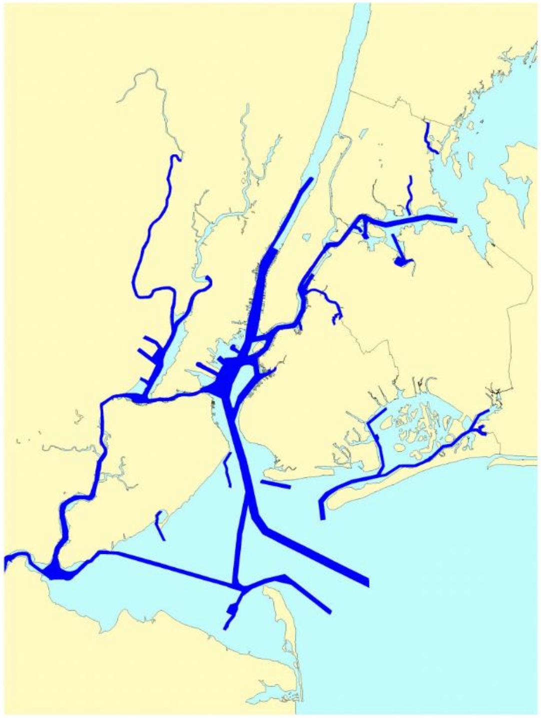
2024

Contamination Assessment and Reduction Project – Phase 2 (CARP II)

Appendix A-5. CARP II Loadings Report



UPDATE OF CARP MODEL EXTERNAL LOADING FORCING FUNCTIONS

NY/NJ Harbor Contamination Assessment and Reduction Project, CARP II

New Jersey Department of Transportation,

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Table of Contents

LIST OF TABLES

UPDATE OF CARP MODEL EXTERNAL LOADING FORCING FUNCTIONS

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ABSTRACT

A modeling-related task for the CARP 2 project has been completed. This task involved developing external loading forcing functions for the hydrodynamic, sediment transport/organic carbon production, and contaminant fate and transport models for the period October 1, 1998 through September 30, 2016. The external loading forcing functions represented in the models include tributary head-of-tide; overland runoff represented as direct drainage, stormwater, and combined sewer overflow; wastewater treatment plants; atmospheric deposition; and landfill leachate. The external loading forcing functions except for atmospheric deposition are specified as both water inflows and associated concentrations of suspended solids, organic carbon and other nutrients, PCB homologs, and dioxin/furan congeners. The atmospheric deposition external loading forcing functions are specified as mass loading rates only. In most cases, the CARP 2 external loading forcing function development effort involved the application of methods developed during CARP 1 using additional years of measurements, including measurements collected as part of CARP 2 sampling. In other cases, new methods were also applied to better represent real world conditions. The external loading forcing functions developed are necessary for improving the technical defensibility of CARP 2 model calculations for the 1998 to 2016 years during which and since CARP 1 measurements were collected as well as providing a more robust basis for applying the CARP 2 models for projections of future conditions. Ongoing model calibration work for the sediment transport and organic carbon production and contaminant fate and transport models provides further opportunity for assessment of model responses to specific external loading forcing functions.

KEY WORDS: CARP, model, HARS suitable, navigation channel, PCB, dioxin, NY/NJ Harbor and Estuary, dredged material testing, contaminant sources

1.0 INTRODUCTION

The Contamination Assessment and Reduction Project (CARP) 1 model was developed as a series of sub-models to provide a detailed representation of the hydrodynamics, sediment transport, organic carbon cycling, and fate and transport of contaminants in the NY/NJ Harbor and Estuary (HydroQual 2007a, 2007b, 2008). The CARP 1 sub-models were calibrated using field measurements that were primarily collected during the 1999-2002 CARP 1 sampling program. The calibrated sub-models were applied in 2002 to project concentrations of PCBs and PCDD/Fs for a 37-year period commencing in October 2002 and ending in September 2039. The projections made in 2002 were necessarily based on information available at that time. Model-projected concentrations were assessed relative to dredged material testing endpoints to estimate the time when Harbor sediments would meet Historic Area Remediation Site (HARS) disposal criteria.

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Since the 2002 CARP 1 model projections of time to HARS suitable Harbor sediments were made, the bathymetry of the Harbor has changed significantly. Deepening of navigation channels was accomplished by several projects. In addition, the Harbor has experienced extreme flow events (including Tropical Storms Irene, Lee, and Sandy) that were not simulated in the CARP 1 model projections. Further, measurement collection related to several Superfund projects in the Harbor has been ongoing since 2002. Therefore, in order to provide NJDOT with a tool for determining the current and future levels of contamination in the sediments within navigation channels of NJ/NY Harbor, refinement of the CARP sub-models is in-progress to account for the deepening of navigation channels, to assess the impacts of extreme flow events on contaminant responses in Harbor sediments, and to consider additional measurements of Harbor contaminant concentrations. The effort to ultimately provide NJDOT with a tool for determining the current and future levels of contamination in the sediments within navigation channels is being performed in a series of subtasks which started with a now completed post-audit evaluation of the CARP 1 model and will end with revised projections of PCB and PCDD/Fs contamination in Harbor sediments and dredged-material-test organisms based on new measurements and model refinements. The second subtask in the series is the update of model external loading forcing functions.

The completed second subtask, update of model external loading forcing functions, is described herein. The ultimate purpose of updating model loading forcing functions is to increase the reliability and technical defensibility of the modeled time responses for Harbor water and sediment concentrations (i.e., biota exposure concentrations) for model projections beyond the current year, based on extrapolation of available information from recent years rather than only on CARP 1 information from prior to 2002. Measurements collected by other CARP 2 investigators in 2018 and 2019 along with readily available measurements compiled from a variety of sources for the period 2012 to 2016 were used for updating the model external loading forcing functions. New model simulations were performed at key points during the development of updated external loading forcing functions to assess interim model responses incrementally. Given the overall project schedule and the timing of availability of measurements collected by other CARP investigators, early assessments were performed using model simulations based on the CARP 1 model grid and later assessments were performed using model simulations based on the higher resolution CARP 2 model grid and will continue and complete as part of overall model refinement and skill assessment efforts. The update of model external loading forcing functions is a necessary precursor to the subsequent planned subtasks focused on model refinement and model projections.

2.0 METHODS

The development of revised model external loading forcing functions involved obtaining flow and concentration information and processing the information into model inputs. Information pertaining to hydrographs was obtained, processed, and assessed first with revisions to loading concentrations addressed as a second step. In each step, the methods followed were specific to the various loading types. The specific methods for each model external loading type are described below. Both applications of methods adopted during CARP 1 for additional years of measurements and methods newly developed for CARP 2 are included. The loading types include tributary head-of-tide; stormwater and direct drainage; combined sewer overflow; wastewater treatment plants; atmospheric deposition; and landfill leachate.

2.1 Methods for Head-of-Tide Loadings

The CARP 1 models included head-of-tide inputs at twenty-eight discrete locations for thirty-four individual rivers for six water years: 1998-99, 1999-2000, 2000-01, 2001-02, 1994-95, and 1988-89. For purposes of CARP 2, revised head-of-tide inputs are specified at fifty-six locations for gaged and ungauged rivers and drainage areas for the eighteen consecutive water years 1998-99 through 2015-16. It was also necessary to expand the number of head-of-tide input locations for purposes of CARP 2 for use of revised USGS methods for estimating ungauged flows in the Hudson River watershed and for consistency with other ongoing modeling efforts throughout the Harbor since CARP 1 and the use of finer model grid resolution for CARP 2.

2.1.1 Hydrographs for Head-of-Tide Loadings

Tables 2-1 through 2-5 list the fifty-six head-of-tide model input locations considered for CARP 2 and the basis for flow estimation. The fifty-six head-of-tide model input locations were divided across five tables on a geographic basis. As noted on Tables 2-1 through 2-5, in some cases, nearby tributaries without a real-world connection were grouped and considered as a single head-of-tide model input location. One example of a grouping is the Shark and Manasquan Rivers in New Jersey which each discharge to the Atlantic Ocean at separate points along the New Jersey shoreline. Also as noted in Tables 2-1 through 2-5, many of the head-of-tide model input locations are downstream of the confluence of several streams. For example, the Navesink River model head-of-tide input location in New Jersey represents the confluence of the Swimming and Shrewsbury Rivers.

As in CARP 1, flow estimation for most of the fifty-six head-of-tide model input locations involves drainage-area scaled applications of U.S. Geological Survey (USGS) daily flow records, either for individual gages or for summations of multiple gages. The specific USGS gages relied upon for each of the fifty-six head-of-tide input locations are identified in Tables 2-1 through 2-5. As indicated on Table 2-2, different than other head-of-tide model input locations and maintained from CARP 1, flow estimation for the tidal Elizabeth and Rahway Rivers in New Jersey continues to be accomplished through runoff modeling of the urban watershed. Also indicated on Table 2-2 and new for CARP 2, the use of the runoff model for flow estimation for the Second River, Third River and McDonald's Brook tributaries to the lower Passaic River was discontinued. In CARP 2, daily flows for the Second River, Third River and McDonald's Brook tributaries to the lower Passaic River are estimated based on drainage area scaling of the daily flows measured at the USGS Saddle River at Lodi, NJ gage.

Table 2-3 includes thirty-five of the fifty-six head-of-tide model input locations. One of these is the confluence of the Hudson and Mohawk Rivers. The remaining thirty-four head-of-tide model input locations in Table 2-3 are sub-basin locations representing gauged and ungauged tributaries to the Hudson River and portions of Western Long Island Sound. Following recommendations from the NY USGS, the USGS Streamflow Statistics and Spatial Analysis Tools for Water Resources Applications, referred to as StreamStats, (Ries et al., 2017), were used to estimate daily flows for the model input locations in Table 2-3. Use of the StreamStats tools is new for CARP 2. Within the 13,100 mi^2 drainage area of the NY Hudson River and western Long Island Sound head-of-tide model input locations listed in Table 2-3, the USGS maintains seven permanent flow gaging stations. These include: Upper Hudson at Waterford, NY; Mohawk River at Cohoes, NY; Esopus Creek at Kingston, NY; Rondout Creek at Rosendale, NY; Wappinger Creek near Wappinger Falls, NY; Wallkill River at Gardiner, NY; and Croton River at New Croton Dam near Croton-on-Hudson, NY. The gage numbers are included in Table 2-3. The permanent gaging stations combined provide daily streamflow data for 10,111 mi^2. The remaining 2,989 mi^2 of the drainage area are either un-gaged or have only a partial streamflow record. There are five gaging stations with partial records:

Kinderhook Creek at Rossman, NY; Roeliff Jansen Kill near Linlithgo, NY; Catskill Creek at South Cairo, NY; Normans Kill at Albany, NY; and Rondout Creek at Rondout, NY.

For each of the thirty-four sub-basins of the Hudson River listed below the Hudson and Mohawk Rivers in Table 2-3, watershed drainage area, mean annual runoff, percent forest cover, percent impervious surface, storage area, and mean basin slope were obtained using the StreamStats tools. The StreamStats tools were also used to identify the latitude and longitude for the mouth of each tributary input. For sub-basins with two or more streams, latitude and longitude were identified for the midpoint along the Hudson shoreline. The StreamStats tools were also used to determine drainage area, mean annual runoff, percent forest cover, percent impervious surface, storage area and mean basin slope for the collection area of the seven permanent gaging stations and for the five gaging stations with partial daily streamflow records. Daily streamflow data were downloaded from the USGS website for the seven permanent gaging stations for the 1998-2016 period, and for the periods of record for the five gaging stations with partial streamflow records. Daily streamflow records from one or more of the gaging stations were used for estimating daily flows in the thirty-four sub-basins. In these calculations, adjustments in the gaged streamflow were made to account for differences in drainage area and mean annual runoff as follows:

$$Q_{ws} = Q_{gaged} \times \left(\frac{DA_{ws}}{DA_{gage}}\right) \times \left(\frac{MAR_{ws}}{MAR_{gage}}\right)$$

Equation 2.1.1-1

where Q, DA and MAR represent the daily streamflow, drainage area and mean annual runoff of the watershed sub-basin ('ws') and a selected gaging station ('gage').

Selection of a representative gaging station was made based on the following criteria:

1. If the watershed sub-basin included a permanent gaging station, streamflow records for that gaging station were used. Adjustments in drainage area (and if necessary, mean annual runoff) were made to account for additional area located downstream of the gaging station using Equation 2.1.1-1.
2. If the watershed sub-basin included a gaging station with a partial streamflow record, streamflow records for that gaging station were used for the available gaging period. Adjustments in drainage area and mean annual runoff were again considered.
3. If the watershed sub-basin was not gaged or did not have gage in operation during the time period of interest, the selection of a representative permanent gaging station was based on location (east versus west side of the Hudson River to account for potential differences in geology). A further differentiation was based on mean annual runoff, which served as an aggregate parameter accounting for local differences in precipitation and runoff behavior associated with land cover, mean channel slope and storage.

For the third criterion noted above, Wappinger Creek near Wappinger Falls, NY and Croton River at Croton Falls near Croton-on-Hudson NY were selected as representative gaging stations for watershed sub-basins on the east side of the Hudson with low and high mean annual runoff, respectively. For watershed sub-basins on the west side of the Hudson River, the Wallkill River at Gardiner, NY, Rondout Creek at Rosendale, NY, and Esopus Creek at Kington, NY were selected as represented gaging stations for watershed sub-basins with low, medium and high mean annual runoff, respectively.

To test the approach applied to the sub-basins of the Hudson River, daily streamflow records from the permanent gaging stations were used to estimate daily stream flows for five USGS gaging stations in NY with partial records. These partial records locations included: Catskill Creek at South Cairo, Kinderhook Creek at Rossman, Normans Kill at Albany, Rondout Creek at Rondout, and Roeliff Jansen Kill near

Linlithgo. As described above, information on drainage area and mean annual runoff for the five stations were obtained using StreamStats tools. Daily stream flows for the five stations were then estimated using Equation 2.1.1-1 and records from representative permanent gaging stations. Estimated streamflow records were then compared to actual USGS streamflow records using time series plots. Additional comparisons were also made by comparing statistical distributions of the estimated and actual stream flows. Appendix 1 includes the approach testing results. Appendix 1 includes a tabulation of the bias and precision for the estimates and the time series and probability distribution diagrams for measured and estimated flows.

Collectively, throughout the CARP 2 model domain the flows estimated daily for the fifty-six head-of-tide model input locations as described and summarized on Tables 2-1 through 2-5 were carried forward to develop loading estimates for suspended sediments, organic carbon and nutrients, and contaminants.

2.1.2 Suspended Sediment Concentrations for Head-of-Tide Loadings

The USGS provides measurements of suspended sediment loading concentrations for some, but not all, of the fifty-six head-of-tide input locations included in the CARP 2 model on a less frequent than daily basis. It is therefore necessary to estimate suspended sediment loading concentrations for head-of-tide input locations where and when USGS measurements are not available. As in CARP 1, the Normalized Sediment Load (NSL) approach (HydroQual, 1996) was modified and used for CARP 2 for estimating daily varying suspended sediment concentrations for the fifty-six head-of-tide model input locations. CARP 2 modifications to the NSL approach, referred to as mNSL, are more extensive than NSL modifications applied during CARP 1. The mNSL development and mNSL applications to specific CARP 2 head-of-tide model input locations are presented below in Sections 2.1.2.1 and 2.1.2.2.

2.1.2.1 mNSL Regression Development at Measurement Locations

The NSL function as originally developed by HydroQual (1996) is a six-parameter empirical regression method for estimating daily suspended sediment loads (i.e., concentration multiplied by flow) in rivers with limited or no suspended sediment data. The NSL approach is based on an observed behavior of rivers, i.e., a large fraction of the annual sediment load occurs during a relatively small number of high flow events, or floods, each year. NSL was originally developed, calibrated, and validated based on an analysis of sediment discharge data from a variety of rivers in the eastern United States and took advantage of general trends and behaviors across the rivers. The basis of the approach is that across many rivers a consistent relationship between sediment discharge and flow exists. The original approach found that daily observations of sediment discharge and flow rate for each river show a consistent relationship across rivers when normalized by mean daily sediment discharge under non-flood (i.e., flow rate less than or equal to twice the mean flow rate) conditions and long term mean flow rate, respectively.

Similar to the original NSL development (HydroQual, 1996), the NSL approach as applied on CARP 1 (HydroQual, 2007b) calculated daily suspended sediment loadings normalized by mean daily sediment discharge under non-flood conditions as a function of the daily flow rate normalized by the long term mean flow rate, drainage basin characteristics, and a stochastic term which accounts for variability.

One problem with the original 1996 and CARP 1 NSL approaches is that the record length available for suspended sediment concentration and flow measurements is often incomplete, varying from tributary to tributary. As a result, computed arithmetic means from the available measurements that were relied upon in the NSL equations were not necessarily representative of the true mean of flow or suspended sediment loading concentration for a given tributary. For example, a tributary may have a relatively short measurement record length where several anomalous flow events occurred, which would result in an inaccurate prediction of the true mean for flow and suspended sediment load concentration. A modified NSL function (mNSL) was therefore developed for estimating suspended sediment loading concentrations for the fifty-six CARP 2 tributary input locations.

For the CARP 2 mNSL approach applied to fifty-six CARP 2 model input locations, drainage area (km^2) is used as the normalization parameter for both flow (m^3/sec) and sediment load (metric tons/day). Using drainage area as the normalization parameter, rather than mean concentrations and flows, eliminates issues associated with accurately determining long-term arithmetic means from sparse measurements because drainage area remains constant over time and is not affected by anomalous events. The use of drainage area for normalization of data also allows the CARP 2 mNSL function to be used to estimate sediment loads in areas where daily flow is not gaged but can be estimated (e.g., using drainage areas and flow records from nearby gaging stations).

The details of the CARP 2 mNSL function may be described as a series of steps. First, drainage area (DA) in km^2 corresponding to USGS gaging station flows in m^3/sec for a given location were used in transforming daily flows and sediment loads in metric tons/day (Q_d, L_d) from paired observations into normalized flows and normalized sediment loads (Q_N, L_N) in m^3/sec/ km^2 and metric tons/day/km^2 units, respectively:

$$Q_N = \frac{Q_d}{DA}$$

Equation 2.1.2.1-1a

$$L_N = \frac{L_d}{DA}$$

Equation 2.1.2.1-1b

Q_N and L_N were then fit using separate regression lines for non-flood and flood conditions assuming log-log relationships:

Non-flood condition:

$$\log L_N = \log a_1 + \ b_1 \log Q_N$$

Equation 2.1.2.1-2

Flood condition:

$$\log L_N = \log a_2 + \ b_2 \log Q_N$$

Equation 2.1.2.1-3

where log a and b represent the intercept and slope of the regression lines. Determination of the delineation for non-flood and flood conditions (i.e. defined as a break point, BP), log a_1, b_1, and b_2 values was accomplished by minimizing the sum of the squared residuals about the regression lines for non-flood and flood conditions. The process of minimizing the residuals was completed by using the Solver Add-In for Microsoft Excel 2007. The settings used in the Solver Add-In for Microsoft Excel were: Max Time = 100s, Iterations = 100, Precision = 0.000001, Tolerance = 5%, Convergence = 0.0001, Tangent Estimates, Forward Derivatives, and Newton Search. The 95% confidence limits for the regression parameters were also determined using the Excel Macro, SolverAid (de Levie, 1999, 2001).

In the CARP 2 mNSL application, the intercept of the regression equation for flood conditions (log a_2) was fixed and was set as:

$$\log a_2 = \log a_1 + \ (b_1 \ - \ b_2) \log(BP)$$

Equation 2.1.2.1-4

to ensure that the regression equation for flood conditions matched the regression equation for non-flood conditions at the break point. Variations of log L_N observations about the regression lines were assumed to be normally distributed (in log space) and were quantified by standard deviations of the residuals of normalized sediment loads (S_{logLN}) across the entire range of normalized sediment loads.

For calculating daily suspended sediment loads, the calibrated CARP 2 mNSL parameters were used, with the normalized flow (Q_N) computed using Equation 2.1.2.1-1a and the remaining mNSL regression coefficient (log a_2) calculated using Equation 2.1.2.1-4. Daily estimates of log L_N for non-flood and flood conditions were determined directly from the regression equations (Equations 2.1.2.1-2 and 2.1.2.1-3). Since this calculation is based on mNSL regressions that were developed in log space, the computed daily log L_N values correspond to the median or 50th percentile values of the probability distributions of the daily sediment load. Median log L_N values were therefore converted into arithmetic mean L_N values, L_{Nadj}, as follows:

$$L_{Nadj} = 10^{\log L_N + \frac{\ln 10}{2} S^2_{logL_N}}$$

Equation 2.1.2.1-5

Finally, L_{Nadj} values were multiplied by drainage area to obtain the arithmetic mean daily loads at measurement locations.

It is important to note again the assumptions of the mNSL approach applied for CARP 2: (1) the regression equations (Equations 2.1.2.1-2 and 2.1.2.1-3) provide good estimates of the observed median log L_N values, (2) the residual observed log L_N values are normally distributed about the median, and (3) the standard deviation of the residuals, $S_{log\,LN}$, applies across the entire range of normalized sediment loads.

2.1.2.2 mNSL Application Fifty-Six Head-of-Tide Model Input Locations

Of the fifty-six CARP 2 head-of-tide model input locations, fourteen had sufficient USGS measurements for applying mNSL on a site-specific basis. Site-specific mNSL applications use drainage areas and flows at the model input location which is typically further downstream than the measurement location where the regression coefficients were developed. For the remaining forty-two locations, mNSL was applied on a surrogate basis. Tables 2-6 through 2-10 detail the site specific and surrogate mNSL parameters for each of the fifty-six head-of-tide model input locations. Tables 2-6 through 2-10 provide the rationale for surrogate assignments. Like Tables 2-1 through 2-5, Tables 2-6 to 2-10 sort the input information for modeled head-of-tide locations across five tables on a geographic basis.

Note well that since the CARP 2 model inputs for head-of-tide locations are specified as daily average loading concentrations rather than loads, the arithmetic mean daily loads calculated with the mNSL parameters in Tables 2-6 through 2-10 are divided by the model inputs of daily flow that were estimated by the methods presented in Section 2.1.1 to obtain loading concentrations for CARP 2 model input files.

Appendix 2 includes diagrams showing comparisons between the mNSL regression lines and underlying SSC/TSS measurements; SSC/TSS measurement frequency distributions; and the mass errors of the mNSL regression estimates considered as part of the mNSL method development and method selection.

2.1.3 Organic Carbon and Nutrient Concentrations for Head-of-Tide Loadings

In general, the monthly to seasonally varying loading concentrations for organic carbon and nutrients assigned to heads-of-tide in CARP 1 (HydroQual, 2007b) were maintained and were used to calculate loadings based on hydrographs for October 1,1998 through September 30, 2016, for the CARP 2 sediment transport and organic carbon production model. A few noted exceptions for assigning head-of-tide organic carbon and nutrient loading concentrations for CARP 2 sediment transport and organic carbon production modeling different than CARP 1 include the Second River, Third River, and McDonald's Brook along the lower Passaic River in New Jersey and the Hudson River, the Mohawk River and the thirty-four sub-basins of the Hudson River and western Long Island Sound in New York below the Hudson and Mohawk Rivers.

For the Second River, the Third River, and the McDonald's Brook which were modeled with constant stormwater-based concentrations in CARP 1, CARP2 organic carbon and nutrient loading concentrations were specified to match the time-varying loading concentrations assigned for the Lower Passaic River and Saddle River which are based on Lower Passaic River measurements. For the Hudson River, the Mohawk River, and the thirty-four sub-basins of the Hudson River and western Long Island Sound in New York below the Hudson and Mohawk Rivers, daily varying CARP 2 loading concentrations for POC were developed using mNSL solids loadings (see Section 2.1.2) and a regression equation between POC and suspended sediments (see Section 2.1.4.2 and Appendix 3). This approach is consistent with the approach of CARP 1 for specifying POC loading concentrations at these head-of-tide input locations and has the advantage of using a revised relationship between POC and suspended sediment. As in CARP 1, the nutrient loading concentrations at these head-of-tide input locations continue to be specified based on the Connecticut River.

2.1.4 Contaminant Concentrations for Head-of-Tide Loadings

The method developed and tested during CARP 1 for specifying contaminant loadings concentrations at model head-of-tide input locations (HydroQual, 2008) was maintained for CARP 2. For purposes of CARP 2, newly available measurements were incorporated into the CARP 1 method to produce revised head-of-tide contaminant loading concentrations. The method for estimating contaminant loadings concentrations at model head-of-tide input locations involves several steps, starting with median concentrations for dissolved and particulate contaminant phases and ending up with daily varying concentrations for total contaminants as described below. Together with revised estimates of head-of-tide flows, the revised head-of-tide daily loadings concentration estimates ultimately provide updated estimates of daily contaminant head-of-tide mass loadings for CARP 2 modeling.

2.1.4.1 Head-of-Tide Dissolved and Particulate Phase Median Contaminant Concentrations

For both CARP 1 and CARP 2, median dissolved and median organic carbon normalized particulate contaminant concentrations were estimated for each head-of-tide location based on analysis of probability distributions of available measurements. Tables 2-11 through 2-21 list the median dissolved and median organic carbon normalized concentrations for PCB homologs and dioxin/furan congeners for fifty-six model head-of-tide input locations applied for CARP 2 modeling. The individual tables address contaminant loading concentrations for specific head-of-tide model input locations grouped geographically and by chemical class.

Of note, for four out of five of the major New Jersey headwaters tributary to the Harbor presented on Tables 2-11 and 2-12, the Hackensack, Passaic, Saddle, and Raritan Rivers, and for the highly urban Elizabeth River presented on Tables 2-13 and 2-14, new contaminant measurements were collected as part of CARP 2 sampling. The CARP 2 measurements for these New Jersey rivers were combined with measurements collected during CARP 1 to perform updated probability analyses and to develop updated estimates of median concentrations to be used in the development of head-of-tide contaminant concentrations for application in the CARP 2 model. As noted in the tables, the probability distributions of combined CARP 1 and CARP 2 concentration measurements for these rivers are included in Appendix 3.

For the specific case of the Lower Passaic River head-of-tide, the diagrams in Appendix 3 include comparisons to contaminant loading concentration median values applied for Lower Passaic River Superfund RI/FFS (Appendix BII, Attachment G, *Revisions to CARP Loads*) and Lower 8.3 miles Record of Decision (Attachment E, Section 10.1, *Updated Mechanistic Model Lower 8.3 Miles of the Lower Passaic River*) modeling. The Lower Passaic River Superfund modeling did not have the benefit of CARP 2 measurements. Without the benefit of CARP 2 measurements, the Lower Passaic Superfund Study augmented CARP 1 water column contaminant measurements from the Lower Passaic River near Little Falls, NJ, with particulate contaminant phase only measurements from the local bed surface, sediment traps, the water column near Dundee Dam, and also applied the Kaplan-Meier approach for distribution predictions to revise the median head-of-tide contaminant loading concentration estimates developed during CARP 1. As shown on the diagrams in Appendix 3, the median contaminant concentration revisions developed during Lower Passaic River Superfund efforts were found to be largely confirmatory of the CARP 1 median contaminant loading concentration estimates and generally do not differ appreciably with the most recent median loading contaminant concentrations for the Lower Passaic River head-of-tide developed and applied for CARP 2.

For the remainder of the fifty-six head-of-tide model input locations which were not sampled during CARP 2 that are listed in Tables 2-11 through 2-21, CARP 1 measurements and CARP 1 surrogate estimation procedures were carried forward for CARP 2 as detailed in the tables. As indicated on Tables 2-15 and 2-16, PCB homolog loading concentrations for the Upper Hudson River above its confluence with the Mohawk River are an exception and were derived following a regression method originally developed by Farley et al., 2017 and extended for CARP 2 which takes advantage of comprehensive measurements records unique to the Hudson River. As indicated on Table 2-16, diagrams showing the Hudson above Mohawk regression equations for PCB homolog concentrations and flow with comparisons to underlying measurements are included in Appendix 3.

2.1.4.2 Head-of-Tide Time-Varying Contaminant Concentrations

With the exception of PCBs for the Upper Hudson River for which a unique method was applied, the median organic carbon normalized particulate contaminant concentrations obtained from measurements for model head-of-tide input locations as presented in Tables 2-11 through 2-21 were multiplied by daily varying particulate organic carbon concentrations to obtain daily varying particulate contaminant concentrations for each model head-of-tide input location on a volumetric basis. The daily varying particulate organic carbon concentrations applied were developed from an observed relationship between particulate organic carbon and suspended sediments for seven rivers and from the time varying NSL estimates of suspended sediment loading concentrations described in Section 2.1.2.

In CARP 1, the relationship between particulate organic carbon and suspended sediment was based on entire historical periods of records and was defined in terms of pooled measurements across thirteen rivers and also considered site specific relationships between POC and flow for ten of those rivers (HydroQual, 2008). For CARP 2, the period of record for considering the head-of-tide relationship between particulate organic carbon and suspended sediment was restricted to the sixteen water years modeled to be consistent with the period of record applied for flow and suspended sediment estimation as described in Section 2.1.1 and 2.1.2.

For the CARP 2 contemporary period of record, coincident measurements of suspended sediment and particulate organic carbon available from seven rivers were pooled to define a new relationship. The resulting log linear relationship along with the underlying contemporary measurements is presented in Appendix 3. The seven rivers for which contemporary paired suspended sediment and particulate organic carbon measurements were available include the Hackensack River at New Milford, NJ; the Lower Passaic

River at Little Falls, NJ; the Rahway River at Rahway, NJ; the Manasquan River at Squankum, NJ; the Toms River near Toms River, NJ; the Connecticut River at Thompsonville, CT; and the Mohawk River at Cohoes, NY. The regression relationship was applied to the daily varying estimates of suspended sediment concentrations obtained using NSL (Section 2.1.2) to yield daily varying estimates of particulate organic carbon concentrations. The daily varying estimates of particulate organic carbon concentrations were multiplied by the median organic carbon normalized particulate contaminant concentrations presented in Tables 2-11 through 2-21 to obtain daily varying particulate contaminant concentrations in volumetric units.

As a final step in the estimation of contaminant loadings at head-of-tide model input locations, the median dissolved and the daily varying particulate contaminant concentrations in volumetric units were summed to obtain total contaminant concentrations which were multiplied by daily flows to yield daily contaminant mass loadings.

2.2 Methods for Stormwater Loadings

The CARP 1 and CARP 2 models include hourly inputs to represent overland runoff reaching the Estuary either through separated storm sewers (i.e., stormwater) or as direct drainage for flow, solids, organic carbon and nutrients, and contaminants. The model representation of overland runoff reaching the Estuary as stormwater and direct drainage includes 960 model input locations within the CARP 2 model grid, significantly increased from CARP 1 which used an aggregation approach to reduce the number of model input locations based on CARP 1 model grid resolution. Of the 960 CARP 2 model input locations for stormwater loadings, 10 of the locations are used to represent a net outflow of water from the Meadowlands into the Hackensack River. Further, beyond the stormwater from the 960 CARP 2 model input locations, additional stormwater reaching the Estuary is included in the modeled head-of-tide basin loadings developed with the USGS StreamStats tools as discussed in Section 2.1.1 and presented in Table 2-3.

2.2.1 Hydrographs for Stormwater Loadings

For the flow portion of stormwater loadings, both CARP 1 and CARP 2 relied upon the HDR model, RAINMAN. The HDR RAINMAN model has been continuously updated since the completion of CARP 1, not only to include additional years of rainfall records but also to include more rigorous representation of infrastructure and land areas as more detailed models of individual sewer system drainage areas became available through ongoing CSO long term control planning and MS4 management efforts. CARP 2 utilized available HDR RAINMAN model outputs generated with various local 1998-2016 rainfall records. Care was taken to avoid double-counting stormwater in the drainage basins included in both the HDR RAINMAN model and the USGS StreamStats tools. The updated flows obtained from RAINMAN were applied in the CARP 2 hydrodynamic model and the stormwater loadings in the CARP 2 sediment transport and organic carbon production and contaminant fate and transport models were calculated based on the updated flows as further described below.

2.2.2 Concentrations for Stormwater Loadings

For the suspended sediment, nutrient, and organic carbon portions of stormwater loadings, loading concentrations developed during CARP 1 (HydroQual, 2007b) were maintained for CARP 2 and CARP 2 loadings were calculated using 1998-2016 stormwater flows from RAINMAN. For the contaminant portion of stormwater loadings, additional measurements of stormwater contaminant loading concentrations collected for CARP 2 (up to 10 measurements) and complied from USEPA Superfund efforts (up to 57 measurements) were combined with CARP 1 measurements (up to 26 measurements) in probability distributions to identify loading concentrations for use in the CARP2 contaminant fate and transport model.

Probability distributions of stormwater loading concentration measurements for PCB homologs and dioxin and furan congeners are included in Appendix 4. Based on analysis of the probability distributions of contaminant loading concentrations for stormwater and consistent with CARP 1, loading concentrations assigned for stormwater for CARP 2 modeling were spatially constant across outfalls for PCB homologs and varied between urban and rural outfalls for dioxin and furan congeners. Rural measurements of dioxin and furan congers collected during CARP 1 were consistently lower than other CARP 1 measurements and CARP 2 and Superfund measurements.

New for CARP 2 and supported by the number of measurements of stormwater contaminant concentrations available, temporal variation was incorporated into the assignment of hourly stormwater contaminant loading concentrations for CARP 2 using Monte Carlo analysis of the probability distributions of the measurements for the PCB homologs and dioxin and furan congeners. This approach may improve the ability of the CARP 2 model to capture short-term variation in water column concentrations while still maintaining the longer-term average mass of contaminants delivered to the sediment bed from stormwater. Table 2-22 and Table 2-23 present the statistics used for the Monte Carlo selections of the time varying stormwater contaminant loading concentrations for PCB homologs and for urban dioxin and furan congeners assigned in the CARP 2 model. Table 2-24 presents the median stormwater contaminant loading concentrations for rural dioxin and furan congeners assigned in the CARP 2 model. The contaminant loadings concentrations developed for stormwater were combined with 1998-2016 stormwater flows from RAINMAN to develop the CARP2 model contaminant loading inputs for stormwater.

2.3 Methods for Combined Sewer Overflow Loadings

The CARP 1 and CARP 2 models include hourly inputs to represent overland runoff reaching the Estuary through combined sewer overflows (CSOs) for flow, solids, organic carbon and nutrients, and contaminants. The CARP 2 model representation of overland runoff reaching the Estuary as CSO includes 572 model input locations within the CARP 2 model grid, a significant increase from CARP 1 which used an aggregation approach to reduce the number of model input locations based on CARP 1 model grid resolution. As in CARP 1, the runoff volumes due to CSOs were obtained from the HDR RAINMAN model. The HDR RAINMAN model has been continuously updated since the completion of CARP 1, not only to include additional years of rainfall records but also to include more rigorous representation of infrastructure as more detailed models of individual sewer system drainage areas became available through ongoing CSO long term control planning efforts. CARP 2 utilized available HDR RAINMAN model outputs generated with various local 1998-2016 rainfall records. CSO loading concentrations for solids, organic carbon and nutrients, and contaminants for CARP 2 were maintained from CARP 1 (HydroQual, 2007b; 2008). The updated flows obtained from RAINMAN were applied in the CARP 2 hydrodynamic model and all CSO loadings in the CARP 2 sediment transport and organic carbon production and contaminant fate and transport models were calculated based on the updated flows.

2.4 Methods for Wastewater Treatment Plant (WWTP) Loadings

The CARP 1 and CARP 2 models include hourly to monthly varying inputs to represent treated effluents reaching the Estuary. The model representation of the treated effluents reaching the Estuary includes flow, solids, organic carbon and nutrients, and contaminants at one hundred model WWTP input locations. Median total contaminant loading concentrations (HydroQual, 2008) and monthly and seasonally varying solids, organic carbon, and nutrient loading concentrations (HydroQual, 2007b) developed during CARP 1 were maintained for CARP 2. As part of CARP 2, the flows for all one hundred model WWTP input locations were updated on a monthly to hourly basis for the eighteen consecutive water years October 1, 1998 through September 30, 2016 using available discharge records from several sources.

The informational repositories relied upon for CARP 2 WWTP flows include four sources: the joint USEPA Permit Compliance System (PCS) and Integrated Compliance Information System (ICIS) databases, https://www.epa.gov/enviro/pcs-icis-overview ; the NJDEP database, http://www.state.nj.us/dep/dwq/database.htm; the USEPA Enforcement and Compliance History Online (ECHO) database, https://echo.epa.gov ; and previously compiled NYCDEP landside models and associated NYCDEP WWTP facility records. The PCS and ICIS databases provided effluent flows from New Jersey facilities for October 1998 through August 2012, from non-NYC facilities in New York for October 1998 through October 2012, and from Connecticut facilities for October 1998 through September 2008. The NJDEP database provided effluent flows from New Jersey facilities for September 2012 through September 2016. The ECHO database provided effluent flows from non-NYC facilities in New York for November 2012 through September 2016 and from Connecticut facilities for October 2008 through September 2016. Finally, various NYCDEP landside models provided effluent flows from fourteen NYC facilities in New York. The updated flows obtained from the repositories were applied in the CARP 2 hydrodynamic model and all WWTP loadings in the CARP 2 sediment transport and organic carbon production and contaminant fate and transport models were calculated based on the updated flows.

As part of updating modeled WWTP flows and loadings, several facility changes were also included in the CARP 2 model inputs. Due to conversions to pump stations, the North Bergen Central WWTP discharge in New Jersey to the Hackensack River was discontinued after October 2010 and the Inwood WWTP discharge in New York to Jamaica Bay was discontinued after April 1999.

2.5 Methods for Atmospheric Deposition Loadings

Wet, dry particle, and gas adsorption deposition fluxes over the open water surface of the CARP 2 model were specified with the same mass per surface area rates developed during CARP 1 for nutrients and for 17 dioxin/furan congeners (HydroQual, 2007b; HydroQual, 2008). New for CARP 2, wet, dry particle, and gas adsorption deposition fluxes of PCB homologs were updated based on more recent annual mass per surface area rates published by New Jersey Atmospheric Deposition Network (NJADN) researchers (Totten et al., 2006) after the completion of CARP 1 modeling. The updated PCB homolog atmospheric deposition fluxes used for CARP 2 modeling are found in Table 27.1 of Totten et al., 2006. There is a noted discrepancy between the wet deposition fluxes reported in Table 27.1 and in Table 27.2 of Totten et al., 2006. Per personal communication with the author, the wet deposition fluxes as reported in Table 27.1 of Totten et al., 2006 were relied upon for CARP 2 modeling.

2.6 Methods for Landfill Leachate Loadings

The CARP 1 and CARP 2 models include both treated and untreated landfill leachate reaching the Estuary. Leachate loadings of contaminants per unit rainfall reaching the Estuary as developed during CARP 1 (HydroQual, 2008) were maintained for CARP 2. As in CARP 1, leachate loadings of contaminants per unit rainfall were scaled up and down based on the rainfall records from Newark Airport for the periods modeled.

3.0 RESULTS

The results of applying methods adopted during CARP 1 for additional years of measurements and applying methods newly developed for CARP 2 for estimating loadings are summarized below for tributary head-of-tide; overland runoff represented as direct drainage, stormwater, and combined sewer overflow; wastewater treatment plants; atmospheric deposition; and landfill leachate.

3.1 Tributary Head-of-Tide Results

Head-of-tide results from river basins include freshwater flow inputs for the hydrodynamic model; suspended sediment and organic carbon/nutrient loadings for the sediment transport model; and contaminant loadings for the contaminant fate and transport model, at fifty-six locations for gaged and ungauged rivers and drainage areas for the eighteen consecutive water years 1998-99 through 2015-16. In particular, the results are highlighted for the flow inputs, suspended sediment loadings and contaminant loadings given the first-time application of the Stream Stats tools to large portions of the drainage area, the extensive CARP 2 modifications to the NSL estimator, and CARP 2 head-of-tide sampling for contaminants.

3.1.1 Tributary Head-of-Tide Results – Freshwater Flow Inputs

The freshwater flow inputs for head-of-tide for the CARP 2 models are summarized in Tables 3-1 to 3-5. For Tables 3-1 to 3-5, the daily freshwater flow inputs for head-of-tide for eighteen water years were summarized as average flow rates in cubic meters per second (CMS) for each year and the maximum, minimum, and average from the annual average results for the eighteen water years are displayed. For each head-of-tide, the extreme and average water year results captured by the CARP 2 model inputs are shown in the various table columns. Within the geographic regions presented on each of the tables, the various rows allow for comparing the magnitudes of flows across individual flow input locations. The 2010-11 and 2001-02 water years represent the maximum and minimum flow years, respectively, for most tributary locations. The flow input locations delivering the largest annual volumes of freshwater flow are the Connecticut River (Table 3-5) and the Hudson River below its confluence with the Mohawk River (Table 3-3). The flow input locations delivering the smallest annual volumes of freshwater flows are the Tallman Park and Nyack, NY ungauged drainage basins (Table 3-3) and the Hackensack River (Table 3-1). The range between the maximum annual average discharges reported for the largest flow volume location and the minimum annual average discharges reported for the smallest flow volume location spans four orders of magnitude, from 0.01 CMS (Tallman Park basin) to 750 CMS (Connecticut River).

3.1.2 Tributary Head-of-Tide Results – Suspended Sediment Loading Inputs

The suspended sediment loading inputs for head-of-tide for the CARP 2 models are summarized in Tables 3-6 to 3-10. For Tables 3-6 to 3-10, the daily suspended sediment loading inputs for head-of-tide for eighteen water years were summarized as the annual mass of solids (tonnes) for each year and the maximum, minimum, and average from the annual results for the eighteen water years are displayed. For each head-of-tide, the extreme and average water year results captured by the CARP 2 model inputs are shown in the various table columns. Within the geographic regions presented on each of the tables, the various rows allow for comparing the magnitudes of solids loadings across individual solids loadings input locations. Like the flow inputs, the 2010-11 and 2001-02 water years represent the maximum and minimum solids loadings years, respectively, for most tributary locations. The input locations delivering the largest annual masses of solids from head-of-tide are the Connecticut River (Table 3-10) and the Hudson River below its confluence with the Mohawk River (Table 3-8). The input locations delivering the smallest annual masses of solids from head-of-tide are the Tallman Park and Nyack, NY ungauged drainage basins (Table 3-8) and the Hackensack River (Table 3-6). The range between the maximum annual average solids loading masses reported for the largest solids loading location and the minimum annual average solids loading masses reported for the smallest solids loading location spans six orders of magnitude, from 1.61

tonnes/yr (Tallman Park basin) to 2.28 x 10^6 tonnes/yr (Hudson River).

3.1.3 Tributary Head-of-Tide Results – Contaminant Loading Inputs

The contaminant loading inputs for head-of-tide for the CARP 2 models are summarized in Tables 3-11 to 3-15 for total PCB and Tables 3-16 to 3-20 for 2,3,7,8-TCDD. For Tables 3-11 to 3-20, the daily contaminant loading inputs for head-of-tide for eighteen water years were summarized as the annual mass of either total PCB or 2,3,7,8-TCDD (kg) for each year and the maximum, minimum, and average from the annual results for the eighteen water years are displayed. For each head-of-tide, the extreme and average water year results captured by the CARP 2 model inputs are shown in the various table columns. Within the geographic regions presented on each of the tables, the various rows allow for comparing the magnitudes of total PCB and 2,3,7,8-TCDD loadings across individual contaminant loadings input locations. Like the flow inputs, the 2010-11 and 2001-02 water years represent the maximum and minimum total PCB and 2,3,7,8-TCDD loadings years, respectively, for most tributary locations. A noted exception is for tributaries to the NY Bight where maximum total PCB and 2,3,7,8-TCDD loadings do not occur in the 2010-11 water year.

For total PCB, the input locations delivering the largest annual masses of total PCBs from head-of-tide are the Connecticut River (Table 3-15) and the Hudson River below its confluence with the Mohawk River (Table 3-13). The input locations delivering the smallest annual masses of total PCBs from head-of-tide are the Tallman Park and Nyack, NY ungauged drainage basins (Table 3-13) and the Hackensack River (Table 3-11). The range between the maximum annual average total PCB loading masses reported for the largest total PCB loading location and the minimum annual average total PCB loading masses reported for the smallest total PCB loading location spans seven orders of magnitude, from 6.85 x 10^{-5} kg/yr (Tallman Park basin) to 6.61 x 10^2 kg/yr (Hudson River). For 2,3,7,8-TCDD, the input locations delivering the largest annual masses of 2,3,7,8-TCDD from head-of-tide are the Lower Passaic River (Table 3-16) and the Hudson River below its confluence with the Mohawk River (Table 3-18). The input locations delivering the smallest annual masses of 2,3,7,8-TCDD from head-of-tide are the Tallman Park and Nyack, NY ungauged drainage basins (Table 3-18) and the Hackensack River (Table 3-16). The range between the maximum annual average 2,3,7,8-TCDD loading masses reported for the largest 2,3,7,8-TCDD loading location and the minimum annual average 2,3,7,8-TCDD loading masses reported for the smallest 2,3,7,8-TCDD loading location spans five orders of magnitude, from 3.99 x 10^{-9} kg/yr (Tallman Park basin) to 5.51 x 10^{-4} kg/yr (Hudson River).

