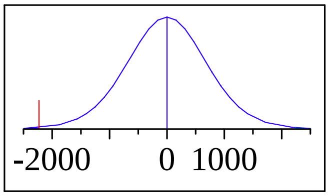
Rsquare	0.433883
Adj Rsquare	0.393446
Root Mean Square Error	1351.269
Mean of Response	3131.437
Observations (or Sum Wgts)	16

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-2230.6	t Ratio	-3.27565
Std Err Dif	681.0	DF	14
Upper CL Dif	-770.1	Prob > |t|	0.0055*
Lower CL Dif	-3691.2	Prob > t	0.9972
Confidence	0.95	Prob < t	0.0028*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	19591961	19591961	10.7299	0.0055*
Error	14	25563004	1825928.8		
C. Total	15	45154964			

Oneway Analysis of Cadmium (ug/kg) By Source&Type

Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	4107.34	450.42	3141.3	5073.4
EPA 2007-2008	7	1876.70	510.73	781.3	2972.1

Std Error uses a pooled estimate of error variance

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.14478	0.05

Abs(Dif)-LSD

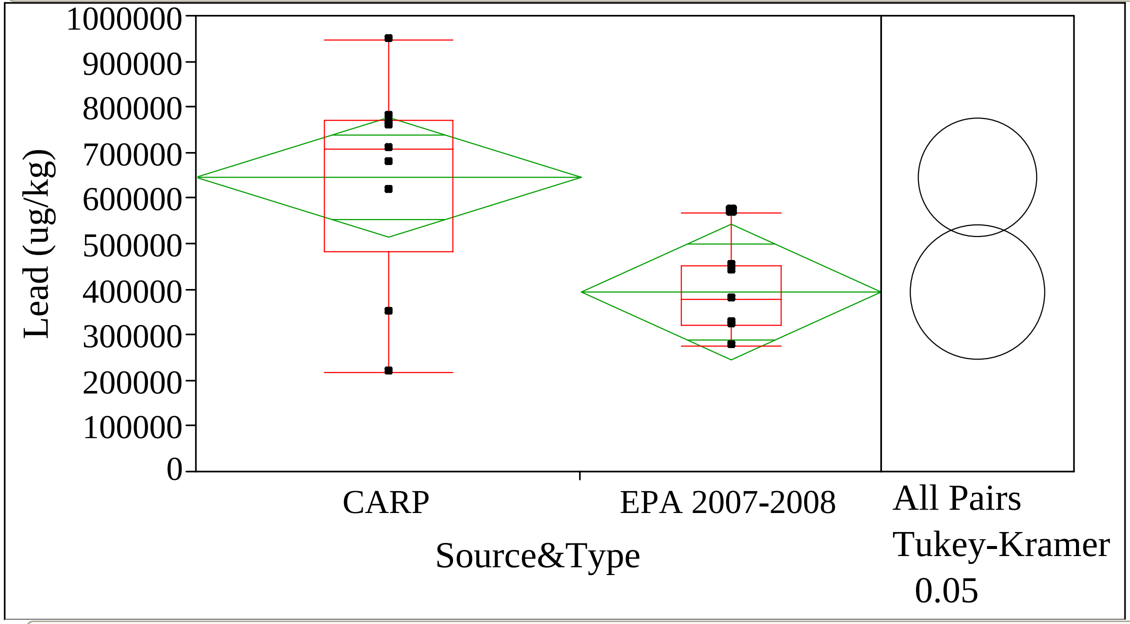
	CARP	EPA 2007-2008
CARP	-1366.2	770.1
EPA 2007-2008	770.1	-1549.1

Positive values show pairs of means that are significantly different.

Level			Mean
CARP	A		4107.3398
EPA 2007-2008		B	1876.7040

Levels not connected by same letter are significantly different.

Oneway Analysis of Lead (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	217210.1	217210.1	482100.3	707289.7	770344.4	946546.5	946546.5
EPA 2007-2008	275000	275000	320754.7	377777.8	451247.2	567287.8	567287.8

Oneway Anova

Summary of Fit

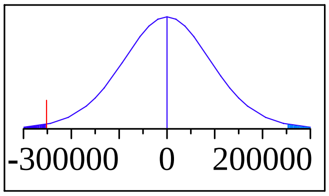
Rsquare	0.346076
Adj Rsquare	0.299367
Root Mean Square Error	183534.9
Mean of Response	535380.5
Observations (or Sum Wgts)	16

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-251764	t Ratio	-2.72198
Std Err Dif	92493	DF	14
Upper CL Dif	-53387	Prob > |t|	0.0165*
Lower CL Dif	-450142	Prob > t	0.9917
Confidence	0.95	Prob < t	0.0083*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	2.4958e+11	2.496e+11	7.4092	0.0165*
Error	14	4.7159e+11	3.369e+10		
C. Total	15	7.2117e+11			

Oneway Analysis of Lead (ug/kg) By Source&Type

Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	645527	61178	514313	776742
EPA 2007-2008	7	393763	69370	244980	542546

Std Error uses a pooled estimate of error variance

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.14478	0.05

Abs(Dif)-LSD

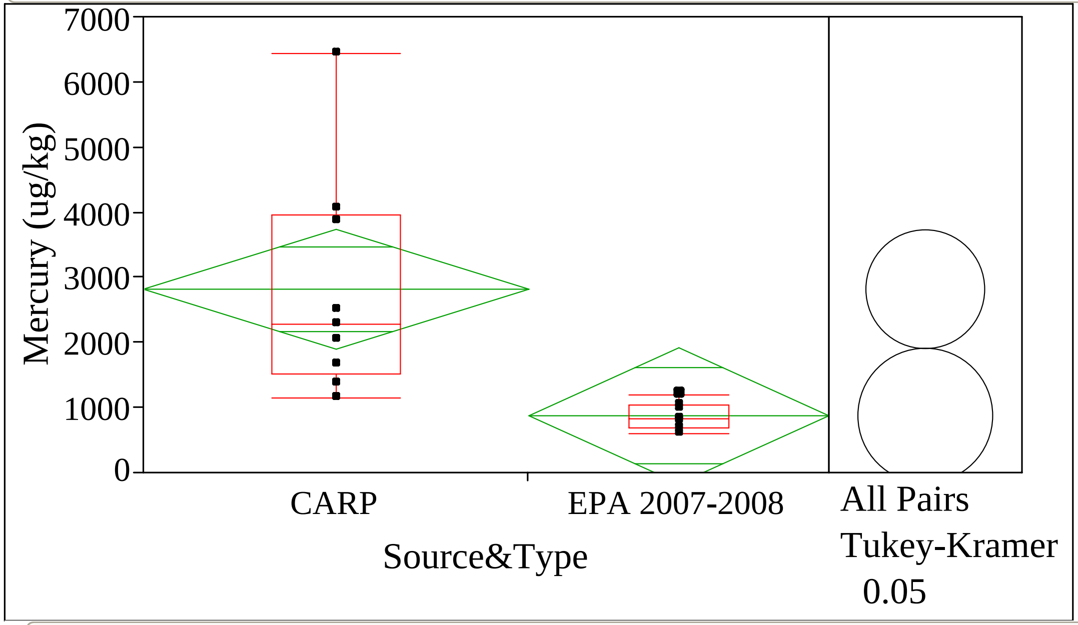
	CARP	EPA 2007-2008
CARP	-185564	53387
EPA 2007-2008	53387	-210410

Positive values show pairs of means that are significantly different.

Level			Mean
CARP	A		645527.37
EPA 2007-2008		B	393763.15

Levels not connected by same letter are significantly different.