3.2 Other Loading Results

Other loading results include freshwater flow inputs for the hydrodynamic model, suspended sediment and organic carbon/nutrient loadings for the sediment transport model, and contaminant loadings for the contaminant fate and transport model, at 960 locations for stormwater and direct drainage, at 572 locations for combined sewer overflow, at 100 locations for wastewater treatment plants, throughout the model domain for atmospheric deposition, and at several locations for landfill leachate, for the eighteen consecutive water years 1998-99 through 2015-16. As presented in Sections 2.3 through 2.6, for stormwater and direct drainage, new sampling for contaminant loading concentrations was conducted and a more sophisticated loading estimation method was implemented for CARP 2. For combined sewer overflow, wastewater treatment plants, and landfill leachate, loading concentrations and loading estimation methods were maintained from CARP 1 and were updated to reflect 1998-99 through 2015-16 hydrographs. While loading estimation protocols for atmospheric deposition of dioxin and furans has not changed, NJADN researchers provided updated atmospheric deposition fluxes for PCB homologs (Totten et al., 2006). A summary of CARP 2 loading results is presented for annual maximum, average, and minimum loading conditions in Table 3-21 to 3-23 for the suspended sediment loadings and in Tables 3-24 to 3-29 for the contaminant loadings. The tabulated summaries facilitate comparisons to the CARP 2 head-of-tide loading results and the loading results across the various loading categories and provide the range of suspended sediment and contaminant loading conditions captured by the CARP 2 models.

3.2.1 Other Loading Results – Suspended Sediment Loading Inputs

The total suspended sediment loading inputs to the CARP 2 model range from 0.85 million tonnes to 7.8 million tonnes per year. While the suspended sediment loading inputs from head-of-tide account for 74% to 89% of the total suspended sediment loadings for the minimum and maximum annual loadings considered for CARP 2, the remaining 11% to 26% of the annual suspended sediment loadings are split across stormwater and direct drainage, combined sewer overflow, and wastewater treatment plants as indicated in Tables 3-21 to 3-23. Stormwater and direct drainage combined account for 2.4% to 15.7% of the total suspended sediment loadings for the minimum and maximum annual loadings considered for CARP 2.

3.2.2 Other Loading Results – Contaminant Loading Inputs

The total PCB loading inputs to the CARP 2 model range from 1572 kg to 2255 kg per year. While the total PCB loading inputs from head-of-tide account for 8.7% to 31.8% of the total PCB loadings for the minimum and maximum annual loadings considered for CARP 2, the remaining 68.2% to 91.3% of the annual total PCB loadings are split across stormwater and direct drainage, combined sewer overflow, wastewater treatment plants, atmospheric deposition, and landfill leachate as indicated in Tables 3-24 to 3-26. Atmospheric deposition accounts for 55.1% to 79% of the total PCB loadings for the minimum and maximum annual loadings considered for CARP 2. Stormwater and direct drainage account for 8.1% to 8.4% of the total PCB loadings for the minimum and maximum annual loadings considered for CARP 2.

The 2,3,7,8-TCDD loading inputs to the CARP 2 model range from 10.2 g to 17.5 g per year. While the 2,3,7,8-TCDD loading inputs from head-of-tide account for 6.6% to 14.7% of the 2,3,7,8-TCDD loadings for the minimum and maximum annual loadings considered for CARP 2, the remaining 85.3% to 93.4% of the annual 2,3,7,8-TCDD loadings are split across stormwater and direct drainage, combined sewer overflow, wastewater treatment plants, atmospheric deposition, and landfill leachate as indicated in Tables 3-27 to 3-29. Atmospheric deposition accounts for 76.9% to 85.5% of the 2,3,7,8-TCDD loadings for the minimum and maximum annual loadings considered for CARP 2. Stormwater and direct drainage account for 5.5% to 6.3% of the 2,3,7,8-TCDD loadings for the minimum and maximum annual loadings considered for CARP 2.

Additional results of the CARP 2 loadings development will be considered with the presentation of modeling results in a subsequent CARP 2 modeling report.

4.0 DISCUSSION

The loading estimates developed are ultimately used as model inputs which form the basis of the model simulations performed for model skill assessment. The intention is that the model inputs as developed will not require adjustment during model skill assessment and in that sense are final; however, if any adjustments to loading results are needed during model skill assessment they would be documented and discussed in the reporting pertaining to model skill assessment. The loading results as developed for model application are discussed below for tributary head-of-tide; overland runoff represented as direct drainage, stormwater, and combined sewer overflow; wastewater treatment plants; atmospheric deposition; and landfill leachate.

4.1 Tributary Head-of Tide Loadings Results Discussion

Much of the CARP 2 loading development effort was focused on head-of-tide inputs and involved expanding CARP 1 efforts to additional years; developing and utilizing new estimation methods such as mNSL; defining drainage basin properties based on modern measurements such as for solids and POC; and incorporating contaminant measurements collected specifically for CARP 2. Tributary head-of-tide inputs account for 8.7% to 31.8% of total PCB loadings and 6.6% to 14.7% of 2,3,7,8-TCDD loadings system-wide (i.e., including the Bight and the Sound) as identified in Tables 3-24 through 3-29. If atmospheric deposition which occurs predominantly over the large expanse of the open water surface of the Bight and the Sound is omitted, tributary head-of-tide inputs account for 41.6% to 70.7% of non-atmospheric total PCB loadings and 45.6% to 63.9% of non-atmospheric 2,3,7,8-TCDD loadings, highlighting the importance of head-of-tide contaminant loadings to the Harbor.

4.1.1 Tributary Head-of Tide Loadings Results Discussion – Freshwater Flow Inputs

The tributary freshwater inflows developed for CARP 2 across eighteen years broaden the range of conditions modeled as compared to the years modeled for CARP 1. The water years represented by the CARP 1 model calibration appear to have been biased toward below average river flow conditions as evidenced by the CARP 2 flow input results presented in Tables 3-1 to 3-5. Specifically for each of the four CARP 1 water years also included for CARP 2: the 1998-99 water year represents the minimum flow condition for the Hudson River below the confluence with the Mohawk River; the 1999-2000 water year comes closest to the eighteen year average flow condition for several of the tributaries to the lower Hudson River below the confluence with Mohawk River; the 2000-01 water year appears to be unremarkable in terms of extreme or central river flow conditions for the eighteen year period; and the 2001-02 water year is broadly an eighteen year minimum for head-of-tide flow. The CARP 2 model therefore provides dredged material managers with a planning tool representative of higher freshwater flow conditions than the CARP 1 tool, now including head-of-tide flows above the average and minimum conditions for eighteen years.

4.1.2 Tributary Head-of Tide Loadings Results Discussion – Suspended Sediment Loading Inputs

The CARP 2 development of suspended sediment loading inputs for head-of-tide includes not only the broadening of the range of flow conditions modeled but also captures the effect of using new loading estimation techniques. The new techniques include modified NSL equations for determining suspended sediment loadings from all heads-of-tide and the use of the USGS StreamStats tools for the flow portion of the suspended sediment loadings from ungauged drainage areas in New York, tributary to either the Hudson below its confluence with the Mohawk or western Long Island Sound. Given the new techniques, the comparability between CARP2 suspended sediment loading results and published loading results by others, especially for the Hudson, is very important.

For the eleven years October 1, 2004 to September 30, 2015, the CARP 2 loading estimate result for suspended sediment entering the Hudson River above Poughkeepsie, NY is a cumulative sum of 13.6 megatonne (Mt), equivalent to 13.6 x 10^{12} grams. For the same period and location, Ralston and Geyer, 2017a and 2017b, provide summary estimates ranging from 10.7 to 18 Mt. The loadings estimate result for suspended sediment entering the Hudson River above Poughkeepsie, NY includes the summation of loadings entering from the confluence of the Hudson and Mohawk Rivers as well as from fifteen gaged and ungauged watershed areas identified by HDR using the USGS StreamStats tool. The fifteen watershed areas are: Poesten Kill, Wynants Kill – East, Wynants Kill – West, Normans Kill, Hannacrois Creek – West, Hannacrois Creek – East, Kinderhook Creek, Catskill Creek, Roeliff Jansen Kill, Esopus Creek, Saw Kill – West, Saw Kill – East, Rondout Creek, Landsman Kill –West, and Landsman Kill – East. Results comparisons are further considered for the confluence of the Mohawk and Hudson Rivers and for the watershed. The CARP 2 loading estimate result for suspended sediment entering at the confluence of the Hudson and Mohawk Rivers is 8.3 Mt for October 1, 2004 to September 30, 2015. The loading estimate for suspended sediment entering at the confluence of the Hudson and Mohawk Rivers for this period reported by Ralston and Geyer is 8.2 Mt. The CARP 2 loading estimate result for suspended sediment entering from the fifteen watershed areas for October 1, 2004 to September 30, 2015 is 5.2 Mt. Ralston and Geyer 2017a and 2017b report the suspended sediment entering from the watershed areas for this period as ranging from 2.5 to 9.8 Mt. The excellent agreement, between CARP 2 and Ralston and Geyer results, is a significant result supporting the validity of the new loading estimation techniques adopted for CARP 2 beyond the method validation work presented in Sections 2.1.1 and 2.1.2.2 and Appendices 1 and 2.

A further check on the CARP 2 loading estimates for suspended sediments entering from all fifty-six head-of-tide model input locations as a summation is the agreement between CARP 2 and CARP 1 results for the four water years October 1998 through September 2002, common to both models. The CARP 2 and CARP 1 (Figures 3-5 to 3-8 in HydroQual,2007b) loading estimates summed across input locations were within +/- 7% or less for each of these four water years.

The water years represented by the CARP 1 model appear to have been biased toward average to below average head-of-tide suspended sediment loading conditions as evidenced by the CARP 2 suspended sediment loading input results presented in Tables 3-6 to 3-10. Specifically for each of the four CARP 1 water years also included for CARP 2: the 1998-99 water year represents the eighteen year near average suspended sediment loading condition for the Saddle and Elizabeth Rivers; the 1999-2000 water year comes closest to the eighteen year average suspended sediment loading condition for the confluence of the lower Hudson and Mohawk Rivers; the 2000-01 water year appears to be unremarkable in terms of extreme or central suspended sediment riverine loading conditions for the eighteen year period; and the 2001-02 water year is broadly (i.e., for the majority of head-of-tide input locations) an eighteen year minimum for head-of-tide suspended sediment loadings. The CARP 2 model therefore provides dredged material managers with a planning tool representative of higher head-of-tide suspended sediment loading conditions than the CARP 1 tool, now including head-of-tide suspended sediment loadings above the average and minimum conditions for eighteen years.

4.1.3 Tributary Head-of Tide Loadings Results Discussion – Contaminant Loading Inputs

The CARP 2 development of total PCB and 2,3,7,8-TCDD inputs for head-of-tide includes the broadening of the range of flow and suspended sediment conditions modeled and the effect of using the new loading estimation techniques for flow and suspended sediment as discussed above. In addition, the CARP 2 development of total PCB inputs for head-of-tide includes new estimation techniques specific to PCBs from the Upper Hudson River, including pre-, during, and post-dredging conditions. For both total PCB and 2,3,7,8-TCDD, the CARP 2 development of inputs for head-of-tide also incorporates a new relationship between POC and suspended sediment and new CARP 2 measurements collected on the Passaic, Raritan, Elizabeth, Hackensack, and Saddle Rivers.

Since the completion of CARP 1, it does not appear that head-of-tide contaminant loading estimates have been reported in the literature independent of the additional/external work of CARP investigators (Farley et al., 2017; Lower Passaic River Superfund RI/FFS) and/or measurements considered for CARP 1. Given the modified methods and new measurements underlying the CARP 2 head-of-tide loadings results for total PCB and 2,3,7,8-TCDD and absent the opportunity to compare to estimates independent of CARP, it is appropriate to compare CARP 2 and CARP 1 results to understand the culmination of the CARP 2 and CARP 1 differences in estimates of head-of-tide flows and suspended sediment, organic carbon, and contaminant concentrations and the potential implications for model calibration. Selected comparisons between CARP 2 and CARP 1 (HydroQual, 2007c) head-of-tide loading results for PCB and 2,3,7,8-TCDD are discussed below for the October 1, 1998, to September 30, 2002, CARP 1 calibration period.

For October 1, 1998, to September 30, 2002, for the combined Upper Hudson and Mohawk Rivers, the CARP 2 and CARP 1 averaged loading results for the summation of the four PCB homologs, di-CB, tetra-CB, hexa-CB, and octa-CB, are 0.37 kg/d and 0.56 kg/d, respectively, with the CARP 2 result being 34% lower than CARP 1 results. The new CARP 2 regressions for the Upper Hudson for PCB loading concentrations for pre-dredging conditions for CARP 2 were not initiated until after the CARP 1 calibration period considered in this comparison and therefore are not a factor in the difference between the CARP 2 and CARP 1 loading results for October 1, 1998, to September 30, 2002. The difference between CARP 2 and CARP 1 results for October 1, 1998, to September 30, 2002, for the combined Upper Hudson and Mohawk Rivers averaged loading results for the summation of the four PCB homologs can be attributed to an error found in the CARP 1 input file generation tool which was corrected and not repeated for CARP 2. The error was in developing the CARP 1 flow weighted concentration for the two Rivers combined. The concentration was inputted into the model as the full concentration from the Upper Hudson increased by a flow weighted fraction of the concentration from the Mohawk. The input should have also flow weighted the concentration coming from the Upper Hudson portion when combining the Upper Hudson and Mohawk concentrations into a single concentration.

For October 1, 1998, to September 30, 2002, for the combined Upper Hudson and Mohawk Rivers, the CARP 2 and CARP 1 averaged loading results for 2,3,7,8-TCDD are 7.25×10^{-7} kg/d and 6.42×10^{-7} kg/d, respectively, with the CARP 2 result being 13% higher than CARP 1 result. This suggests that updated CARP 2 estimates of flows, suspended sediment concentrations, and organic carbon concentrations for the Upper Hudson and Mohawk Rives tended to increase contaminant loadings as evidenced by the somewhat higher 2,3,7,8-TCDD results for CARP 2 as compared to CARP 1. In the case of PCB's, the increase associated with updates to flows, suspended sediment concentrations, and organic carbon concentrations is masked by the flow weighting averaging error noted above.

Regarding head-of-tide loading inputs besides the Upper Hudson and Mohawk Rivers, for October 1, 1998, to September 30, 2002, for fifty-five head-of-tide input locations, the CARP 2 and CARP 1 averaged loading results for the summation of the di-CB, tetra-CB, hexa-CB, and octa-CB homologs are 0.026 kg/d and 0.022 kg/d, respectively, with the CARP 2 result being 21% higher than CARP 1 result. Regarding head-of-tide loading inputs besides the Upper Hudson and Mohawk Rivers, for October 1, 1998, to September 30, 2002, for fifty-five head-of-tide input locations, the CARP 2 and CARP 1 averaged loading results for 2,3,7,8-TCDD are 2.14×10^{-6} kg/d and 2.28×10^{-6} kg/d, respectively, with the CARP 2 result being 6% lower than CARP 1 result. These differences reflect the small differences in CARP 2 and CARP 1 solids loading results for all head-of-tide locations collectively as discussed in Section 4.1.2 as well as differences in contaminant loading concentrations at specific head-of-tide input locations and the updated calculation of fraction organic carbon. CARP 2 and CARP 1 methods and available measurements generally produced comparable contaminant loading results for the head-of-tide input locations in addition to the Upper Hudson and Mohawk Rivers.

In summary, substantial CARP 2 efforts resulted in relatively modest changes to tributary head-of-tide loading estimates for contaminants for the 1998-99 through 2001-02 water years which were the basis of the CARP 1 model calibration. Of perhaps greater significance, the CARP 2 efforts expanded the loading conditions modeled through consideration of fourteen additional water years.

The water years represented by the CARP 1 model appear to have been biased toward average to below average head-of-tide contaminant loading conditions as evidenced by the CARP 2 contaminant loading input results for total PCB and 2,3,7,8-TCDD presented in Tables 3-11 to 3-20. Specifically for total PCB for each of the four CARP 1 water years also included for CARP 2: the 1998-99 water year is unremarkable in terms of central or extreme total PCB riverine loading conditions; the 1999-2000 water year comes closest to the eighteen year average total PCB loading condition for the confluence of the lower Hudson and Mohawk Rivers, the Roeliff Jansen Kill, and the Connecticut River; the 2000-01 water year appears to be unremarkable in terms of extreme or central total PCB riverine loading conditions for the eighteen year period; and the 2001-02 water year is broadly (i.e., for the majority of head-of-tide input locations) an eighteen year minimum for head-of-tide total PCB loadings. Specifically for 2,3,7,8-TCDD for each of the four CARP 1 water years also included for CARP 2, the 1998-99 water year is unremarkable in terms of central or extreme 2,3,7,8-TCDD riverine loading conditions; the 1999-2000 water year comes closest to the eighteen year average 2,3,7,8-TCDD loading condition for the Roeliff Jansen Kill; the 2000-01 water year appears to be unremarkable in terms of extreme or central 2,3,7,8-TCDD riverine loading conditions for the eighteen year period; and the 2001-02 water year is broadly (i.e., for the majority of head-of-tide input locations) an eighteen year minimum for head-of-tide 2,3,7,8-TCDD loadings. The CARP 2 model therefore provides dredged material managers with a planning tool representative of higher head-of-tide total PCB and 2,3,7,8-TCDD loading conditions than the CARP 1 tool, now including head-of-tide total PCB and 2,3,7,8-TCDD loadings above the average and minimum conditions for eighteen years.

4.2 Other Loadings Results Discussion

While tributary head-of-tide loading inputs are an important delivery mechanism of freshwater inflows, suspended sediment loadings, and contaminant loadings, other loading inputs include stormwater (delivered to the Estuary by pipes and direct drainage) and combined sewer overflow portions of overland runoff; treated effluents from wastewater treatment plants; landfill leachate; and atmospheric deposition. CARP 2 effort focused on calculating suspended sediment and contaminant loadings for the other than tributary loading types across an eighteen-year period and refining contaminant loading concentration estimates for stormwater. The results of the expanded period and new contaminant concentrations are discussed below.

4.2.1 Other Loadings Results Discussion – Suspended Sediment Loading Inputs

The summation of CARP 2 annual suspended sediment loading results for stormwater, combined sewer overflow and treated effluents from wastewater treatment plants are relatively consistent across the eighteen water years considered, ranging from 218,000 to 316,000 tonnes/year, and as expected are considerably smaller in comparison to head-of-tide solids loading results (Tables 3-21 to 3-23). The results presented in Tables 3-21 to 3-23 further indicate that central and extreme annual solids loadings for stormwater, combined sewer overflow, and treated effluents from wastewater treatment plants did not occur in the four water years 1998-2002 common to CARP 2 and CARP 1.

Considering only the four water years common to both CARP 2 and CARP 1, 1998-2002, the solids loading results expressed as the average tonnes per year from all loading sources (including head-of-tide) are

1,571,000 tonnes per year for CARP 2 and 1,540,000 tonnes per year for CARP 1 (Figures 3-5 to 3-8 in HydroQual, 2007b), with the CARP 2 refined loading results being 2% higher than the CARP 1 loading results. Despite this agreement between CARP 2 and CARP 1 solids loadings results from all sources (dominated by head-of-tide) for the common period, there are differences among the solids loadings results for the portion of the solids loading from stormwater, combined sewer overflow and treated effluents from wastewater treatment plants. The summation of CARP 1 annual suspended sediment loading results for stormwater, combined sewer overflow and treated effluents from wastewater treatment plants ranges from 153,000 tonnes per year to 186,000 tonnes per year across four water years (Figures 3-5 to 3-8 in HydroQual, 2007b). The summation of CARP 2 annual suspended sediment loading results for stormwater, combined sewer overflow and treated effluents from wastewater treatment plants is higher and ranges from 223,000 tonnes per year to 258,000 tonnes per year across the same four water years. While the difference in CSO, stormwater, and WWTP suspended solids loading results for corresponding years is dwarfed by the head-of-tide loading results, it is appropriate to consider why the difference occurs.

The 1998-2002 solids loading results for CARP 2 as compared to CARP 1 for each of four water years include a 2% decrease to 5% increase for WWTP; a 34% to 46% decrease for CSO; and a 189% to 234% increase for stormwater. The changes in WWTP solids loading results can be attributed to applying actual flows to WWTPs outside of NYC for CARP 2 as opposed to the 1994-95 flows applied for CARP 1, with the 2001-02 actual flows being smaller and causing a decrease in solids loading results and the 1998-99, 1999-2000, and 2000-01 actual flows being larger and causing an increase in solids loading results. The CARP 2 changes to CSO and stormwater solids loading results (i.e., 34% to 46% decrease, 189% to 234% increase, respectively) are also volume/flow rather than solids concentration related, associated with the use of a more advanced and complete version of the RAINMAN model for CARP 2 to estimate runoff flows from overland direct drainage and from the combined and separated sewer systems. In the elapsed time since the CARP 1 model development, the available models of individual sewer systems and drainage areas included in the RAINMAN model now have more comprehensive representation of separated sewer systems and overland direct drainage, an improvement over models previously emphasizing combined sewer systems. Further, as noted in Sections 2.2 and 2.3, the CARP 1 loading estimate approach of scaling the available landside model outputs for a unit rainfall condition has been replaced by the availability of runoff model results based on actual high frequency rainfall records. While some portion of the reduction in CSO loadings and increase in stormwater loadings may be associated with sewer separation efforts, most of the change in loading results is associated with landside modeling advances available for CARP 2.

4.2.2 Other Loadings Results Discussion – Contaminant Loading Inputs

Contaminant loading results for total PCB and 2,3,7,8-TCDD are dominated by atmospheric deposition as displayed in Tables 3-24 to 3-29 and noted in Section 3.2.2. As indicated in Section 4.1 in the context of head-of-tide loadings, the contaminant loading results for atmospheric deposition are spread across the open water surface of the estuary and the Bight and Sound have the largest expanse of open water surface receiving atmospheric deposition. The contaminant loading results for stormwater, CSO, WWTPs and landfills collectively are of perhaps greater interest for dredged material management than atmospheric deposition given proximity within the Harbor and local magnitude, especially in low flow years.

The summation of CARP 2 annual total PCB and 2,3,7,8-TCDD loading results for stormwater, combined sewer overflow, treated effluents from wastewater treatment plants, and landfill leachate are relatively consistent across the eighteen water years considered, ranging from 193 to 296 kg/year for total PCB (Tables 3-24 to 3-26) and 7.99×10^{-4} to 1.45×10^{-3} kg/year for 2,3,7,8-TCDD (Tables 3-27 to 3-29). These loading input results collectively can be as significant as head-of-tide loading results for total PCB (Tables 3-24 to 3-26) and 2,3,7,8-TCDD (Tables 3-27 to 3-29) in specific water years.

Comparisons between CARP 2 and readily accessible CARP 1 (HydroQual, 2007c) PCB homolog and 2,3,7,8-TCDD loadings results for atmospheric deposition, stormwater, combined sewer overflow, treated effluents from wastewater treatment plants, and landfill leachate are discussed below for the four water years, October 1, 1998, to September 30, 2002, common to both the CARP 2 and CARP 1 models.

Due to the NJADN updates to annual mass per surface area rates for wet, dry particle, and gas adsorption deposition fluxes of PCB homologs (Totten et al., 2006), atmospheric deposition of total PCB in CARP 2 is greater than in CARP 1. For example, averaging over October 1, 1998, to September 30, 2002, the four water years common to both the CARP 2 and CARP 1 models, and considering the summation of di-CB, tetra-CB, hexa-CB, and octa-CB, atmospheric deposition is 84% greater in CARP 2 than in CARP 1 (Totten et al., 2006). The NJADN updates available for CARP 2 include the addition of fluxes for di-CB as well as increases to estimated fluxes for other PCB homologs. Atmospheric deposition of dioxin and furan congeners is the same in both CARP 2 and CARP 1 for water years in common. The higher rainfall conditions captured by the fourteen additional years included in CARP 2 as compared to CARP 1 expands the overall range of CARP 2 atmospheric deposition loading for dioxins and furans as compared to CARP 1.

As discussed in Section 4.2.1 for stormwater and CSO solids loading results, differences in CARP 2 and CARP 1 loading results for water years common to both CARP2 and CARP 1 are associated with landside modeling advances for flow estimation available for CARP 2. For CSOs, contaminant loading changes between CARP 1 and CARP 2 are associated strictly with the landside modeling advances. Specific to contaminant loading results for stormwater, another source of differences in CARP 1 and CARP 2 loading results is the incorporation of concentration measurements collected by CARP 2 and other programs since CARP 1 and the use of a Monte Carlo approach for selecting time-varying concentrations. The newer concentration measurements for stormwater are generally reduced as compared to measurements available from CARP 1 as displayed in Appendix 4. A noted exception is that di-CB concentrations in stormwater increased with the inclusion of newer measurements. For stormwater contaminant loading results for CARP 2 and CARP 1, decreases in loading concentrations and increases in flow estimates from advances in landside models have offsetting net effects. As an example of the net effect on loading results, CARP 1 loading results for CSO and stormwater combined for October 1, 1998, through September 30, 2002, as reported in HydroQual, 2007c are 0.15 kg/d for the summation of di-CB, tetra-CB, hexa-CB, and octa-CB and 4.64×10^{-6} kg/d for 2,3,7,8-TCDD. The corresponding CARP 2 results are 0.24 kg/d (a 59% increase) for the summation of di-CB, tetra-CB, hexa-CB, and octa-CB and 2.01×10^{-6} kg/d (a 57% decrease) for 2,3,7,8-TCDD.

A concern that emerged as CARP 1 ended was that CARP 1 urban stormwater samples for contaminant concentrations may have been compromised by estuarine water present in the limited number of stormwater pipes sampled for CARP 1. The greater number of urban stormwater samples available for CARP 2, collected for both local Superfund efforts and specifically for CARP 2, is therefore very important for establishing the credibility of the urban stormwater contaminant loading concentrations for PCB homologs and dioxin/furan congeners.

Like the WWTP solids loading results noted above in Section 4.2.1, 1998-2002 four-year averaged WWTP loading results for di-CB, tetra-CB, hexa-CB, and octa-CB, and 2,3,7,8 for CARP 2 and CARP 1 (HydroQual, 2007c) are essentially the same, with time averaged CARP 2 results 1.4% to 3.4% larger across contaminants, attributable to the use of actual rather than assigned hydrographs for CARP 2.

The water years represented by the CARP 1 model appear to have been biased toward average to below average head-of-tide contaminant loading conditions as evidenced by the CARP 2 contaminant loading input results for total PCB and 2,3,7,8-TCDD presented in Tables 3-24 to 3-29. Specifically for total PCB, the four CARP 1 water years also included for CARP 2 are each unremarkable in terms of central or extreme total PCB loading conditions across loading types. Specifically for 2,3,7,8-TCDD for each of the four CARP 1 water years also included for CARP 2, the 1998-99, 1999-2000, and 2000-01 water years are unremarkable in terms of central or extreme 2,3,7,8-TCDD loading conditions across loading types. The 2001-02 water year is an eighteen year minimum for all external 2,3,7,8-TCDD loadings combined and for all head-of-tide loadings combined. The CARP 2 model therefore provides dredged material managers with a planning tool more representative of total PCB and 2,3,7,8-TCDD loading conditions than the CARP 1 tool, now including total PCB and 2,3,7,8-TCDD loadings with greater range in central and maximum conditions for eighteen years.

Additional discussion of CARP 2 loadings development methods and results will be considered with the presentation of modeling results in a subsequent CARP 2 modeling report.

5.0 CONCLUSION

As part of CARP 2 efforts, new measurements and refined methods have been applied to update and expand the external loading forcing functions represented in the CARP models including water inflows and associated concentrations of suspended solids, organic carbon and other nutrients, ten PCB homologs, and seventeen dioxin/furan congeners from tributary head-of-tide; overland runoff represented as direct drainage, stormwater, and combined sewer overflow; wastewater treatment plants; atmospheric deposition; and landfill leachate. The updated and expanding loading forcing functions are in-use for eighteen-year hydrodynamic, sediment transport/organic carbon production, and contaminant fate and transport CARP 2 model simulations and skill assessments on the increased spatial resolution CARP 2 model computational grid. It is anticipated that after skill assessments, the CARP 2 models will be applied to assess future conditions Ultimately, the utility and success for dredged material management purposes of expanding and updating the external loading forcing functions is tied to the application of the CARP 2 models.

For the four years common to both the CARP 2 and CARP 1 models, the availability of updated measurements and revised estimation methods have resulted in modest changes to PCB and 2,3,7,8-TCDD head-of-tide loading estimate results and a higher percentage change to PCB atmospheric deposition loading estimate results. On a percentage increase basis, changes to PCB and 2,3,7,8-TCDD CSO and stormwater loading estimate results are somewhat larger than for head-of-tide but are smaller on a magnitude basis.

Apart from the use of the updated and expanded loading forcing functions in the CARP 2 models, several conclusions can be drawn from the loading results themselves with implications for dredged material management. More solids and contaminants were delivered to the Estuary from external sources annually in years occurring after the conclusion of CARP 1 than in years evaluated by CARP 1, especially for the 2010-11 water year. Head-of-Tide, followed by stormwater, is the dominant external source of solids to the Estuary. Atmospheric deposition aside, head-of-tide and stormwater are the dominant external sources of PCBs and dioxin to the Estuary.

6.0 NEXT STEPS

The completion of the loadings report is an intermediate project deliverable supporting other project modeling activity that has been ongoing in parallel, especially work on refined CARP 2 models. Reporting on the CARP 2 models and the application to projections will be addressed in separate deliverables.

7.0 ACKNOWLEDGMENTS AND DISCLAIMERS

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8.0 LITERATURE CITED

de Levie, R. 1999. Estimating parameter precision in nonlinear least squares with Excel's solver. *J. Chem. Educ.* 76: 1594–1598.

de Levie, R. 2001. Some useful macros. In *How to Use Excel® in Analytical Chemistry: And in General Scientific Data Analysis* (pp. 375-483). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511808265.011.

Farley, Kevin J., J.E. Baker, W.F. Bohlen, W.R. Geyer, S.P. Litten, and D.K. Ralston. 2017. *An Independent Evaluation of the PCB Dredging Program on the Upper Hudson and Lower Hudson River*. White paper supported by the Hudson River Foundation, New York, NY.

HydroQual, Inc. 1996. Appendix A, An Empirical Method for Estimating Suspended Sediment Loads in Rivers. In: *Contaminant Transport and Fate Modeling of the Pawtuxet River, Rhode Island*. Technical report prepared for the Ciba Corporation, Toms River, New Jersey.

HydroQual, Inc. (2007a). A Model for the Evaluation and Management of Contaminants of Concern in Water, Sediment, and Biota in the NY/NJ Harbor Estuary: Hydrodynamic Sub-model, Final Report, Submitted to the Hudson River Foundation, New York, NY. (Appendix A-5 at https://www.hudsonriver.org/article/carp-appendices).

HydroQual, Inc. (2007b). A Model for the Evaluation and Management of Contaminants of Concern in Water, Sediment, and Biota in the NY/NJ Harbor Estuary: Sediment Transport/Organic Carbon Production, Final Report, Submitted to the Hudson River Foundation, New York, NY. (Appendix A-6 at https://www.hudsonriver.org/article/carp-appendices).

HydroQual, Inc. (2007c). Contamination Assessment and Reduction Project (CARP) Water Column, Sediment, and Biota Component Response Matrix. (Available upon request).

HydroQual, Inc. (2008). A Model for the Evaluation and Management of Contaminants of Concern in Water, Sediment, and Biota in the NY/NJ Harbor Estuary: Contaminant Fate and Transport and Bioaccumulation Sub-models, Final Report, Submitted to the Hudson River Foundation, New York, NY. (Appendix A-7 at https://www.hudsonriver.org/article/carp-appendices).

Ralston, D. K., and Geyer, W. R. 2017a. Sediment transport time scales and trapping efficiency in a tidal river. *Journal of Geophysical Research: Earth Surface*, 122, 2042–2063. https://doi.org/10.1002/2017JF004337

Ralston, D. K., and Geyer, W. R. 2017b. *FINAL REPORT Sediment Delivery, Trapping, and Storage during Extreme Flow Events Hudson River Foundation Grant No. 004/13A*, Woods Hole Oceanographic Institution Woods Hole, MA 02543

Ries, K.G., III, Newson J.K., Smith, M.J., Guthrie, J.D., Steeves, P.A., Haluska, T.L., Kolb, K.R., Thompson, R.F., Santoro, R.D., and Vraga, H.W., 2017, StreamStats, version 4: U.S. Geological Survey Fact 2017–3046, 4 p., https://doi.org/10.3133/fs20173046. [Supersedes USGS Fact Sheet 2008–3067.]

Totten, L.A., S.J. Eisenreich, C.L. Gigliotti, J. Dachs, D.A. VanRy, S. Yan, and M. Aucott. 2006. Atmospheric Deposition of PCBs and PAHs in the New York/New Jersey Harbor Estuary. In: Levinton, J.S., and Waldman, J.R., eds., *The Hudson River Estuary*, New York: Cambridge University Press. Chapter 27, pages 398-412.

SECTION 2 TABLES

Table 2-1. CARP 2 Model Specifications of Hydrographs for New Jersey Headwaters Tributary to the Harbor – 5 out of 56 Model Head-of-Tide Input Locations

MODEL INPUT	USGS MEASUREMENT GAGE
Hackensack River	01378500 Hackensack River at New Milford, NJ
Passaic River	01389500 Passaic River at Little Falls, NJ
Saddle River	01391500 Saddle River at Lodi, NJ
Raritan River	01403060 Raritan River below Calco Dam at Bound Brook, NJ
South River and Lawrence Brook[1]	01405400 Manalapan Brook at Spotswood, NJ 01405030 Lawrence Brook at Weston Mills, NJ

Notes:
[1]Nearby independent waterways were entered into the model at a single location.

Table 2-2. CARP 2 Model Specifications of Hydrographs for New Jersey and New York Urban Streams Tributary to the Harbor – 6 out of 56 Model Head-of-Tide Input Locations	
MODEL INPUT	USGS MEASUREMENT GAGE
Second River, NJ	01391500 Saddle River at Lodi, NJ
Third River, NJ	01391500 Saddle River at Lodi, NJ
McDonald's Brook, NJ	01391500 Saddle River at Lodi, NJ
Elizabeth River, NJ	flow generated with HDR rainfall runoff model
Rahway River, NJ	flow generated with HDR rainfall runoff model
Bronx River, NY	01375000 Croton River at New Croton Dam Croton-on-Hudson, NY

Table 2-3. CARP 2 Model Specifications of Hydrographs for New York Basins Tributary to the Hudson and Western Long Island Sound – 35 out of 56 Model Head-of-Tide Input Locations

MODEL INPUT	DRAINAGE AREA (mi 2)	MEAN ANNUAL RUNOFF (in)	USGS MEASUREMENT GAGE[7]
Hudson River/Mohawk River[6]	4620 3470	24 24.2	01335754 Hudson River at Waterford, NY/ 01357500 Mohawk River at Cohoes, NY
Poesten Kill	96.3	18.3	01372500 Wappinger Creek near Wappinger Falls, NY
Wynants Kill – East	110.0	16	01372500 Wappinger Creek near Wappinger Falls, NY
Wynants Kill – West	41.2	15.8	01371500 Wallkill River at Gardiner, NY
Normans Kill	177.0	18.2	01371500 Wallkill River at Gardiner, NY[1]
Hannacrois Creek – West	191.0	18.6	01371500 Wallkill River at Gardiner, NY
Hannacrois Creek – East	66.3	14.7	01372500 Wappinger Creek near Wappinger Falls, NY
Claverack/Kinderhook Creek[6]	189 329	17.6 17.9	01372500 Wappinger Creek near Wappinger Falls, NY[2]
Kaaterskill/Catskill Creek[6]	70.8 343	24 21.1	01367500 Rondout Creek at Rosendale, NY/ 01371500 Wallkill River at Gardiner, NY[3]
Roeliff Jansen Kill	230.0	21	01372500 Wappinger Creek near Wappinger Falls, NY[4]
Esopus Creek	424.0	28.5	01364500 Esopus Creek at Mount Marion, NY
Saw Kill – West	60.0	16.5	01371500 Wallkill River at Gardiner, NY
Saw Kill – East	95.0	17.4	01372500 Wappinger Creek near Wappinger Falls, NY
Shawangunk Kill/ Upper Wallkill River/ Middle Wallkill River/ Lower Wallkill River/ Upper Rondout Creek/ Lower Rondout Creek[6]	147 253 240 140 235 169	20.8 18.2 21 22.4 27.4 25.1	01371500 Wallkill River at Gardiner, NY[5]/ 01371500 Wallkill River at Gardiner, NY[5]/ 01371500 Wallkill River at Gardiner, NY[5]/ 01371500 Wallkill River at Gardiner, NY[5]/ 01367500 Rondout Creek at Rosendale, NY[5]/ 01367500 Rondout Creek at Rosendale, NY[5]
Landsman Kill –West	68.5	17.6	01371500 Wallkill River at Gardiner, NY
Landsman Kill – East	112.0	17.9	01372500 Wappinger Creek near Wappinger Falls, NY
Wappinger Creek	212.0	19.5	01372500 Wappinger Creek near Wappinger Falls, NY
FishKill Creek	194.0	21.6	01375000 Croton River at New Croton Dam, NY
Quassaic Creek – West	135.0	22.2	01371500 Wallkill River at Gardiner, NY
Quassaic Creek – East	44.8	25	01375000 Croton River at New Croton Dam, NY
Moodna Creek	179.0	22.3	01371500 Wallkill River at Gardiner, NY
Peekskill Hollow Creek – East	105.0	26.5	01375000 Croton River at New Croton Dam, NY
Peekskill Hollow Creek – West	58	27.7	01367500 Rondout Creek at Rosendale, NY
Croton River	207	25.9	01375000 Croton River at New Croton Dam, NY
Ossining	11.5	24.4	01375000 Croton River at New Croton Dam, NY
Gory Brook	14.8	24.6	01375000 Croton River at New Croton Dam, NY
Nyack	6.19	23.6	01375000 Croton River at New Croton Dam, NY
Irvington and Dobbs Ferry	15.9	23.9	01375000 Croton River at New Croton Dam, NY
Sparkill Creek	11.2	22.8	01375000 Croton River at New Croton Dam, NY
Tallman Park	1.91	23.5	01375000 Croton River at New Croton Dam, NY
Sawmill River	26.1	24.1	01375000 Croton River at New Croton Dam, NY
Hutchinson River	19.3	19.6	01372500 Wappinger Creek near Wappinger Falls, NY
New Rochelle	16.2	19.1	01372500 Wappinger Creek near Wappinger Falls, NY
Mamaroneck River	28.7	20.3	01372500 Wappinger Creek near Wappinger Falls, NY
Blind Brook	11.5	21.5	01372500 Wappinger Creek near Wappinger Falls, NY

Notes:
[1]For the periods 7/1/2012 to 2/28/2014 and 5/28/2015 to 9/30/2016, measured flows from USGS Gage 01359528 Normans Kill at Albany, NY were applied.
[2]For the period 8/1/2011 to 9/30/2016, measured flows from USGS Gage 01361000 Kinderhook Creek at Rossman, NY were applied.
[3]For the period 3/1/2011 to 3/31/2015, measured flows from USGS Gage 01362000 Catskill Creek at South Cairo, NY were applied.
[4]For the period 3/1/2011 to 2/28/2014, measured flows from USGS Gage 01362182 Roeliff Jansen Kill near Linlithgo, NY were applied.
[5]For the period 3/1/2011 to 3/31/2015, measured flows from USGS Gage 01372007 Rondout Creek at Rondout, NY were applied.
[6]A "/" is used to separate various named reaches of connected waterways entering the model.
[7]The twelve USGS measurement gage locations capture these drainage areas and mean annual runoff:

USGS MEASUREMENT GAGE	Drainage Area (mi^2)	Mean Annual Runoff (in)
01335754 Hudson River at Waterford, NY	4605	24
01357500 Mohawk River at Cohoes, NY	3450	24.2
01372500 Wappinger Creek near Wappinger Falls, NY	181	19.4
01375000 Croton River at New Croton Dam, NY	378	25.5
01364500 Esopus Creek at Mount Marion, NY	419	28.6
01367500 Rondout Creek at Rosendale, NY	383	26.8
01371500 Wallkill River at Gardiner, NY	695	20.4
01359528 Normans Kill at Albany, NY	168	18.2
01361000 Kinderhook Creek at Rossman, NY	329	17.9
01362000 Catskill Creek at South Cairo, NY	270	21.9
01362182 Roeliff Jansen Kill near Linlithgo, NY	212	21.3
01372007 Rondout Creek at Rondout, NY	1185	22.4

Table 2-4. CARP 2 Model Specifications of Hydrographs for New Jersey Headwaters Tributary to the New York Bight – 5 of 56 Model Head-of-Tide Input Locations	
MODEL INPUT	USGS MEASUREMENT GAGE
Shark River and Manasquan River[1]	01405400 Manalapan Brook near Spotswood, NJ 01408000 Manasquan River near Squankum, NJ
Westecunk Creek and Oswego/Bass/Mullica River[1,2]	01408500 Toms River near Toms River, NJ 01410000 Oswego River at Harrisville, NJ 01410150 Bass River East Branch near New Gretna, NJ 01409400 Mullica River near Batsto, NJ
Great Egg Harbor River and Tuckahoe River[1]	01411000 Great Egg Harbor River at Folsom, NJ 01411300 Tuckahoe River at Head of River, NJ
Shrewsbury River/ Navesink River[2]	01407500 Swimming River near Red Bank, NJ
Metedeconk River and Toms River[1]	01408120 Metedeconk River North Branch near Lakewood, NJ 01408500 Toms River near Toms River, NJ
Notes: [1]Nearby independent waterways were entered into the model at a single location. [2]A “/” is used to separate various named reaches of connected waterways entering the model.	

Table 2-5. CARP 2 Model Specifications of Hydrographs for Connecticut Rivers Tributary to Long Island Sound – 5 out of 56 Model Head-of-Tide Input Locations

MODEL INPUT	USGS MEASUREMENT GAGE
Connecticut River	01184000 Connecticut River at Thompsonville, CT
Housatonic River/Naugatuck River[1]	01205500 Housatonic River at Stevenson, CT 01208500 Naugatuck River at Beacon Falls, CT
Norwalk River	01209700 Norwalk River at South Wilton, CT
Quinnipiac River	01196500 Quinnipiac River at Wallingford, CT
Quinebaug/Shetucket/Thames River[1]	01122500 Quinebaug River at Jewett City, CT 01127000 Shetucket River at Willimantic, CT

Notes:
[1] A "/" is used to separate various named reaches of connected waterways entering the model.

Table 2-6. CARP 2 Model Specifications of mNSL Regression Parameters[2] for Solids Loadings for New Jersey Headwaters Tributary to the Harbor – 5 out of 56 Model Head-of-Tide Input Locations

MODEL INPUT	DRAINAGE AREA (km^2)	N[4]	BREAK[3]	NON-FLOOD[3]		FLOOD[3]		S_L
				Log a_1	b_1	Log a_2	b_2	
Hackensack River	293	240	0.084 ±0.164	-0.416 ±0.192	0.934 ±0.071	0.271	1.573 ±1.239	0.228
Passaic River	2087.4	205	0.009 ±0.007	-0.428 ±0.653	0.909 ±0.270	0.517	1.370 ±0.201	0.287
Saddle River	141.6	278	0.020 ±0.003	-0.886 ±0.0535	0.774 ±0.275	2.110	2.546 ±0.334	0.302
Raritan River	2084.8	206	0.011 ±0.004	0.325 ±0.432	1.300 ±0.180	1.896	2.109 ±0.215	0.275
South River and Lawrence Brook[1]	245 100	0 0	Based on proximity, apply the mNSL parameters from the Raritan River					

Notes:

[1]Nearby independent waterways were entered into the model at a single location.

[2]mNSL equations with state variables and units for state variables are presented in Section 2.1.2.1

[3] Log a_1, b_1, and b_2 and breakpoint regression parameter estimates reported as coefficients ± 95% confidence limits.

[4]The indicated number of available measurements used for the mNSL regressions were collected by the SSC method for the Raritan River and by the TSS method for the other New Jersey rivers.