Oneway Analysis of Mercury (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	1145.85	1145.85	1512.528	2278.131	3956.531	6433.877	6433.877
EPA 2007-2008	595.9596	595.9596	684.432	825.3968	1037.037	1192.547	1192.547

Oneway Anova

Summary of Fit

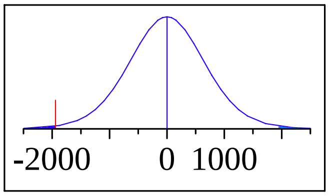
Rsquare	0.390269
Adj Rsquare	0.346717
Root Mean Square Error	1287.184
Mean of Response	1965.116
Observations (or Sum Wgts)	16

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-1941.8	t Ratio	-2.99349
Std Err Dif	648.7	DF	14
Upper CL Dif	-550.5	Prob > |t|	0.0097*
Lower CL Dif	-3333.1	Prob > t	0.9952
Confidence	0.95	Prob < t	0.0048*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	14846906	14846906	8.9610	0.0097*
Error	14	23195798	1656842.7		
C. Total	15	38042704			

Oneway Analysis of Mercury (ug/kg) By Source&Type

Oneway Anova

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	2814.66	429.06	1894	3734.9
EPA 2007-2008	7	872.85	486.51	-171	1916.3

Std Error uses a pooled estimate of error variance

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.14478	0.05

Abs(Dif)-LSD

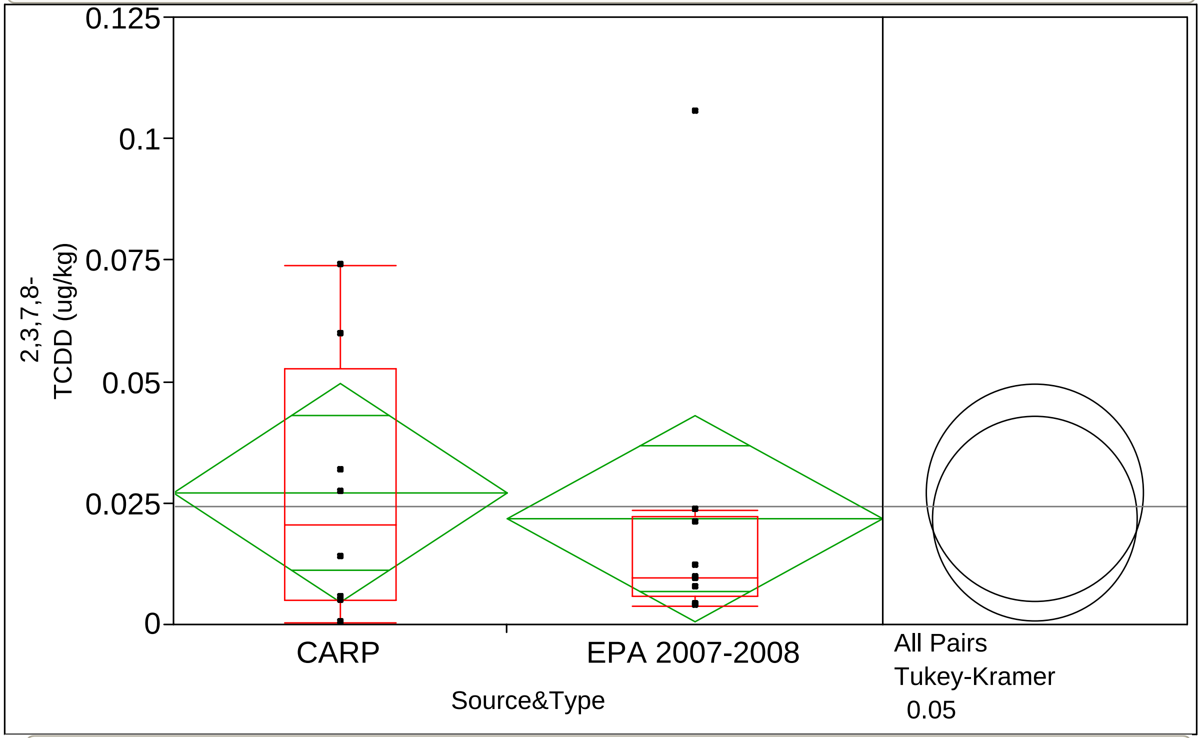
	CARP	EPA 2007-2008
CARP	-1301.4	550.5
EPA 2007-2008	550.5	-1475.7

Positive values show pairs of means that are significantly different.

Level			Mean
CARP	A		2814.6602
EPA 2007-2008		B	872.8459

Levels not connected by same letter are significantly different.

Oneway Analysis of 2,3,7,8-TCDD (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	0.000344	0.000344	0.004959	0.020476	0.052648	0.073886	0.073886
EPA 2007-2008	0.003767	0.003767	0.00579	0.009591	0.022198	0.105455	0.105455

Oneway Anova

Summary of Fit

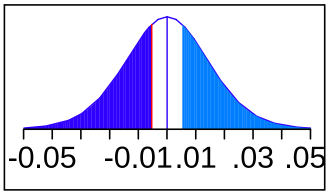
Rsquare	0.008859
Adj Rsquare	-0.05722
Root Mean Square Error	0.029863
Mean of Response	0.024279
Observations (or Sum Wgts)	17

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-0.00531	t Ratio	-0.36617
Std Err Dif	0.01451	DF	15
Upper CL Dif	0.02562	Prob > |t|	0.7194
Lower CL Dif	-0.03624	Prob > t	0.6403
Confidence	0.95	Prob < t	0.3597



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	0.00011957	0.000120	0.1341	0.7194
Error	15	0.01337659	0.000892		
C. Total	16	0.01349616			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	8	0.027092	0.01056	0.00459	0.04960
EPA 2007-2008	9	0.021779	0.00995	0.00056	0.04300

Std Error uses a pooled estimate of error variance

Oneway Analysis of 2,3,7,8-TCDD (ug/kg) By Source&Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.13144	0.05

Abs(Dif)-LSD

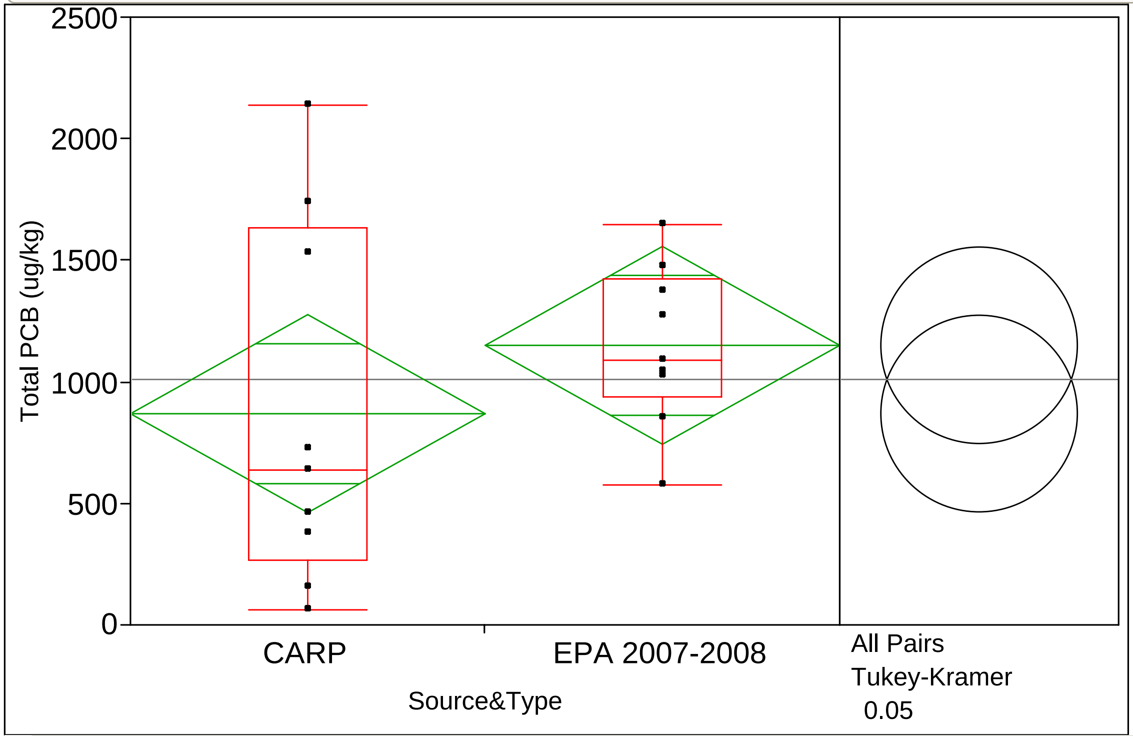
	CARP	EPA 2007-2008
CARP	-0.03183	-0.02562
EPA 2007-2008	-0.02562	-0.03001

Positive values show pairs of means that are significantly different.

Level		Mean
CARP	A	0.02709225
EPA 2007-2008	A	0.02177892

Levels not connected by same letter are significantly different.

Oneway Analysis of Total PCB (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	62.12433	62.12433	266.4628	637.0838	1633.647	2138.653	2138.653
EPA 2007-2008	575.6601	575.6601	938.2486	1089.024	1423.744	1646.734	1646.734

Oneway Anova

Summary of Fit

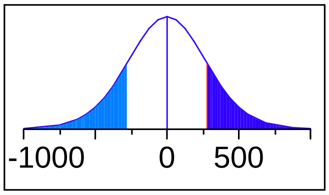
Rsquare	0.062659
Adj Rsquare	0.004075
Root Mean Square Error	576.2587
Mean of Response	1009.61
Observations (or Sum Wgts)	18

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	280.94	t Ratio	1.034196
Std Err Dif	271.65	DF	16
Upper CL Dif	856.81	Prob > |t|	0.3164
Lower CL Dif	-294.93	Prob > t	0.1582
Confidence	0.95	Prob < t	0.8418



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	355173.7	355174	1.0696	0.3164
Error	16	5313185.4	332074		
C. Total	17	5668359.2			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	869.14	192.09	461.94	1276.3
EPA 2007-2008	9	1150.08	192.09	742.88	1557.3

Std Error uses a pooled estimate of error variance

Oneway Analysis of Total PCB (ug/kg) By Source&Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.11990	0.05

Abs(Dif)-LSD

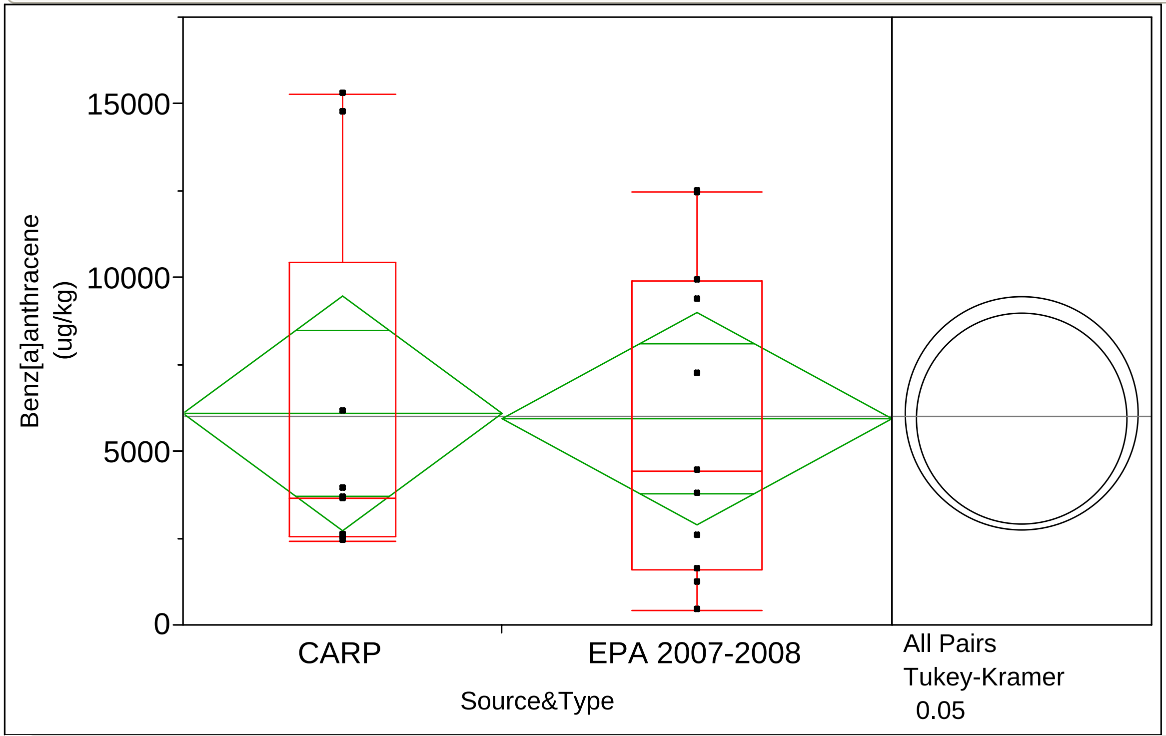
	EPA 2007-2008	CARP
EPA 2007-2008	-575.87	-294.93
CARP	-294.93	-575.87

Positive values show pairs of means that are significantly different.

Level		Mean
EPA 2007-2008	A	1150.0806
CARP	A	869.1402

Levels not connected by same letter are significantly different.

Oneway Analysis of Benz[a]anthracene (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	2406.867	2406.867	2540.651	3646.555	10438.34	15281.91	15281.91
EPA 2007-2008	414.2857	571.9286	1587.517	4427.245	9905.512	12461.09	12471.26

Oneway Anova

Summary of Fit

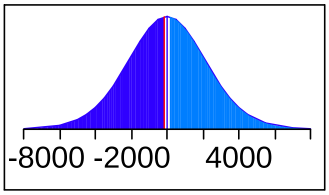
Rsquare	0.000276
Adj Rsquare	-0.05526
Root Mean Square Error	4825.731
Mean of Response	6006.194
Observations (or Sum Wgts)	20

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-152.9	t Ratio	-0.07048
Std Err Dif	2169.0	DF	18
Upper CL Dif	4404.0	Prob > |t|	0.9446
Lower CL Dif	-4709.8	Prob > t	0.5277
Confidence	0.95	Prob < t	0.4723



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	115671	115671.43	0.0050	0.9446
Error	18	419178299	23287683		
C. Total	19	419293970			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	6090.27	1608.6	2710.8	9469.8
EPA 2007-2008	11	5937.40	1455.0	2880.5	8994.3

Std Error uses a pooled estimate of error variance

Oneway Analysis of Benz[a]anthracene (ug/kg) By Source&Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.10092	0.05

Abs(Dif)-LSD

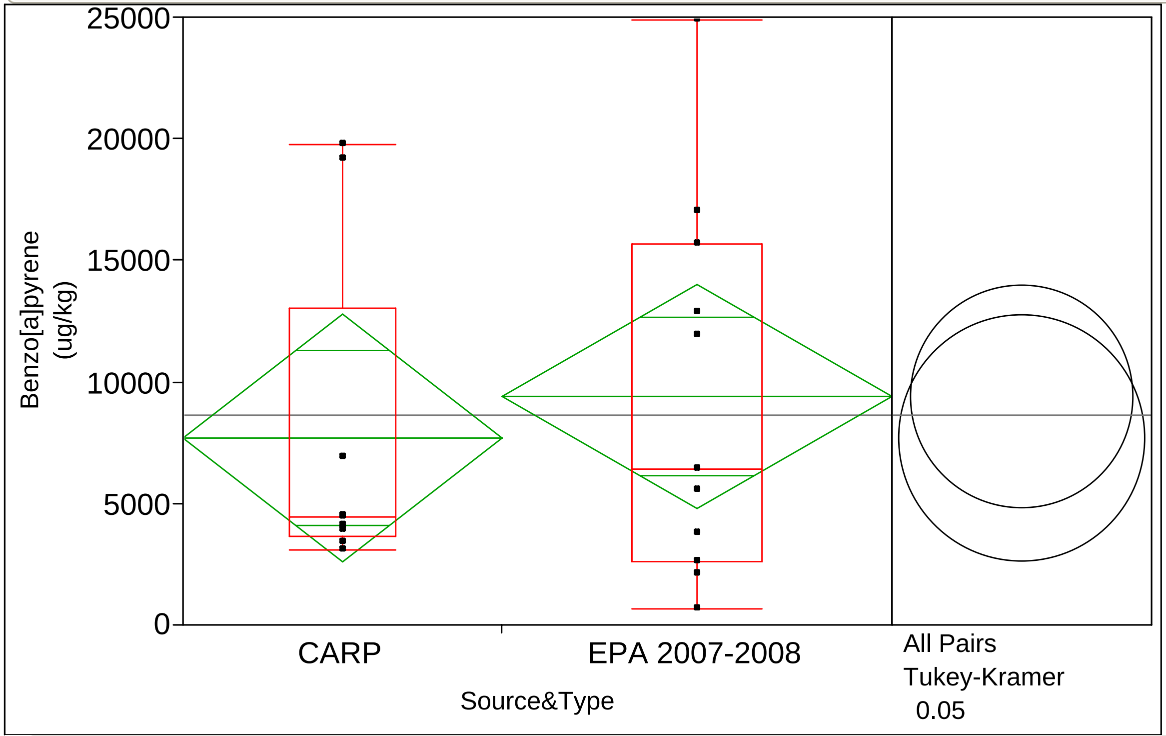
	CARP	EPA 2007-2008
CARP	-4779.3	-4404.0
EPA 2007-2008	-4404.0	-4323.1

Positive values show pairs of means that are significantly different.

Level		Mean
CARP	A	6090.2702
EPA 2007-2008	A	5937.4044

Levels not connected by same letter are significantly different.