Table 2-7. CARP 2 Model Specifications of mNSL Regression Parameters[1] for Solids Loadings for New Jersey and New York Urban Streams Tributary to the Harbor – 6 out of 56 Model Head-of-Tide Input Locations

MODEL INPUT	DRAINAGE AREA (km^2)	N[3]	BREAK[2]	NON-FLOOD[2]		FLOOD[2]		S_L
				Log a_1	b_1	Log a_2	b_2	
Second River	31.1	0	Apply the mNSL parameters from the Elizabeth River[4]					
Third River	30.0	0	Apply the mNSL parameters from the Elizabeth River[4]					
McDonald's Brook	11.4	0	Apply the mNSL parameters from the Elizabeth River[4]					
Elizabeth River[5]	43.8	232	0.014 $\pm$0.007	-0.641 $\pm$0.861	0.555 $\pm$0.403	0.730	1.291 $\pm$0.192	0.340
Rahway River[5]	106.1	234	0.019 $\pm$0.005	-1.183 $\pm$0.429	0.377 $\pm$0.194	1.326	1.828 $\pm$0.348	0.339
Bronx River	99.5	0	Apply the mNSL parameters from the Rahway River[4]					

Notes:

[1]mNSL equations with state variables and units for state variables are presented in Section 2.1.2.

[2] Log a_1, b_1, b_2 and breakpoint regression parameter estimates reported as coefficients $\pm$ 95% confidence limits.

[3]The indicated number of available measurements used for the mNSL regressions were collected by the TSS method.

[4]Surrogate river assignments are based on similar drainage area size within the grouping.

[5]SS loading modeled as stormwater runoff consistent with hydrodynamic transport and CARP 1.

Table 2-8. CARP 2 Model Specifications of mNSL Regression Parameters[1] for Solids Loadings for New York Basins Tributary to the Hudson River and Western Long Island Sound – 35 out of 56 Model Head-of-Tide Input Locations

MODEL INPUT	DRAINAGE AREA (mi^2)	N[3]	BREAK[2]	NON-FLOOD[2]		FLOOD[2]		S_L
				Log a_1	b_1	Log a_2	b_2	
Hudson River/ Mohawk River[9]	4620 3470	5660 4384	0.020 0.016	0.299 0.348	1.426 1.296	2.973 2.463	2.996 2.474	0.291 0.277
Poesten Kill	96.3	0	Apply the mNSL parameters from Kinderhook Creek[4]					
Wynants Kill – East	110.0	0	Apply the mNSL parameters from Kinderhook Creek[4]					
Wynants Kill – West	41.2	0	Apply the mNSL parameters from Catskill Creek[5]					
Normans Kill	177.0	0	Apply the mNSL parameters from Catskill Creek[5]					
Hannacrois Creek W	191.0	0	Apply the mNSL parameters from Catskill Creek[5]					
Hannacrois Creek E	66.3	0	Apply the mNSL parameters from Catskill Creek[5]					
Claverack/ Kinderhook Creek[9]	189 329	942	0.012	-0.749	0.806	2.832	2.661	0.318
Kaaterskill/ Catskill Creek[9]	70.8 343	1491	0.011	0.009	1.154	2.331	2.350	0.325
Roeliff Jansen Kill	230.0	1095	0.007	-0.270	1.084	2.067	2.169	0.295
Esopus Creek	424.0	691	0.019	0.948	1.492	2.357	2.316	0.217
Saw Kill – West	60.0	0	Apply the mNSL parameters from Catskill Creek[5]					
Saw Kill – East	95.0	0	Apply the mNSL parameters from Kinderhook Creek[4]					
Shawangunk Kill/ Upper Wallkill River/ Middle Wallkill River/ Lower Wallkill River/ Upr. Rondout Creek/ Lwr. Rondout Creek[9]	147 253 240 140 235 169	1491	0.018	0.412	1.299	1.838	2.113	0.204
Landsman Kill –West	68.5	0	Apply the mNSL parameters from Catskill Creek[5]					
Landsman Kill – East	112.0	0	Apply the mNSL parameters from Kinderhook Creek[4]					
Wappinger Creek	212.0	0	Apply the mNSL parameters from Kinderhook Creek[4]					
FishKill Creek	194.0	0	Apply the mNSL parameters from Roeliff Jansen Kill[6]					
Quassaic Creek W	135.0	0	Apply the mNSL parameters from Rondout Creek[7]					
Quassaic Creek East	44.8	0	Apply the mNSL parameters from Roeliff Jansen Kill[6]					
Moodna Creek	179.0	0	Apply the mNSL parameters from Rondout Creek[7]					
Peekskill Hollow E	105.0	0	Apply the mNSL parameters from Roeliff Jansen Kill[6]					
Peekskill Hollow W	58	0	Apply the mNSL parameters from Esopus Creek[8]					
Croton River	207	0	Apply the mNSL parameters from Roeliff Jansen Kill[6]					
Ossining	11.5	0	Apply the mNSL parameters from Roeliff Jansen Kill[6]					
Gory Brook	14.8	0	Apply the mNSL parameters from Roeliff Jansen Kill[6]					
Nyack	6.19	0	Apply the mNSL parameters from Rondout Creek[7]					
Irvington-Dobbs Ferry	15.9	0	Apply the mNSL parameters from Roeliff Jansen Kill[6]					
Sparkill Creek	11.2	0	Apply the mNSL parameters from Rondout Creek[7]					
Tallman Park	1.91	0	Apply the mNSL parameters from Rondout Creek[7]					
Sawmill River	26.1	0	Apply the mNSL parameters from Roeliff Jansen Kill[6]					
Hutchinson River	19.3	0	Apply the mNSL parameters from Kinderhook Creek[4]					
New Rochelle	16.2	0	Apply the mNSL parameters from Kinderhook Creek[4]					
Mamaroneck River	28.7	0	Apply the mNSL parameters from Roeliff Jansen Kill[6]					
Blind Brook	11.5	0	Apply the mNSL parameters from Roeliff Jansen Kill[6]					

Notes:

[1]mNSL equations with state variables and units for state variables presented in Section 2.1.2. Reported drainage areas should be converted from mi^2 to km^2.
[2] Log a_1, b_1, b_2 and breakpoint mNSL regression parameter estimates reported as coefficients only.
[3]The indicated number of available measurements used for the mNSL regressions were collected by the SSC method. On days when available, measurements, corrected for drainage area differences between model input locations and gauges, were used for modeled SS loadings in lieu of mNSL estimates.
[4]Surrogate river assignment based on east side of River geology and low mean annual runoff.
[5]Surrogate river assignment based on west side of River geology and low mean annual runoff.
[6]Surrogate river assignment based on east side of River geology and high mean annual runoff.
[7]Surrogate river assignment based on west side of River geology and medium mean annual runoff.
[8]Surrogate river assignment based on west side of River geology and high mean annual runoff.
[9]A "/" is used to separate various named reaches of connected waterways entering the model.

Table 2-9. CARP 2 Model Specifications of mNSL Regression Parameters[3] for Solids Loadings for New Jersey Headwaters Tributary to the New York Bight – 5 out of 56 Model Head-of-Tide Input Locations

MODEL INPUT	DRAINAGE AREA (km^2)	N[5]	BREAK	NON-FLOOD[4]		FLOOD[4]		S_L
				Log a_1	b_1	Log a_2	b_2	
Shark River and Manasquan River[1]	25.8 114.1	0 57	Not used	0.856 ±0.517	1.653 ±0.578	Same as non-flood[6]		0.332
Westecunk Creek and Oswego/Bass/Mullica River[1,2]	725 1453	0 0						
Great Egg Harbor River and Tuckahoe River[1]	148 79.8	0 0						
Shrewsbury River/ Navesink River[2]	161	0						
Metedeconk River and Toms River[1]	90.4 318.9	0 41						

Notes:

[1]Nearby independent waterways were entered into the model at a single location.

[2]A "/" is used to separate various named reaches of connected waterways entering the model

[3]mNSL equations with state variables and units for state variables are presented in Section 2.1.2.

[4] Log a_1, and b_1 regression parameter estimates are reported as coefficients ± 95% confidence limits.

[5]The indicated number of available measurements used for the mNSL regressions were collected by the TSS method.

[6] Measurements from the Manasquan and Toms Rivers were pooled to develop a single set of mNSL regression parameters applied to the five model input locations and nine independent waterways listed. Observed slopes for non-flood and flood conditions for the Manasquan and Toms River combined were not apparently different so separate regressions for non-flood and flood conditions were not warranted.

Table 2-10. CARP 2 Model Specifications of mNSL Regression Parameters[2] for Solids Loadings for Connecticut Headwaters Tributary to Long Island Sound – 5 out of 56 Model Head-of-Tide Input Locations

MODEL INPUT	DRAINAGE AREA (km^2)	N[4]	BREAK[3]	NON-FLOOD[3,5]		FLOOD[3,5]		S_L
				Log a_1	b_1	Log a_2	b_2	
Connecticut River	25049	217	0.013 ±0.004	-0.186 ±0.994	1.194 ±0.465	2.551	2.636 ±0.284	0.418
Housatonic River/ Naugatuck River[1]	4672	0						
Norwalk River	77.7	0						
Quinnipiac River	298	0						
Quinebaug/Shetucket/ Thames River[1]	2893	0						

Notes:

[1]A "/" is used to separate various named reaches of connected waterways entering the model

[2]mNSL equations with state variables and units for state variables are presented in Section 2.1.2.

[3] Log a_1, b_1, b_2 and breakpoint regression parameter estimates are reported as coefficients ± 95% confidence limits.

[4]The indicated number of available measurements used for the mNSL regressions were collected by the SSC method.

[5] Measurements from the Connecticut River were used to develop the mNSL regression parameters applied to the five model input locations and waterways listed.

Table 2-11. CARP 2 Model Specifications of Median[2] PCB Homolog Concentrations for New Jersey Headwaters Tributary to the Harbor – 5 out of 56 Model Head-of-Tide Input Locations

MODEL INPUT	HOMOLOG	DISSOLVED ng/L	PARTICULATE ng/g OC
Hackensack River	Mono+Di-	0.057	13.7
	Tri-	0.070	17.3
	Tetra-	0.099	82
	Penta-	0.064	161
	Hexa-	0.026	108
	Hepta-	0.010	53.3
	Octa-	0.004	17.4
	Nona+Deca-	0.003	6.35
Passaic River	Mono+Di-	0.112	138
	Tri-	0.295	535
	Tetra-	0.327	1184
	Penta-	0.161	1441
	Hexa-	0.051	1131
	Hepta-	0.019	495
	Octa-	0.009	194
	Nona+Deca-	0.009	105
Saddle River	Mono+Di-	0.112	618
	Tri-	0.179	308
	Tetra-	0.168	510
	Penta-	0.133	796
	Hexa-	0.088	952
	Hepta-	0.037	271
	Octa-	0.011	111
	Nona+Deca-	0.004	29.6
Raritan River	Mono+Di-	0.055	8.76
	Tri-	0.134	21.4
	Tetra-	0.125	78.9
	Penta-	0.078	161
	Hexa-	0.075	143
	Hepta-	0.021	73.7
	Octa-	0.005	26.2
	Nona+Deca-	0.003	9.86
South River and Lawrence Brook[1]	Absent measurements, Hackensack River concentrations applied.		

Notes:
[1]Nearby independent waterways were entered into the model at a single location.
[2]Probability distributions displaying measurements and medians are included in Appendix 3.

Table 2-12. CARP 2 Model Specifications of Median[2] Dioxin/Furan Concentrations for New Jersey Headwaters Tributary to the Harbor – 5 out of 56 Model Head-of-Tide Input Locations		
MODEL INPUT	CONGENER	PARTICULATE[3] ng/g OC
Hackensack River	2,3,7,8-TCDD	0.019
	1,2,3,7,8-PeCDD	0.019
	1,2,3,7,8,9-HxCDD	0.075
	1,2,3,4,7,8-HxCDD	0.036
	1,2,3,6,7,8-HxCDD	0.080
	1,2,3,4,6,7,8-HpCDD	1.93
	OCDD	24
	2,3,7,8-TCDF	0.057
	1,2,3,7,8-PeCDF	0.017
	2,3,4,7,8-PeCDF	0.023
	1,2,3,4,7,8-HXCDF	0.079
	2,3,4,6,7,8-HXCDF	0.037
	1,2,3,6,7,8-HxCDF	0.057
	1,2,3,7,8,9-HXCDF	0.018
	1,2,3,4,6,7,8-HpCDF	0.704
	1,2,3,4,7,8,9-HpCDF	0.042
	OCDF	1.40
Passaic River	2,3,7,8-TCDD	0.123
	1,2,3,7,8-PeCDD	0.070
	1,2,3,7,8,9-HxCDD	0.320
	1,2,3,4,7,8-HxCDD	0.134
	1,2,3,6,7,8-HxCDD	0.367
	1,2,3,4,6,7,8-HpCDD	9.74
	OCDD	138
	2,3,7,8-TCDF	0.339
	1,2,3,7,8-PeCDF	0.104
	2,3,4,7,8-PeCDF	0.140
	1,2,3,4,7,8-HXCDF	0.350
	2,3,4,6,7,8-HXCDF	0.156
	1,2,3,6,7,8-HxCDF	0.341
	1,2,3,7,8,9-HXCDF	0.053
	1,2,3,4,6,7,8-HpCDF	3.93
	1,2,3,4,7,8,9-HpCDF	0.241
	OCDF	8.06
Saddle River	2,3,7,8-TCDD	0.077
	1,2,3,7,8-PeCDD	0.302
	1,2,3,7,8,9-HxCDD	1.11
	1,2,3,4,7,8-HxCDD	0.388
	1,2,3,6,7,8-HxCDD	0.996
	1,2,3,4,6,7,8-HpCDD	16.5
	OCDD	106
	2,3,7,8-TCDF	0.198
	1,2,3,7,8-PeCDF	0.072
	2,3,4,7,8-PeCDF	0.109
	1,2,3,4,7,8-HXCDF	0.279
	2,3,4,6,7,8-HXCDF	0.172
	1,2,3,6,7,8-HxCDF	0.313

	1,2,3,7,8,9-HXCDF	0.009
	1,2,3,4,6,7,8-HpCDF	4.77
	1,2,3,4,7,8,9-HpCDF	0.465
	OCDF	7.58
Raritan River	2,3,7,8-TCDD	0.012
	1,2,3,7,8-PeCDD	0.019
	1,2,3,7,8,9-HxCDD	0.013
	1,2,3,4,7,8-HxCDD	0.053
	1,2,3,6,7,8-HxCDD	0.138
	1,2,3,4,6,7,8-HpCDD	4.754
	OCDD	192
	2,3,7,8-TCDF	0.088
	1,2,3,7,8-PeCDF	0.024
	2,3,4,7,8-PeCDF	0.043
	1,2,3,4,7,8-HXCDF	0.094
	2,3,4,6,7,8-HXCDF	0.039
	1,2,3,6,7,8-HxCDF	0.079
	1,2,3,7,8,9-HXCDF	0.027
	1,2,3,4,6,7,8-HpCDF	0.773
	1,2,3,4,7,8,9-HpCDF	0.041
	OCDF	1.52
South River and Lawrence Brook[1]	Absent measurements, Hackensack River concentrations applied.	

Notes:
[1]Nearby independent waterways were entered into the model at a single location.
[2]Probability distributions displaying measurements and medians are included in Appendix 3.
[3]Specification of dissolved phase concentrations is unchanged from CARP 1, HydroQual, 2008. For head-of-tide input locations in New Jersey, dissolved phase concentrations are based on CARP 1 Wallkill River, NY measurements.

Table 2-13. CARP 2 Model Specifications of Median[1] PCB Homolog Concentrations for New Jersey and New York Urban Streams Tributary to the Harbor – 6 out of 56 Model Head-of-Tide Input Locations

MODEL INPUT	HOMOLOG	DISSOLVED ng/L	PARTICULATE ng/g OC
Second River	Stormwater concentrations from CARP 2 Monte Carlo analysis applied to these urban rivers. Refer to Table 2-22.		
Third River			
McDonald's Brook			
Elizabeth River	Mono+Di-	0.447	38.4
	Tri-	0.476	114
	Tetra-	0.278	266
	Penta-	0.204	325
	Hexa-	0.181	734
	Hepta-	0.105	507
	Octa-	0.021	147
	Nona+Deca-	0.005	30.5
Rahway River	Site-specific as developed during CARP 1. Refer to HydroQual, 2008.		
Bronx River	Site-specific as developed during CARP 1. Refer to HydroQual, 2008.		

Notes:
[1]Probability distributions displaying measurements and medians are included in Appendix 3.

Table 2-14. CARP 2 Model Specifications of Median[1] Dioxin/Furan Concentrations for New Jersey and New York Urban Streams Tributary to the Harbor – 6 out of 56 Model Head-of-Tide Input Locations		
MODEL INPUT	CONGENER	PARTICULATE[2] ng/g OC
Second River	Stormwater concentrations from CARP 2 Monte Carlo analysis are applied to these highly urban rivers. Refer to Table 2-23.	
Third River		
McDonald's Brook		
Elizabeth River	2,3,7,8-TCDD	0.015
	1,2,3,7,8-PeCDD	0.048
	1,2,3,7,8,9-HxCDD	0.241
	1,2,3,4,7,8-HxCDD	0.105
	1,2,3,6,7,8-HxCDD	0.189
	1,2,3,4,6,7,8-HpCDD	6.13
	OCDD	77.9
	2,3,7,8-TCDF	0.113
	1,2,3,7,8-PeCDF	0.052
	2,3,4,7,8-PeCDF	0.088
	1,2,3,4,7,8-HXCDF	0.262
	2,3,4,6,7,8-HXCDF	0.129
	1,2,3,6,7,8-HxCDF	0.291
	1,2,3,7,8,9-HXCDF	0.007
	1,2,3,4,6,7,8-HpCDF	2.42
	1,2,3,4,7,8,9-HpCDF	0.158
	OCDF	4.61
Rahway River	Site-specific as developed during CARP 1. Refer to HydroQual, 2008.	
Bronx River	Site-specific as developed during CARP 1. Refer to HydroQual, 2008.	

Notes:
[1]Probability distributions displaying measurements and medians are included in Appendix 3.
[2]Specification of dissolved phase concentrations is unchanged from CARP 1, HydroQual, 2008. For head-of-tide input locations in New Jersey, dissolved phase concentrations are based on CARP 1 Wallkill River, NY measurements.

Table 2-15. CARP 2 Model Specifications of Median PCB Homolog Concentrations for New York Basins Tributary to the Hudson and Western Long Island Sound – 35 out of 56 Model Head-of-Tide Input Locations

MODEL INPUT	BASIS FOR PCB HOMOLOG LOADING CONCENTRATIONS
Hudson River/Mohawk River[1,2]	Refer to notes 3 and 4
Poesten Kill	Absent site-specific measurements, CARP 2 loading concentrations are based on Wallkill River, "New York most often cleanest", as developed during CARP 1, refer to HydroQual, 2008
Wynants Kill – East	
Wynants Kill – West	
Normans Kill	
Hannacrois Creek Total – West	
Hannacrois Creek Total – East	
Claverack/Kinderhook Creek[1]	
Kaaterskill/Catskill Creek[1]	
Roeliff Jansen Kill	
Esopus Creek	
Saw Kill – West	
Saw Kill – East	
Shawangunk Kill/Wallkill River/Rondout Creek[1]	
Landsman Kill –West	
Landsman Kill – East	
Wappinger Creek	
FishKill Creek	
Quassaic Creek – West	
Quassaic Creek – East	
Moodna Creek	
Peekskill Hollow Creek – East	
Peekskill Hollow Creek – West	
Croton River	
Ossining	
Gory Brook	
Nyack	
Irvington and Dobbs Ferry	
Sparkill Creek	
Tallman Park	
Sawmill River	Site-specific as developed during CARP 1, see HydroQual, 2008
Hutchinson River	Absent site-specific measurements, CARP 2 loading concentrations are based on Wallkill River, "New York most often cleanest", as developed during CARP 1, refer to HydroQual, 2008
New Rochelle	
Mamaroneck River	
Blind Brook	

Notes:
[1]A "/" is used to separate various named reaches of connected waterways entering the model.
[2]Flows and loadings for the Upper Hudson River above Mohawk River and Mohawk Rivers enter the CARP models as summations after each are estimated independently.
[3]Using extensive measurement records, Upper Hudson River above Mohawk PCB loading concentrations were developed from regressions of measured PCB homolog concentrations and flow originally developed by Farley et al., 2017 and extended for CARP 2. CARP 2 regression information for the Upper Hudson River PCB loading concentrations are provided in Table 2-16.
[4]Mohawk PCB loading concentrations are as developed during CARP 1, refer to HydroQual, 2008

Table 2-16. CARP 2 Flow – PCB Homolog Regression Equation Parameters for Hudson River above Mohawk River

PERIOD[1]	PARAMETER	MONO	DI	TRI	TETRA	PENTA	HEXA	HEPTA	OCTA	NONA	DECA
Pre-Dredging 2004-2008	loga1	1.04	3.99	2.24	2.10	0.46	0.14	-3.09	-1.29	0.14	
	b1	-0.14	-0.79	-0.40	-0.43	-0.13	-0.20	0.36	-0.34	-0.23	
	loga2	-8.47	-8.02	-7.88	-7.97	-8.33	-8.82	-9.90	-10.08	-9.88	
	b2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	
	Breakpoint	28087	20100	16488	14247	13400	12100	14600	5823	30630	
	SSR	30.67	34.69	17.08	21.73	33.46	40.30	13.38	17.94	0.98	
During Dredging 2009-2015	loga1	3.01	2.97	2.91	1.02	-0.53	2.04	-2.06	-2.44	5.41	
	b1	-0.54	-0.47	-0.50	-0.07	0.21	-0.62	0.26	0.24	-1.27	
	loga2	-8.27	-7.84	-7.60	-7.63	-8.08	-8.22	-8.99	-9.80	-9.23	
	b2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	
	Breakpoint	27957	24049	16149	14814	16877	8140	9500	15400	30519	
	SSR	123.1	111.4	105.0	86.81	109.5	153	48.84	44.15	2.99	
Post-Dredging 2016-2019	loga1	1.62	3.74	3.93	2.62	0.93	0.76	1.23	2.14	0.90	0.10
	b1	-0.47	-0.93	-0.94	-0.62	-0.29	-0.37	-0.66	-1.04	-0.78	-0.66
	loga2	-8.66	-8.29	-8.20	-8.17	-8.62	-8.99	-9.55	-9.95	-10.13	-10.49
	b2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	Breakpoint	14668	12841	13373	13298	14548	13190	11306	9540	9372	9470
	SSR	14.36	15.58	7.64	6.33	11.37	10.72	7.70	10.28	11.71	10.56

Notes:

[1]Dredging status regression periods are specified in calendar years. Water years are modeled. The pre-dredging regression equations were applied for the water years 0203 through 0708 and the period October through December 2008. The during dredging regression equations were applied for the period January through September 2009, the water years 0910 through 1415, and the period October through December 2015. The post-dredging regression equations were applied to the period January through September 2016 and are likely to be applied for projection purposes. As in CARP 1, actual high frequency measurements from General Electric were applied for the 9899 through 0102 water years.

[2]Regression analyses were performed based on Hudson River flow (cfs) and PCB homolog concentrations (ng/L) at Waterford, New York.

[3]The underlying log linear regression equation is:

$$\log_{10} PCB\left(\frac{ng}{L}\right) = \log a + b \times \log_{10} FLOW\left(\frac{ft^3}{s}\right)$$

[4]Tabulated loga1 and b1 and loga2 and b2 designations denote regression parameters for non-flood and flood conditions, respectively, which are used in the regression equation as loga and b. Non-flood and flood conditions are defined at the breakpoint value of flow.

[5]Diagrams showing the regression lines and underlying measurements are included in Appendix 3.

<table>
<tr><th colspan="2">Table 2-17. CARP 2 Model Specifications of Median Dioxin/Furan Concentrations for New York Basins Tributary to the Hudson and Western Long Island Sound – 35 out of 56 Model Head-of-Tide Input Locations</th></tr>
<tr><td>MODEL INPUT</td><td>BASIS FOR DIOXIN/FURAN LOADING CONCENTRATIONS</td></tr>
<tr><td>Hudson River and Mohawk River[1,2]</td><td>As developed during CARP 1, refer to HydroQual, 2008</td></tr>
<tr><td>Poesten Kill</td><td rowspan="30">Absent site-specific measurements, CARP 2 loading concentrations are based on Wallkill River, “New York most often cleanest”, as developed during CARP 1, refer to HydroQual, 2008</td></tr>
<tr><td>Wynants Kill – East</td></tr>
<tr><td>Wynants Kill – West</td></tr>
<tr><td>Normans Kill</td></tr>
<tr><td>Hannacrois Creek Total – West</td></tr>
<tr><td>Hannacrois Creek Total – East</td></tr>
<tr><td>Claverack/Kinderhook Creek[1]</td></tr>
<tr><td>Kaaterskill/Catskill Creek[1]</td></tr>
<tr><td>Roeliff Jansen Kill</td></tr>
<tr><td>Esopus Creek</td></tr>
<tr><td>Saw Kill – West</td></tr>
<tr><td>Saw Kill – East</td></tr>
<tr><td>Shawangunk Kill/Wallkill River/Rondout Creek[1]</td></tr>
<tr><td>Landsman Kill –West</td></tr>
<tr><td>Landsman Kill – East</td></tr>
<tr><td>Wappinger Creek</td></tr>
<tr><td>FishKill Creek</td></tr>
<tr><td>Quassaic Creek – West</td></tr>
<tr><td>Quassaic Creek – East</td></tr>
<tr><td>Moodna Creek</td></tr>
<tr><td>Peekskill Hollow Creek – East</td></tr>
<tr><td>Peekskill Hollow Creek – West</td></tr>
<tr><td>Croton River</td></tr>
<tr><td>Ossining</td></tr>
<tr><td>Gory Brook</td></tr>
<tr><td>Nyack</td></tr>
<tr><td>Irvington and Dobbs Ferry</td></tr>
<tr><td>Sparkill Creek</td></tr>
<tr><td>Tallman Park</td></tr>
<tr><td>Sawmill River</td></tr>
<tr><td>Sawmill River</td><td>Site-specific as developed during CARP 1, see HydroQual, 2008</td></tr>
<tr><td>Hutchinson River</td><td rowspan="4">Absent site-specific measurements, CARP 2 loading concentrations are based on Wallkill River, “New York most often cleanest”, as developed during CARP 1, refer to HydroQual, 2008</td></tr>
<tr><td>New Rochelle</td></tr>
<tr><td>Mamaroneck River</td></tr>
<tr><td>Blind Brook</td></tr>
<tr><td colspan="2">Notes:
[1]A “/” is used to separate various named reaches of connected waterways entering the model.
[2]Flows and loadings for the Upper Hudson River above Mohawk River and Mohawk Rivers enter the CARP models as summations after each are estimated independently.</td></tr>
</table>

Table 2-18. CARP 2 Model Specifications of Median PCB Homolog Concentrations for New Jersey Headwaters Tributary to the New York Bight – 5 of 56 Model Head-of-Tide Input Locations

MODEL INPUT	BASIS FOR PCB HOMOLOG LOADING CONCENTRATIONS
Shark River and Manasquan River[1]	Absent site-specific measurements, CARP 2 loading concentrations are based on Hackensack River, "New Jersey most often cleanest". Refer to Table 2-11 for Hackensack River concentrations applied for CARP 2.
Westecunk Creek and Oswego/Bass/Mullica River[1,2]	
Great Egg Harbor River and Tuckahoe River[1]	
Shrewsbury River/ Navesink River[2]	
Metedeconk River and Toms River[1]	

Notes:
[1]Nearby independent waterways were entered into the model at a single location.
[2]A "/" is used to separate various named reaches of the connected waterways entering the model

Table 2-19. CARP 2 Model Specifications of Median Dioxin/Furan Concentrations for New Jersey Headwaters Tributary to the New York Bight – 5 of 56 Model Head-of-Tide Input Locations

MODEL INPUT	BASIS FOR DIOXIN/FURAN LOADING CONCENTRATIONS
Shark River and Manasquan River[1]	Absent site-specific measurements, CARP 2 loading concentrations are based on Hackensack River, "New Jersey most often cleanest". Refer to Table 2-12 for Hackensack River particulate concentrations applied for CARP 2. Specification of dissolved phase concentrations is unchanged from CARP 1, HydroQual, 2008. For head-of-tide input locations in New Jersey, dissolved phase concentrations are based on CARP 1 Wallkill River, NY measurements.
Westecunk Creek and Oswego/Bass/Mullica River[1,2]	
Great Egg Harbor River and Tuckahoe River[1]	
Shrewsbury River/ Navesink River[2]	
Metedeconk River and Toms River[1]	

Notes:
[1]Nearby independent waterways were entered into the model at a single location.
[2]A "/" is used to separate various named reaches of connected waterways entering the model.

Table 2-20. CARP 2 Model Specifications of Median PCB Homolog Concentrations for Connecticut Rivers Tributary to Long Island Sound – 5 out of 56 Model Head-of-Tide Input Locations

MODEL INPUT	BASIS FOR PCB HOMOLOG LOADING CONCENTRATIONS
Connecticut River	Absent site-specific measurements, CARP 2 loading concentrations are based on Wallkill River, "New York most often cleanest", as developed during CARP 1, refer to HydroQual, 2008
Housatonic River/Naugatuck River[1]	
Norwalk River	
Quinnipiac River	
Quinebaug/Shetucket/Thames River[1]	

Notes:
[1] A "/" is used to separate various named reaches of connected waterways entering the model.

Table 2-21. CARP 2 Model Specifications of Median Dioxin/Furan Concentrations for Connecticut Rivers Tributary to Long Island Sound – 5 out of 56 Model Head-of-Tide Input Locations	
MODEL INPUT	BASIS FOR DIOXIN/FURAN LOADING CONCENTRATIONS
Connecticut River	Absent site-specific measurements, CARP 2 loading concentrations are based on Wallkill River, "New York most often cleanest", as developed during CARP 1, refer to HydroQual, 2008
Housatonic River/Naugatuck River[1]	
Norwalk River	
Quinnipiac River	
Quinebaug/Shetucket/Thames River[1]	
Notes: [1] A "/" is used to separate various named reaches of connected waterways entering the model.	

Table 2-22. CARP 2 Model Specifications of Time-Varying PCB Homolog Loading Concentrations for Stormwater, Log$_e$ Linear Regression Parameters Applied for Monte Carlo Stochastic Selection		
PCB Homolog	**Concentration and Probability[1] log$_e$ Linear Regression Parameters[2,3]**	
	Y-INTERCEPT (at 50%, z-score = 0) (log$_e$ mean, ng/L)	**SLOPE (log$_e$ standard deviation, ng/L)**
Mono	-2.7899	1.5068
Di	0.0507	1.6299
Tri	0.7783	1.9008
Tetra	1.5188	1.8251
Penta	1.868	1.6128
Hexa	1.6453	1.5696
Hepta	0.8742	1.62
Octa	-0.3488	1.6006
Nona	-1.7232	1.5422
Deca	-2.9259	1.4962

Notes:
[1]Probabilities are expressed as z-scores for the x-axis values of the linear regression analysis.
[2]Probability distributions of measured PCB stormwater loading concentrations and calculated linear regression lines are included in Appendix 4.
[3]Monte Carlo selection of hourly loading concentrations from the linear regression restricted to the range of measured values.

Table 2-23. CARP 2 Model Specifications of Time-Varying Urban Dioxin and Furan Congener Loading Concentrations for Stormwater, Log_e Linear Regression Parameters Applied for Monte Carlo Stochastic Selection

Dioxin/Furan Congeners	Concentration and Probability[1] Log_e Linear Regression Parameters[2,3]	
	Y-INTERCEPT (at 50%, z-score = 0) (log_e mean, pg/L)	SLOPE (log_e standard deviation, pg/L)
2,3,7,8-TCDD	-0.3362	1.0749
1,2,3,7,8-PeCDD	0.4911	0.9612
1,2,3,7,8,9-HxCDD	0.6599	0.974
1,2,3,4,7,8-HxCDD	1.1348	1.1989
1,2,3,6,7,8-HxCDD	1.2028	1.0388
1,2,3,4,6,7,8-HpCDD	3.6506	1.8465
OCDD	5.7279	2.0412
2,3,7,8-TCDF	0.1525	0.9283
1,2,3,7,8-PeCDF	0.0047	1.1188
2,3,4,7,8-PeCDF	0.3483	1.1949
1,2,3,4,7,8-HXCDF	0.7462	1.1646
1,2,3,6,7,8-HxCDF	0.685	1.2334
1,2,3,7,8,9-HXCDF	0.0747	1.3941
2,3,4,6,7,8-HXCDF	0.6546	1.3176
1,2,3,4,6,7,8-HpCDF	2.7179	1.8104
1,2,3,4,7,8,9-HpCDF	1.011	1.1662
OCDF	3.5624	1.6963

Notes:
[1]Probabilities are expressed as z-scores for the x-axis values of the linear regression analysis.
[2]Probability distributions of measured dioxin and furan urban stormwater loading concentrations and calculated linear regression lines are included in Appendix 4.
[3]Monte Carlo selection of hourly loading concentrations from the linear regression restricted to the range of measured values.

Table 2-24. CARP 2 Model Specifications of Median Rural Dioxin and Furan Congener Loading Concentrations for Stormwater	
Dioxin and Furan Congeners	**Median[1] (pg/L)**
2,3,7,8-TCDD	0.038
1,2,3,7,8-PeCDD	0.046
1,2,3,7,8,9-HxCDD	0.055
1,2,3,4,7,8-HxCDD	0.104
1,2,3,6,7,8-HxCDD	0.157
1,2,3,4,6,7,8-HpCDD	4.213
OCDD	123.6
2,3,7,8-TCDF	0.041
1,2,3,7,8-PeCDF	0.032
2,3,4,7,8-PeCDF	0.058
1,2,3,4,7,8-HXCDF	0.047
1,2,3,6,7,8-HxCDF	0.040
1,2,3,7,8,9-HXCDF	0.007
2,3,4,6,7,8-HXCDF	0.038
1,2,3,4,6,7,8-HpCDF	0.652
1,2,3,4,7,8,9-HpCDF	0.035
OCDF	1.113

Notes:
[1]Probability distributions of measured dioxin and furan rural stormwater loading concentrations and calculated median concentrations are included in Appendix 4.

SECTION 3 TABLES

Table 3-1. CARP 2 Model Daily River Flow Inputs Annual Flow Summary Results for New Jersey Headwaters Tributary to the Harbor - 5 out of 56 Model Head-of-Tide Input Locations

	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[2]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT	WATER YEAR	AVERAGE FLOW (CMS)	WATER YEAR	AVERAGE FLOW (CMS)	WATER YEAR	AVERAGE FLOW (CMS)
Hackensack River	2011-12	1.8	2010-11	5.1	2001-02	0.03
Passaic River	2012-13	34.6	2010-11	69.4	2001-02	6.0
Saddle River	2008-09	3.1	2010-11	5.1	2001-02	1.5
Raritan River	2004-05	33.6	2010-11	54.5	2001-02	12.2
South River and Lawrence Brook[1]	2008-09	6.5	2010-11	9.6	2001-02	2.6

Notes:
[1]Nearby independent waterways were entered into the model at a single location.
[2]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-2. CARP 2 Model Daily River Flow Inputs Annual Flow Summary Results for New Jersey and New York Urban Streams Tributary to the Harbor – 6 out of 56 Model Head-of-Tide Input Locations

MODEL INPUT	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[1]		MAXIMUM YEAR		MINIMUM YEAR	
	WATER YEAR	AVERAGE FLOW (CMS)	WATER YEAR	AVERAGE FLOW (CMS)	WATER YEAR	AVERAGE FLOW (CMS)
Second River	2008-09	0.69	2010-11	1.1	2001-02	0.33
Third River	2008-09	0.67	2010-11	1.1	2001-02	0.32
McDonald's Brook	2008-09	0.25	2010-11	0.41	2001-02	0.12
Elizabeth River	2012-13	0.48	2010-11	0.71	2004-05	0.32
Rahway River	2012-13	2.70	2010-11	4.0	2004-05	1.8
Bronx River	2008-09	2.9	2005-06	4.7	2001-02	1.1

Notes:
[1]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-3. CARP 2 Model Daily River Flow Inputs Annual Flow Summary Results for New York Basins Tributary to the Hudson and Western Long Island Sound – 35 out of 56 Model Head-of-Tide Input Locations

	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[1]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT (STREAMSTATS BASIN)	WATER YEAR	AVERAGE (CMS)	WATER YEAR	AVERAGE (CMS)	WATER YEAR	AVERAGE (CMS)
Hudson + Mohawk Rivers	2002-03	445	2010-11	660	1998-99	288
Poesten Kill	2004-05	4.1	2010-11	6.6	2001-02	1.4
Wynants Kill – East	2004-05	4.1	2010-11	6.6	2001-02	1.4
Wynants Kill – West	2009-10	1.5	2010-11	3.1	2001-02	0.55
Normans Kill	1999-00	7.4	2010-11	15.5	2001-02	2.7
Hannacrois Creek – West	2004-05	2.3	2010-11	3.6	2001-02	0.75
Hannacrois Creek – East	2009-10	8.5	2010-11	17.1	2001-02	3.0
Kinderhook Creek	2004-05	22.1	2010-11	34.3	2001-02	7.1
Catskill Creek	2008-09	21.6	2010-11	51.5	2001-02	7.3
Roeliff Jansen Kill	2012-13	11.0	2005-06	17.3	2001-02	3.7
Esopus Creek	2012-13	16.7	2010-11	37.8	2001-02	3.8
Saw Kill – West	2009-10	2.4	2010-11	4.8	2001-02	0.83
Saw Kill – East	2004-05	3.8	2010-11	6.2	2001-02	1.3
Rondout Creek	2009-10	57.1	2010-11	109	2001-02	20.8
Landsman Kill –West	2009-10	2.9	2010-11	5.8	2001-02	1.0
Landsman Kill – East	2004-05	4.7	2010-11	7.5	2001-02	1.5
Wappinger Creek	2004-05	9.6	2010-11	15.4	2001-02	3.2
FishKill Creek	1999-00	7.2	2010-11	12.8	2001-02	0.59
Quassaic Creek – West	2009-10	7.1	2010-11	14.5	2001-02	2.5
Quassaic Creek – East	1999-00	1.9	2010-11	3.4	2001-02	0.16
Moodna Creek	2009-10	9.5	2010-11	19.3	2001-02	3.4
Peekskill Hollow Creek – E	1999-00	4.7	2010-11	8.5	2001-02	0.39
Peekskill Hollow Creek –W	2012-13	3.0	2010-11	5.6	2001-02	1.1
Croton River	1999-00	16.5	2010-11	29.4	2001-02	1.4
Ossining	1999-00	0.48	2010-11	0.85	2001-02	0.04
Gory Brook	1999-00	0.62	2010-11	1.1	2001-02	0.05
Nyack	1999-00	0.25	2010-11	0.44	2001-02	0.02
Irvington and Dobbs Ferry	1999-00	0.65	2010-11	1.2	2001-02	0.05
Sparkill Creek	1999-00	0.44	2010-11	0.78	2001-02	0.04
Tallman Park	1999-00	0.08	2010-11	0.14	2001-02	0.01
Sawmill River	1999-00	1.1	2010-11	1.9	2001-02	0.09
Hutchinson River	2004-05	0.88	2010-11	1.4	2001-02	0.29
New Rochelle	2004-05	0.72	2010-11	1.2	2001-02	0.24
Mamaroneck River	2004-05	1.4	2010-11	2.2	2001-02	0.45
Blind Brook	2004-05	0.57	2010-11	0.92	2001-02	0.19

Notes:
[1]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-4. CARP 2 Model Daily River Flow Inputs Annual Flow Summary Results for New Jersey Headwaters Tributary to the New York Bight – 5 of 56 Model Head-of-Tide Input Locations

	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[3]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT	WATER YEAR	AVERAGE FLOW (CMS)	WATER YEAR	AVERAGE FLOW (CMS)	WATER YEAR	AVERAGE FLOW (CMS)
Shark River and Manasquan River[1]	2008-09	4.2	2009-10	5.9	2001-02	1.8
Westecunk Creek and Oswego/Bass/Mullica River[1,2]	2008-09	29.3	2009-10	42.9	2001-02	14.6
Great Egg Harbor River and Tuckahoe River[1]	2005-06	29.5	2009-10	44.4	2001-02	13.7
Shrewsbury River/Navesink River[2]	2008-09	2.9	2002-03	4.7	2001-02	0.19
Metedeconk River and Toms River[1]	2004-05	21.2	2009-10	30.2	2001-02	11.2

Notes:
[1]Nearby independent waterways were entered into the model at a single location.
[2]A "/" is used to separate various named reaches of the same waterway entering the model
[3]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-5. CARP 2 Model Daily River Flow Inputs Annual Flow Summary Results for Connecticut Rivers Tributary to Long Island Sound – 5 out of 56 Model Head-of-Tide Input Locations

	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[2]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT	WATER YEAR	AVERAGE FLOW (CMS)	WATER YEAR	AVERAGE FLOW (CMS)	WATER YEAR	AVERAGE FLOW (CMS)
Connecticut River	2012-13	531	2010-11	750	2001-02	383
Housatonic/Naugatuck River[1]	2012-13	98.1	2010-11	152	2001-02	46.3
Norwalk River	2004-05	1.64	2005-06	2.57	2001-02	0.784
Quinnipiac River	2004-05	6.81	2005-06	11.3	2001-02	2.99
Quinebaug/Shetucket/ Thames River[1]	2011-12	57.6	2005-06	86.9	2001-02	28.4

Notes:
[1] A "/" is used to separate various named reaches of the same waterway entering the model.
[2]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-6. CARP 2 Model Daily River Solids Loadings Annual Summary Results (tonnes) for New Jersey Headwaters Tributary to the Harbor - 5 out of 56 Model Head-of-Tide Input Locations

	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[2]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT	WATER YEAR	LOAD (tonnes)	WATER YEAR	LOAD (tonnes)	WATER YEAR	LOAD (tonnes)
Hackensack River	2004-05	4.65E+02	2010-11	1.63E+03	2001-02	7.52E+00
Passaic River	2007-08	1.50E+04	2010-11	4.01E+04	2001-02	1.93E+03
Saddle River	1998-99	4.91E+03	2010-11	2.78E+04	2001-02	6.11E+02
Raritan River	2013-14	7.33E+04	2010-11	2.65E+05	2001-02	7.51E+03
South River + Lawrence Brook[1]	2003-04	1.17E+04	2010-11	6.58E+04	2001-02	1.11E+03

Notes:
[1]Nearby independent waterways were entered into the model at a single location.
[2]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-7. CARP 2 Model Daily River Solids Loadings Annual Summary Results (tonnes) for New Jersey and New York Urban Streams Tributary to the Harbor – 6 out of 56 Model Head-of-Tide Input Locations

	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[1]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT	WATER YEAR	LOAD (tonnes)	WATER YEAR	LOAD (tonnes)	WATER YEAR	LOAD (tonnes)
Second River	2007-08	7.45E+02	2010-11	1.46E+03	2001-02	3.51E+02
Third River	2007-08	7.20E+02	2010-11	1.41E+03	2001-02	3.39E+02
McDonald's Brook	2007-08	2.73E+02	2010-11	5.34E+02	2001-02	1.29E+02
Elizabeth River	1998-99	1.06E+03	2010-11	2.51E+03	2001-02	5.11E+02
Rahway River	2013-14	3.02E+03	2010-11	1.11E+04	2001-02	7.20E+02
Bronx River	2002-03	3.42E+03	2010-11	9.33E+03	2001-02	7.35E+02

[1]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-8. CARP 2 Model Daily River Solids Loadings Annual Summary Results for New York Basins Tributary to the Hudson and Western Long Island Sound – 35 out of 56 Model Head-of-Tide Input Locations

MODEL INPUT (STREAMSTATS BASIN)	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[1]		MAXIMUM YEAR		MINIMUM YEAR	
	WATER YEAR	LOAD (tonnes)	WATER YEAR	LOAD (tonnes)	WATER YEAR	LOAD (tonnes)
Hudson River + Mohawk River	1999-00	6.30E+05	2010-11	2.28E+06	2015-16	1.76E+05
Poesten Kill	2002-03	6.13E+03	2010-11	2.50E+04	2001-02	5.97E+02
Wynants Kill – East	2002-03	5.17E+03	2010-11	2.10E+04	2001-02	5.15E+02
Wynants Kill – West	2002-03	2.40E+03	2010-11	1.14E+04	2001-02	2.97E+02
Normans Kill	2002-03	1.40E+04	2010-11	6.74E+04	2001-02	1.73E+03
Hannacrois Creek – East	2002-03	3.15E+03	2010-11	1.28E+04	2001-02	3.18E+02
Hannacrois Creek – West	2002-03	1.61E+04	2010-11	7.64E+04	2001-02	1.95E+03
Kinderhook Creek	2004-05	7.42E+04	2010-11	2.99E+05	2001-02	4.76E+03
Catskill Creek	2012-13	8.93E+04	2010-11	7.49E+05	2001-02	6.23E+03
Roeliff Jansen Kill	2008-09	2.00E+04	2006-07	4.93E+04	2001-02	2.47E+03
Esopus Creek	2009-10	2.40E+04	2010-11	7.94E+04	2001-02	1.41E+03
Saw Kill – East	2002-03	5.40E+03	2010-11	2.20E+04	2001-02	5.30E+02
Saw Kill – West	2002-03	3.86E+03	2010-11	1.83E+04	2001-02	4.75E+02
Rondout Creek	2003-04	7.86E+04	2010-11	2.94E+05	2001-02	1.08E+04
Landsman Kill – East	2002-03	6.78E+03	2010-11	2.77E+04	2001-02	6.63E+02
Landsman Kill – West	2002-03	5.10E+03	2010-11	2.41E+04	2001-02	6.22E+02
Wappinger Creek	2002-03	1.56E+04	2010-11	6.37E+04	2001-02	1.50E+03
FishKill Creek	2003-04	1.11E+04	2010-11	5.77E+04	2001-02	1.32E+02
Quassaic Creek – East	2003-04	3.58E+03	2010-11	1.86E+04	2001-02	4.08E+01
Quassaic Creek – West	2002-03	1.42E+04	2010-11	6.70E+04	2001-02	1.79E+03
Moodna Creek	2002-03	1.91E+04	2010-11	8.98E+04	2001-02	2.39E+03
Peekskill Hollow Creek – East	2003-04	9.59E+03	2010-11	4.99E+04	2001-02	1.08E+02
Peekskill Hollow Creek – West	2007-08	1.15E+04	2010-11	5.23E+04	2001-02	1.00E+03
Croton River	2003-04	3.17E+04	2010-11	1.65E+05	2001-02	3.59E+02
Ossining	2003-04	8.70E+02	2010-11	4.52E+03	2001-02	9.95E+00
Gory Brook	2003-04	1.14E+03	2010-11	5.93E+03	2001-02	1.31E+01
Nyack	2003-04	3.04E+02	2010-11	1.54E+03	2001-02	5.47E+00
Irvington and Dobbs Ferry	2003-04	1.15E+03	2010-11	5.97E+03	2001-02	1.32E+01
Sparkill Creek	2003-04	5.09E+02	2010-11	2.58E+03	2001-02	9.42E+00
Tallman Park	2003-04	9.29E+01	2010-11	4.72E+02	2001-02	1.61E+00
Sawmill River	2003-04	1.92E+03	2010-11	9.98E+03	2001-02	2.21E+01
Hutchinson River	2002-03	1.44E+03	2010-11	5.87E+03	2001-02	1.38E+02
New Rochelle	2002-03	1.14E+03	2010-11	4.64E+03	2001-02	1.10E+02
Mamaroneck River	2002-03	3.43E+03	2010-11	1.40E+04	2001-02	3.15E+02
Blind Brook	2002-03	1.57E+03	2010-11	6.42E+03	2001-02	1.44E+02

[1]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-9. CARP 2 Model Daily River Solids Loadings Annual Summary Results (tonnes) for New Jersey Headwaters Tributary to the New York Bight – 5 of 56 Model Head-of-Tide Input Locations						
	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[3]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT	WATER YEAR	LOAD (tonnes)	WATER YEAR	LOAD (tonnes)	WATER YEAR	LOAD (tonnes)
Shark River and Manasquan River[1]	2013-14	1.22E+03	2010-11	4.48E+03	2001-02	2.32E+02
Westecunk Creek and Oswego/Bass/Mullica River[1,2]	2013-14	3.44E+03	2009-10	7.18E+03	2001-02	9.67E+02
Great Egg Harbor River and Tuckahoe River[1]	2005-06	1.55E+04	2009-10	3.33E+04	2001-02	3.88E+03
Shrewsbury River/Navesink River[2]	2014-15	8.90E+02	2010-11	2.56E+03	2001-02	2.70E+01
Metedeconk River and Toms River[1]	2008-09	6.03E+03	2009-10	1.23E+04	2001-02	1.88E+03

Notes:
[1]Nearby independent waterways were entered into the model at a single location.
[2]A "/" is used to separate various named reaches of the same waterway entering the model
[3]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-10. CARP 2 Model Daily River Solids Loading Annual Summary Results (tonnes) for Connecticut Rivers Tributary to Long Island Sound – 5 out of 56 Model Head-of-Tide Input Locations

	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[2]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT	WATER YEAR	LOAD (tonnes)	WATER YEAR	LOAD (tonnes)	WATER YEAR	LOAD (tonnes)
Connecticut River	2004-05	6.02E+05	2010-11	1.30E+06	2015-16	2.73E+05
Housatonic River/Naugatuck River[1]	2008-09	1.69E+05	2010-11	8.03E+05	2001-02	2.18E+04
Norwalk River	2003-04	8.10E+03	2006-07	3.92E+04	2001-02	7.57E+02
Quinnipiac River	2003-04	1.82E+04	2010-11	5.39E+04	2001-02	1.19E+03
Quinebaug/Shetucket/Thames River[1]	2004-05	9.25E+04	2009-10	2.33E+05	2001-02	1.50E+04

Notes:
[1] A "/" is used to separate various named reaches of the same waterway entering the model.
[2]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-11. CARP 2 Model Daily River PCB Loadings Annual Summary Results (kg) for New Jersey Headwaters Tributary to the Harbor - 5 out of 56 Model Head-of-Tide Input Locations

	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[2]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)
Hackensack River	2011-12	3.61E-02	2010-11	1.05E-01	2001-02	5.69E-04
Passaic River	2012-13	6.60E+00	2010-11	1.50E+01	2001-02	1.00E+00
Saddle River	2004-05	4.39E-01	2005-06	9.48E-01	2001-02	1.56E-01
Raritan River	2007-08	1.39E+00	2010-11	2.38E+00	2001-02	3.73E-01
South River and Lawrence Brook[1]	2013-14	1.99E-01	2006-07	3.12E-01	2001-02	5.94E-02

Notes:

[1]Nearby independent waterways were entered into the model at a single location.