Oneway Analysis of Benzo[a]pyrene (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	3083.215	3083.215	3644.925	4442.314	13029.38	19761.13	19761.13
EPA 2007-2008	655.6391	943.5113	2605.156	6408.669	15668.79	23309.62	24885.06

Oneway Anova

Summary of Fit

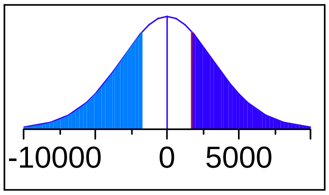
Rsquare	0.014943
Adj Rsquare	-0.03978
Root Mean Square Error	7274.84
Mean of Response	8630.447
Observations (or Sum Wgts)	20

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	1708.6	t Ratio	0.52255
Std Err Dif	3269.8	DF	18
Upper CL Dif	8578.2	Prob > |t|	0.6077
Lower CL Dif	-5161.0	Prob > t	0.3038
Confidence	0.95	Prob < t	0.6962



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	14451136	14451136	0.2731	0.6077
Error	18	952619371	52923298		
C. Total	19	967070508			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	7690.70	2424.9	2596.1	12785
EPA 2007-2008	11	9399.33	2193.4	4791.1	14008

Std Error uses a pooled estimate of error variance

Oneway Analysis of Benzo[a]pyrene (ug/kg) By Source&Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.10092	0.05

Abs(Dif)-LSD

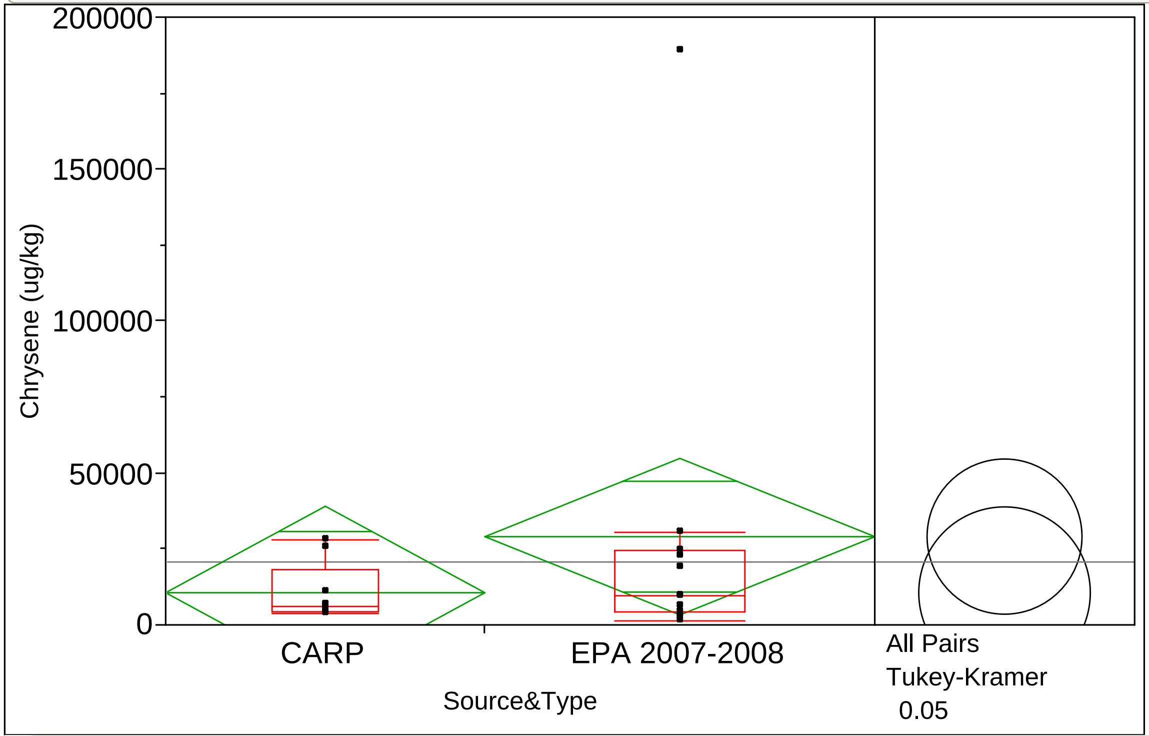
	EPA 2007-2008	CARP
EPA 2007-2008	-6517.1	-5161.0
CARP	-5161.0	-7204.9

Positive values show pairs of means that are significantly different.

Level		Mean
EPA 2007-2008	A	9399.3313
CARP	A	7690.6998

Levels not connected by same letter are significantly different.

Oneway Analysis of Chrysene (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	3739.407	3739.407	4331.79	6080.005	18195.43	27970.78	27970.78
EPA 2007-2008	1315.789	1627.632	4260.516	9623.932	24522.29	157273.1	188976.4

Oneway Anova

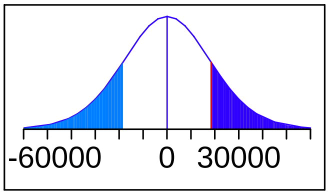
Summary of Fit

Rsquare	0.053439
Adj Rsquare	0.000853
Root Mean Square Error	40692.5
Mean of Response	20723.79
Observations (or Sum Wgts)	20

t Test

EPA 2007-2008-CARP
Assuming equal variances

Difference	18438	t Ratio	1.008074
Std Err Dif	18290	DF	18
Upper CL Dif	56863	Prob > |t|	0.3268
Lower CL Dif	-19988	Prob > t	0.1634
Confidence	0.95	Prob < t	0.8366



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	1682725523	1.6827e+9	1.0162	0.3268
Error	18	2.9806e+10	1.6559e+9		
C. Total	19	3.1489e+10			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	10583.1	13564	-17914	39080
EPA 2007-2008	11	29020.7	12269	3244	54797

Std Error uses a pooled estimate of error variance

Oneway Analysis of Chrysene (ug/kg) By Source&Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.10092	0.05

Abs(Dif)-LSD

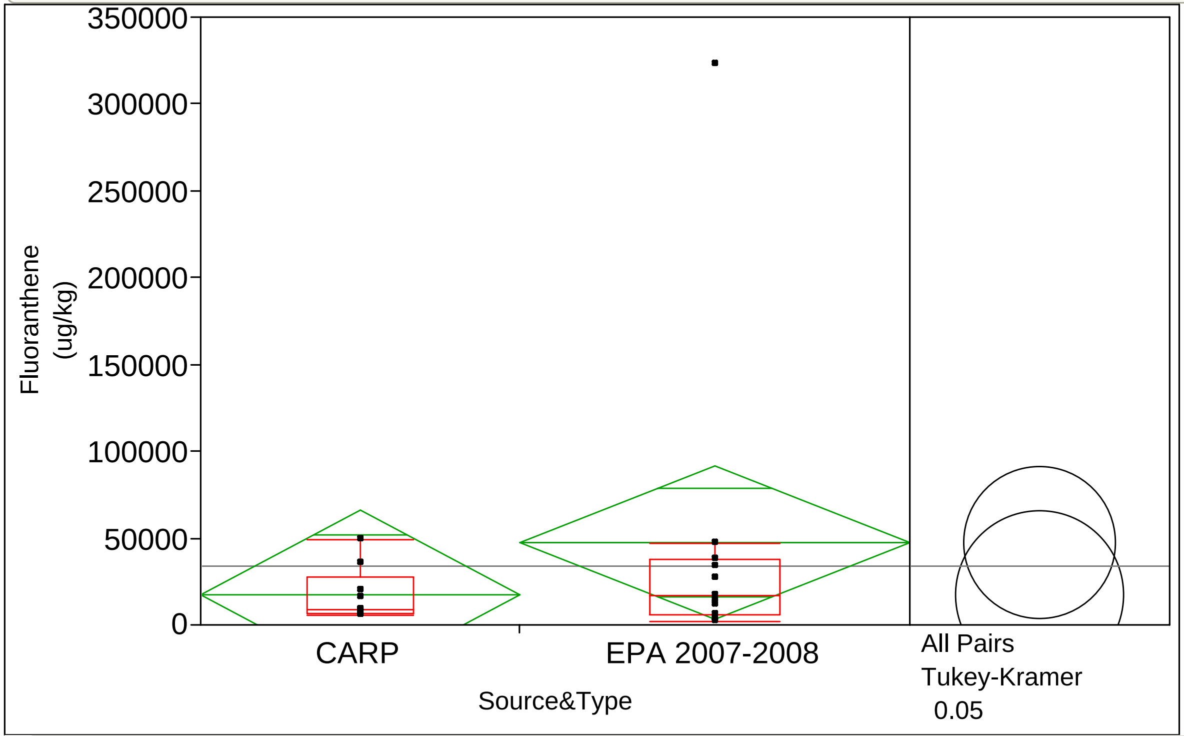
	EPA 2007-2008	CARP
EPA 2007-2008	-36454	-19988
CARP	-19988	-40301

Positive values show pairs of means that are significantly different.

Level		Mean
EPA 2007-2008	A	29020.706
CARP	A	10583.121

Levels not connected by same letter are significantly different.

Oneway Analysis of Fluoranthene (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	5509.952	5509.952	6525.801	8772.832	27597.26	49084.72	49084.72
EPA 2007-2008	1917.293	2178.835	5834.464	16905.98	37756.65	267656.3	322834.6

Oneway Anova

Summary of Fit

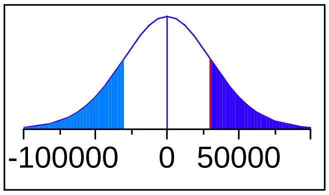
Rsquare	0.048745
Adj Rsquare	-0.0041
Root Mean Square Error	69731.63
Mean of Response	33854.8
Observations (or Sum Wgts)	20

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	30101	t Ratio	0.960397
Std Err Dif	31342	DF	18
Upper CL Dif	95948	Prob > |t|	0.3496
Lower CL Dif	-35746	Prob > t	0.1748
Confidence	0.95	Prob < t	0.8252



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	4484988227	4.485e+9	0.9224	0.3496
Error	18	8.7525e+10	4.8625e+9		
C. Total	19	9.201e+10			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	17299.4	23244	-31534	66133
EPA 2007-2008	11	47400.2	21025	3229	91572

Std Error uses a pooled estimate of error variance

Oneway Analysis of Fluoranthene (ug/kg) By Source&Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.10092	0.05

Abs(Dif)-LSD

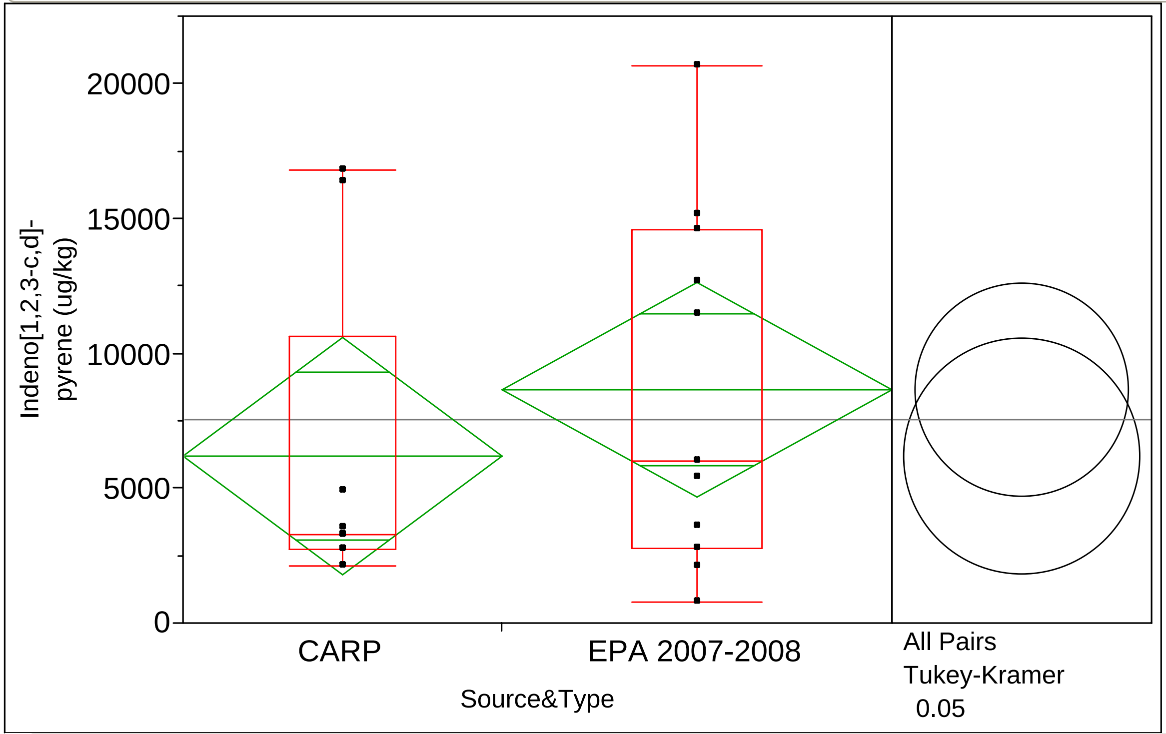
	EPA 2007-2008	CARP
EPA 2007-2008	-62468	-35746
CARP	-35746	-69061

Positive values show pairs of means that are significantly different.

Level		Mean
EPA 2007-2008	A	47400.164
CARP	A	17299.363

Levels not connected by same letter are significantly different.

Oneway Analysis of Indeno[1,2,3-c,d]-pyrene (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	2117.883	2117.883	2736.246	3279.303	10630.15	16796.74	16796.74
EPA 2007-2008	774.4361	1039.049	2767.978	6006.192	14585.99	19558.66	20660.92

Oneway Anova

Summary of Fit

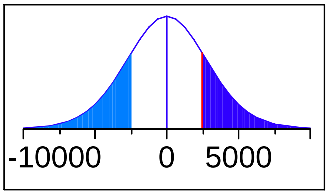
Rsquare	0.040428
Adj Rsquare	-0.01288
Root Mean Square Error	6283.519
Mean of Response	7543.036
Observations (or Sum Wgts)	20

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	2459.5	t Ratio	0.870846
Std Err Dif	2824.2	DF	18
Upper CL Dif	8393.0	Prob > |t|	0.3953
Lower CL Dif	-3474.0	Prob > t	0.1977
Confidence	0.95	Prob < t	0.8023



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	29942539	29942539	0.7584	0.3953
Error	18	710687062	39482615		
C. Total	19	740629601			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	6190.33	2094.5	1789.9	10591
EPA 2007-2008	11	8649.80	1894.6	4669.5	12630

Std Error uses a pooled estimate of error variance

Oneway Analysis of Indeno[1,2,3-c,d]-pyrene (ug/kg) By Source&Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.10092	0.05

Abs(Dif)-LSD

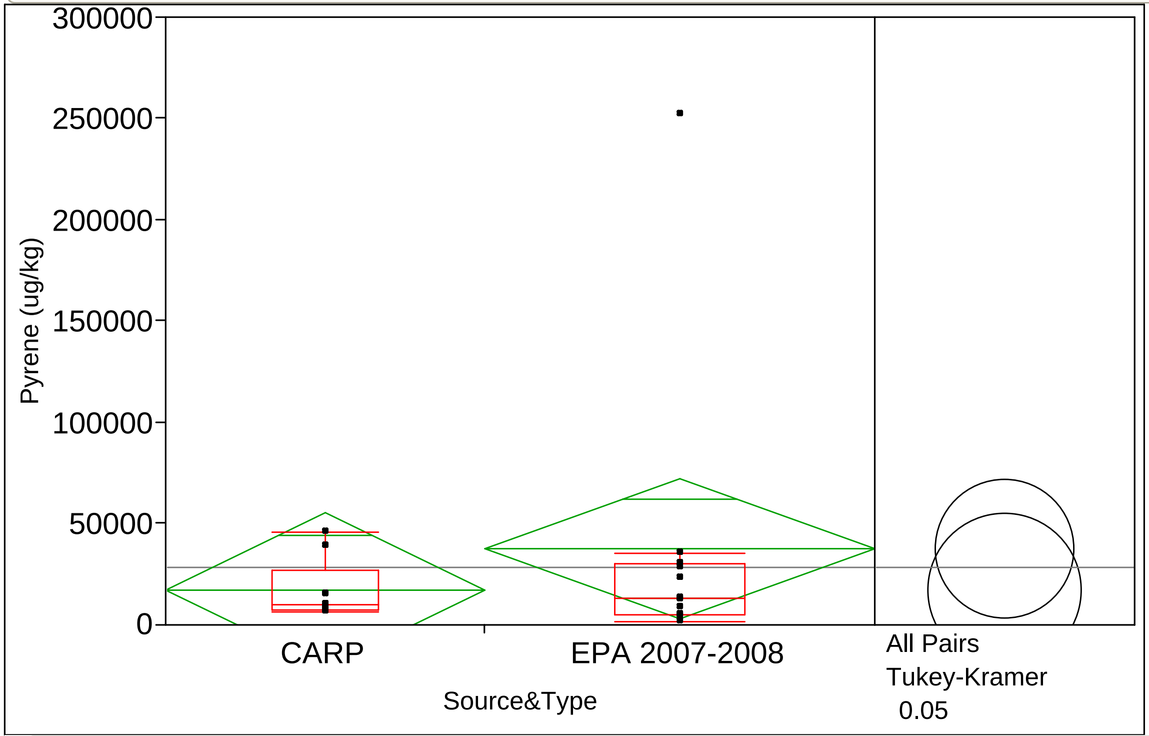
	EPA 2007-2008	CARP
EPA 2007-2008	-5629.0	-3474.0
CARP	-3474.0	-6223.1

Positive values show pairs of means that are significantly different.

Level		Mean
EPA 2007-2008	A	8649.7975
CARP	A	6190.3265

Levels not connected by same letter are significantly different.