[2]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-12. CARP 2 Model Daily River PCB Loadings Annual Summary Results (kg) for New Jersey and New York Urban Streams Tributary to the Harbor – 6 out of 56 Model Head-of-Tide Input Locations

	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[1]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)
Second River	2008-09	5.25E-01	2010-11	8.46E-01	2001-02	2.53E-01
Third River	2008-09	5.08E-01	2010-11	8.18E-01	2001-02	2.45E-01
McDonald's Brook	2008-09	1.93E-01	2010-11	3.10E-01	2001-02	9.29E-02
Elizabeth River	2013-14	4.23E-01	2010-11	1.02E+00	2001-02	1.43E-01
Rahway River	2014-15	1.60E-01	2010-11	3.06E-01	2001-02	8.16E-02
Bronx River	2012-13	1.74E+00	2005-06	3.18E+00	2001-02	5.07E-01

[1]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-13. CARP 2 Model Daily River PCB Loadings Annual Summary Results (kg) for New York Basins Tributary to the Hudson and Western Long Island Sound – 35 out of 56 Model Head-of-Tide Input Locations

MODEL INPUT (STREAMSTATS BASIN)	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[1]		MAXIMUM YEAR		MINIMUM YEAR	
	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)
Hudson River + Mohawk River	1999-00	3.05E+02	2010-11	6.61E+02	2015-16	1.22E+02
Poesten Kill	2012-13	6.13E-02	2010-11	1.18E-01	2001-02	1.56E-02
Wynants Kill – East	2012-13	6.12E-02	2010-11	1.18E-01	2001-02	1.56E-02
Wynants Kill – West	2008-09	2.40E-02	2010-11	5.92E-02	2001-02	6.42E-03
Normans Kill	2008-09	1.31E-01	2010-11	3.85E-01	2015-16	3.31E-02
Hannacrois Creek – East	2012-13	3.39E-02	2010-11	6.52E-02	2001-02	8.64E-03
Hannacrois Creek – West	2008-09	1.31E-01	2010-11	3.23E-01	2001-02	3.50E-02
Kinderhook Creek	2012-13	3.25E-01	2010-11	6.14E-01	2001-02	8.17E-02
Catskill Creek	2012-13	4.11E-01	2010-11	9.83E-01	2001-02	9.79E-02
Roeliff Jansen Kill	1999-00	1.65E-01	2010-11	3.11E-01	2001-02	4.28E-02
Esopus Creek	2009-10	2.75E-01	2005-06	6.93E-01	2001-02	4.13E-02
Saw Kill – East	2012-13	5.75E-02	2010-11	1.11E-01	2001-02	1.47E-02
Saw Kill – West	2008-09	3.65E-02	2010-11	9.00E-02	2001-02	9.76E-03
Rondout Creek	2008-09	8.87E-01	2010-11	2.01E+00	2001-02	2.42E-01
Landsman Kill – East	2012-13	6.97E-02	2010-11	1.34E-01	2001-02	1.78E-02
Landsman Kill – West	2008-09	4.44E-02	2010-11	1.10E-01	2001-02	1.19E-02
Wappinger Creek	2008-09	1.54E-01	2010-11	3.02E-01	2001-02	3.56E-02
FishKill Creek	2012-13	1.02E-01	2010-11	2.24E-01	2001-02	6.39E-03
Quassaic Creek – East	2012-13	2.72E-02	2010-11	6.00E-02	2001-02	1.71E-03
Quassaic Creek – West	2008-09	1.10E-01	2010-11	2.72E-01	2001-02	2.96E-02
Moodna Creek	2008-09	1.47E-01	2010-11	3.63E-01	2001-02	3.94E-02
Peekskill Hollow Creek – East	2012-13	6.75E-02	2010-11	1.49E-01	2001-02	4.24E-03
Peekskill Hollow Creek – West	2009-10	4.58E-02	2010-11	9.17E-02	2001-02	1.29E-02
Croton River	2008-09	2.84E-01	2010-11	6.94E-01	2001-02	1.21E-02
Ossining	2012-13	6.81E-03	2010-11	1.50E-02	2001-02	4.28E-04
Gory Brook	2012-13	8.84E-03	2010-11	1.95E-02	2001-02	5.55E-04
Nyack	2012-13	3.55E-03	2010-11	7.82E-03	2001-02	2.23E-04
Irvington and Dobbs Ferry	2012-13	9.22E-03	2010-11	2.03E-02	2001-02	5.80E-04
Sparkill Creek	2012-13	6.20E-03	2010-11	1.37E-02	2001-02	3.90E-04
Tallman Park	2012-13	1.09E-03	2010-11	2.40E-03	2001-02	6.85E-05
Sawmill River	2008-09	2.97E-01	2010-11	7.51E-01	2001-02	1.13E-02
Hutchinson River	2012-13	1.31E-02	2010-11	2.53E-02	2001-02	3.35E-03
New Rochelle	2012-13	1.08E-02	2010-11	2.07E-02	2001-02	2.74E-03
Mamaroneck River	2012-13	2.03E-02	2010-11	3.90E-02	2001-02	5.17E-03
Blind Brook	2012-13	8.59E-03	2010-11	1.65E-02	2001-02	2.19E-03

[1]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-14. CARP 2 Model Daily River PCB Loadings Annual Summary Results (kg) for New Jersey Headwaters Tributary to the New York Bight – 5 of 56 Model Head-of-Tide Input Locations

MODEL INPUT	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[3]		MAXIMUM YEAR		MINIMUM YEAR	
	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)
Shark River and Manasquan River[1]	2008-09	8.12E-02	2009-10	1.23E-01	2001-02	3.10E-02
Westecunk Creek and Oswego/Bass/Mullica River[1,2]	2008-09	4.97E-01	2009-10	7.85E-01	2001-02	2.21E-01
Great Egg Harbor River and Tuckahoe River[1]	2005-06	7.62E-01	2009-10	1.29E+00	2001-02	2.95E-01
Shrewsbury River/Navesink River[2]	2012-13	5.61E-02	2002-03	9.93E-02	2001-02	3.07E-03
Metedeconk River and Toms River[1]	2004-05	4.50E-01	2009-10	7.05E-01	2001-02	2.08E-01

Notes:
[1]Nearby independent waterways were entered into the model at a single location.
[2]A "/" is used to separate various named reaches of the same waterway entering the model.
[3]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-15. CARP 2 Model Daily River PCBs Loading Annual Summary Results (kg) for Connecticut Rivers Tributary to Long Island Sound – 5 out of 56 Model Head-of-Tide Input Locations

	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[2]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)
Connecticut River	1999-00	8.15E+00	2005-06	1.35E+01	2015-16	4.80E+00
Housatonic River/Naugatuck River[1]	2002-03	1.62E+00	2010-11	3.55E+00	2001-02	5.06E-01
Norwalk River	2002-03	3.41E-02	2006-07	7.89E-02	2001-02	9.85E-03
Quinnipiac River	2008-09	1.20E-01	2005-06	3.12E-01	2001-02	2.98E-02
Quinebaug/Shetucket/Thames River[1]	2012-13	9.69E-01	2005-06	1.83E+00	2001-02	3.25E-01

Notes:

[1] A "/" is used to separate various named reaches of the same waterway entering the model.

[2] Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-16. CARP 2 Model Daily River 2,3,7,8-TCDD Loadings Annual Summary Results (kg) for New Jersey Headwaters Tributary to the Harbor - 5 out of 56 Model Head-of-Tide Input Locations

	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[2]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)
Hackensack River	2011-12	1.36E-06	2010-11	3.95E-06	2001-02	2.15E-08
Passaic River	2012-13	1.43E-04	2010-11	3.28E-04	2001-02	2.13E-05
Saddle River	2004-05	8.96E-06	2005-06	1.97E-05	2001-02	3.12E-06
Raritan River	2007-08	3.17E-05	2010-11	5.44E-05	2001-02	8.52E-06
South River and Lawrence Brook[1]	2013-14	7.74E-06	2006-07	1.22E-05	2001-02	2.25E-06

Notes:

[1]Nearby independent waterways were entered into the model at a single location.

[2]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-17. CARP 2 Model Daily River 2,3,7,8-TCDD Loadings Annual Summary Results (kg) for New Jersey and New York Urban Streams Tributary to the Harbor – 6 out of 56 Model Head-of-Tide Input Locations

	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[1]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)
Second River	2008-09	1.59E-05	2010-11	2.56E-05	2001-02	7.68E-06
Third River	2008-09	1.54E-05	2010-11	2.47E-05	2001-02	7.43E-06
McDonald's Brook	2008-09	5.83E-06	2010-11	9.37E-06	2001-02	2.82E-06
Elizabeth River	2013-14	1.44E-06	2010-11	3.14E-06	2001-02	5.20E-07
Rahway River	2014-15	9.89E-07	2010-11	1.96E-06	2015-16	4.68E-07
Bronx River	2012-13	5.37E-06	2005-06	9.70E-06	2001-02	1.59E-06

[1] Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-18. CARP 2 Model Daily River 2,3,7,8-TCDD Loadings Annual Summary Results (kg) for New York Basins Tributary to the Hudson and Western Long Island Sound – 35 out of 56 Model Head-of-Tide Input Locations						
	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[1]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT (STREAMSTATS BASIN)	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)
Hudson River + Mohawk River	2013-14	3.21E-04	2010-11	5.51E-04	2015-16	1.68E-04
Poesten Kill	2013-14	3.34E-06	2010-11	6.23E-06	2001-02	8.99E-07
Wynants Kill – East	2013-14	3.34E-06	2010-11	6.22E-06	2001-02	8.98E-07
Wynants Kill – West	2008-09	1.30E-06	2010-11	3.11E-06	2001-02	3.68E-07
Normans Kill	2008-09	6.95E-06	2010-11	1.95E-05	2001-02	1.88E-06
Hannacrois Creek – East	2013-14	1.85E-06	2010-11	3.45E-06	2001-02	4.97E-07
Hannacrois Creek – West	2008-09	7.09E-06	2010-11	1.70E-05	2001-02	2.01E-06
Kinderhook Creek	2012-13	1.78E-05	2010-11	3.25E-05	2001-02	4.70E-06
Catskill Creek	2012-13	3.36E-05	2010-11	8.02E-05	2001-02	7.93E-06
Roeliff Jansen Kill	1999-00	8.99E-06	2010-11	1.64E-05	2001-02	2.46E-06
Esopus Creek	2009-10	1.47E-05	2005-06	3.59E-05	2001-02	2.41E-06
Saw Kill – West	2013-14	3.13E-06	2010-11	5.85E-06	2001-02	8.43E-07
Saw Kill – East	2008-09	1.98E-06	2010-11	4.73E-06	2001-02	5.59E-07
Rondout Creek	2008-09	4.80E-05	2010-11	1.06E-04	2001-02	1.39E-05
Landsman Kill – East	2013-14	3.80E-06	2010-11	7.09E-06	2001-02	1.02E-06
Landsman Kill – West	2008-09	2.41E-06	2010-11	5.76E-06	2001-02	6.81E-07
Wappinger Creek	2013-14	8.29E-06	2010-11	1.58E-05	2001-02	2.06E-06
FishKill Creek	2012-13	5.60E-06	2010-11	1.19E-05	2001-02	3.73E-07
Quassaic Creek – East	2012-13	1.50E-06	2010-11	3.18E-06	2001-02	9.96E-08
Quassaic Creek – West	2008-09	5.98E-06	2010-11	1.43E-05	2001-02	1.69E-06
Moodna Creek	2008-09	7.97E-06	2010-11	1.91E-05	2001-02	2.25E-06
Peekskill Hollow Creek – East	2012-13	3.72E-06	2010-11	7.90E-06	2001-02	2.47E-07
Peekskill Hollow Creek – West	2009-10	2.48E-06	2010-11	4.92E-06	2001-02	7.43E-07
Croton River	2012-13	1.51E-05	2010-11	3.53E-05	2001-02	7.42E-07
Ossining	2012-13	3.75E-07	2010-11	7.96E-07	2001-02	2.49E-08
Gory Brook	2012-13	4.86E-07	2010-11	1.03E-06	2001-02	3.24E-08
Nyack	2012-13	1.95E-07	2010-11	4.15E-07	2001-02	1.30E-08
Irvington and Dobbs Ferry	2012-13	5.08E-07	2010-11	1.08E-06	2001-02	3.38E-08
Sparkill Creek	2012-13	3.41E-07	2010-11	7.25E-07	2001-02	2.27E-08
Tallman Park	2012-13	6.00E-08	2010-11	1.27E-07	2001-02	3.99E-09
Sawmill River	2012-13	9.59E-07	2010-11	2.23E-06	2001-02	4.78E-08
Hutchinson River	2013-14	7.17E-07	2010-11	1.34E-06	2001-02	1.93E-07
New Rochelle	2013-14	5.86E-07	2010-11	1.09E-06	2001-02	1.58E-07
Mamaroneck River	2013-14	1.10E-06	2010-11	2.06E-06	2001-02	2.97E-07
Blind Brook	2013-14	4.69E-07	2010-11	8.74E-07	2001-02	1.26E-07
[1]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.						

Table 3-19. CARP 2 Model Daily River 2,3,7,8-TCDD Loadings Annual Summary Results (kg) for New Jersey Headwaters Tributary to the New York Bight – 5 of 56 Model Head-of-Tide Input Locations

	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[3]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)
Shark River and Manasquan River[1]	2008-09	2.31E-06	2009-10	3.46E-06	2001-02	9.13E-07
Westecunk Creek and Oswego/Bass/Mullica River[1,2]	2008-09	1.82E-05	2009-10	2.91E-05	2001-02	8.00E-06
Great Egg Harbor River and Tuckahoe River[1]	2005-06	2.92E-05	2009-10	4.99E-05	2001-02	1.11E-05
Shrewsbury River/Navesink River[2]	2004-05	3.00E-06	2002-03	5.67E-06	2001-02	1.42E-07
Metedeconk River and Toms River[1]	2008-09	1.69E-05	2009-10	2.68E-05	2001-02	7.73E-06

Notes:
[1]Nearby independent waterways were entered into the model at a single location.
[2]A "/" is used to separate various named reaches of the same waterway entering the model
[3]Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-20. CARP 2 Model Daily River 2,3,7,8-TCDD Loading Annual Summary Results (kg) for Connecticut Rivers Tributary to Long Island Sound – 5 out of 56 Model Head-of-Tide Input Locations

	WATER YEARS OCTOBER 1, 1998 TO SEPTEMBER 30, 2016					
	AVERAGE YEAR[2]		MAXIMUM YEAR		MINIMUM YEAR	
MODEL INPUT	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)	WATER YEAR	LOAD (kg)
Connecticut River	2009-10	4.42E-04	2005-06	7.15E-04	2015-16	2.74E-04
Housatonic River/Naugatuck River[1]	2002-03	8.67E-05	2010-11	1.81E-04	2001-02	2.94E-05
Norwalk River	2002-03	1.76E-06	2006-07	3.86E-06	2001-02	5.56E-07
Quinnipiac River	2008-09	6.36E-06	2005-06	1.56E-05	2001-02	1.77E-06
Quinebaug/Shetucket/Thames River[1]	2012-13	5.18E-05	2005-06	9.45E-05	2001-02	1.87E-05

Notes:
[1] A "/" is used to separate various named reaches of the same waterway entering the model.
[2] Water year closest to the average of annual averages for the October 1998 to September 2016 period is reported.

Table 3-21. CARP 2 Solids Loadings Summary Results (tonnes) Comparing All External Sources – Closest to Average Water Year

MODEL INPUT	NEAR AVERAGE YEAR	SS LOADING (tonnes)	SS LOADING (%)
TRIBUTARY	2003-04	2,144,683	89.1
STORMWATER	2013-14	159,122	6.6
CSO	2008-09	41,769	1.7
WWTP	2010-11	61,893	2.6
SUM		2,407,127	100
ALL SOURCES	2003-04	2,346,159	

Table 3-22. CARP 2 Solids Loadings Summary Results (tonnes) All External Sources - Maximum Water Year

MODEL INPUT	MAXIMUM YEAR	SS LOADING (tonnes)	SS LOADING (%)
TRIBUTARY	2010-11	7,478,107	95.9
STORMWATER	2010-11	188,880	2.4
CSO	2005-06	60,509	0.8
WWTP	2002-03	66,118	0.8
SUM		7,793,613	100
ALL SOURCES	2010-11	7,787,576	

Table 3-23. CARP 2 Solids Loadings Summary Results (tonnes) All External Sources - Minimum Water Year

MODEL INPUT	MINIMUM YEAR	SS LOADING (tonnes)	SS LOADING (%)
TRIBUTARY	2001-02	634,881	74.5
STORMWATER	2015-16	133,551	15.7
CSO	2015-16	27,513	3.2
WWTP	2015-16	56,670	6.6
SUM		852,616	100
ALL SOURCES	2001-02	858,302	

Table 3-24. CARP 2 PCB Loadings Summary Results (kg) All External Sources - Closest to Average Water Year			
MODEL INPUT	NEAR AVERAGE YEAR	PCB LOADING (kg)	PCB LOADING (%)
TRIBUTARY	2014-15	334.0	18.4
STORMWATER	2002-03	156.3	8.6
CSO	2009-10	34.82	1.9
WWTP	2007-08	47.97	2.6
LANDFILL	2012-13	0.695	0.0
ATMOSPHERIC	CONSTANT	1,242	68.4
SUM		1,816	100.0
ALL SOURCES	2011-12	1,820	

Table 3-25. CARP 2 PCB Loadings Summary Results (kg) All External Sources - Maximum Water Year			
MODEL INPUT	MAXIMUM YEAR	PCB LOADING (kg)	PCB LOADING (%)
TRIBUTARY	2010-11	716.5	31.8
STORMWATER	2006-07	190.1	8.4
CSO	2010-11	51.67	2.3
WWTP	2002-03	53.50	2.4
LANDFILL	2010-11	1.018	0.0
ATMOSPHERIC	CONSTANT	1,242	55.1
SUM		2,255	100.0
ALL SOURCES	2010-11	2,240	

Table 3-26. CARP 2 PCB Loadings Summary Results (kg) All External Sources - Minimum Water Year			
MODEL INPUT	MINIMUM YEAR	PCB LOADING (kg)	PCB LOADING (%)
TRIBUTARY	2015-16	137.4	8.7
STORMWATER	2004-05	127.0	8.1
CSO	2015-16	22.50	1.4
WWTP	2015-16	42.74	2.7
LANDFILL	2004-05	0.459	0.0
ATMOSPHERIC	CONSTANT	1,242	79.0
SUM		1,572	100.0
ALL SOURCES	2015-16	1,590	

Table 3-27. CARP 2 2,3,7,8-TCDD Loadings Summary Results (kg) All External Sources – Closest to Average Water Year			
MODEL INPUT	NEAR AVERAGE YEAR	2,3,7,8-TCDD LOADING (kg)	LOADING (%)
TRIBUTARY	2008-09	1.43E-03	10.8
STORMWATER	2009-10	7.97E-04	6.0
CSO	2009-10	1.08E-04	0.8
WWTP	2009-10	1.85E-04	1.4
LANDFILL	2012-13	1.27E-07	0.0
ATMOSPHERIC	2012-13	1.07E-02	80.9
SUM		1.32E-02	100
ALL SOURCES	2012-13	1.32E-02	

Table 3-28. CARP 2 2,3,7,8-TCDD Loadings Summary Results (kg) All External Sources - Maximum Water Year			
MODEL INPUT	MAXIMUM YEAR	2,3,7,8-TCDD LOADING (kg)	LOADING (%)
TRIBUTARY	2010-11	2.57E-03	14.7
STORMWATER	2006-07	1.10E-03	6.3
CSO	2010-11	1.47E-04	0.8
WWTP	2002-03	2.06E-04	1.2
LANDFILL	2010-11	1.86E-07	0.0
ATMOSPHERIC	2010-11	1.34E-02	76.9
SUM		1.75E-02	100
ALL SOURCES	2010-11	1.74E-02	

Table 3-29. CARP 2 2,3,7,8-TCDD Loadings Summary Results (kg) All External Sources – Minimum Water Year			
MODEL INPUT	MINIMUM YEAR	2,3,7,8-TCDD LOADING (kg)	LOADING (%)
TRIBUTARY	2001-02	6.69E-04	6.6
STORMWATER	2004-05	5.55E-04	5.5
CSO	2015-16	8.34E-05	0.8
WWTP	2015-16	1.61E-04	1.6
LANDFILL	2004-05	8.37E-08	0.0
ATMOSPHERIC	2004-05	8.69E-03	85.5
SUM		1.02E-02	100.0
ALL SOURCES	2001-02	1.04E-02	

APPENDICES

LIST OF APPENDICES

APPENDIX 1

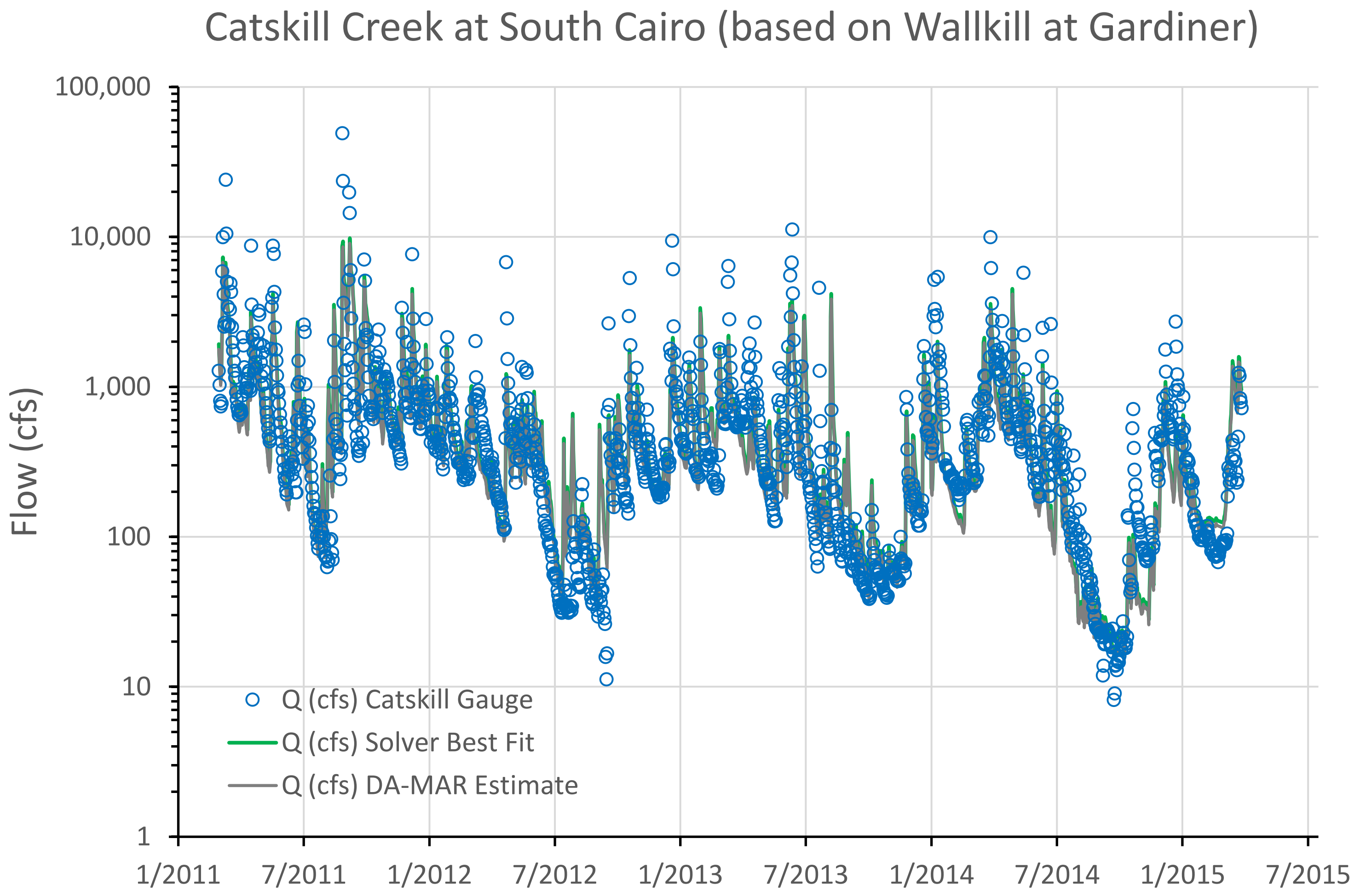
Head-of-Tide Hydrographs Development Method Diagrams

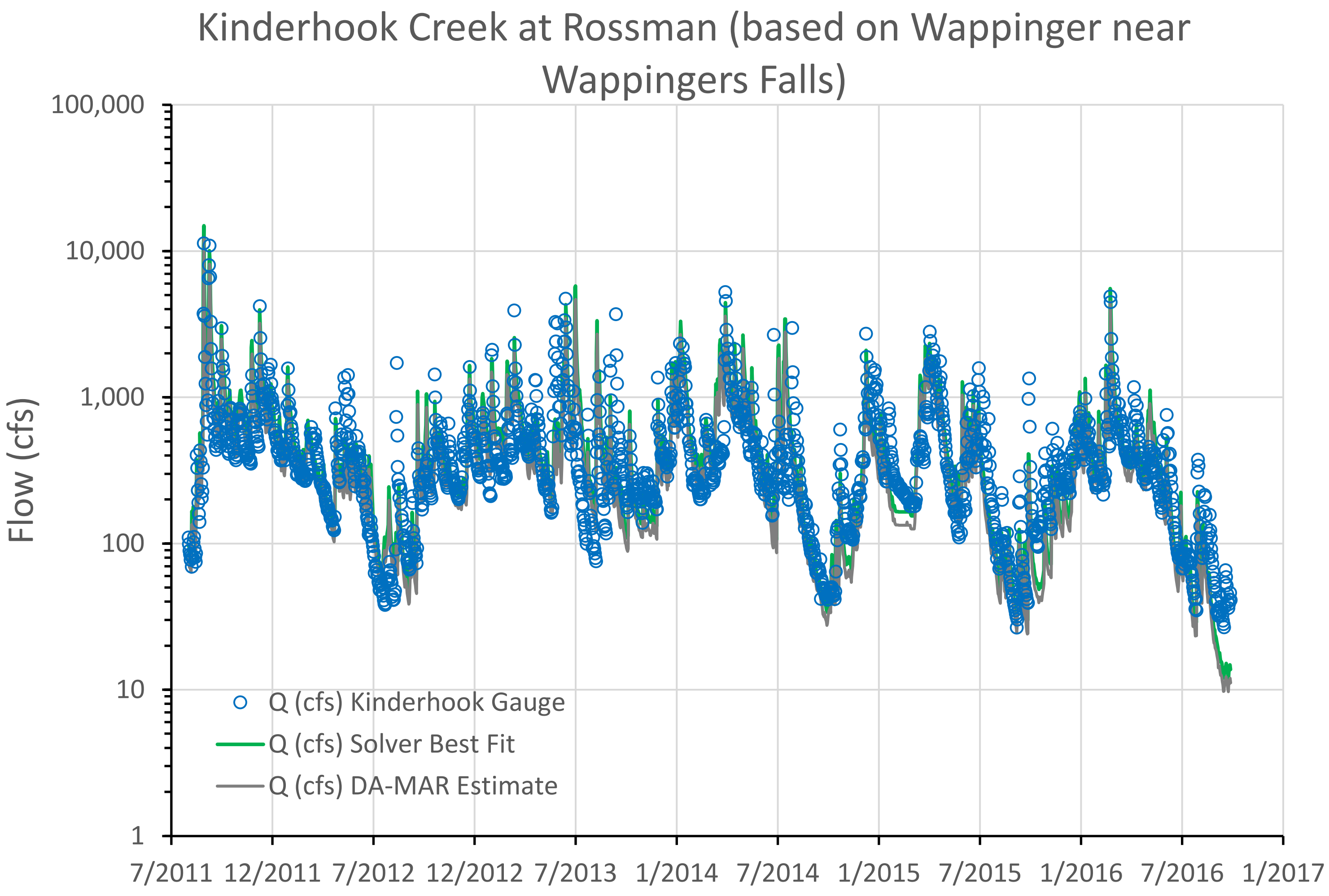
Diagrams showing: Log bias and log precision for the estimated flows; log time series and log probability distributions for measured and estimated flows

Comparisons of Estimated and Measured Flows for Gauge Stations with Partial Records

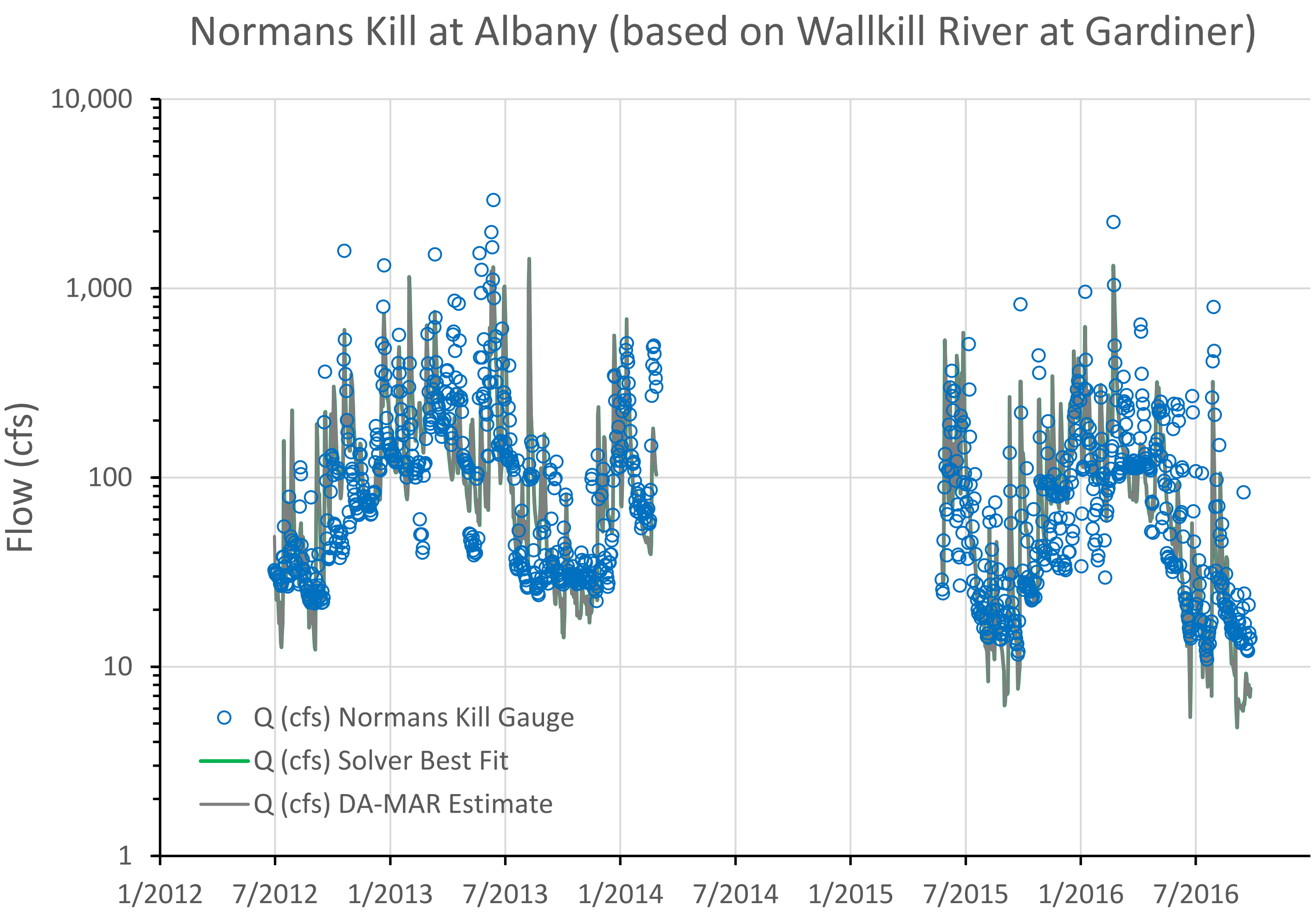
Location	Drainage Area (mi^2)	Mean Annual Runoff (in)	Dates	Gauge for Estimates	log Bias	log Precision
East Side Tributaries						
Kinderhook Creek at Rossman NY	327	17.9	8/1/2011 - 9/30/2016	Wappinger	-0.091	0.245
Roeliff Jansen Kill near Linlithgo NY	214	21.3	3/1/2011 - 2/28/2014	Croton[1]	-0.042	0.204
West Side Tributaries						
Catskill Creek at South Cairo NY	268	21.9	3/1/2011 - 3/31/2015	Wallkill	-0.034	0.275
Normans Kill at Albany NY	170	18.2	7/1/2012 - 9/30/2016	Wallkill	0.000	0.292
Rondout Creek at Rondout NY	1190	22.4	3/1/2011 - 3/31/2015	Wallkill	-0.002	0.148

Notes:
[1]For final flow estimation, Wappinger Creek, not Croton River, was used to estimate daily flows for periods when the Roeliff Jansen Kill was not gaged. The comparison included here is for method demonstration purposes only.

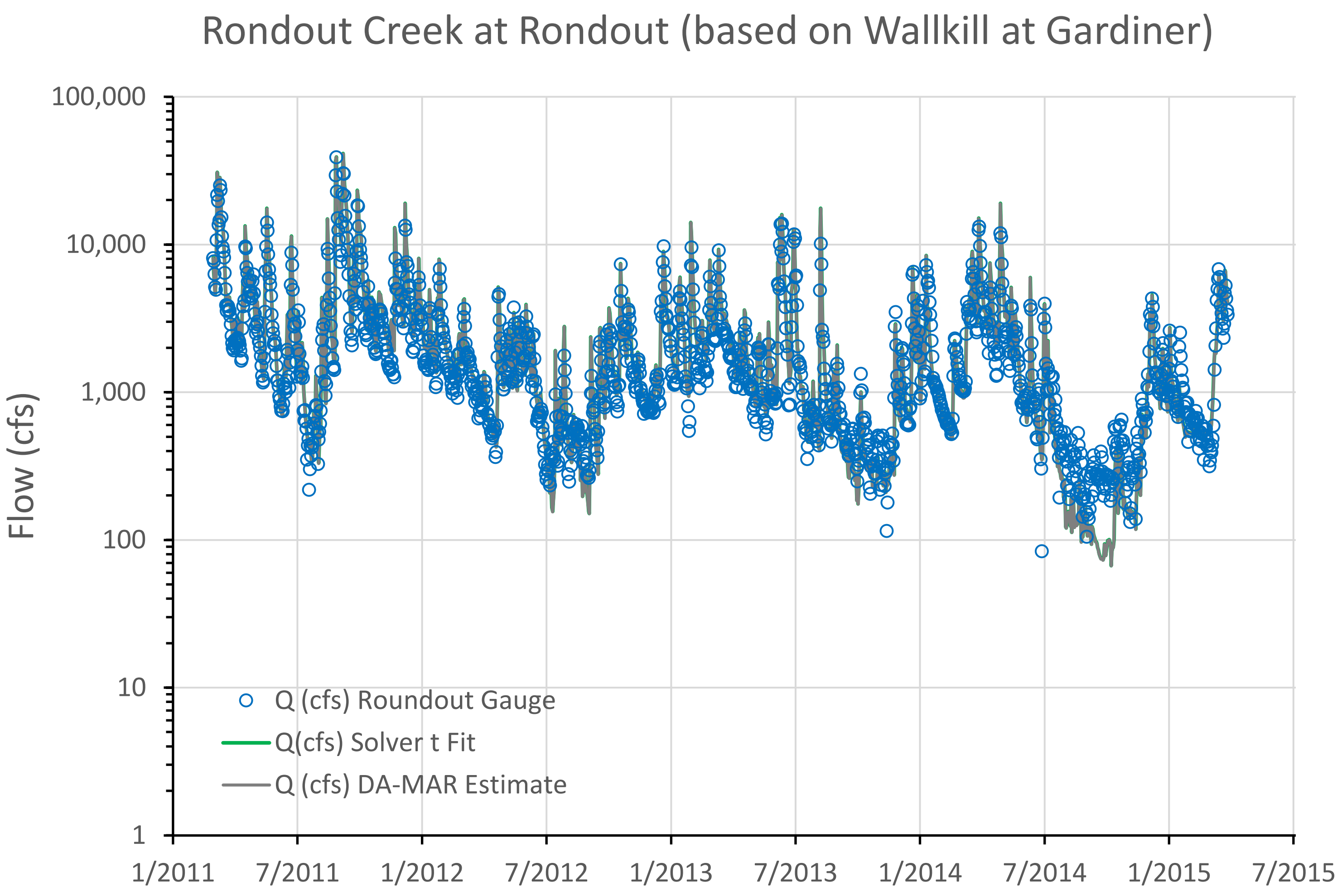

Catskill Creek at South Cairo (based on Wallkill at Gardiner)
100,000
10,000
1,000
100
10
1
Flow (cfs)
Q (cfs) Catskill Gauge
Q (cfs) Solver Best Fit
Q (cfs) DA-MAR Estimate
1/2011
7/2011
1/2012
7/2012
1/2013
7/2013
1/2014
7/2014
1/2015
7/2015



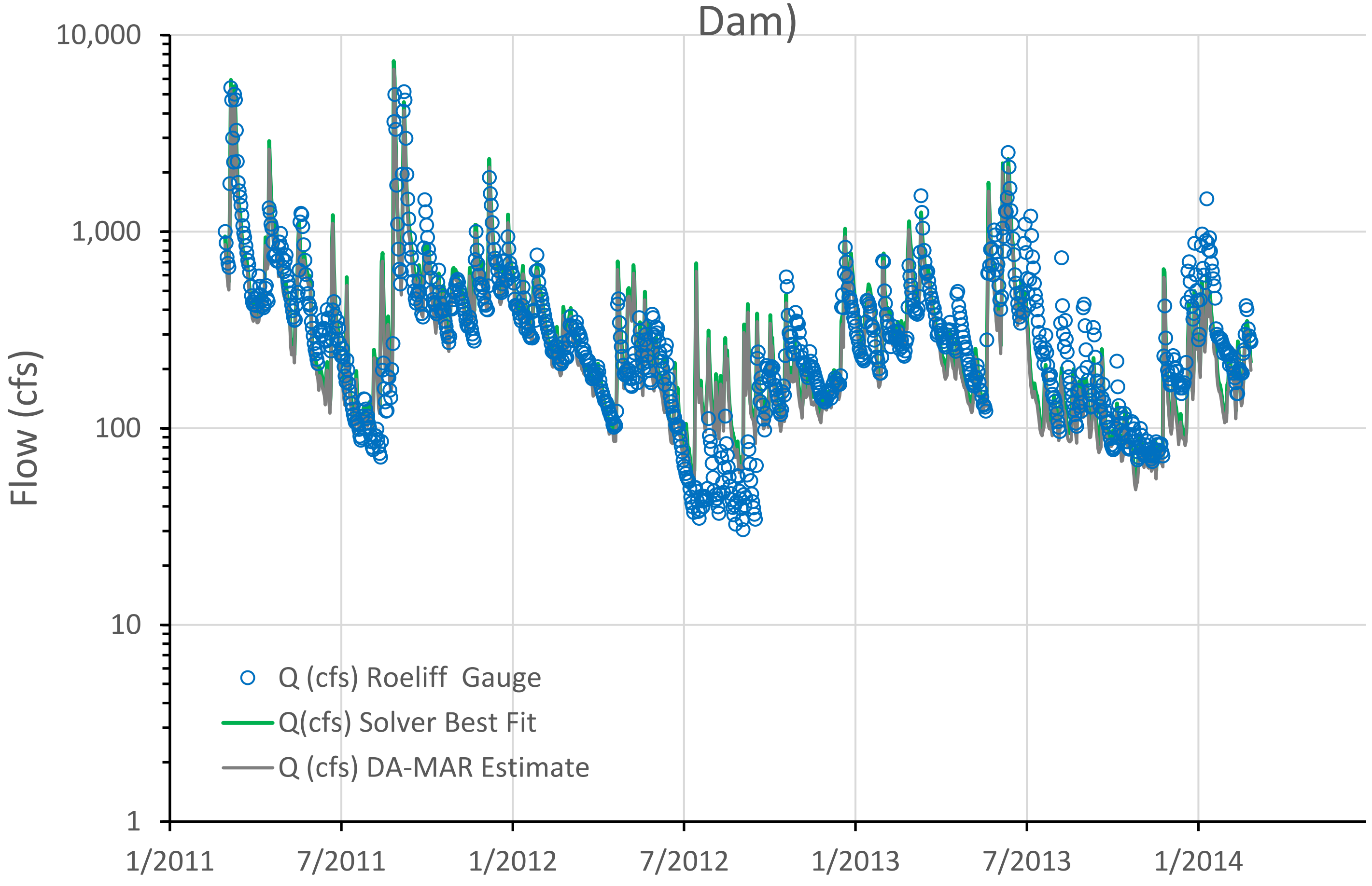
Kinderhook Creek at Rossman (based on Wappinger near Wappingers Falls)
Flow (cfs)
100,000
10,000
1,000
100
10
1
7/2011
12/2011
7/2012
12/2012
7/2013
1/2014
7/2014
1/2015
7/2015
1/2016
7/2016
1/2017
Q (cfs) Kinderhook Gauge
Q (cfs) Solver Best Fit
Q (cfs) DA-MAR Estimate

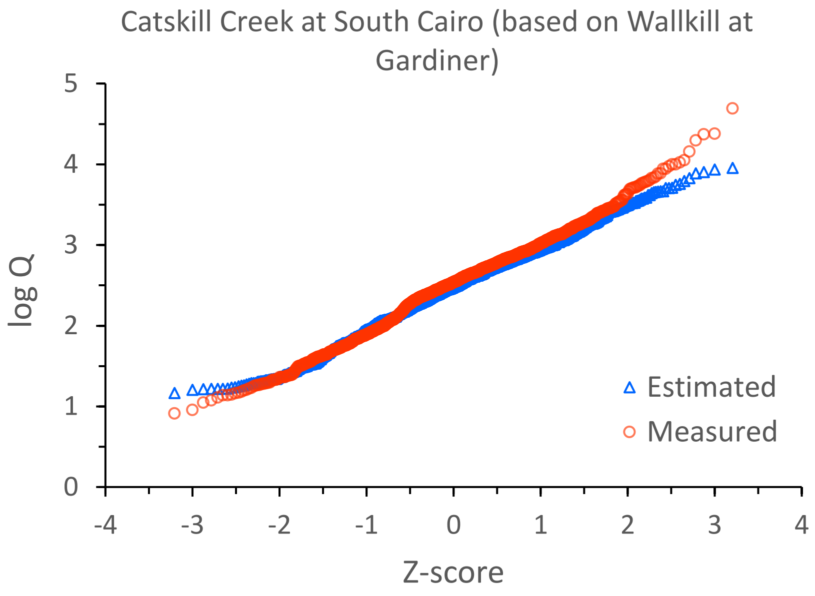

Normans Kill at Albany (based on Wallkill River at Gardiner)
Flow (cfs)
10,000
1,000
100
10
1
1/2012
7/2012
1/2013
7/2013
1/2014
7/2014
1/2015
7/2015
1/2016
7/2016
Q (cfs) Normans Kill Gauge
Q (cfs) Solver Best Fit
Q (cfs) DA-MAR Estimate

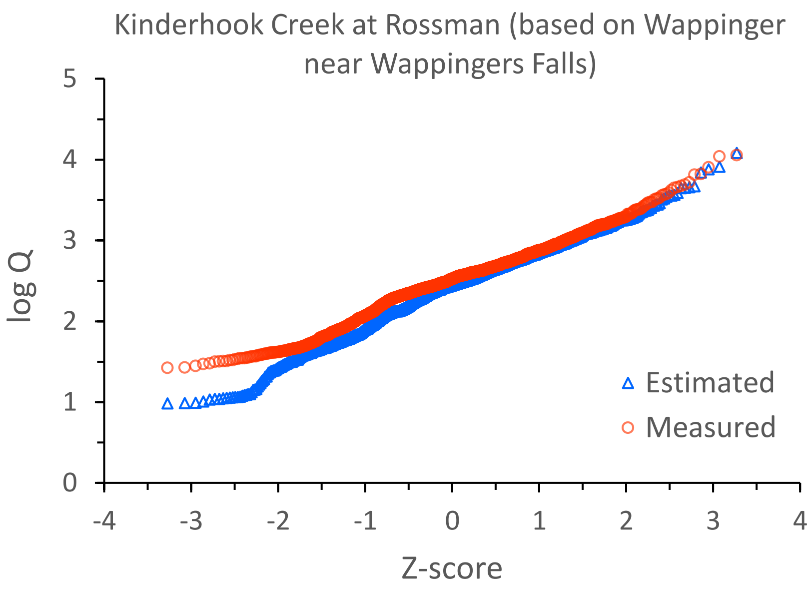
A1 - 4 of 8

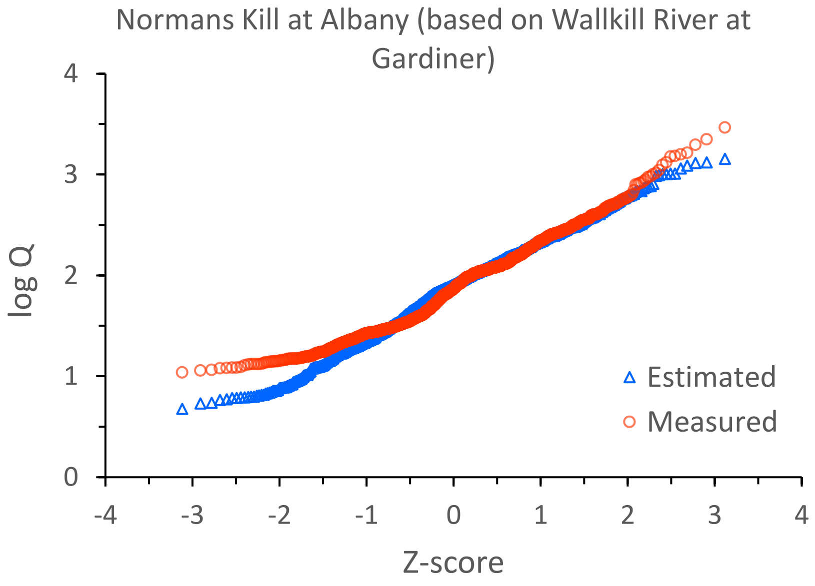

Rondout Creek at Rondout (based on Wallkill at Gardiner)
Flow (cfs)
100,000
10,000
1,000
100
10
1
1/2011
7/2011
1/2012
7/2012
1/2013
7/2013
1/2014
7/2014
1/2015
7/2015
Q (cfs) Roundout Gauge
Q(cfs) Solver t Fit
Q (cfs) DA-MAR Estimate

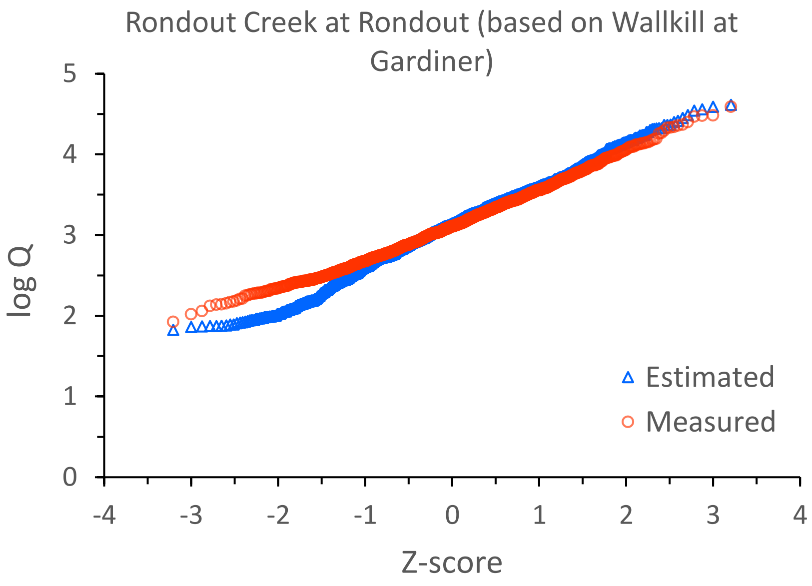
Roeliff Jansen at Linlithgo (based on Croton at New Croton Dam)

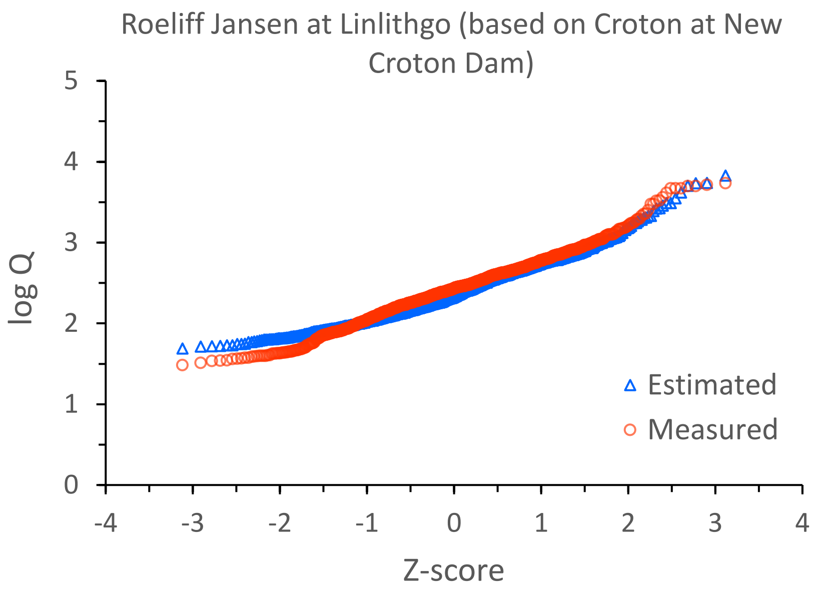



Catskill Creek at South Cairo (based on Wallkill at Gardiner)
log Q
Z-score
Estimated
Measured


Kinderhook Creek at Rossman (based on Wappinger near Wappingers Falls)
log Q
Z-score
Estimated
Measured


Normans Kill at Albany (based on Wallkill River at Gardiner)
log Q
Z-score
Estimated
Measured


Rondout Creek at Rondout (based on Wallkill at Gardiner)
log Q
Z-score
Estimated
Measured

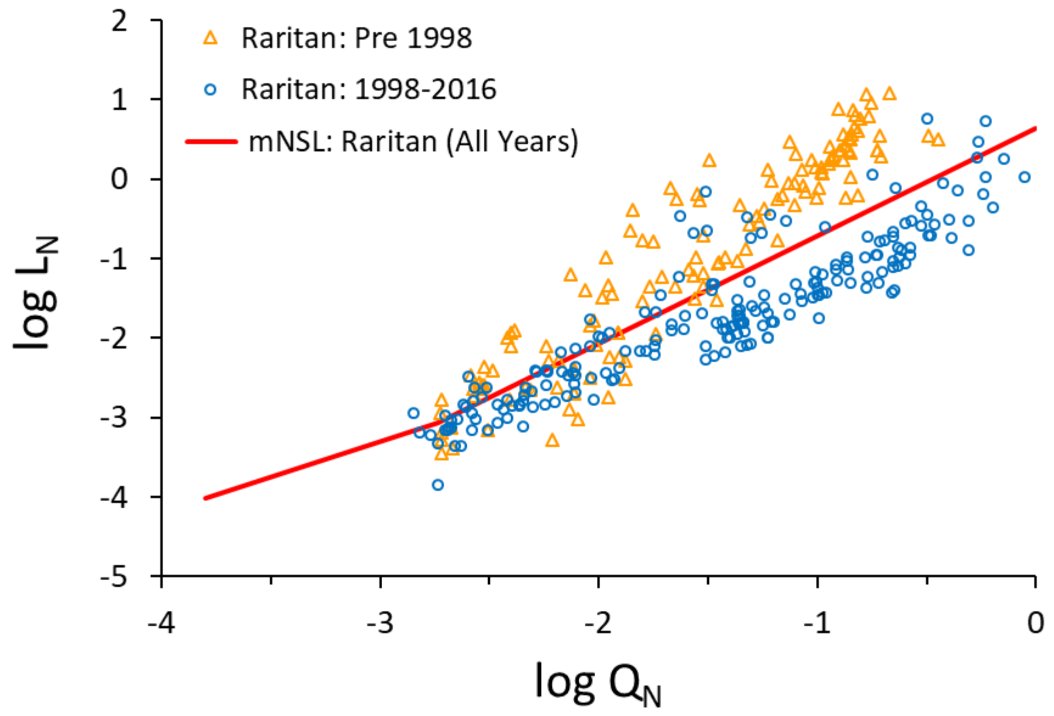

Roeliff Jansen at Linlithgo (based on Croton at New Croton Dam)
log Q
0
1
2
3
4
5
-4
-3
-2
-1
0
1
2
3
4
Z-score
Estimated
Measured

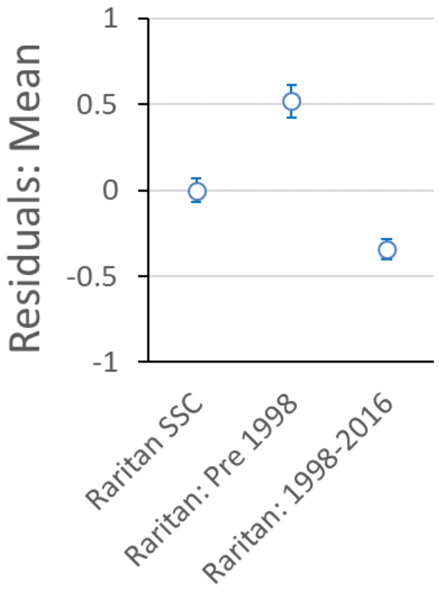
APPENDIX 2

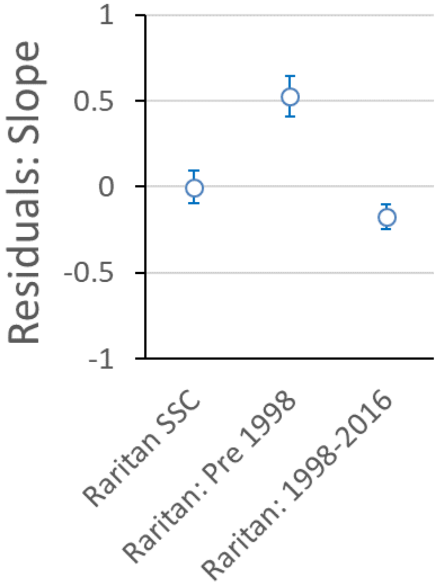
Head-of-Tide Suspended Sediment Loadings Development Method Diagrams

Diagrams showing: mNSL regression results and measurement comparisons; SSC/TSS measurement frequency distributions; and mass errors for mNSL regression estimates

Raritan River: Pre-1998 vs. 1998 – 2016



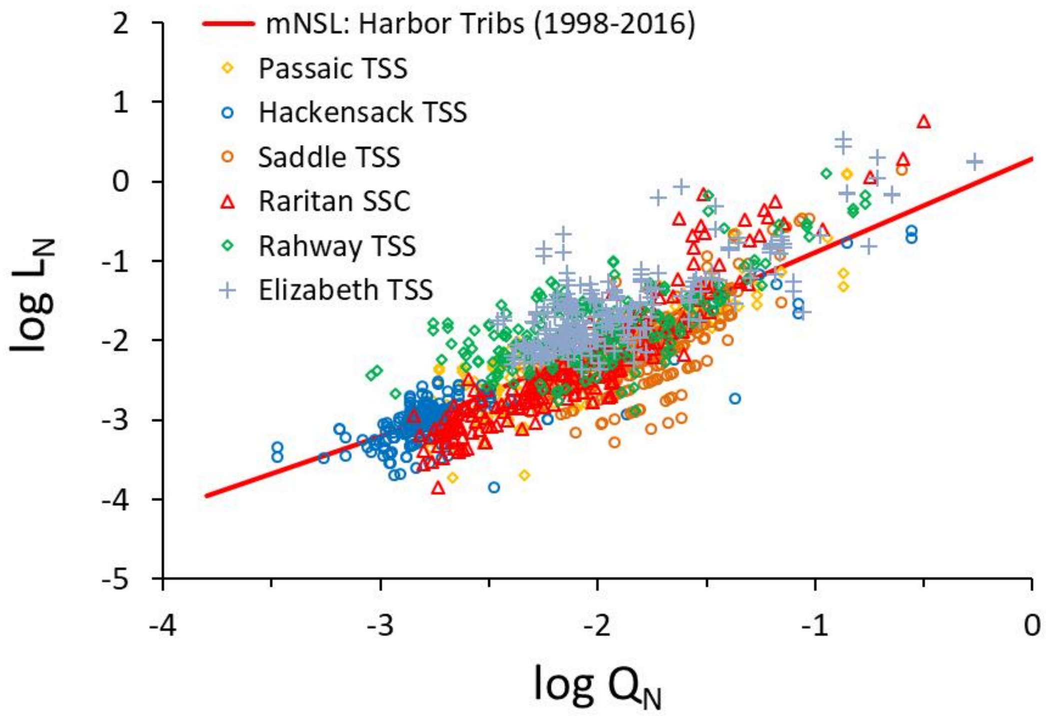


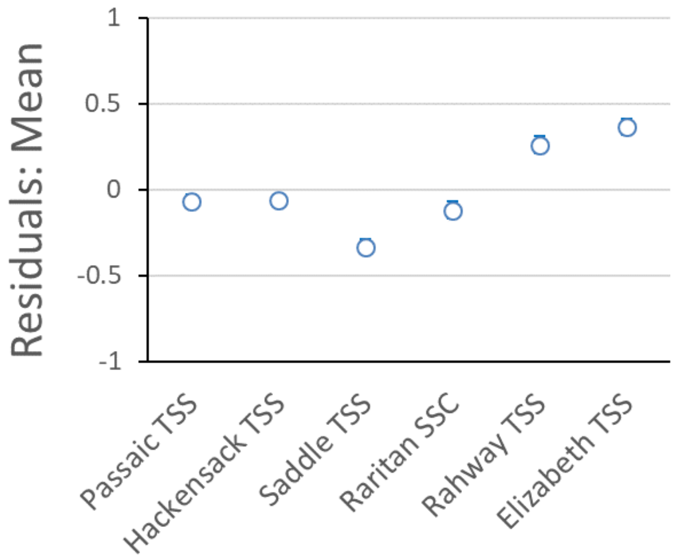


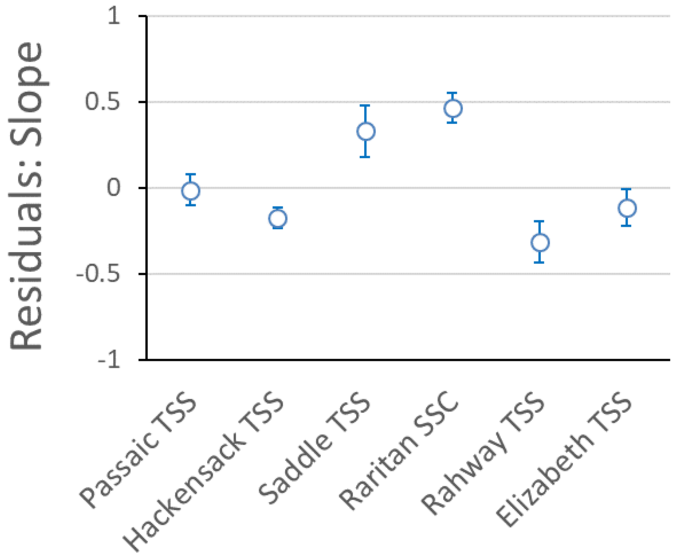
Pre-1998 and 1998-2016 data are from different populations and may reflect changes in land use and/or erosion control measures that were applied over the last few decades.

Use 1998-2016 data for CARP 2 mNSL regressions.

All Harbor Tributaries: 1998 – 2016



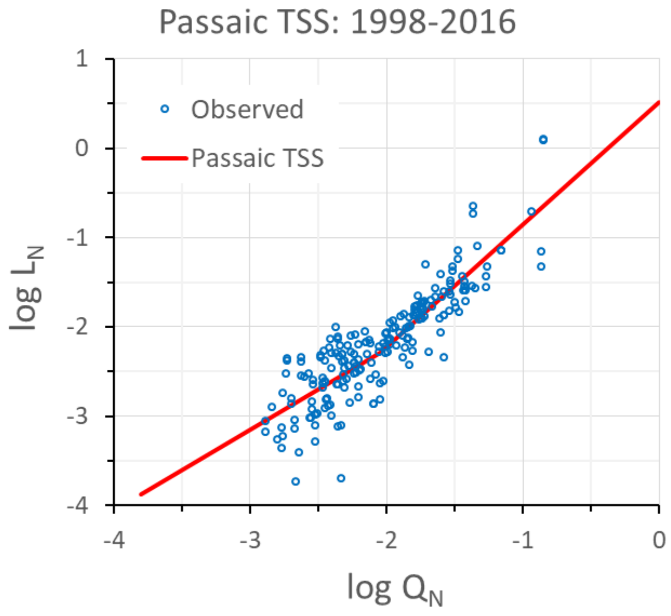


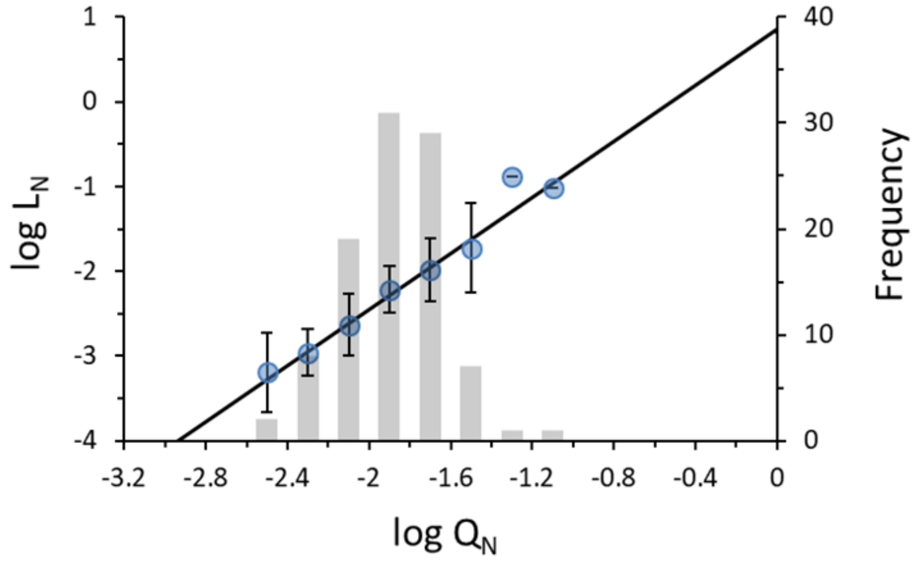


Data for the harbor tributaries appear to be from different populations. In particular, data for the Rahway and Elizabeth Rivers fall above the regression (see positive means for the residuals). Data for the Saddle and Raritan Rivers show increase suspended solids/sediment loads for higher flows (see positive slopes for the residuals).

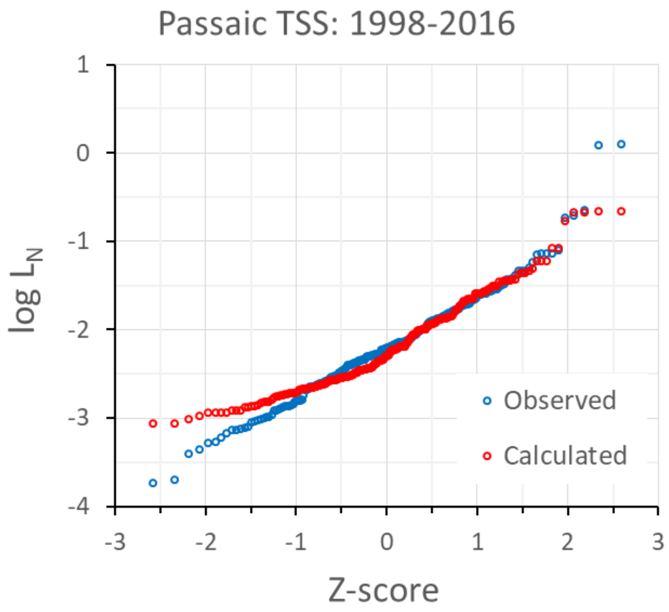
Since there is sufficient data for each tributary, a site-specific mNSL will be developed for each tributary.