Oneway Analysis of Pyrene (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	6393.265	6393.265	7316.302	9992.504	26952.9	45737.88	45737.88
EPA 2007-2008	1601.504	2116.203	4966.079	13126.93	30172.41	208644.9	251968.5

Oneway Anova

Summary of Fit

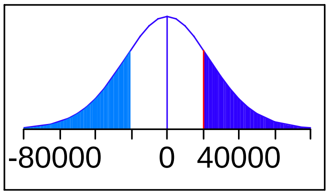
Rsquare	0.037084
Adj Rsquare	-0.01641
Root Mean Square Error	54566.02
Mean of Response	28407.79
Observations (or Sum Wgts)	20

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	20420	t Ratio	0.832594
Std Err Dif	24526	DF	18
Upper CL Dif	71946	Prob > |t|	0.4160
Lower CL Dif	-31107	Prob > t	0.2080
Confidence	0.95	Prob < t	0.7920



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	2064006415	2.064e+9	0.6932	0.4160
Error	18	5.3594e+10	2.9775e+9		
C. Total	19	5.5658e+10			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	17176.9	18189	-21036	55390
EPA 2007-2008	11	37596.7	16452	3032	72162

Std Error uses a pooled estimate of error variance

Oneway Analysis of Pyrene (ug/kg) By Source&Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.10092	0.05

Abs(Dif)-LSD

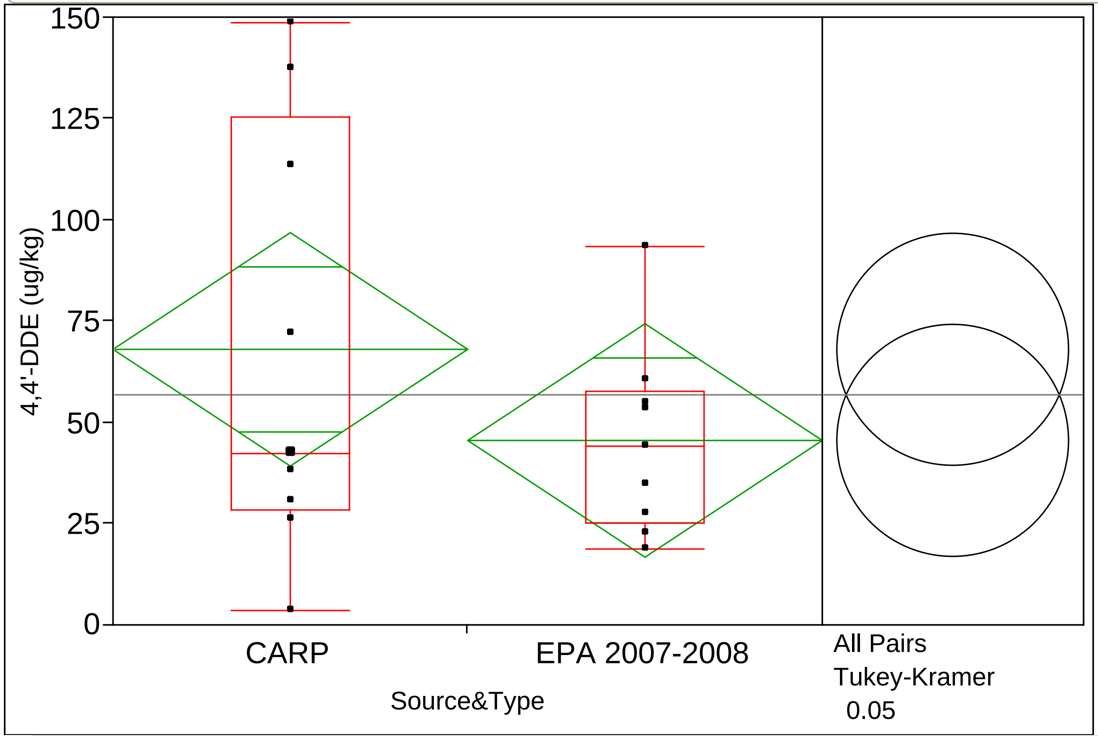
	EPA 2007-2008	CARP
EPA 2007-2008	-48882	-31106
CARP	-31106	-54041

Positive values show pairs of means that are significantly different.

Level		Mean
EPA 2007-2008	A	37596.735
CARP	A	17176.867

Levels not connected by same letter are significantly different.

Oneway Analysis of 4,4'-DDE (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	3.572204	3.572204	28.39605	42.28575	125.3831	148.6614	148.6614
EPA 2007-2008	18.72456	18.72456	25.11764	44.10256	57.67038	93.38583	93.38583

Oneway Anova

Summary of Fit

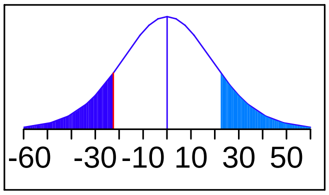
Rsquare	0.078763
Adj Rsquare	0.021186
Root Mean Square Error	40.76771
Mean of Response	56.77889
Observations (or Sum Wgts)	18

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-22.477	t Ratio	-1.1696
Std Err Dif	19.218	DF	16
Upper CL Dif	18.263	Prob > |t|	0.2593
Lower CL Dif	-63.218	Prob > t	0.8704
Confidence	0.95	Prob < t	0.1296



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	2273.556	2273.56	1.3680	0.2593
Error	16	26592.103	1662.01		
C. Total	17	28865.659			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	68.0176	13.589	39.210	96.826
EPA 2007-2008	9	45.5402	13.589	16.732	74.348

Std Error uses a pooled estimate of error variance

Oneway Analysis of 4,4'-DDE (ug/kg) By Source&Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.11990	0.05

Abs(Dif)-LSD

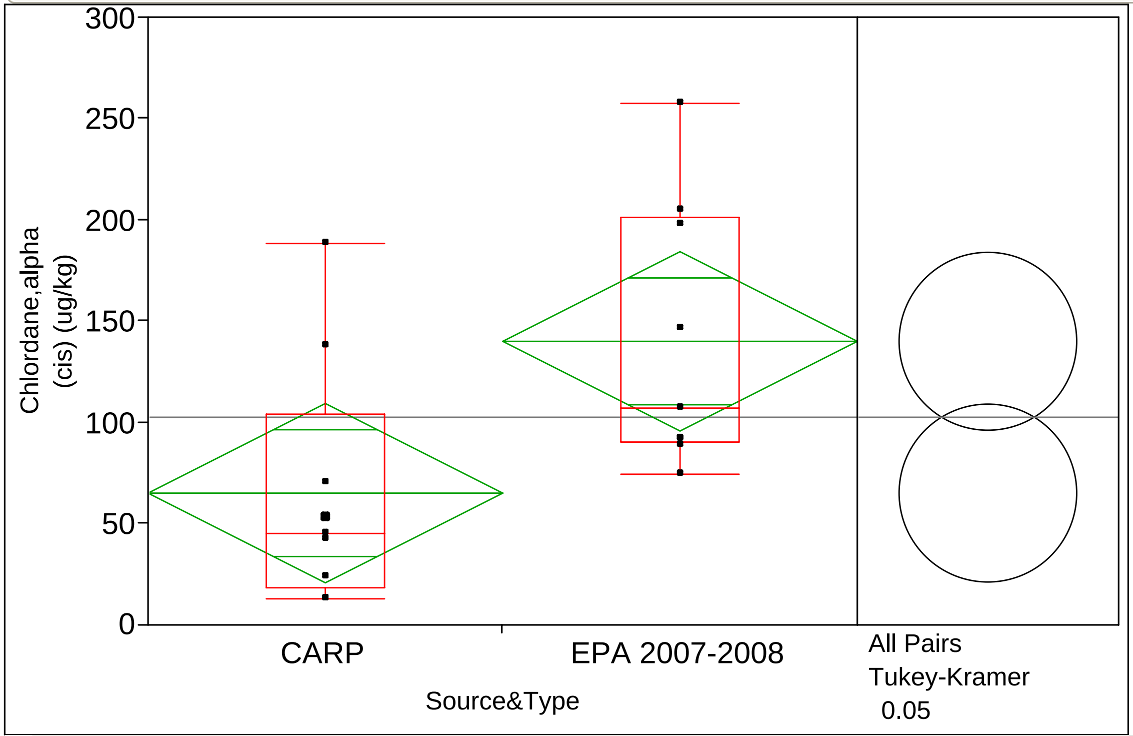
	CARP	EPA 2007-2008
CARP	-40.740	-18.263
EPA 2007-2008	-18.263	-40.740

Positive values show pairs of means that are significantly different.

Level		Mean
CARP	A	68.017608
EPA 2007-2008	A	45.540181

Levels not connected by same letter are significantly different.