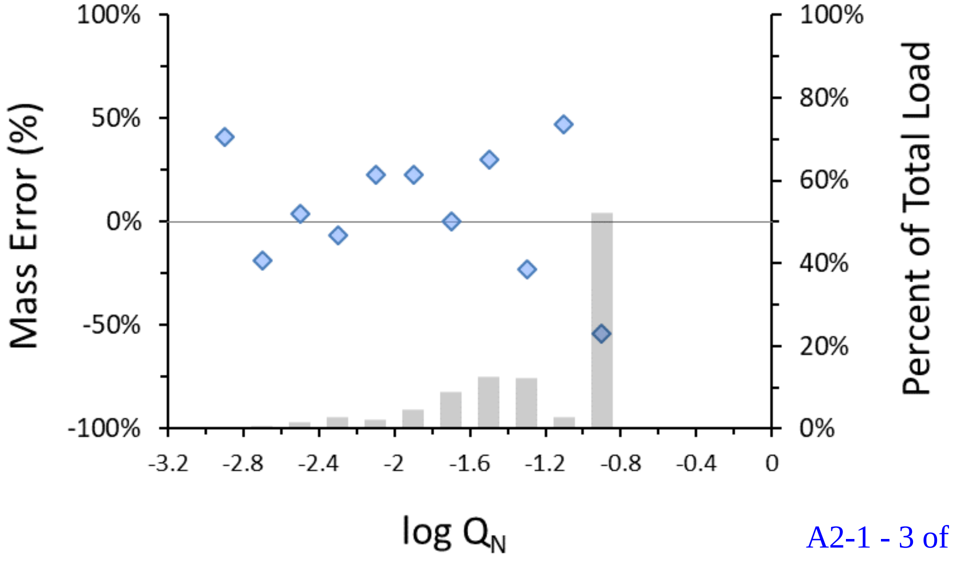
Passaic TSS





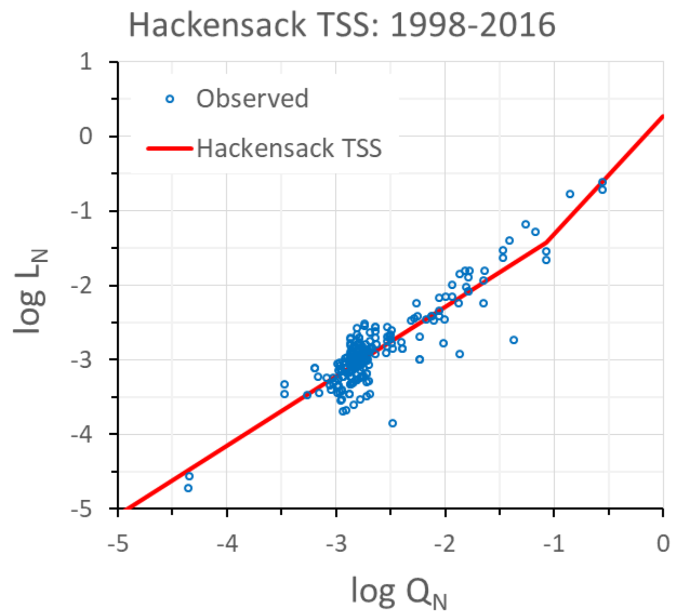
Overall Mass Error -24.6%

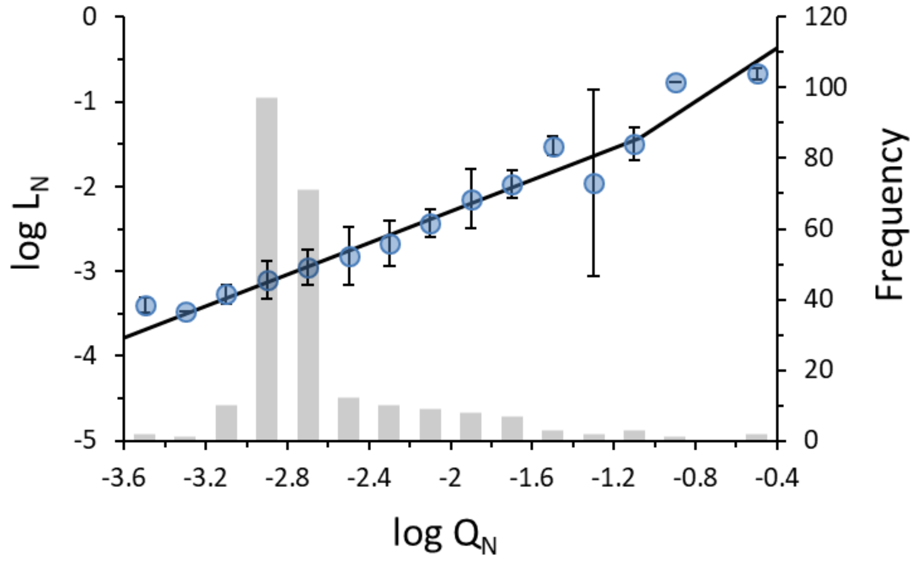




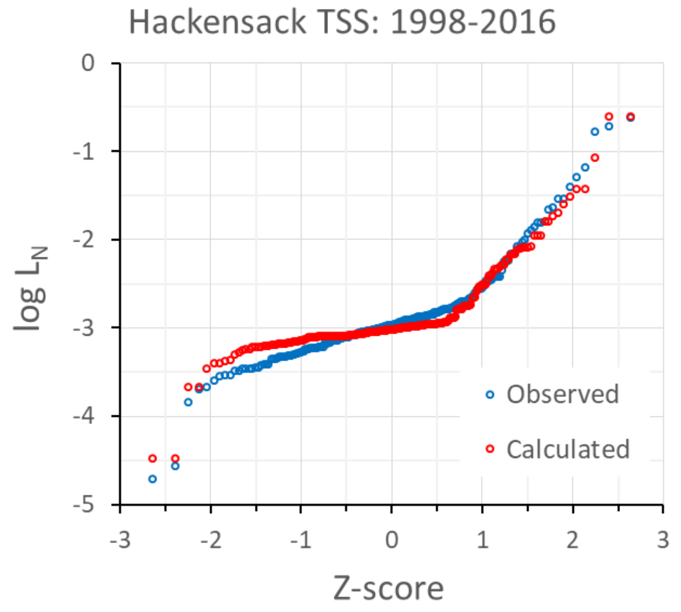
A2-1 - 3 of 13

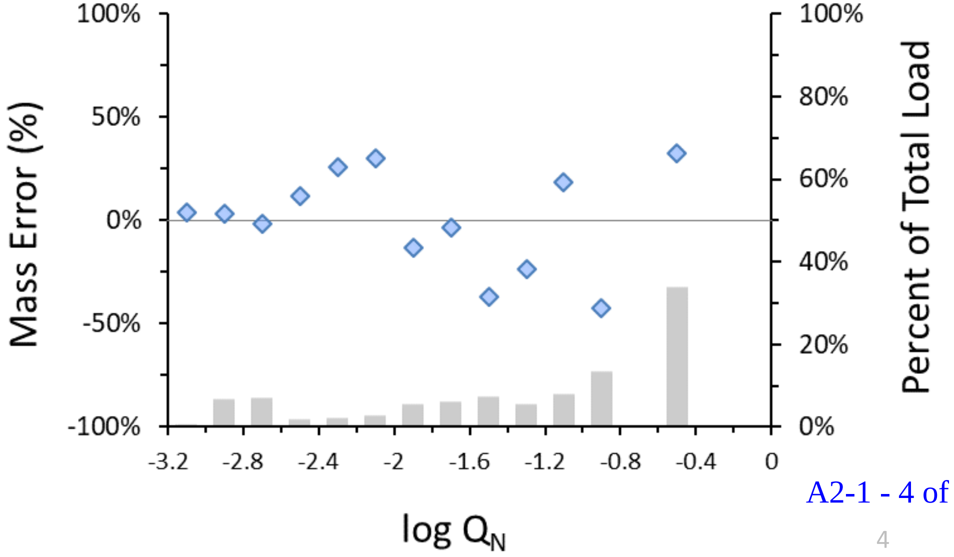
Hackensack TSS



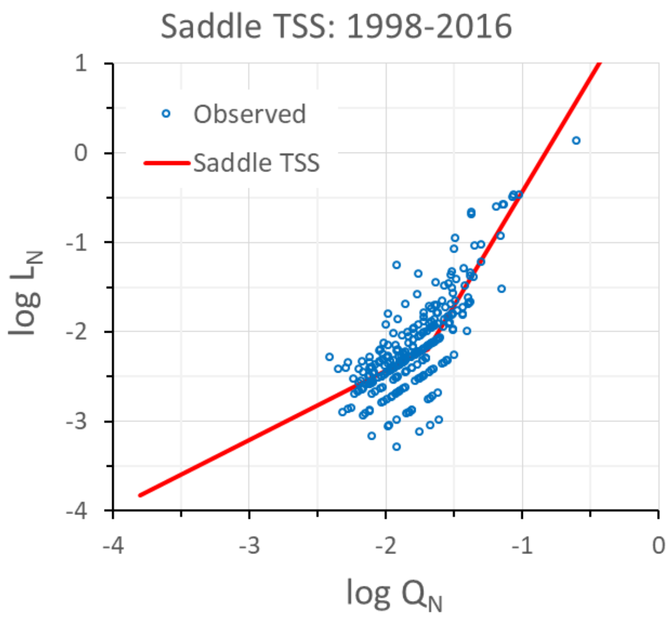


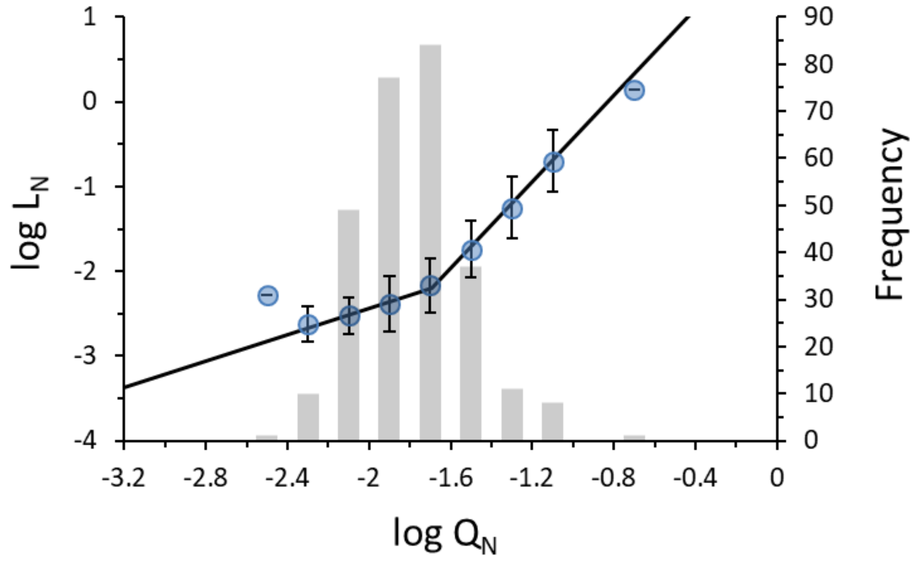
Overall Mass Error 3.6%



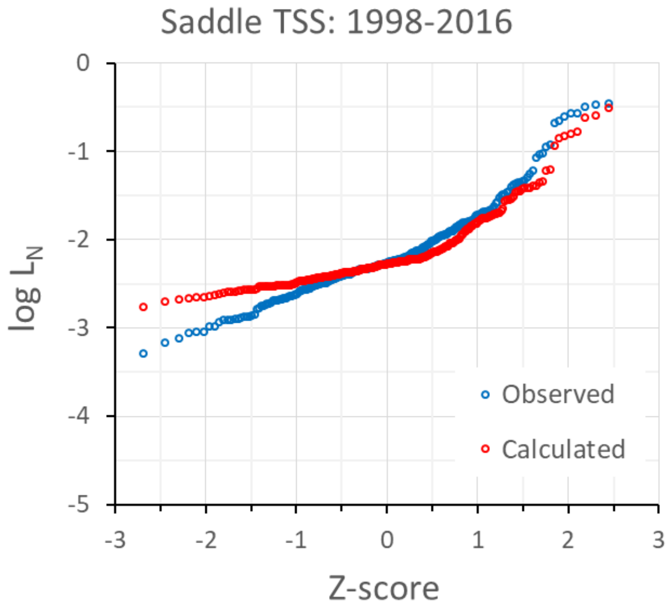


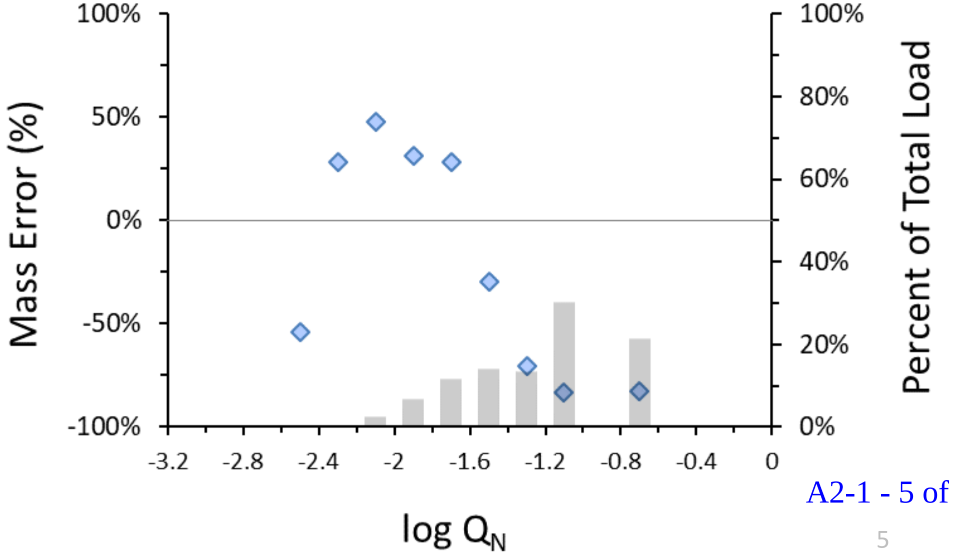
Saddle TSS





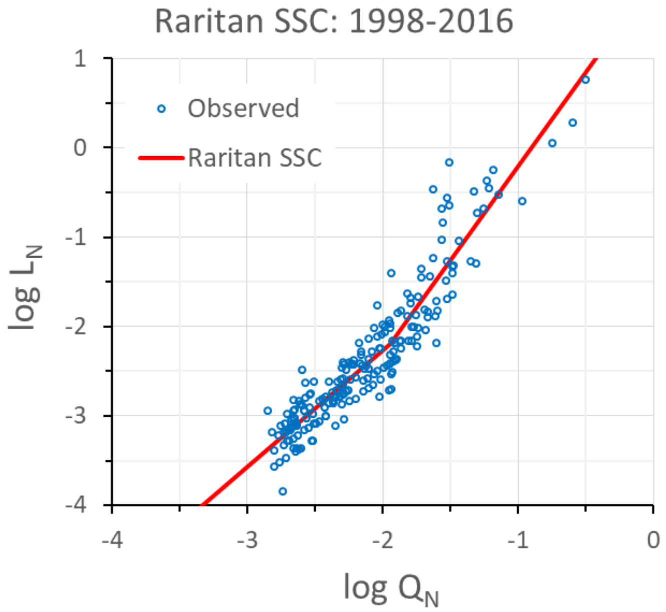
Overall Mass Error -49.7%

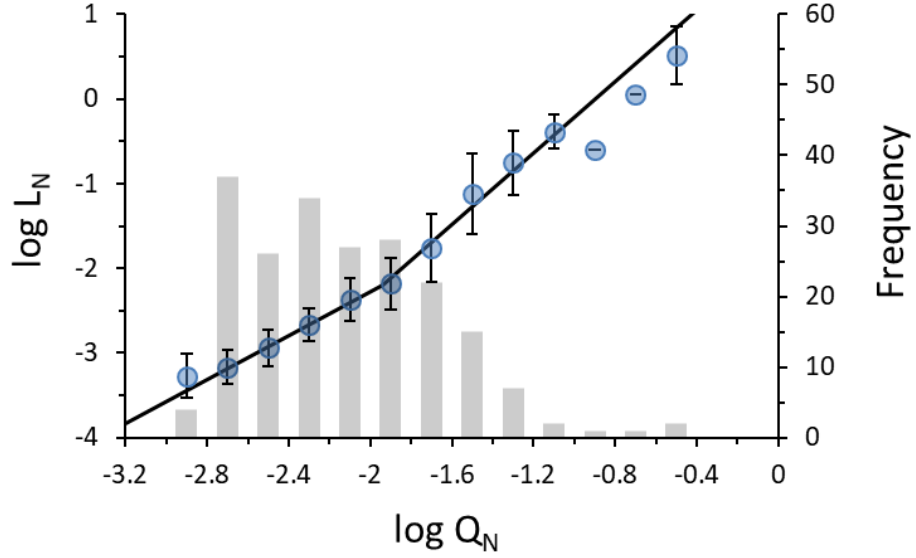




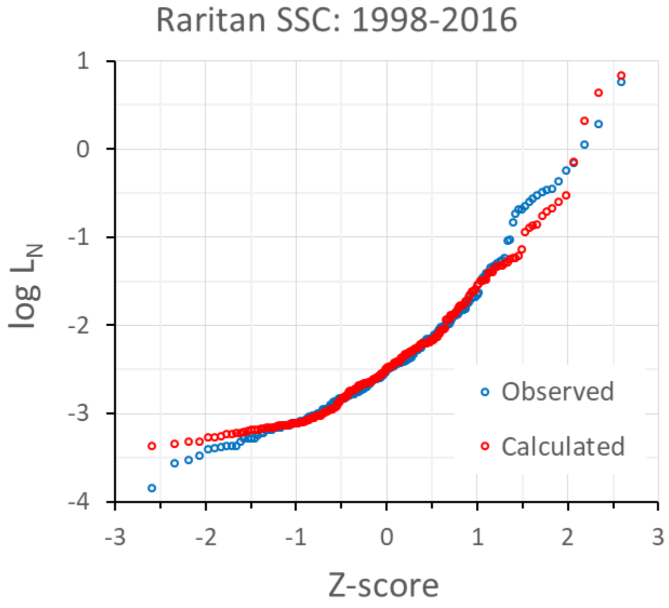
A2-1 - 5 of 13

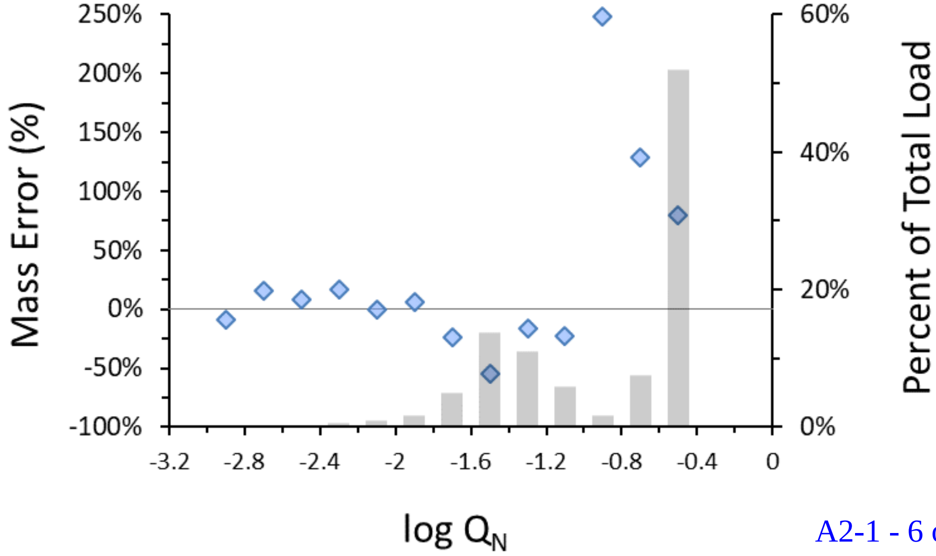
Raritan SSC





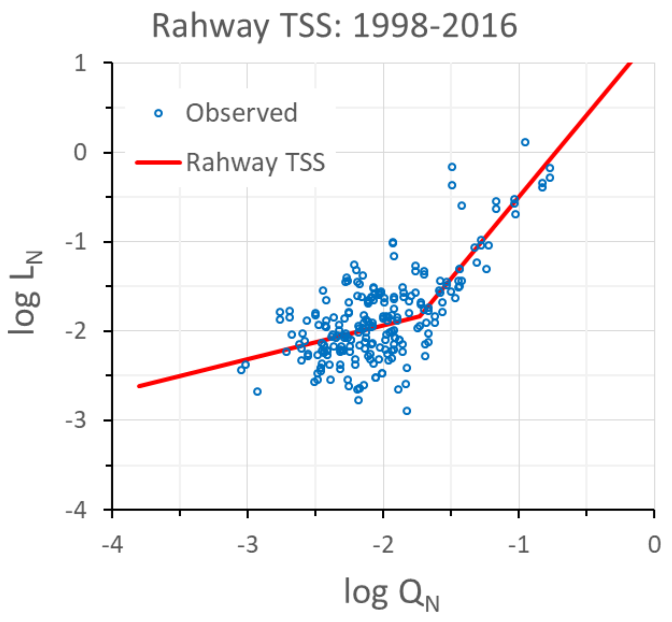
Overall Mass Error 43.6%

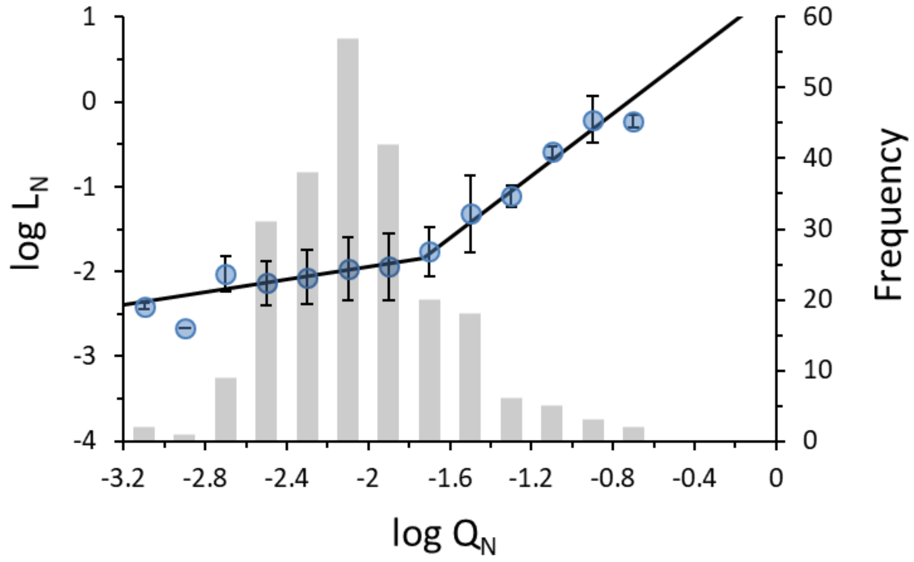


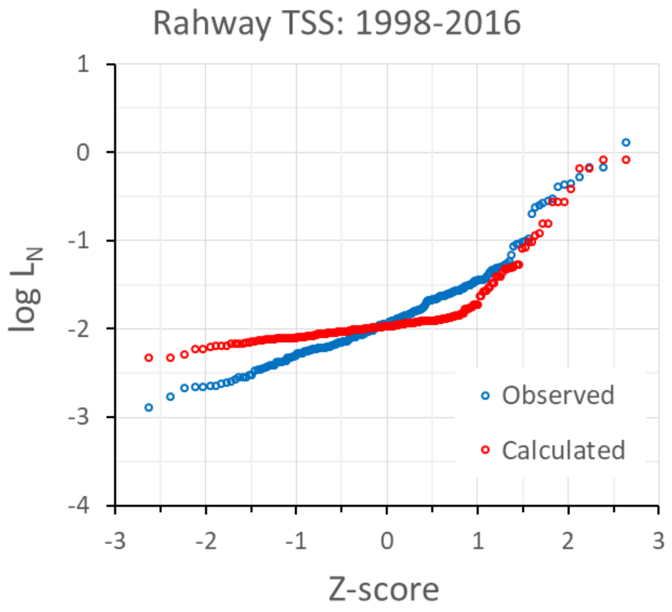


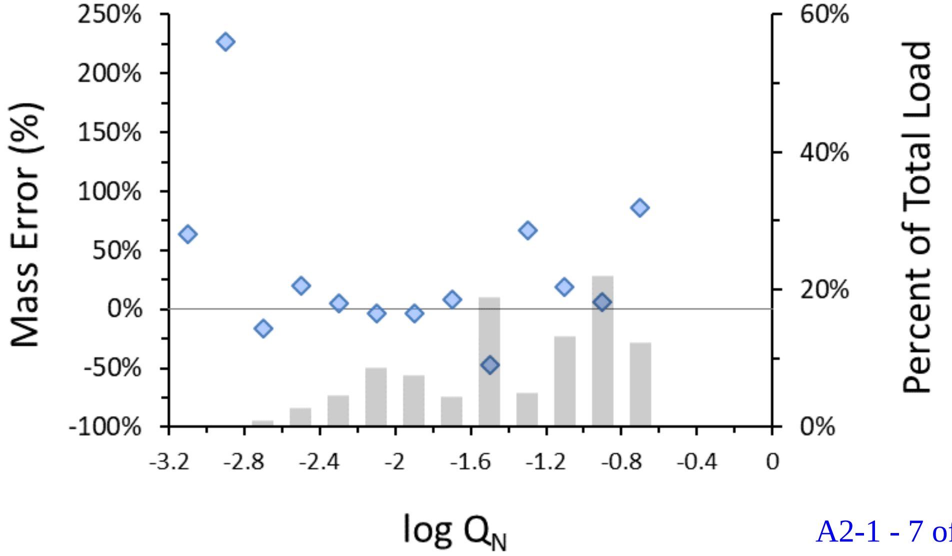
Rahway TSS

Overall Mass Error 9.3%



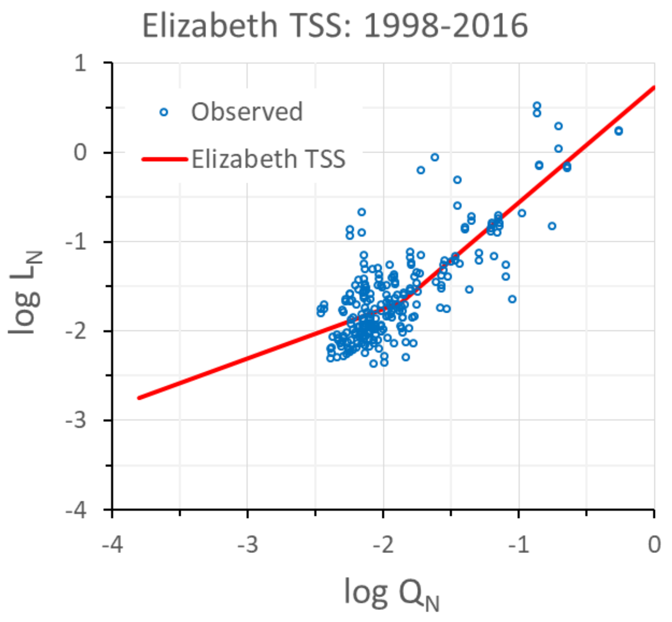


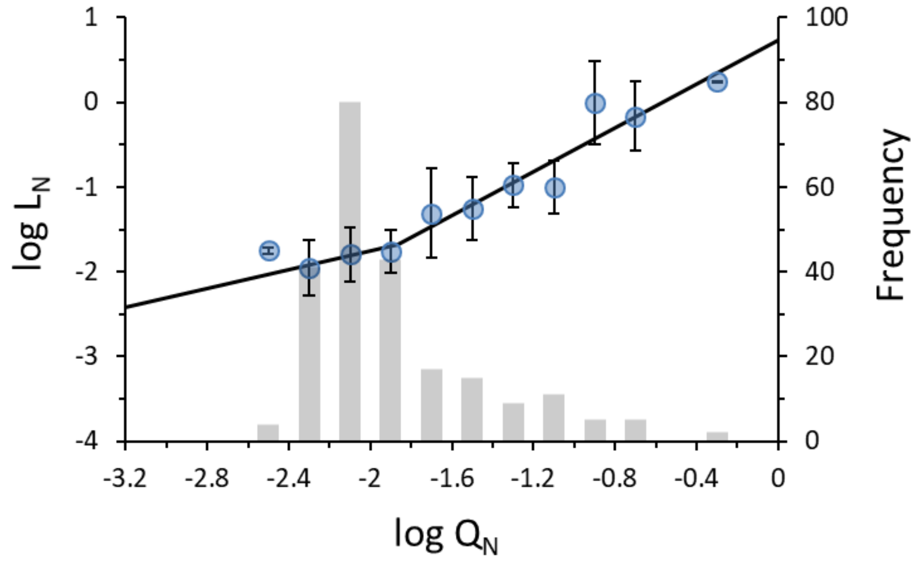




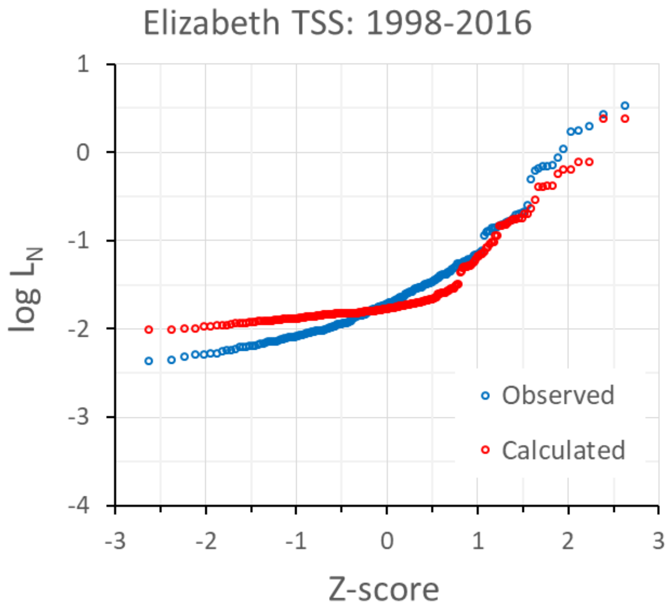
A2-1 - 7 of 13

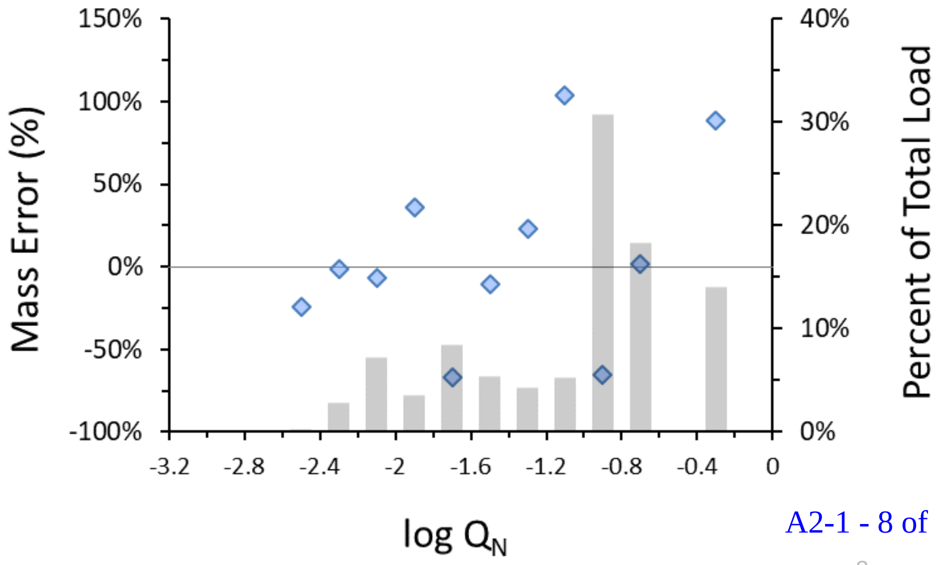
Elizabeth TSS





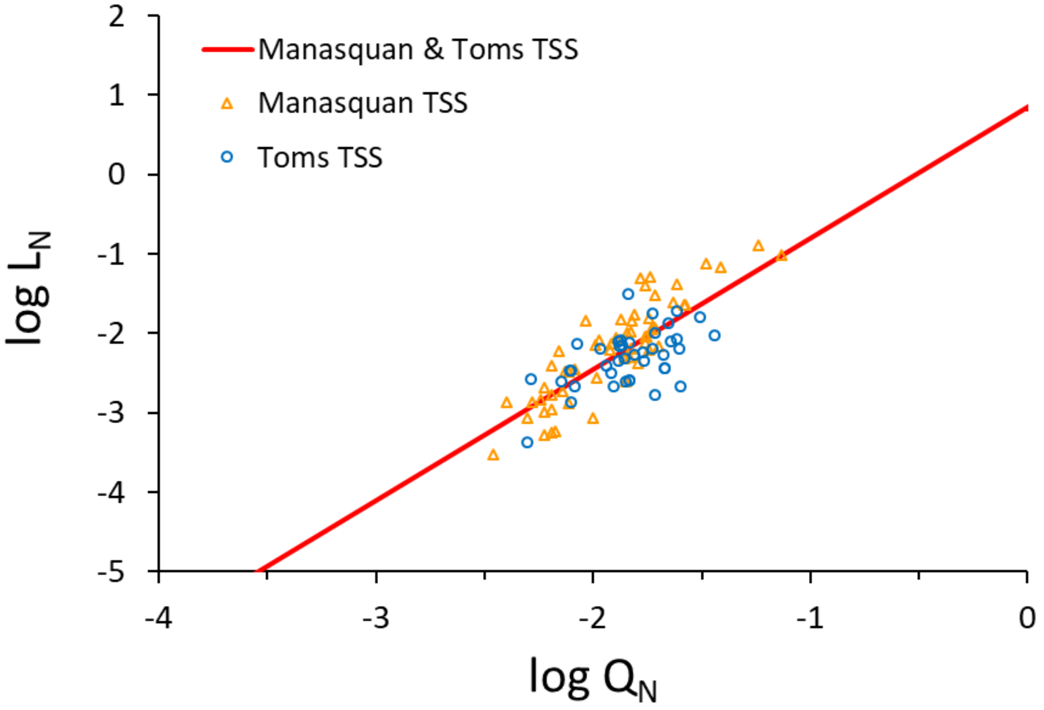
Overall Mass Error -6.5%

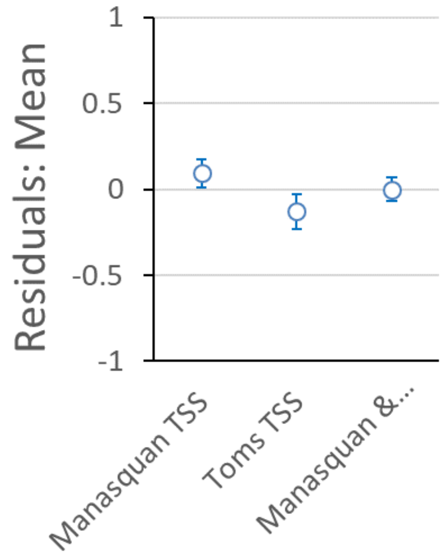


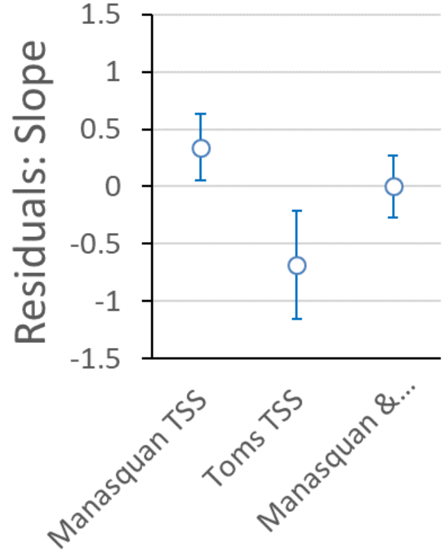


A2-1 - 8 of 13

Non-Harbor Tributaries: 1998 – 2016





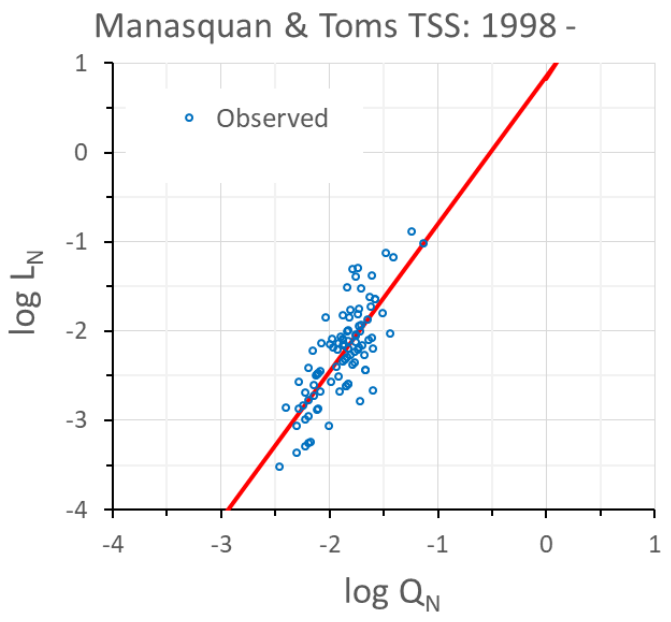


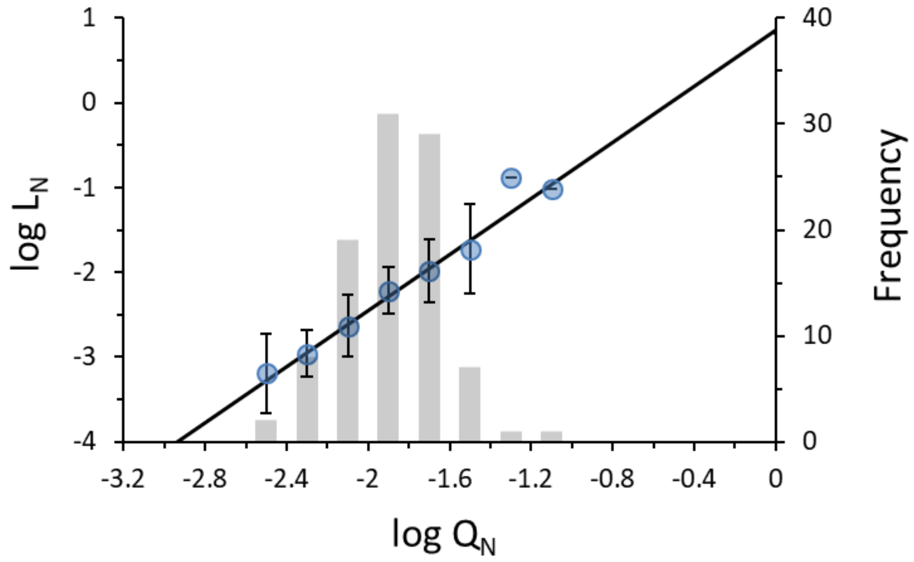
There is limited post-1998 data for two of the non-harbor tributaries: Manasquan River (57 TSS datapoints; 5 SSC datapoints) and Toms River (41 TSS datapoints; 4 SSC datapoints). A mNSL regression was developed for the combined TSS data.

The mean of the residuals for the two rivers indicate that it is reasonable to use the mNSL regression for the combined datasets. The slopes of the residuals showed a larger divergence. This was in part due to the limited range in flow conditions, particularly for the Toms River TSS dataset.

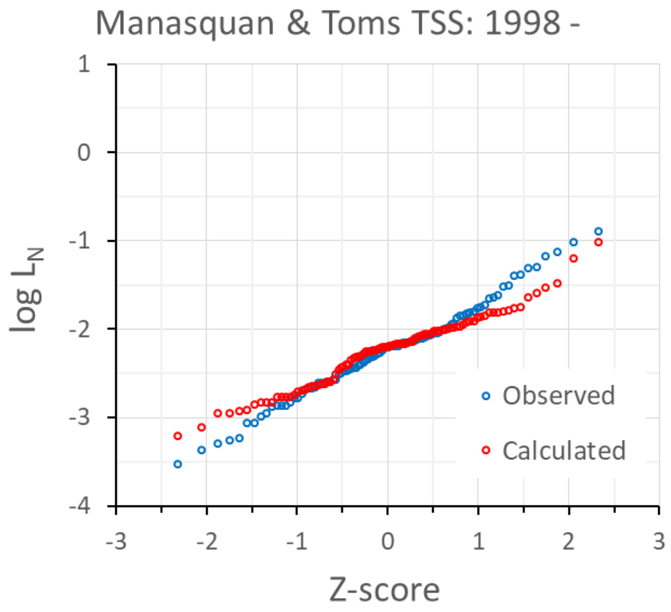
The combined mNSL for the Manasquan and Toms Rivers TSS data will therefore be used in estimating sediment loads for the other no-harbor tributaries.

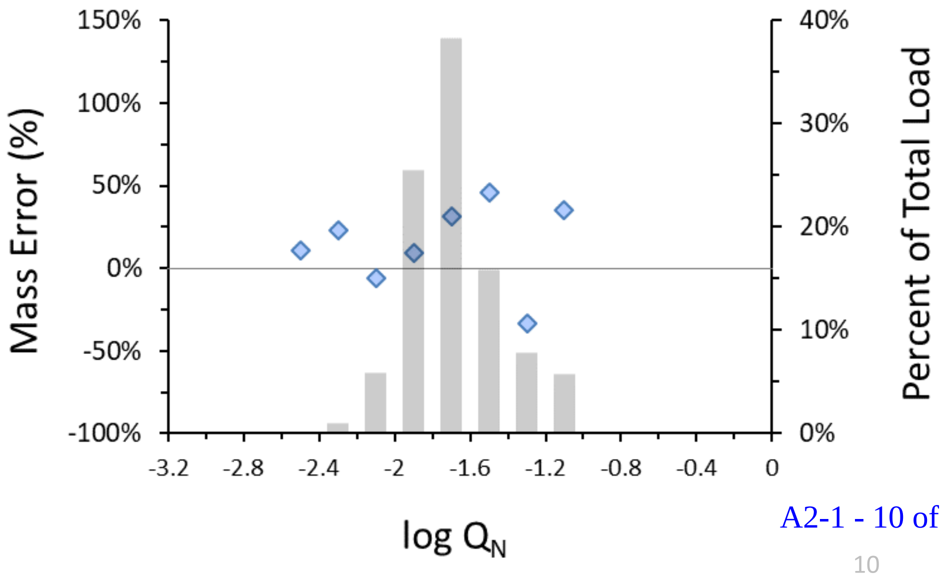
Manasquan & Toms TSS





Overall Mass Error 20.7%

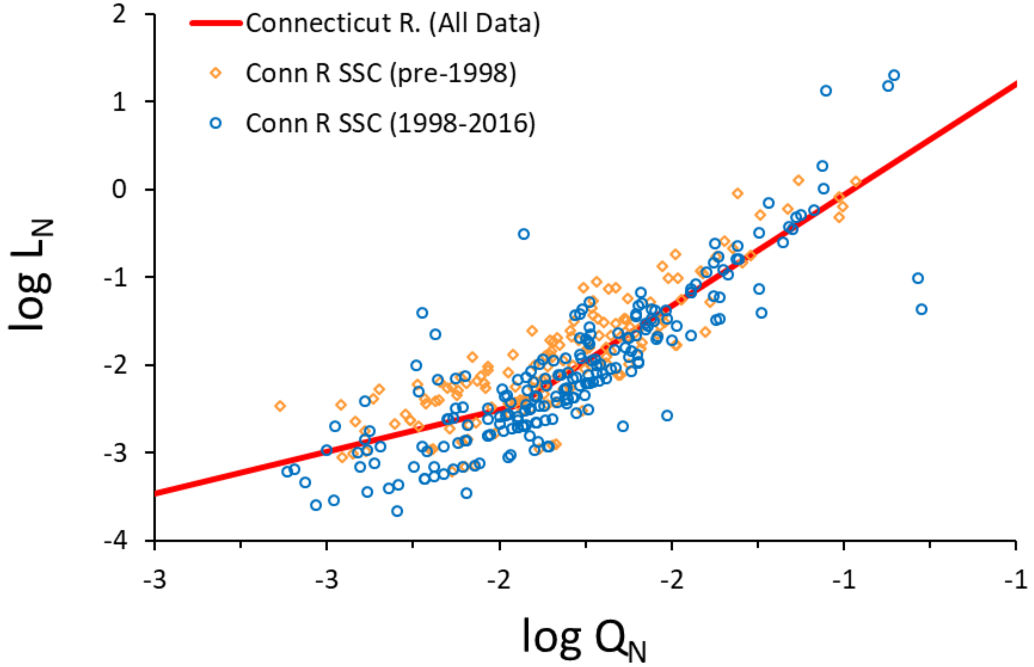


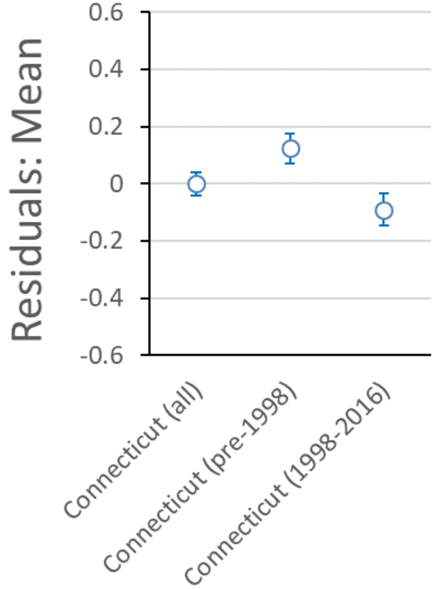


A2-1 - 10 of 13

Connecticut River:

Pre-1998 vs. 1998 – 2016

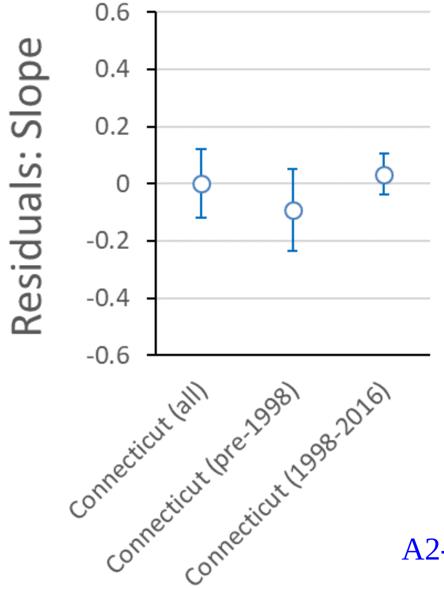




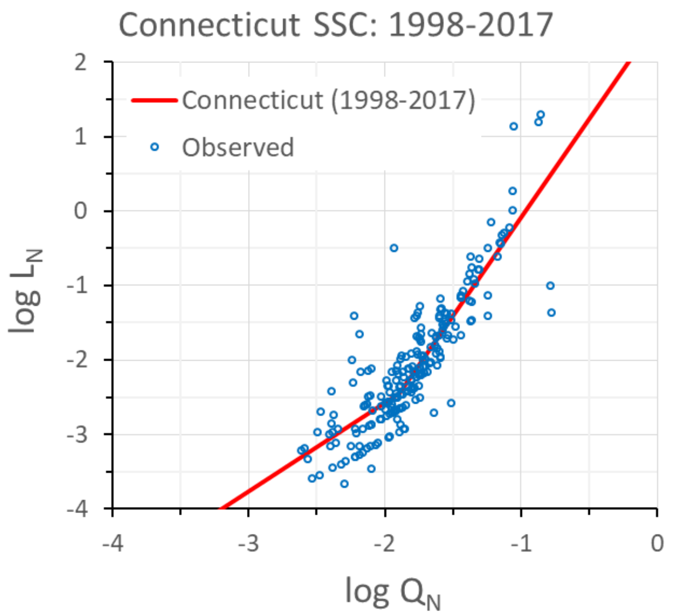
Pre-1998 and 1998-2016 data are from different populations (possibly due to changes in land use). The slopes of the residuals are comparable for the pre-1998 and 1998-2016 periods. Based on the means of the residuals, the pre-1998 sediment loads are approximately 60% higher than the 1998-2016 sediment.

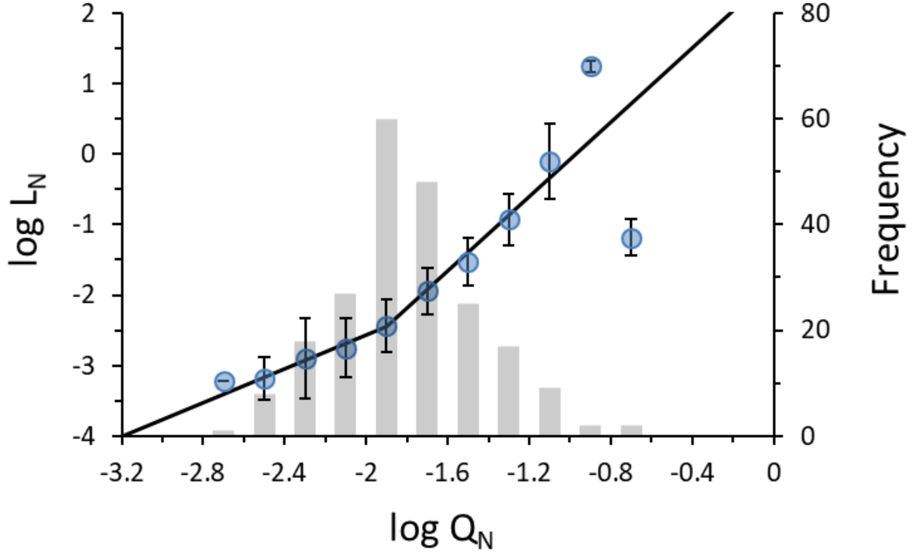
Based on this result (and to be consistent with data analyses for the NY and NJ tributaries), only the 1998-2016 data for the Connecticut River (which represent all but 7 datapoints for the 1998-2016 data) will be used for CARP 2 mNSL regressions.

The mNSL regressions for the 1998-2016 Connecticut River dataset will be applied in estimating sediment loads for all of the CT tributaries.

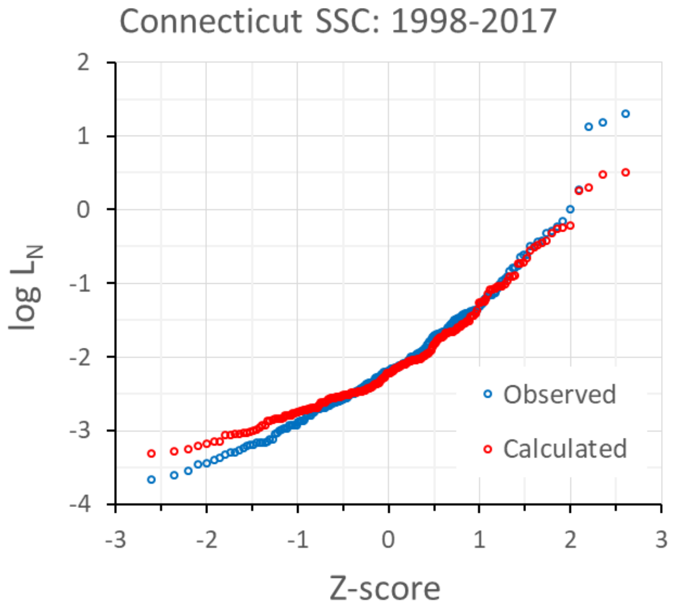


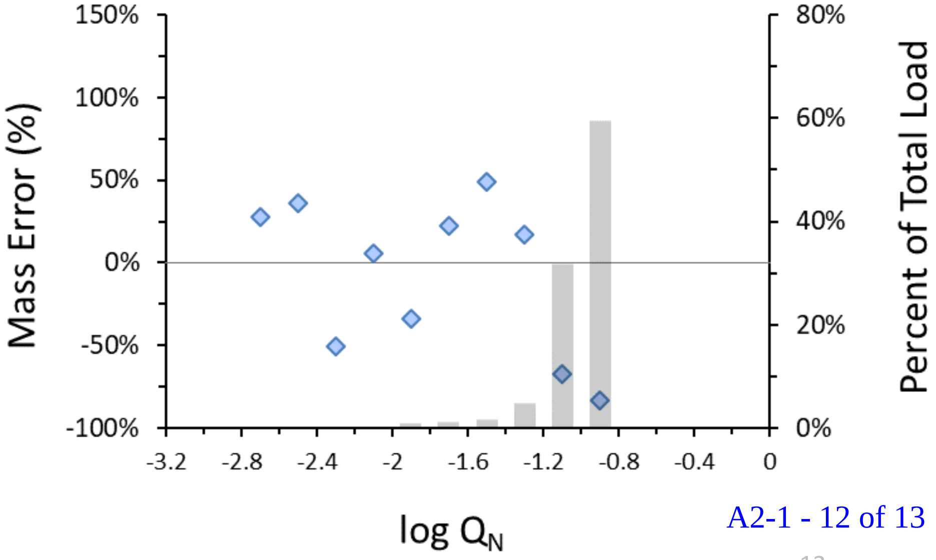
Connecticut (1998-2017)





Overall Mass Error -53.1%





A2-1 - 12 of 13

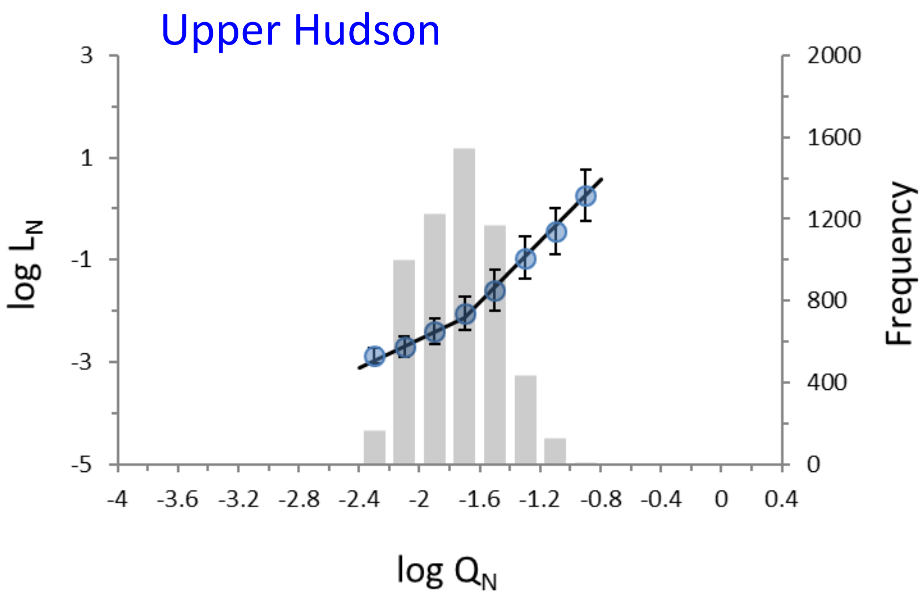
	USGS #	Drainage Area (km^2)	n	log a_1 [a]	b_1 [a]	BrkPt [a]	log a_2 [b]	b_2 [a]	$S_{log\ LN}$
NJ Harbor Tributaries									
Passaic TSS	01389890	2087.4	205	-0.428 ± 0.653	0.909 ± 0.270	0.009 ± 0.007	0.517	1.370 ± 0.201	0.287
Hackensack TSS	01378500	293.0	240	-0.416 ± 0.192	0.934 ± 0.071	0.084 ± 0.164	0.271	1.573 ± 1.239	0.228
Saddle TSS	01391500	141.6	278	-0.886 ± 0.535	0.774 ± 0.275	0.020 ± 0.003	2.110	2.546 ± 0.334	0.302
Raritan SSC	01403300	2084.8	206	0.325 ± 0.432	1.300 ± 0.180	0.011 ± 0.004	1.896	2.109 ± 0.215	0.275
NJ Harbor Urban Tributaries									
Rahway TSS	01395000	106.1	234	-1.183 ± 0.429	0.377 ± 0.194	0.019 ± 0.005	1.326	1.828 ± 0.348	0.339
Elizabeth TSS	01393450	43.8	232	-0.641 ± 0.861	0.555 ± 0.403	0.014 ± 0.007	0.730	1.291 ± 0.192	0.340
NJ Non-harbor Tributaries									
Manasquan TSS [c] Toms TSS	01408000 01408500	114.1 318.9	57 41	0.856 ± 0.517	1.653 ± 0.578				0.332
CT Tributaries									
Connecticut SSC	01184000	25049.2	217	-0.186 ± 0.994	1.194 ± 0.465	0.013 ± 0.004	2.551	2.636 ± 0.284	0.418

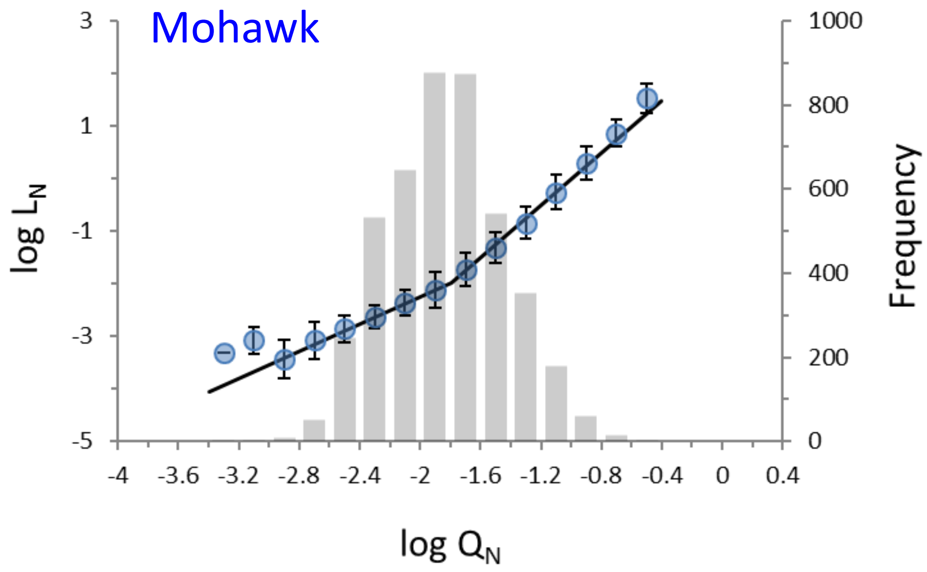
a) Values for log a_1, b_1, BrkPt, b_2 were obtained using MS Excel Solver and SolverAid and are reported as regression coefficients ± 95% confidence values.)

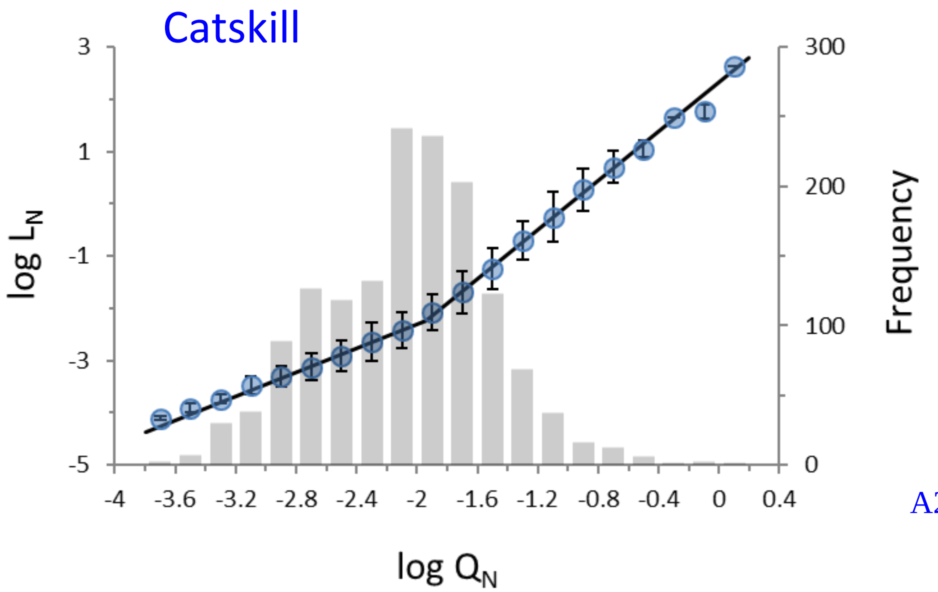
b) Values for log a_2 were determined from regressions coefficients: $\log a_2 = \log a_1 + (b_1 - b_2) \times \text{BrkPt}$, based on matching the non-flood and flood regression lines at the BrkPt.

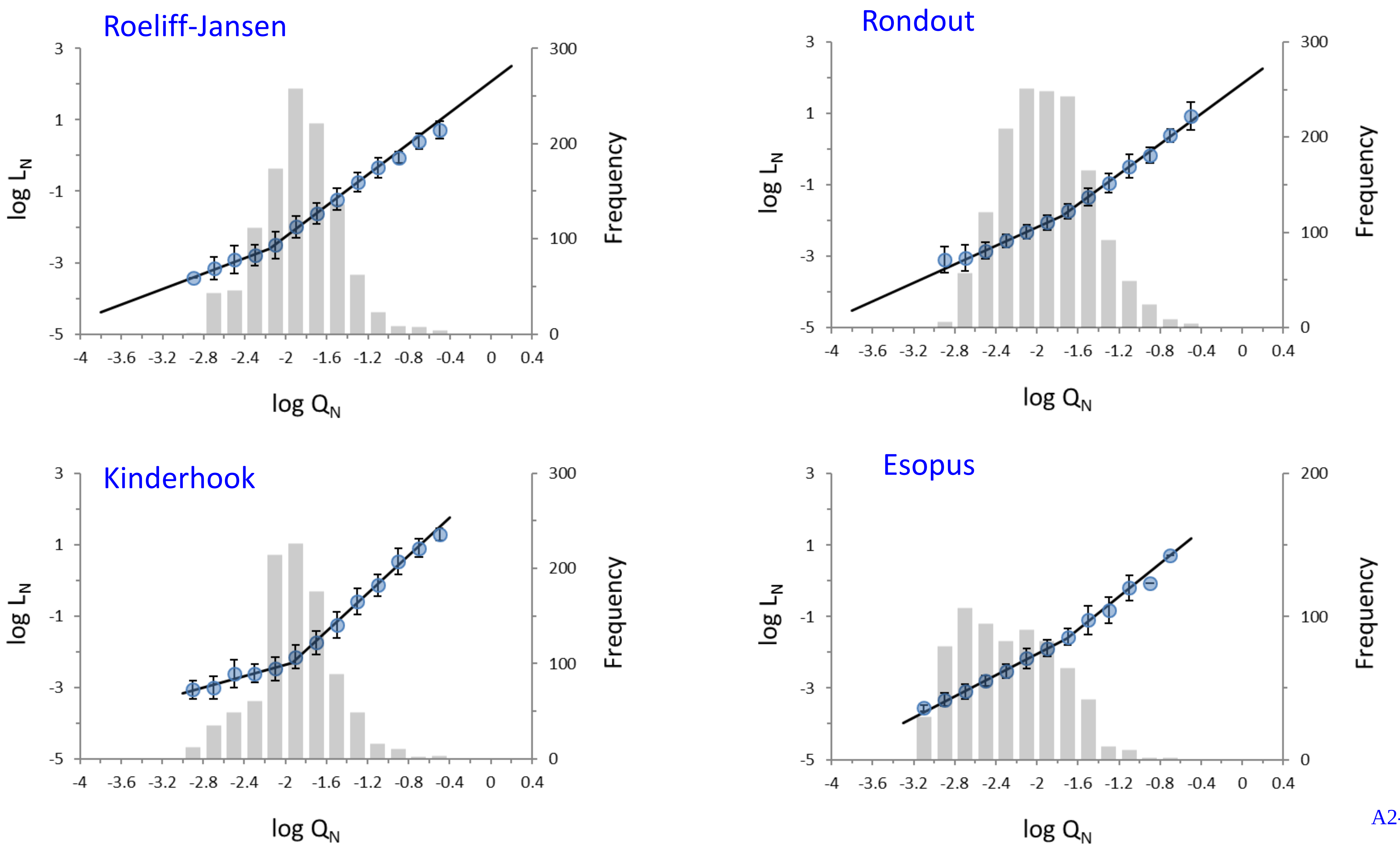
c) Due to the limited number of datapoints and the limited range of flow conditions for the Toms River TSS data, the Manasquan and Toms River data were therefore combined to develop the regression for the NJ non-harbor tributaries. Note: the Manasquan and Toms River TSS regression is described as: $\log L_N = b_1 \log Q_N + \log a_1$ since there was no apparent difference in the regression slopes for the low and high flow data.