Oneway Analysis of Chlordane,alpha (cis) (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	12.89288	12.89288	18.32165	45.14948	103.9978	188.3076	188.3076
EPA 2007-2008	74.39153	74.39153	90.25834	107.0064	201.2215	257.5	257.5

Oneway Anova

Summary of Fit

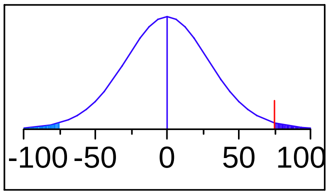
Rsquare	0.287163
Adj Rsquare	0.242611
Root Mean Square Error	62.62287
Mean of Response	102.5503
Observations (or Sum Wgts)	18

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	74.947	t Ratio	2.538803
Std Err Dif	29.521	DF	16
Upper CL Dif	137.528	Prob > |t|	0.0219*
Lower CL Dif	12.366	Prob > t	0.0109*
Confidence	0.95	Prob < t	0.9891



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	25276.917	25276.9	6.4455	0.0219*
Error	16	62745.988	3921.6		
C. Total	17	88022.905			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	65.077	20.874	20.825	109.33
EPA 2007-2008	9	140.024	20.874	95.772	184.28

Std Error uses a pooled estimate of error variance

Oneway Analysis of Chlordane,alpha (cis) (ug/kg) By Source&Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.11990	0.05

Abs(Dif)-LSD

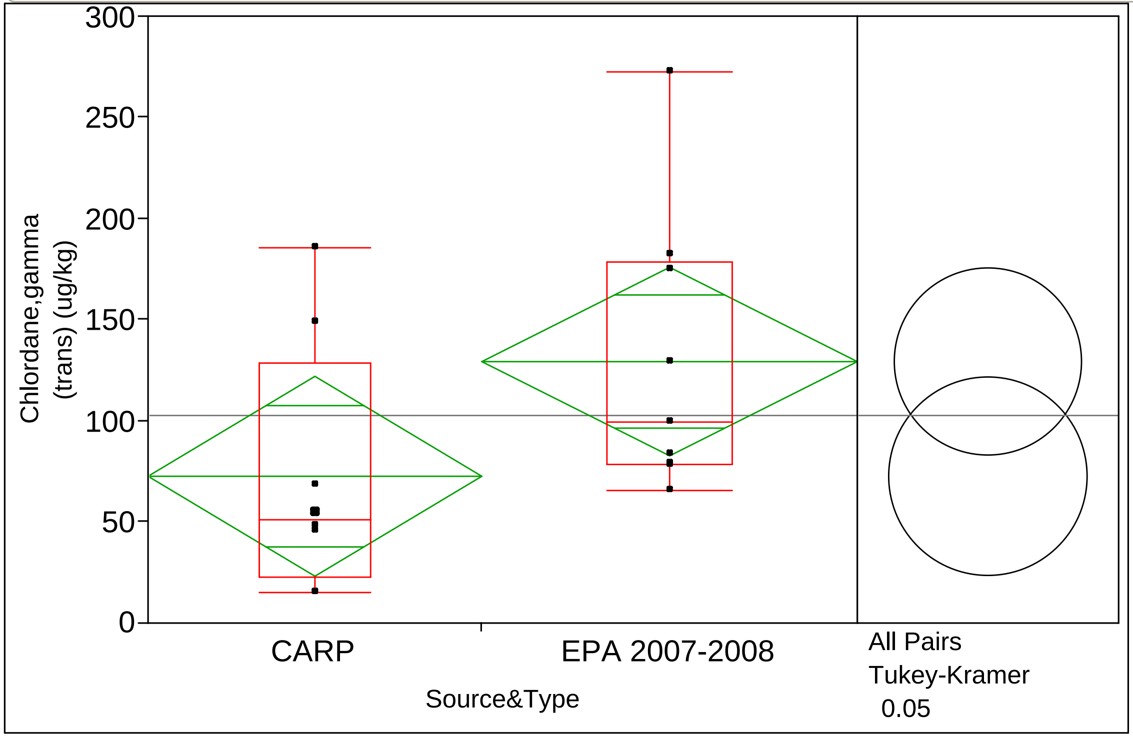
	EPA 2007-2008	CARP
EPA 2007-2008	-62.581	12.366
CARP	12.366	-62.581

Positive values show pairs of means that are significantly different.

Level			Mean
EPA 2007-2008	A		140.02398
CARP		B	65.07672

Levels not connected by same letter are significantly different.

Oneway Analysis of Chlordane,gamma (trans) (ug/kg) By Source&Type



Missing Rows 1

Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	15.06613	15.06613	22.72576	51.10425	128.5565	185.5586	185.5586
EPA 2007-2008	65.50265	65.50265	78.41121	99.36306	178.4662	272.5	272.5

Oneway Anova

Summary of Fit

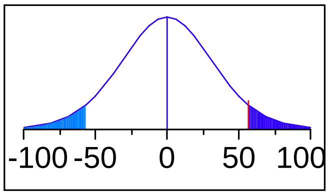
Rsquare	0.174614
Adj Rsquare	0.119588
Root Mean Square Error	65.5589
Mean of Response	102.592
Observations (or Sum Wgts)	17

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	56.75	t Ratio	1.78138
Std Err Dif	31.86	DF	15
Upper CL Dif	124.65	Prob > |t|	0.0951
Lower CL Dif	-11.15	Prob > t	0.0476*
Confidence	0.95	Prob < t	0.9524



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	13638.805	13638.8	3.1733	0.0951
Error	15	64469.539	4298.0		
C. Total	16	78108.343			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	8	72.549	23.179	23.145	121.95
EPA 2007-2008	9	129.297	21.853	82.718	175.88

Std Error uses a pooled estimate of error variance

Oneway Analysis of Chlordane,gamma (trans) (ug/kg) By Source&Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.13144	0.05

Abs(Dif)-LSD

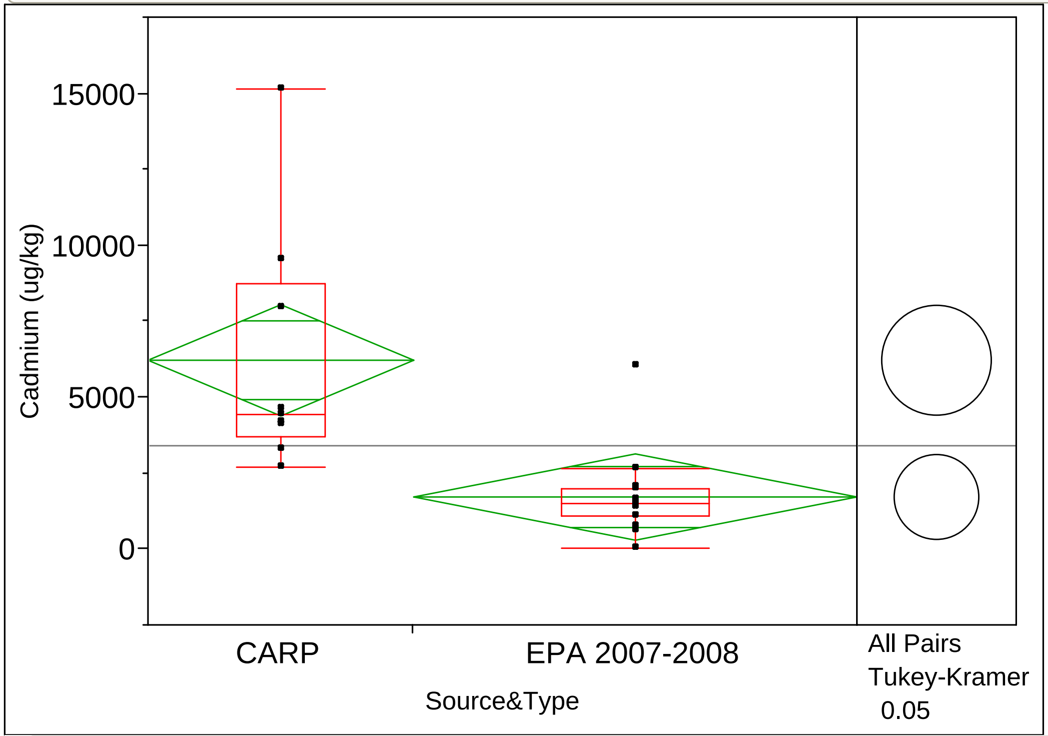
	EPA 2007-2008	CARP
EPA 2007-2008	-65.872	-11.152
CARP	-11.152	-69.868

Positive values show pairs of means that are significantly different.

Level		Mean
EPA 2007-2008	A	129.29668
CARP	A	72.54923

Levels not connected by same letter are significantly different.