Application of mNSL to individual tributaries draining to the Hudson River and western Long Island Sound

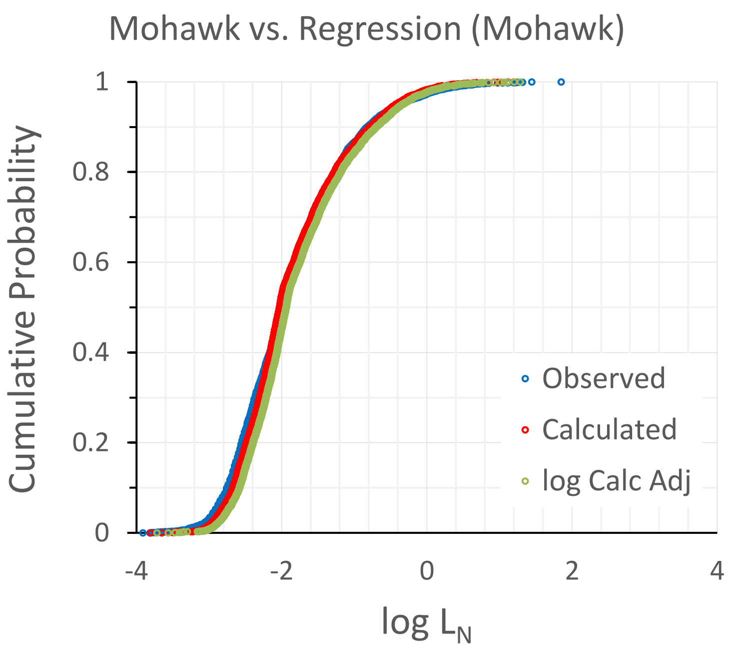


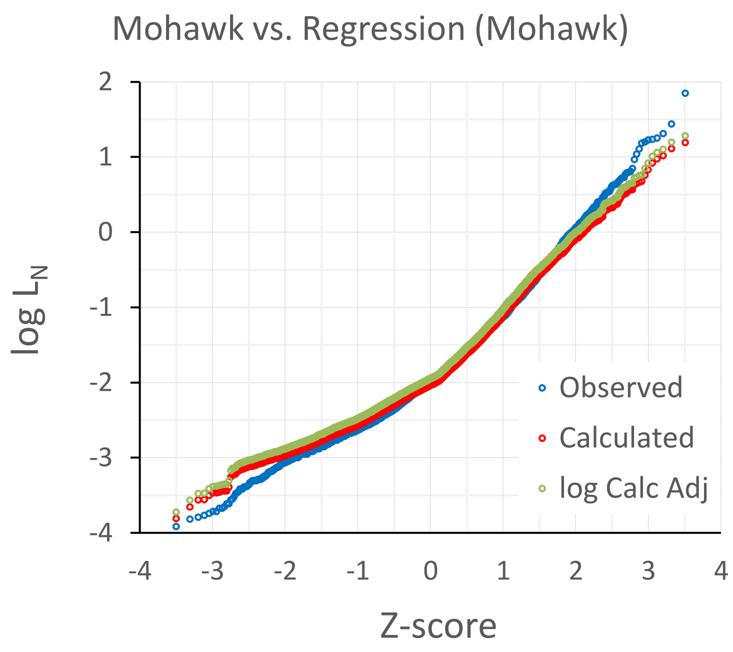


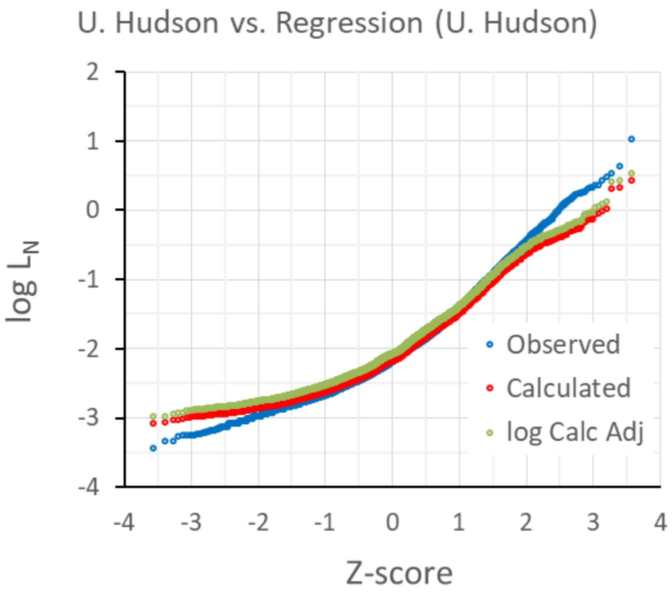


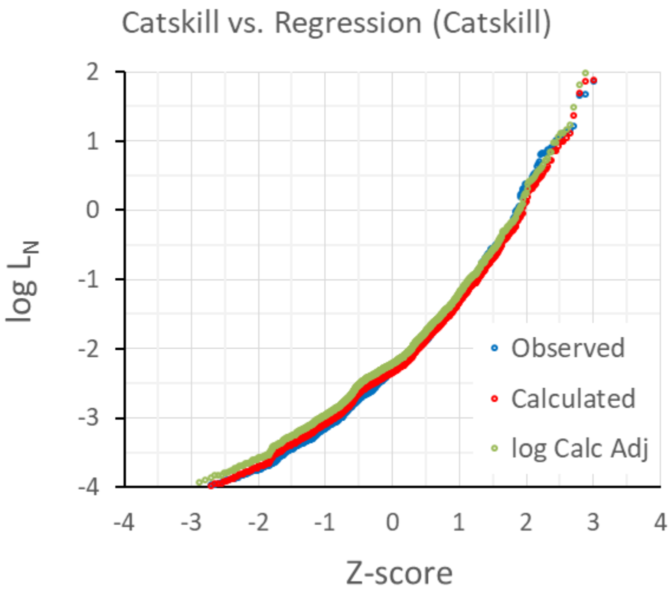

Roeliff-Jansen
Rondout
Kinderhook
Esopus
log L_N
log Q_N
Frequency
3
1
-1
-3
-5
300
200
100
0
-4
-3.6
-3.2
-2.8
-2.4
-2
-1.6
-1.2
-0.8
-0.4
0
0.4

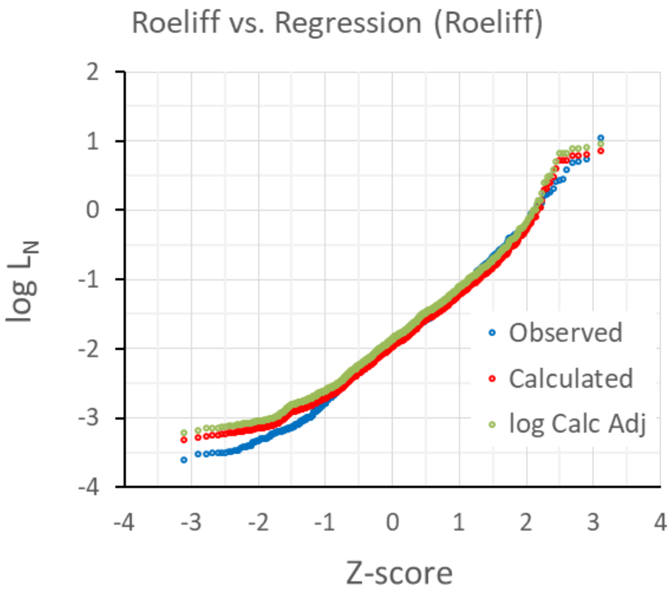
Check Probability Distributions: Measured vs. NSL Regressions

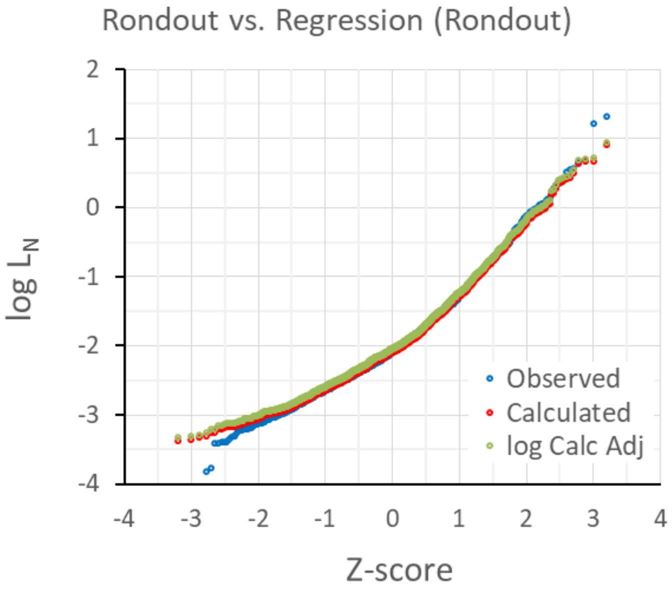


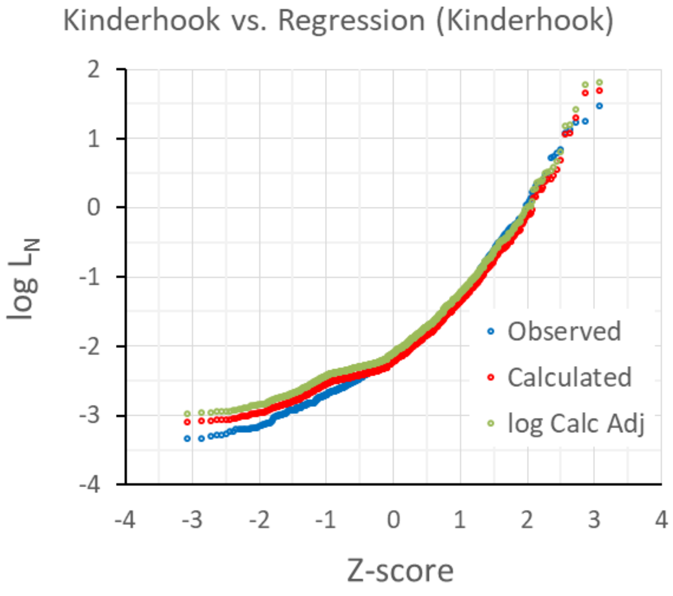


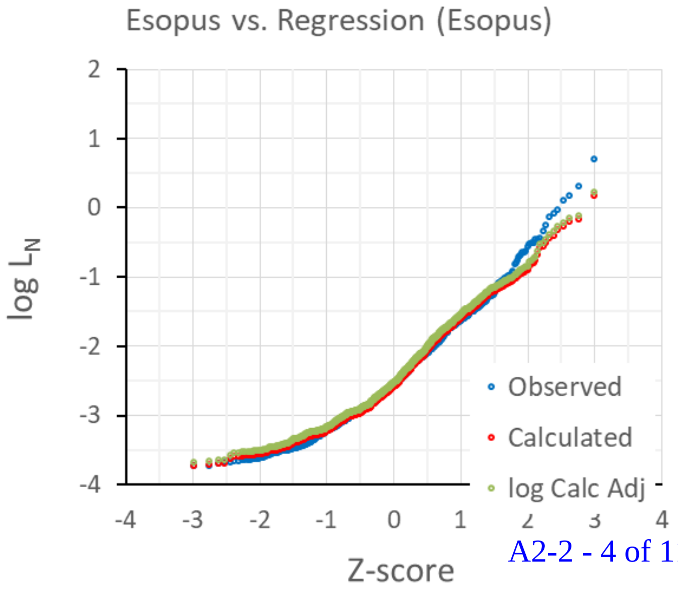

U. Hudson vs. Regression (U. Hudson)
log L_N
Z-score
Observed
Calculated
log Calc Adj


Catskill vs. Regression (Catskill)
log L_N
Z-score
Observed
Calculated
log Calc Adj


Roeliff vs. Regression (Roeliff)
log L_N
Z-score
Observed
Calculated
log Calc Adj


Rondout vs. Regression (Rondout)
log L_N
Z-score
Observed
Calculated
log Calc Adj


Kinderhook vs. Regression (Kinderhook)
log L_N
Z-score
Observed
Calculated
log Calc Adj


Esopus vs. Regression (Esopus)
log L_N
Z-score
Observed
Calculated
log Calc Adj

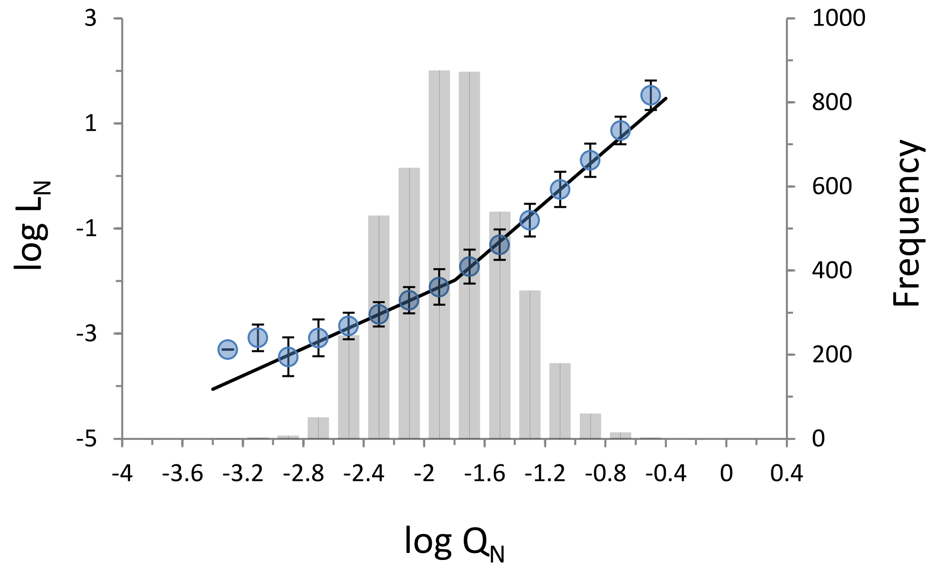
Check Mass Loadings Using NSL regressions

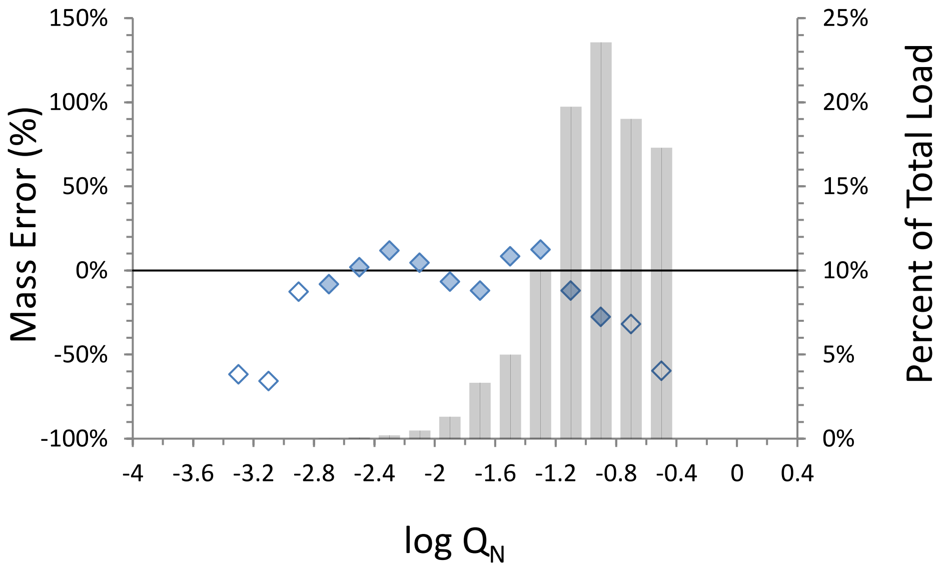
Mohawk River: 4383 data points

Overall Mass Error = - 24.1%

Open symbols < 20 data points

- Regressions are largely determined by the middle of the distribution where we have the bulk of the observations.
- Mass loadings are strongly affected by less-frequent, high-flow events where we have few observations.
- Mass errors are sometimes positive and sometimes negative.

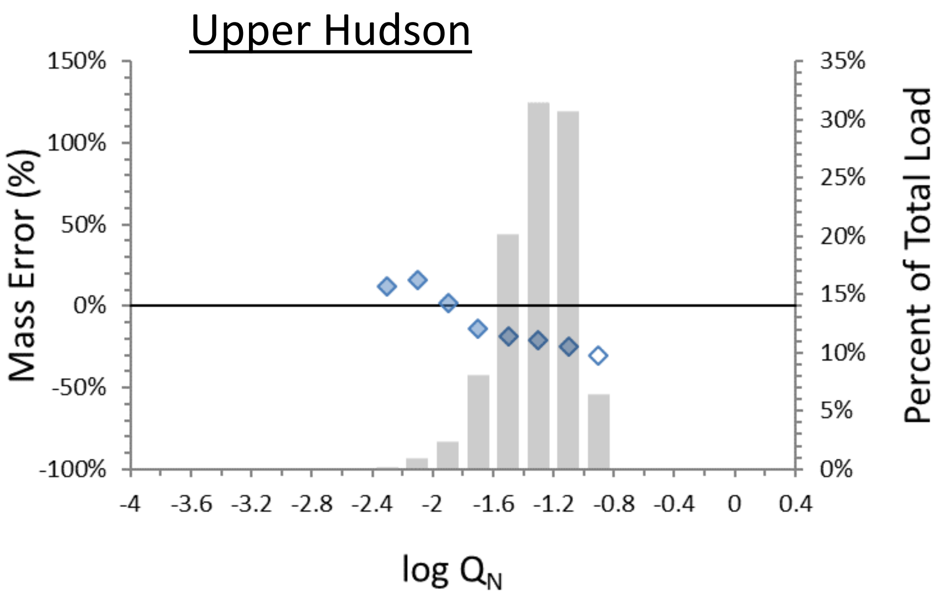


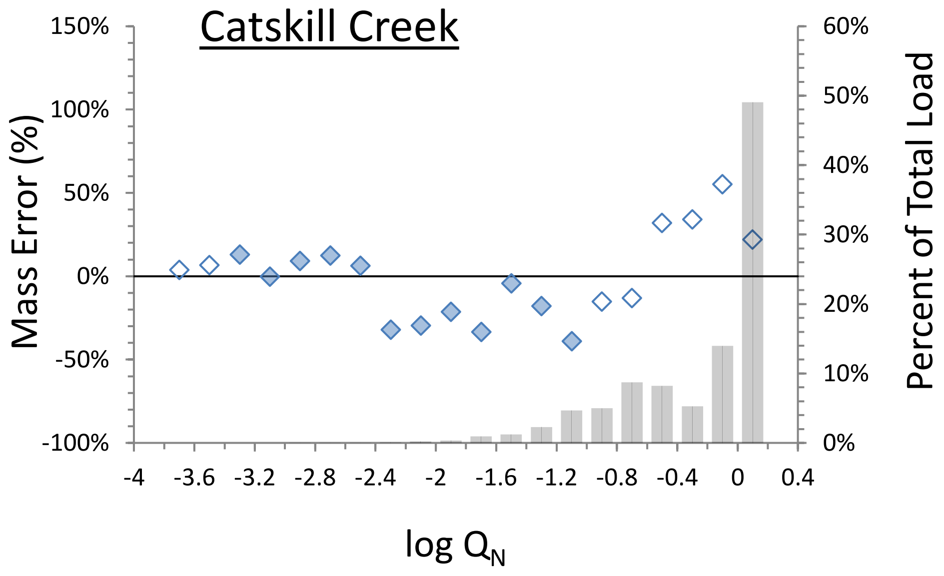


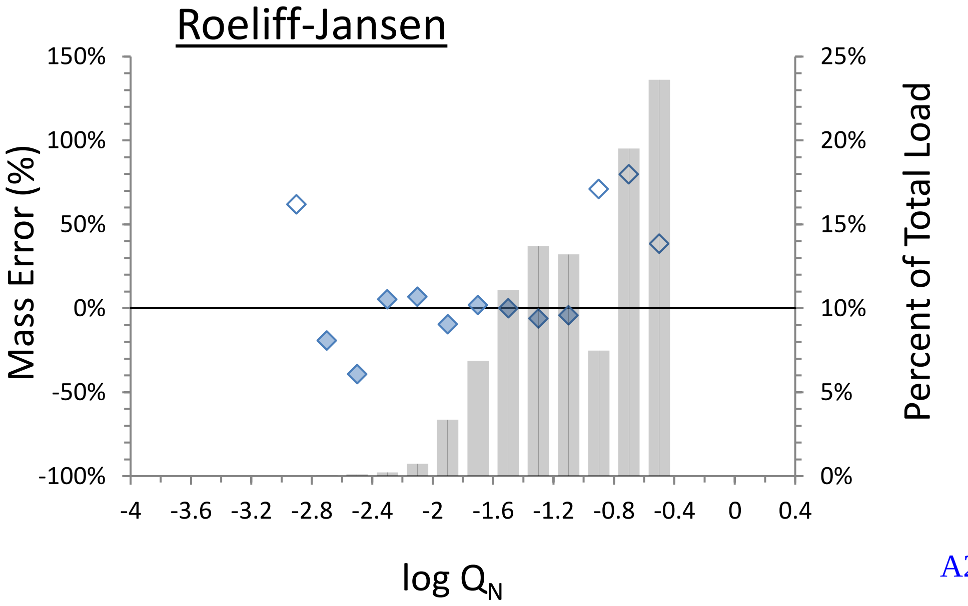
Upper Hudson: 5660 data points; -21.0% error

Catskill Creek: 1491 data points: +18.2% error

Roeliff-Jansen: 1095 data points; +28.4% error



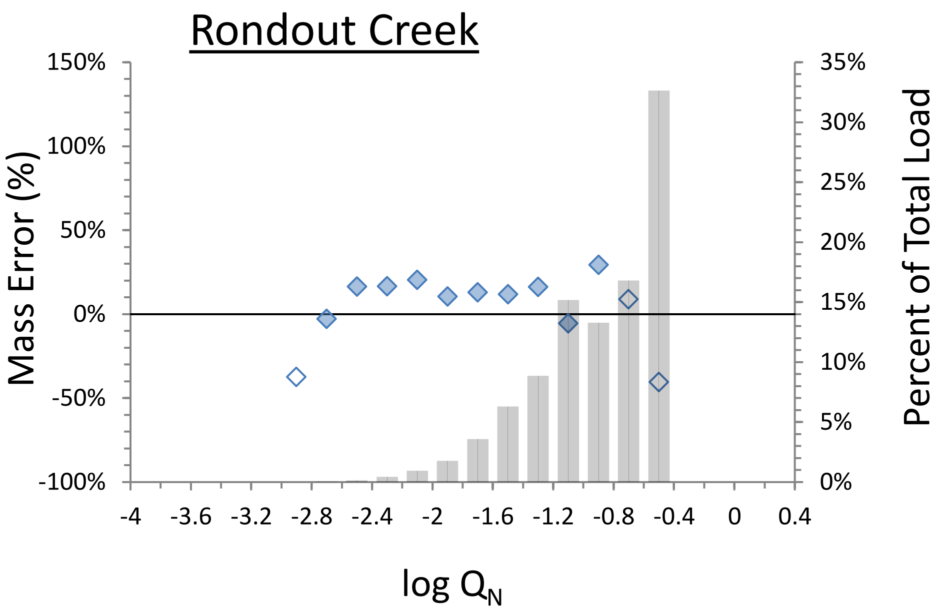


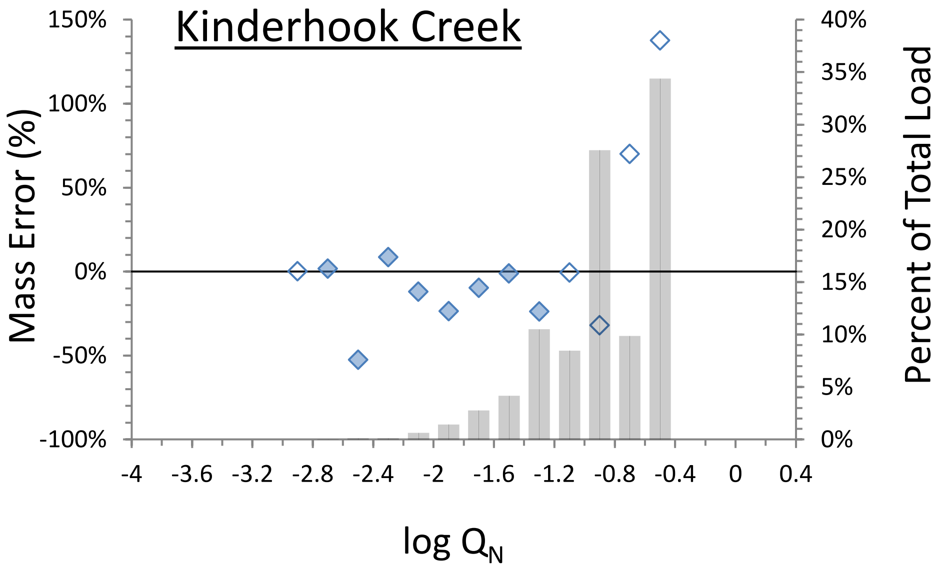


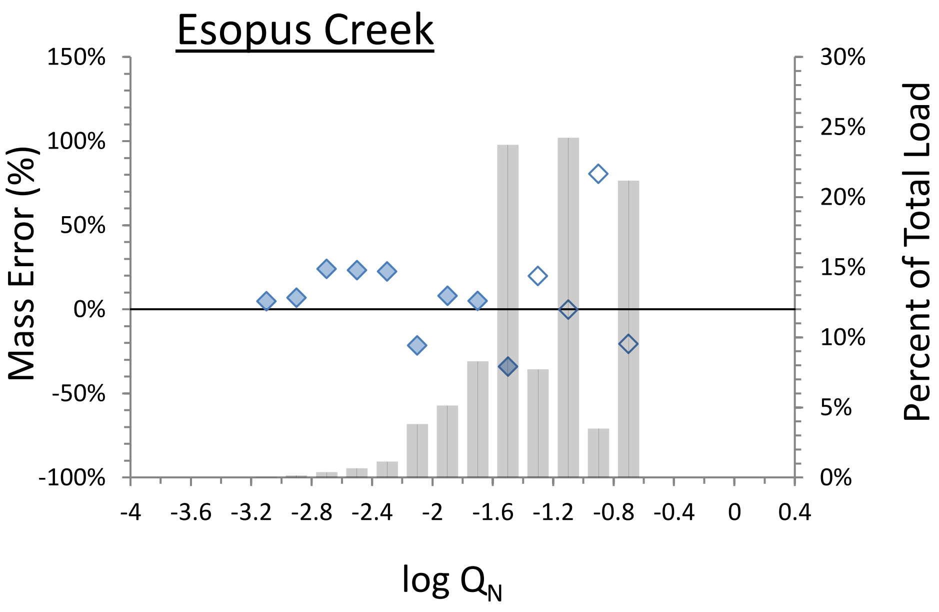
Rondout Creek: 1478 data points; -5.50% error

Kinderhook Creek: 942 data points: +42.0% error

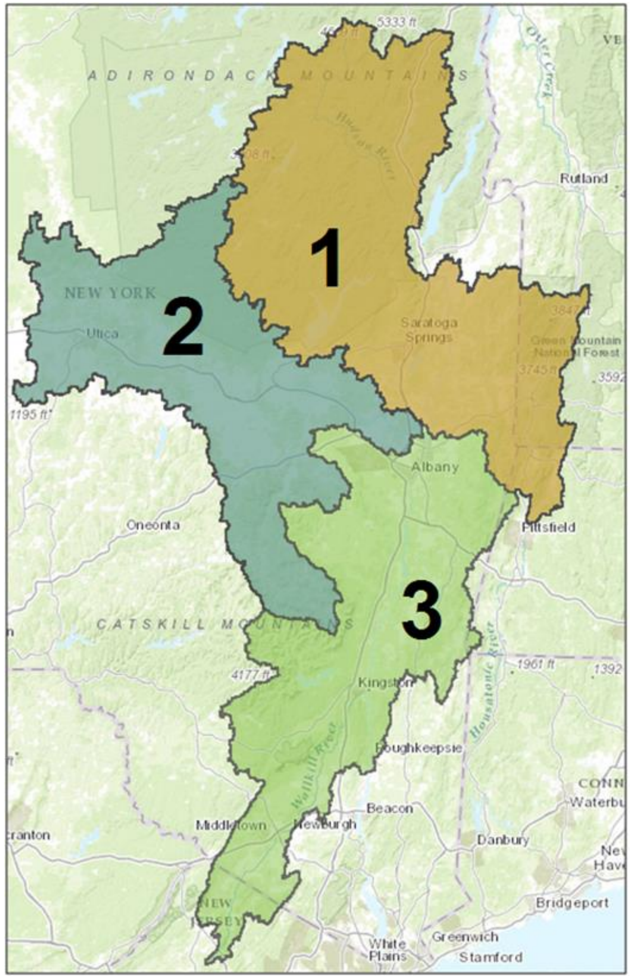
Esopus Creek: 1095 data points; -7.6% error







Evaluation of October 1998 to September 2016 suspended sediment loads



The three drainage areas for the tidal, freshwater Hudson were divided into sub-basins.

The drainage area and mean annual runoff (MAR) for each sub-basin were determined using the USGS StreamStat software tool. (Note: MAR was used as an overall indicator of rainfall precipitation and sub-basin runoff behavior associated with basin slopes, land cover, etc.)

Each sub-basin was then matched to a representative USGS flow gaging station as follows:

- Sub-region 1: Hudson River at Waterford
- Sub-region 2: Mohawk River at Cohoes
- Sub-region 3: The watershed was first divided into the east and west sides of the Hudson to account for differences in the geology and rainfall precipitation patterns on the two sides of the river. Sub-basins on the east and west sides of the Hudson were then matched to a USGS flow gaging station that had a similar MAR.

Gaged flows were then adjusted by ratios of the drainage area and MAR of the gaged drainage basin to that of the specific sub-basin.

Suspended sediment loads were calculated using measured suspended sediment loads where available. Site-specific NSL regressions and daily flows were used to estimate missing suspended sediment load information. Site-specific NSL regressions were assigned as surrogates for basins without measurements.

Note: The monitored tributaries represent 90.4% of the Hudson River watershed above Poughkeepsie.

For the remaining 9.6% of the watershed, sub-basins were matched to site-specific NSL regressions based on the Hudson River sub-regions.

For sub-basins in Sub-region 3, site-specific NSL regressions were assigned based on east vs. west side of the Hudson and on the monitoring station with the most similar MAR.

	DA (mi^2)	MAR (in/yr)
Sub-region 1		
Hudson River at Waterford NY	4605	24.0
Sub-region 2		
Mohawk River at Cohoes NY	3450	24.2
Sub-region 3 (East)		
Kinderhook Creek at Rossman NY	329	17.9
Roeliff-Jansen near Hillsdale NY	212	21.0
Sub-region 3 (West)		
Catskill Creek near Catskill NY	405	21.8
Esopus Creek at Mt. Marion NY	419	28.6
Rondout Creek at Rondout NY	1185	22.4

Consider tributaries on east and west sides of the Hudson (to account for differences in geology)

Apply NSL-regressions for monitored tributaries to sub-watershed areas with no data based on east versus west side of the river and on closest MAR.

	Side	MAR
Kinderhook Creek at Rossman NY	east	17.9
Roeliff-Jansen near Hillsdale NY	east	21.0
Catskill Creek near Catskill NY	west	21.8
Rondout Creek at Rondout NY	west	22.4
Esopus Creek at Mt. Marion NY	west	28.6

APPENDIX 3

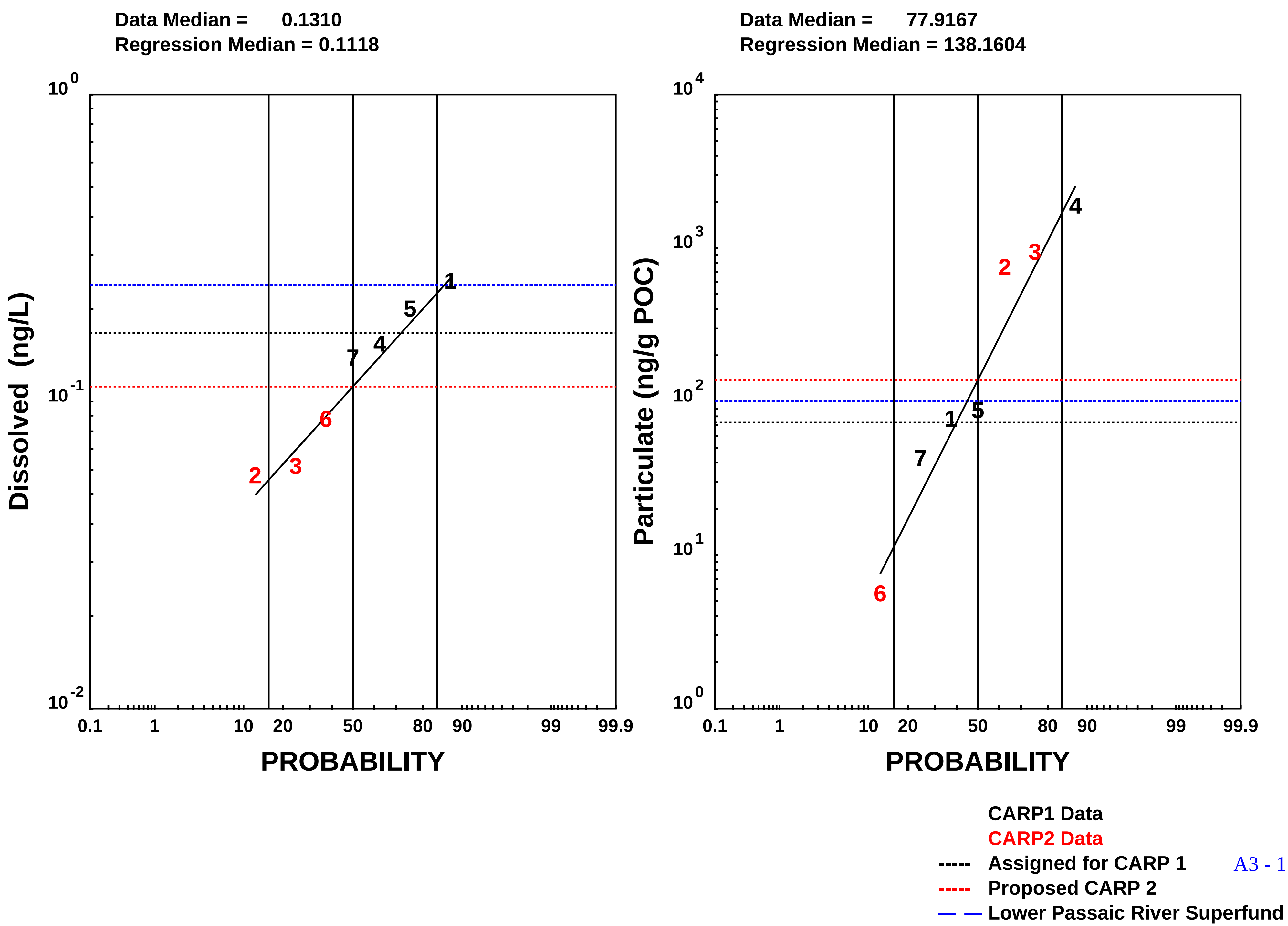
Head-of-Tide Contaminant Loadings Development Method Diagrams

Log probability diagrams with combined CARP1 and CARP 2 head-of-tide measurements and CARP 2 loading concentration assignments for modeling – five locations, twenty-seven contaminants

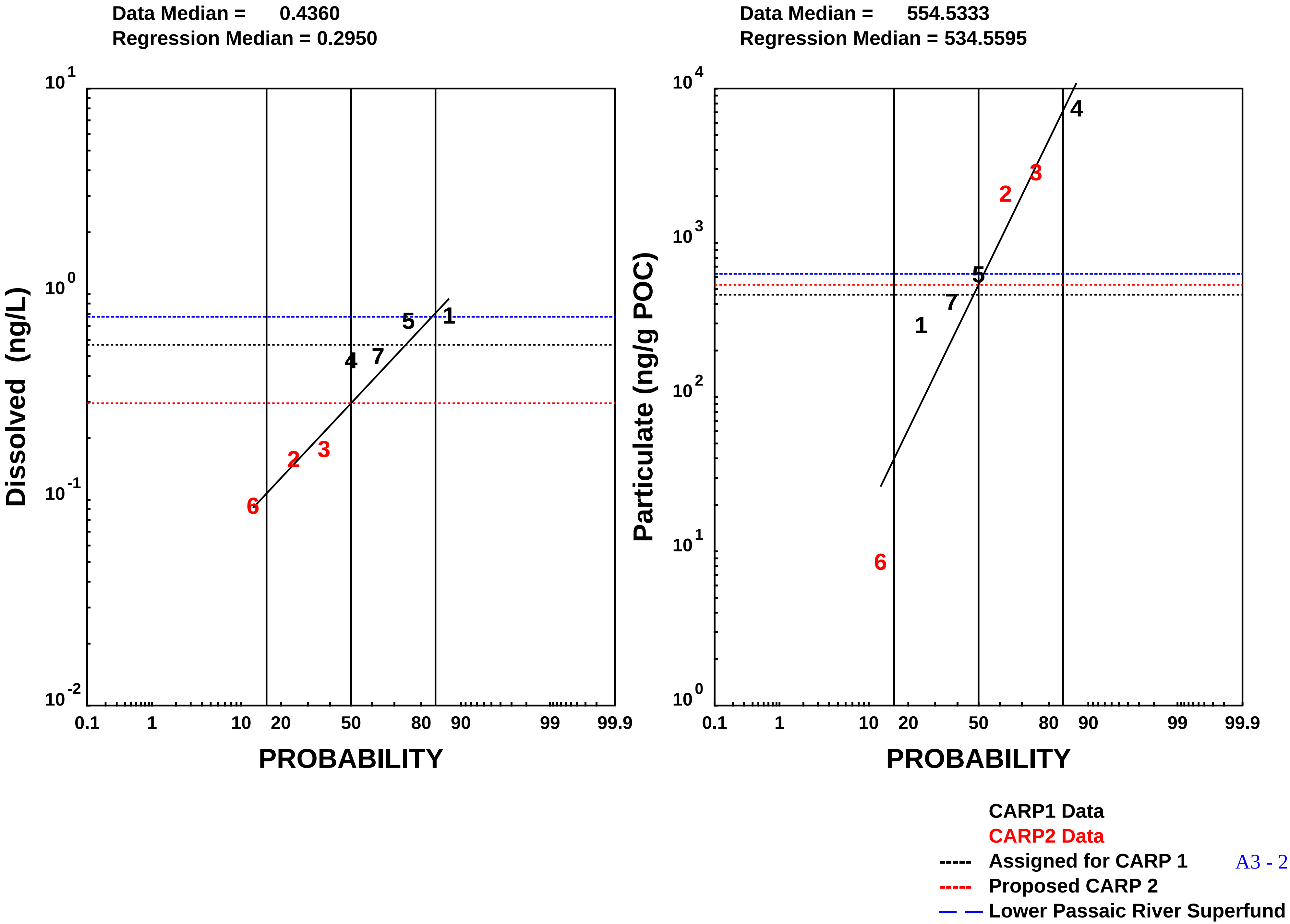
PCB homolog concentration and flow regressions for the Upper Hudson River above the confluence with the Mohawk River, selected homologs, three periods relative to remedial dredging status

Log linear relationship between 1998-2016 measurements of particulate organic carbon and suspended sediment pooled from seven rivers in the study area