Oneway Analysis of Cadmium (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	2690.191	2690.191	3691.604	4427.425	8733.458	15137.1	15137.1
EPA 2007-2008	24.59016	372.1697	1082.803	1493.902	1978.022	3994.844	6024.845

Oneway Anova

Summary of Fit

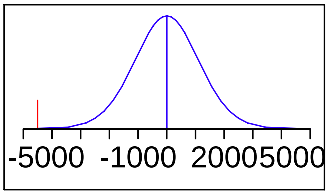
Rsquare	0.424846
Adj Rsquare	0.398703
Root Mean Square Error	2648.602
Mean of Response	3397.211
Observations (or Sum Wgts)	24

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-4501.8	t Ratio	-4.03121
Std Err Dif	1116.7	DF	22
Upper CL Dif	-2185.9	Prob > |t|	0.0006*
Lower CL Dif	-6817.8	Prob > t	0.9997
Confidence	0.95	Prob < t	0.0003*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	113999739	113999739	16.2506	0.0006*
Error	22	154332094	7015095.2		
C. Total	23	268331832			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	6210.87	882.87	4379.9	8041.8
EPA 2007-2008	15	1709.02	683.87	290.8	3127.3

Std Error uses a pooled estimate of error variance

Oneway Analysis of Cadmium (ug/kg) By Source&Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.07387	0.05

Abs(Dif)-LSD

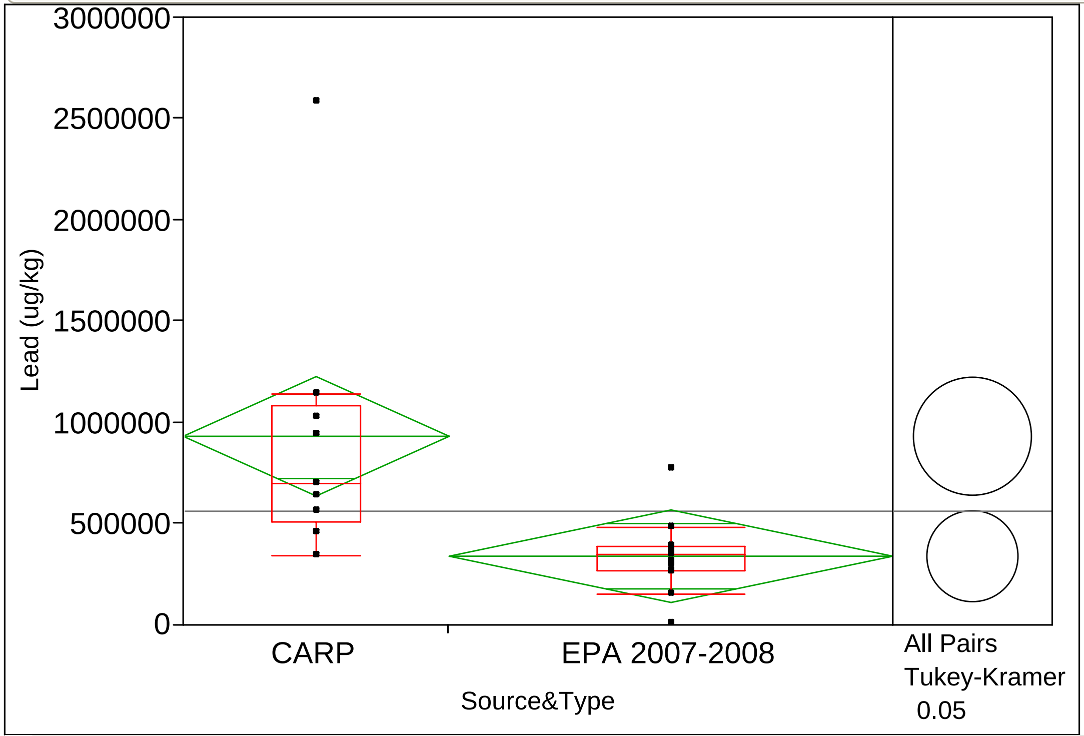
	CARP	EPA 2007-2008
CARP	-2589.4	2185.8
EPA 2007-2008	2185.8	-2005.7

Positive values show pairs of means that are significantly different.

Level			Mean
CARP	A		6210.8654
EPA 2007-2008		B	1709.0191

Levels not connected by same letter are significantly different.

Oneway Analysis of Lead (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	341721.4	341721.4	508399	697739.2	1082125	2581955	2581955
EPA 2007-2008	6475.41	93480.64	267500	348113.2	387500	597098.9	770186.3

Oneway Anova

Summary of Fit

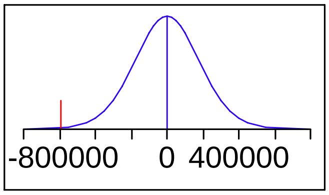
Rsquare	0.329804
Adj Rsquare	0.299341
Root Mean Square Error	426545.2
Mean of Response	561163.2
Observations (or Sum Wgts)	24

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-591756	t Ratio	-3.29032
Std Err Dif	179847	DF	22
Upper CL Dif	-218775	Prob > |t|	0.0033*
Lower CL Dif	-964736	Prob > t	0.9983
Confidence	0.95	Prob < t	0.0017*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	1.9697e+12	1.97e+12	10.8262	0.0033*
Error	22	4.0027e+12	1.819e+11		
C. Total	23	5.9724e+12			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	931011	142182	636144	1225877.4
EPA 2007-2008	15	339255	110134	110852	567657.65

Std Error uses a pooled estimate of error variance

Oneway Analysis of Lead (ug/kg) By Source&Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.07387	0.05

Abs(Dif)-LSD

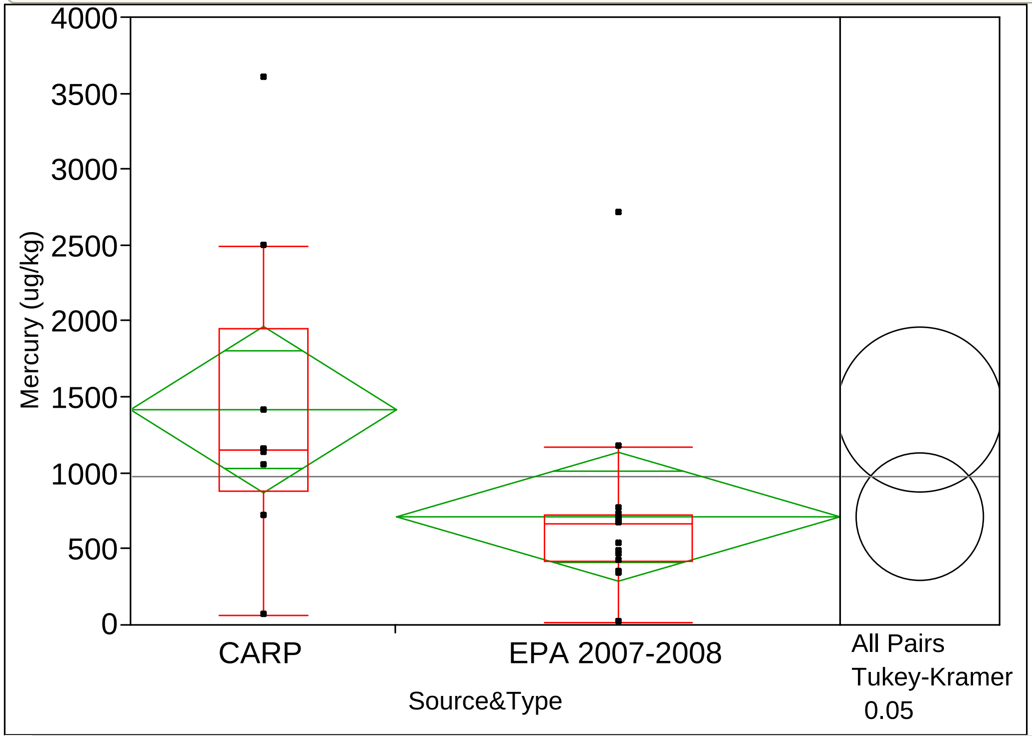
	CARP	EPA 2007-2008
CARP	-417005	218775
EPA 2007-2008	218775	-323011

Positive values show pairs of means that are significantly different.

Level		Mean
CARP	A	931010.55
EPA 2007-2008	B	339254.74

Levels not connected by same letter are significantly different.

Oneway Analysis of Mercury (ug/kg) By Source&Type



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
CARP	62.72794	62.72794	880.2361	1150.714	1949.4	3598.997	3598.997
EPA 2007-2008	14.83607	206.5714	418.0139	664.8352	723.4043	1785.117	2708.075

Oneway Anova

Summary of Fit

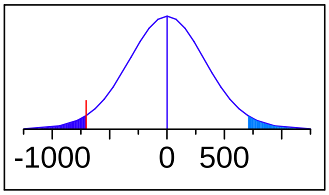
Rsquare	0.16848
Adj Rsquare	0.130684
Root Mean Square Error	792.1843
Mean of Response	976.0946
Observations (or Sum Wgts)	24

t Test

EPA 2007-2008-CARP

Assuming equal variances

Difference	-705.2	t Ratio	-2.1113
Std Err Dif	334.0	DF	22
Upper CL Dif	-12.5	Prob > |t|	0.0463*
Lower CL Dif	-1397.9	Prob > t	0.9768
Confidence	0.95	Prob < t	0.0232*



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Source&Type	1	2797379	2797379	4.4576	0.0463*
Error	22	13806230	627556		
C. Total	23	16603610			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
CARP	9	1416.85	264.06	869.22	1964.5
EPA 2007-2008	15	711.64	204.54	287.45	1135.8

Std Error uses a pooled estimate of error variance

Oneway Analysis of Mercury (ug/kg) By Source&Type

Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

q*	Alpha
2.07387	0.05

Abs(Dif)-LSD

	CARP	EPA 2007-2008
CARP	-774.47	12.50
EPA 2007-2008	12.50	-599.90

Positive values show pairs of means that are significantly different.

Level		Mean
CARP	A	1416.8467
EPA 2007-2008	B	711.6433

Levels not connected by same letter are significantly different.