PASSAIC RIVER -- mono+di-PCB

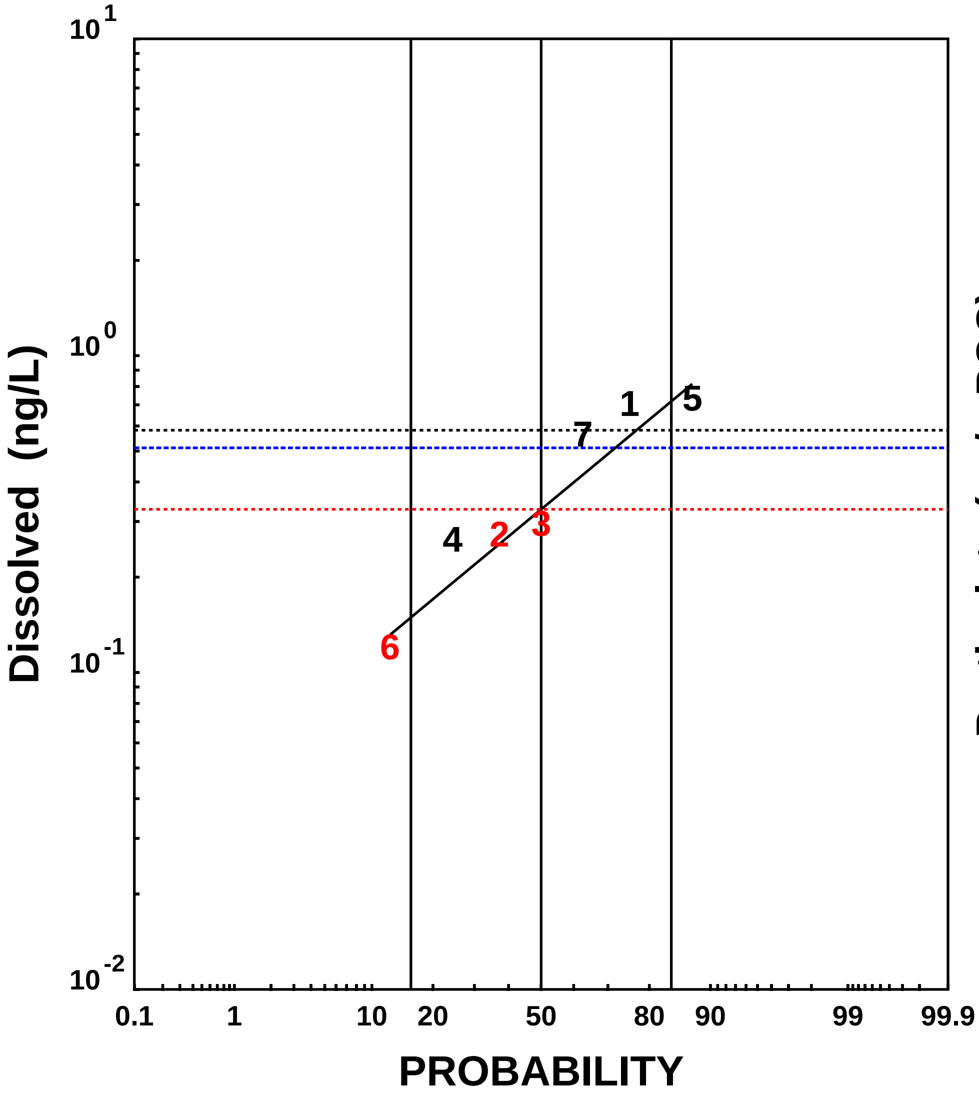


PASSAIC RIVER -- tri-PCB

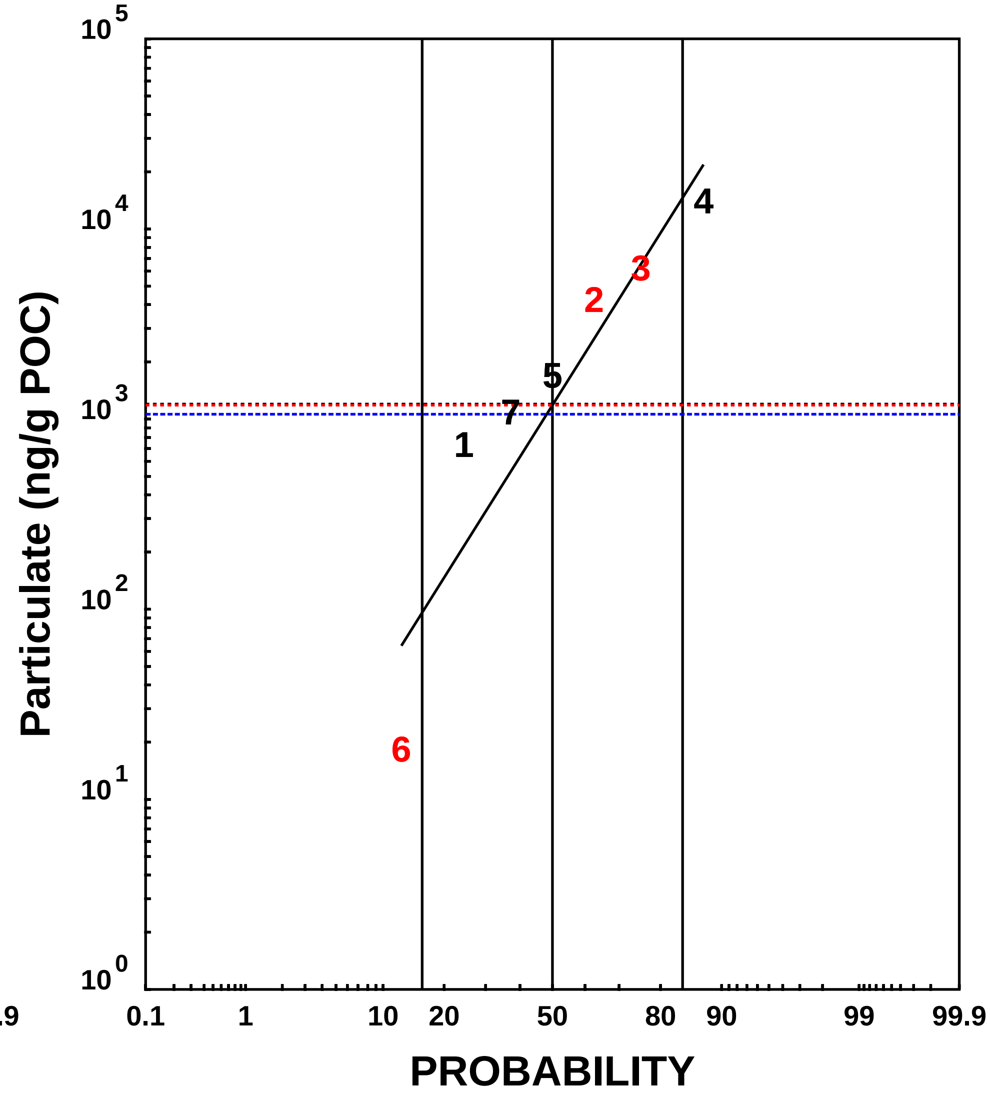


PASSAIC RIVER -- tetra-PCB

Data Median = 0.2705
Regression Median = 0.3274

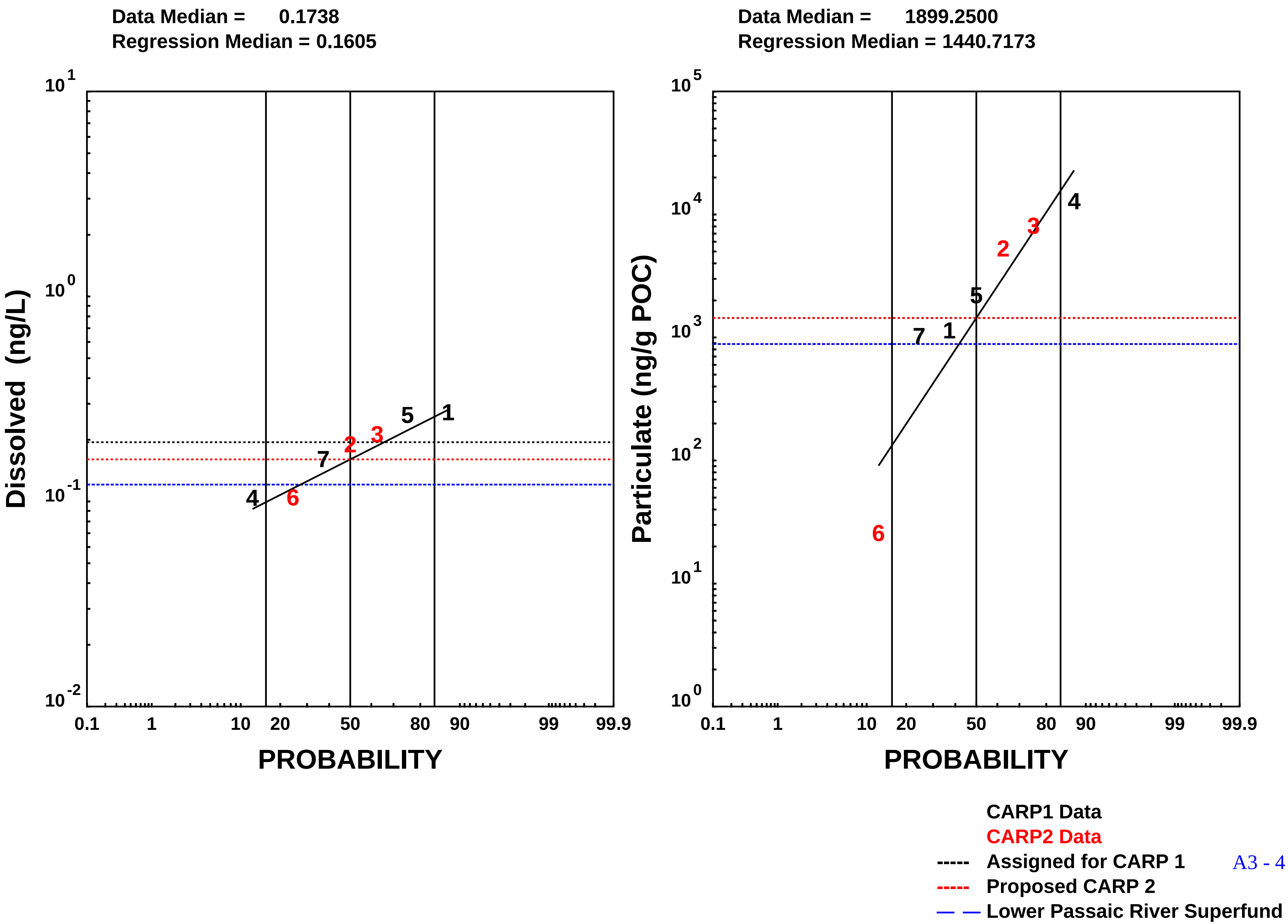


Data Median = 1462.6500
Regression Median = 1183.8594



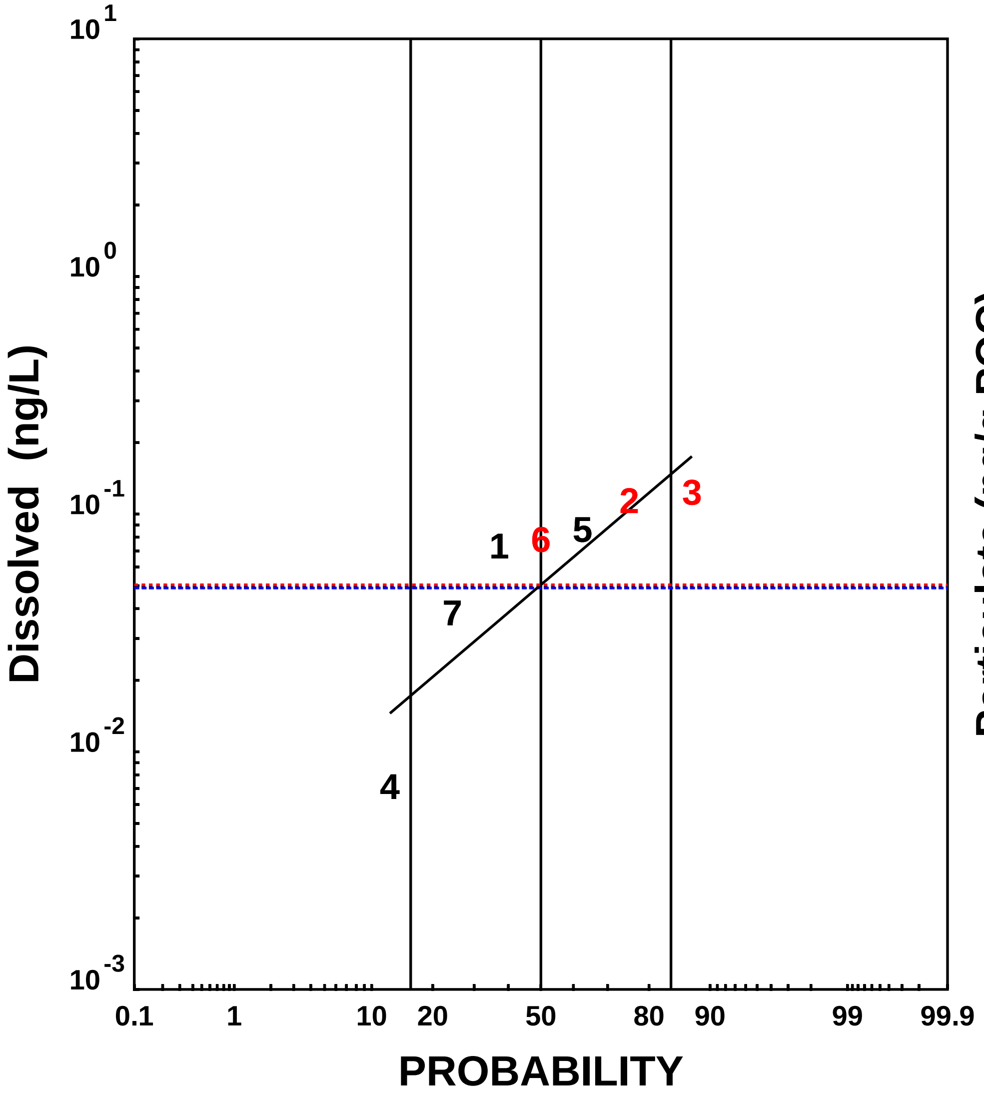
CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2
— — Lower Passaic River Superfund

PASSAIC RIVER -- penta-PCB

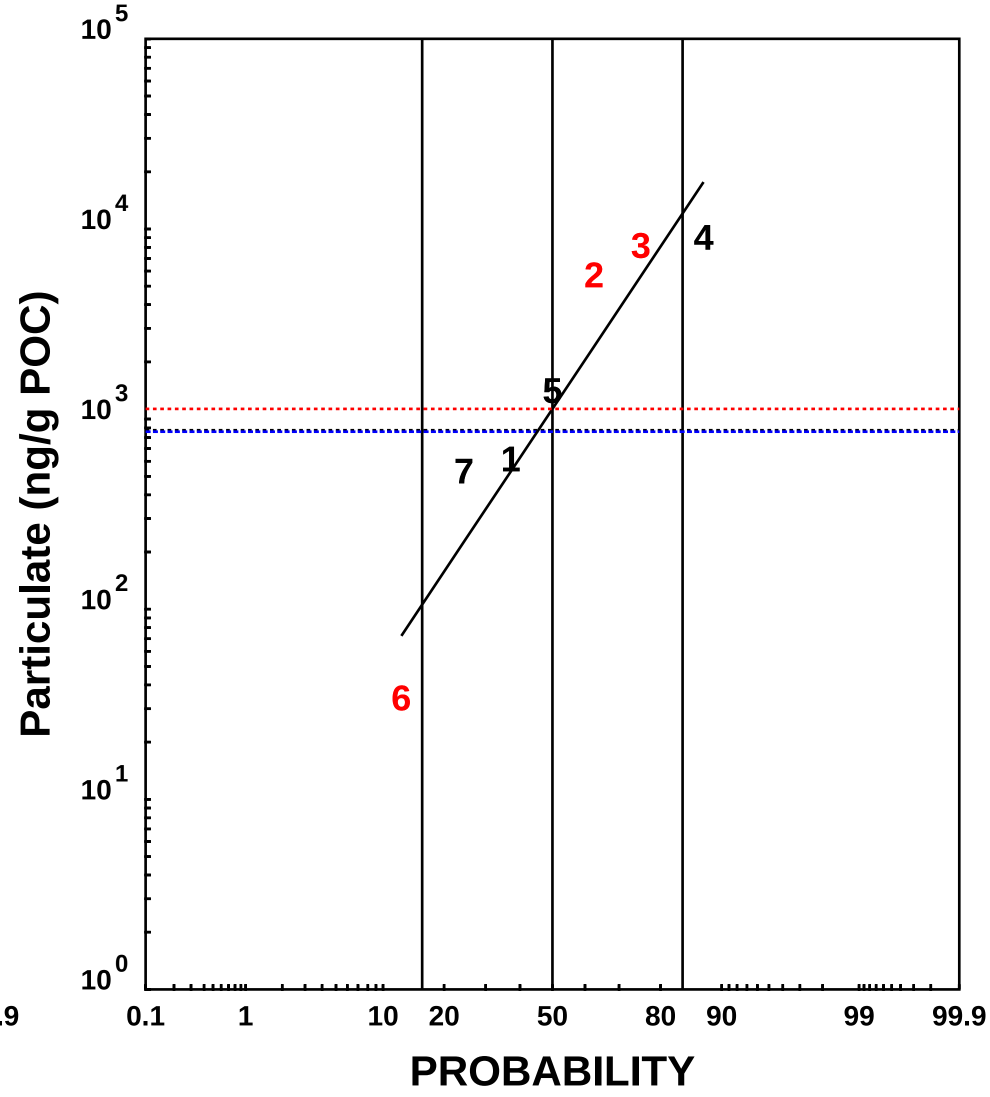


PASSAIC RIVER -- hexa-PCB

Data Median = 0.0694
Regression Median = 0.0504

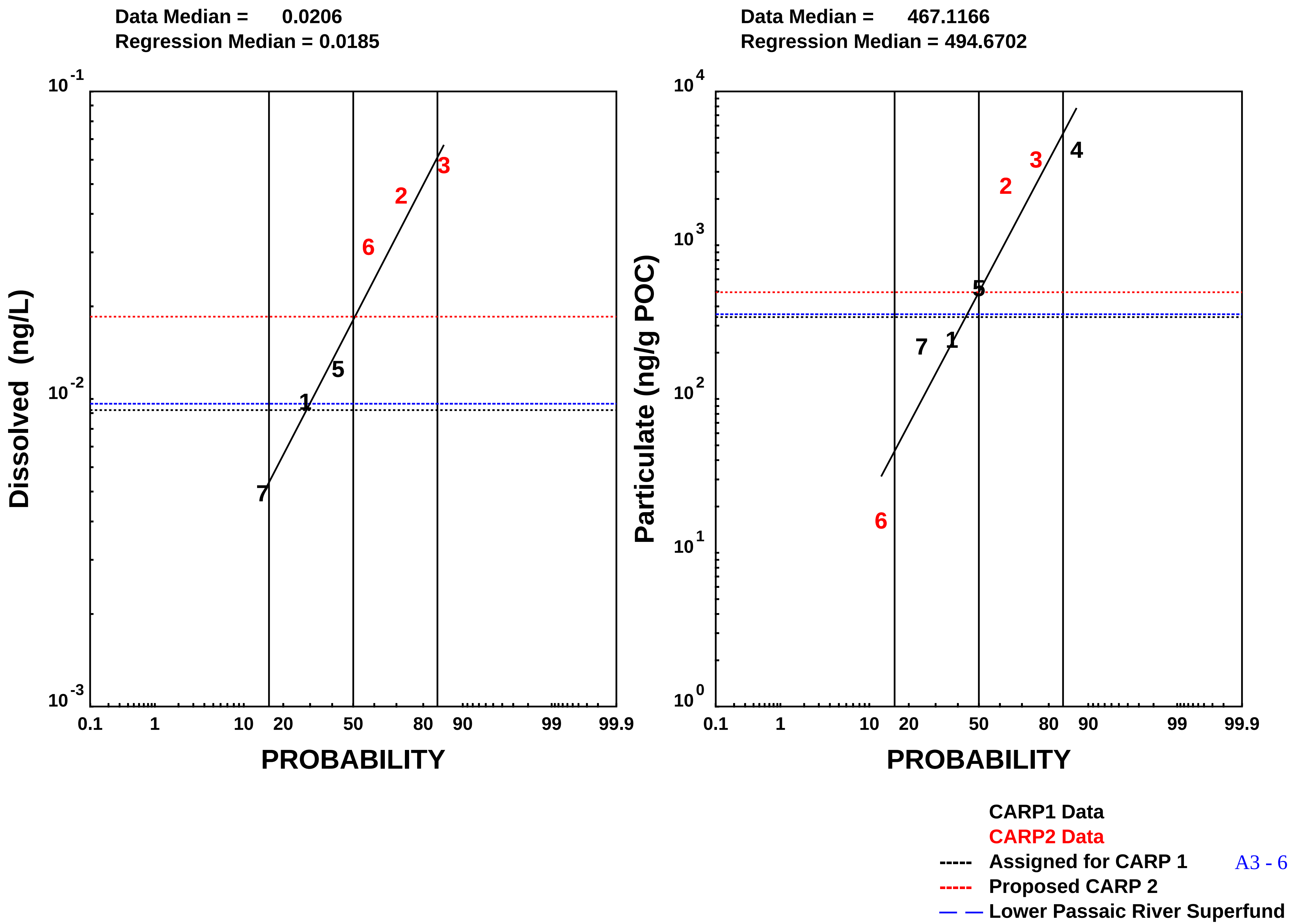


Data Median = 1217.0833
Regression Median = 1130.7356

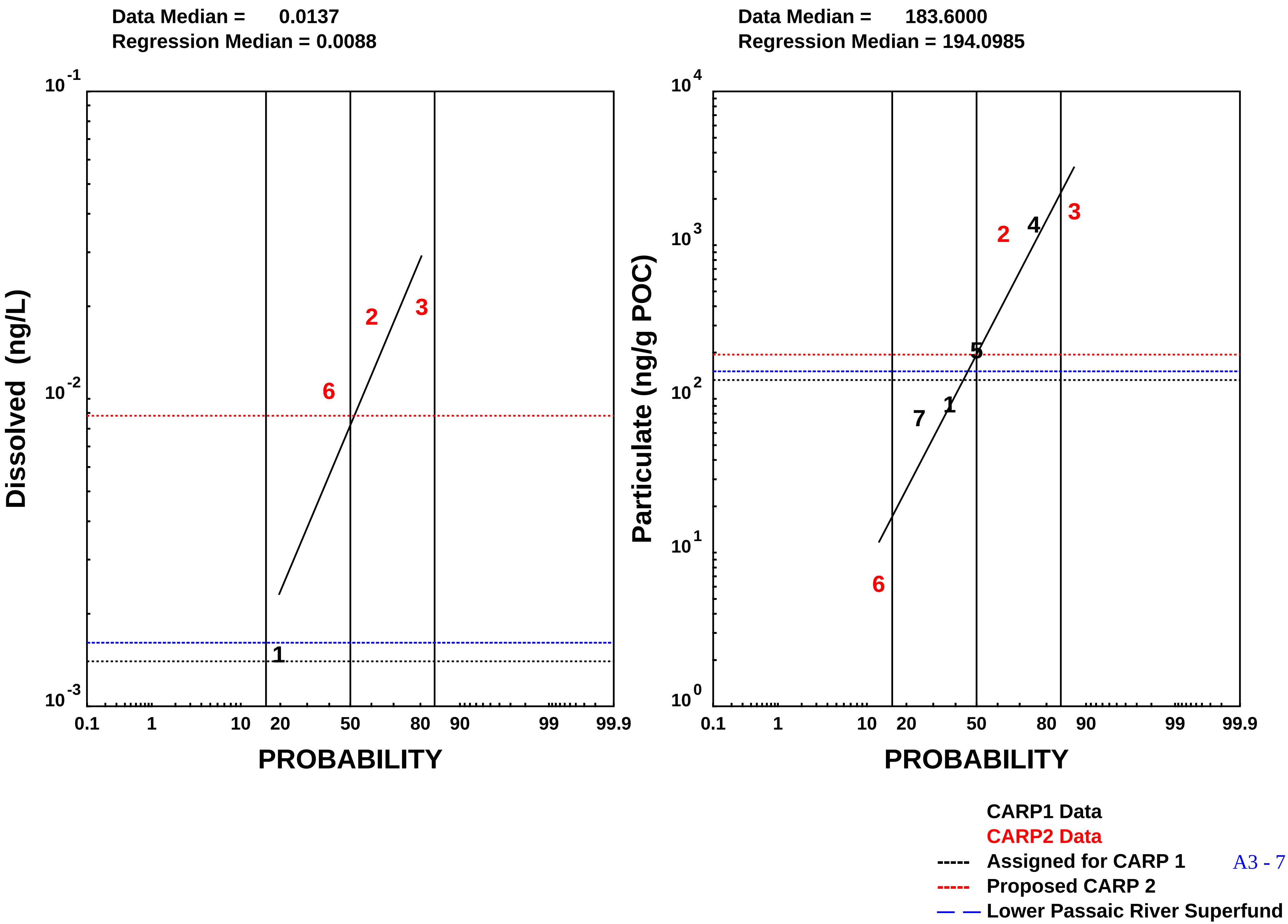


CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2
— — Lower Passaic River Superfund

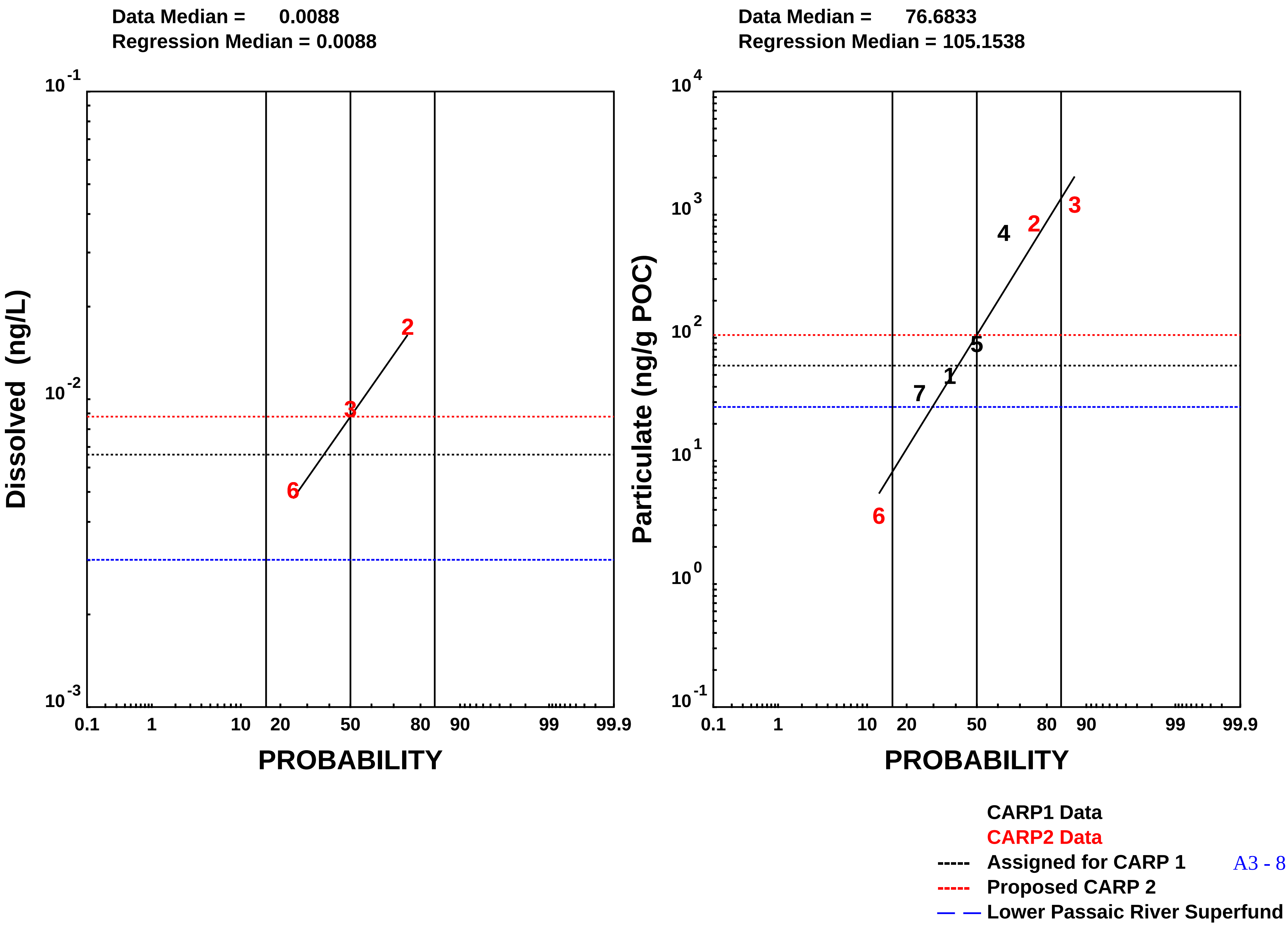
PASSAIC RIVER -- hepta-PCB



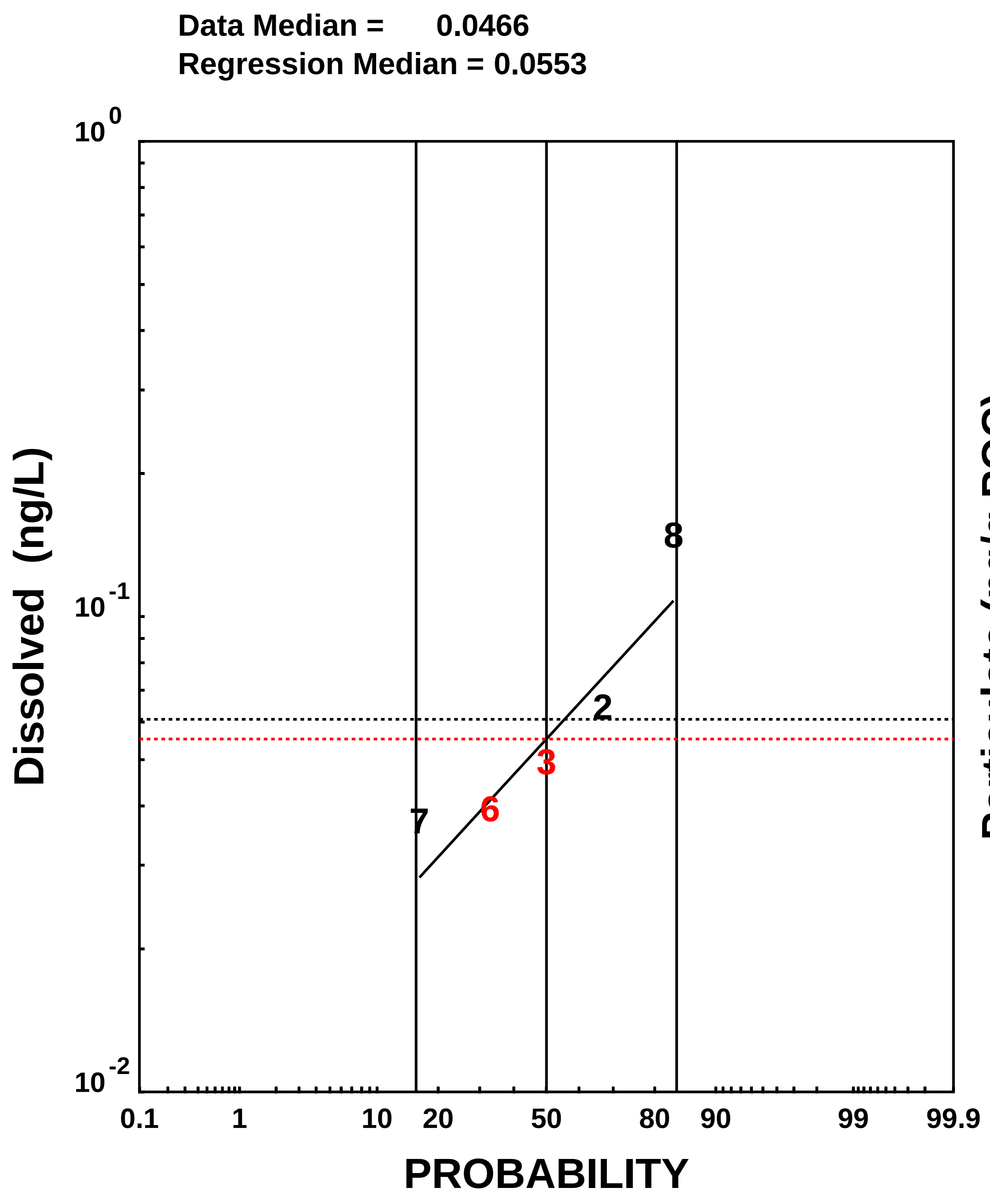
PASSAIC RIVER -- octa-PCB

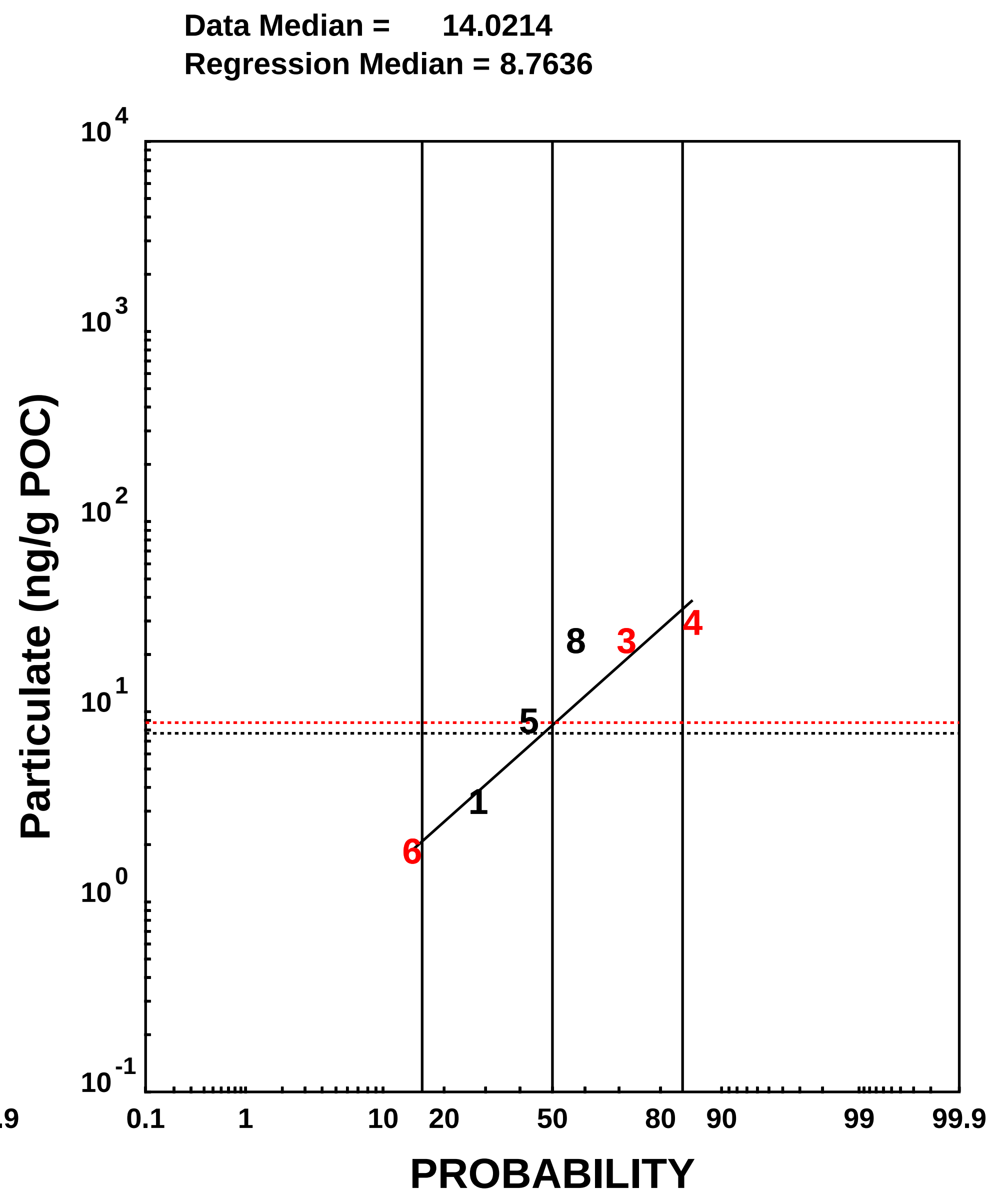


PASSAIC RIVER -- nona+deca-PCB



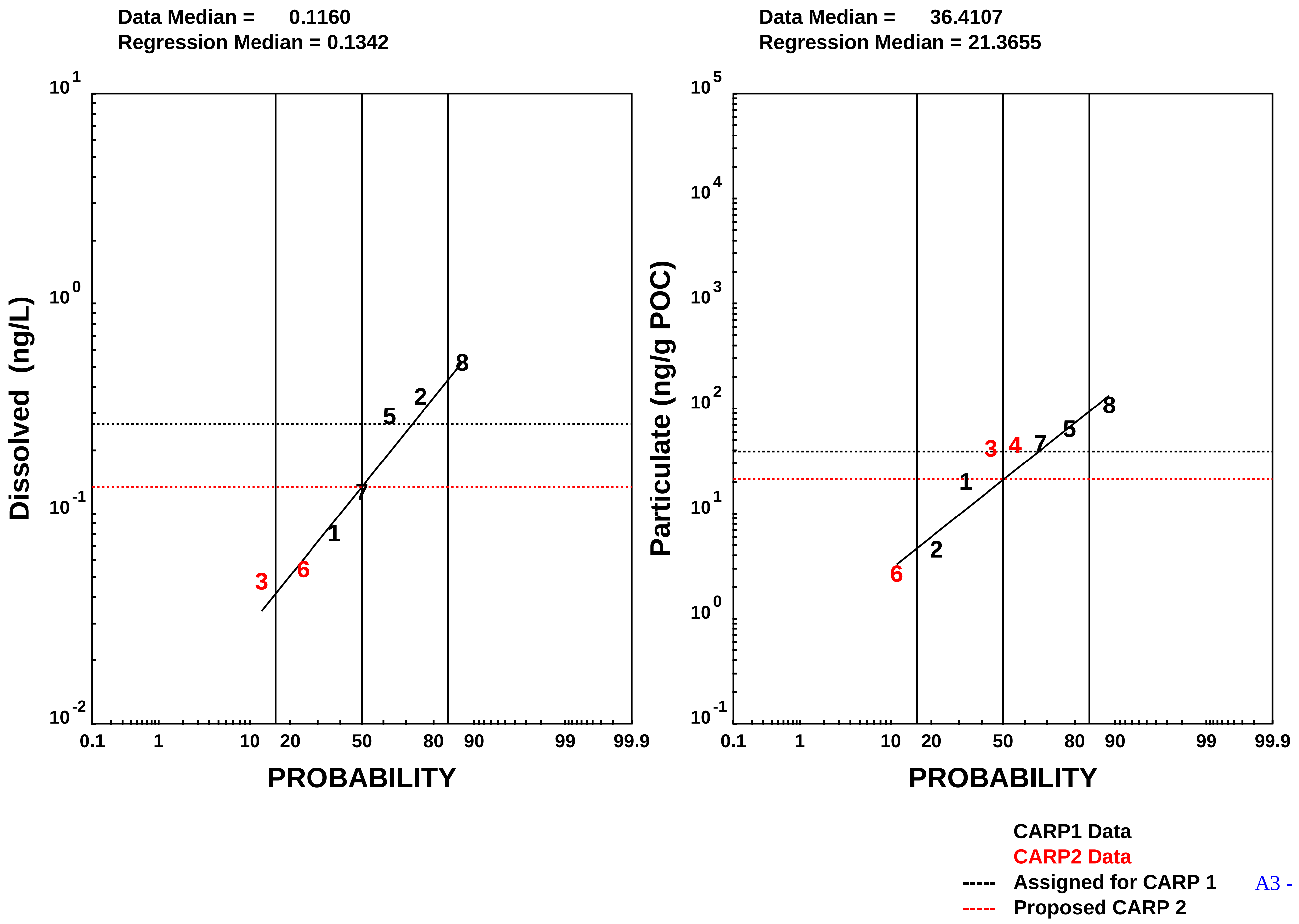
RARITAN RIVER NEAR SOUTH BOUND BROOK -- mono+di-PCB





CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2

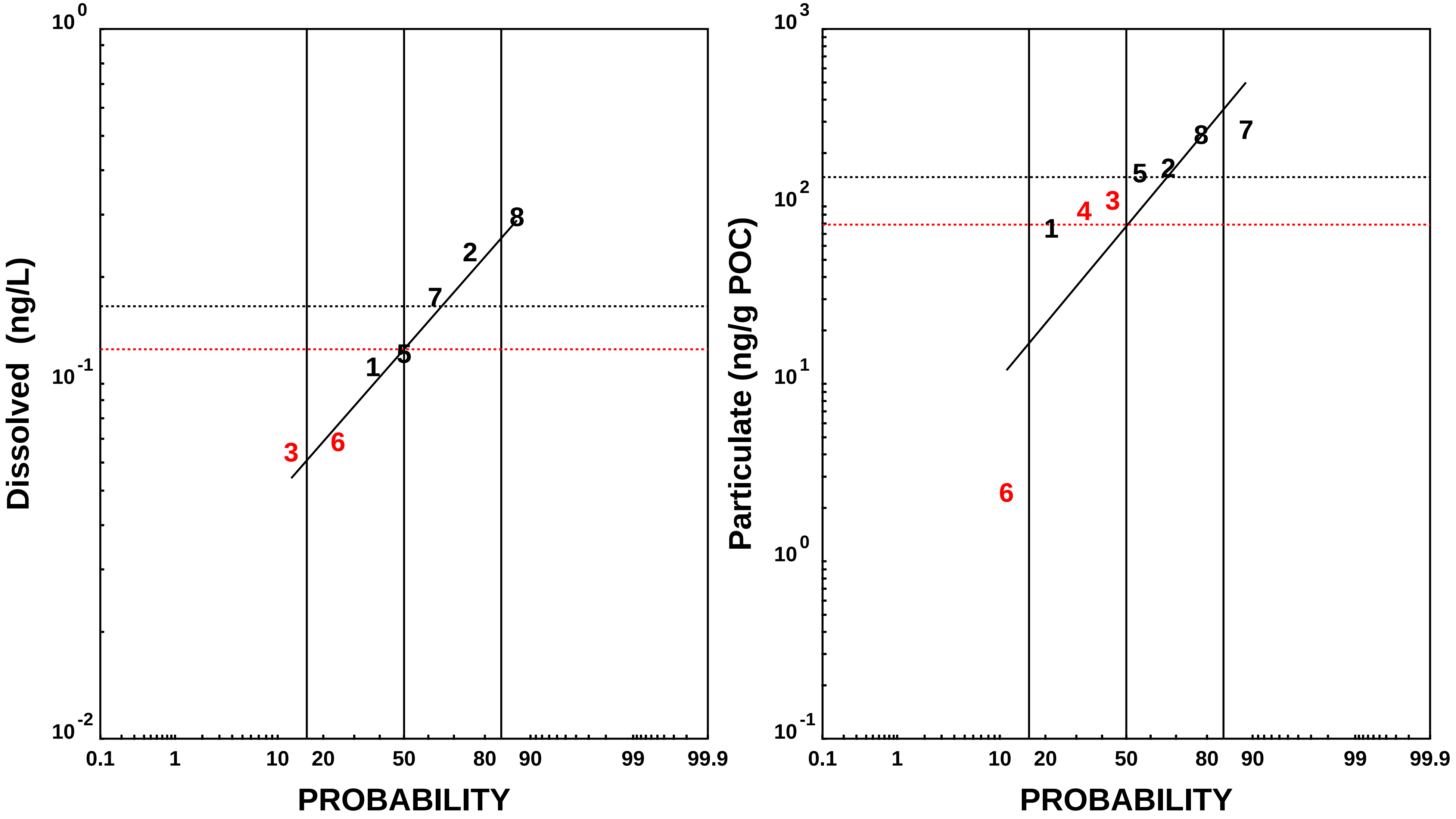
RARITAN RIVER NEAR SOUTH BOUND BROOK -- tri-PCB



RARITAN RIVER NEAR SOUTH BOUND BROOK -- tetra-PCB

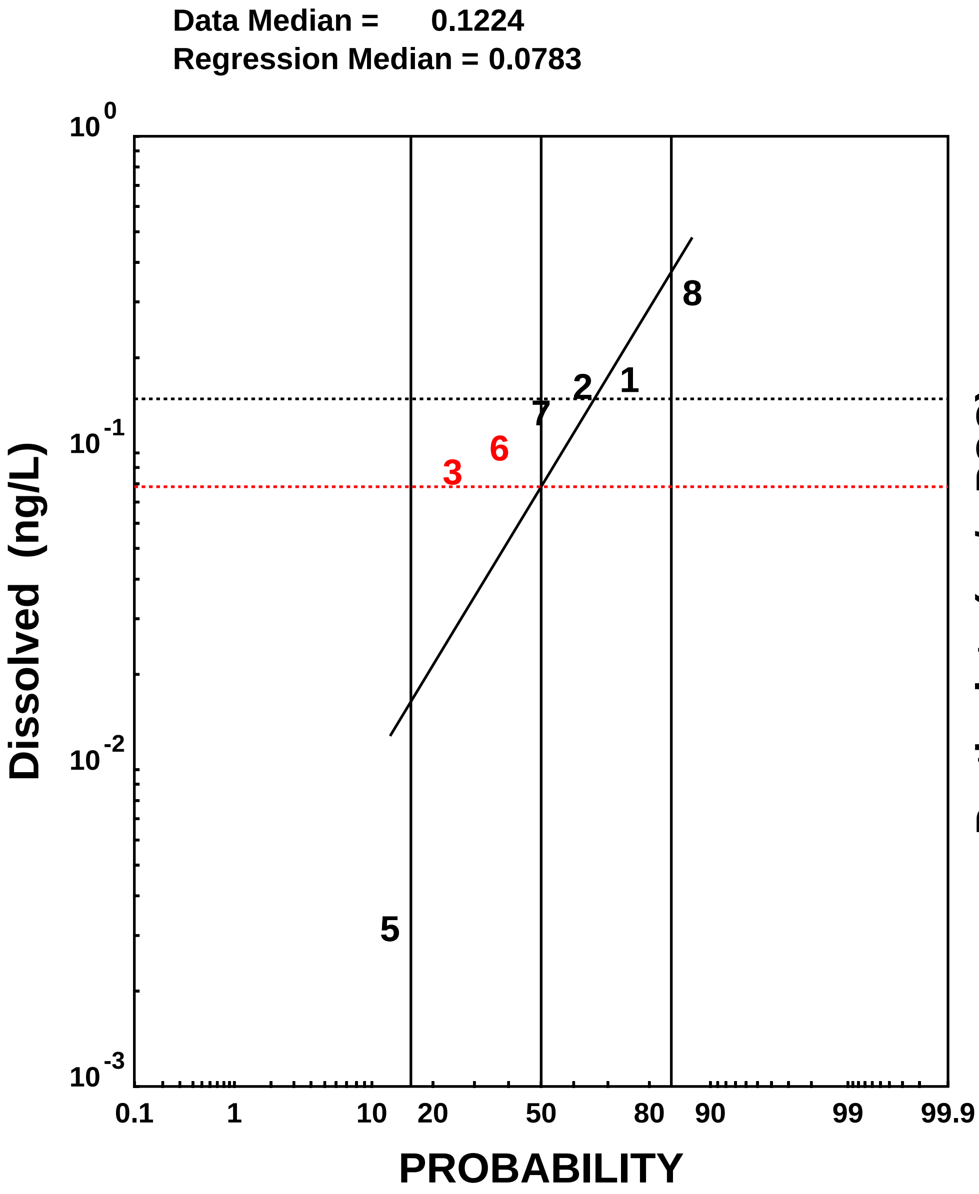
Data Median = 0.1146
Regression Median = 0.1252

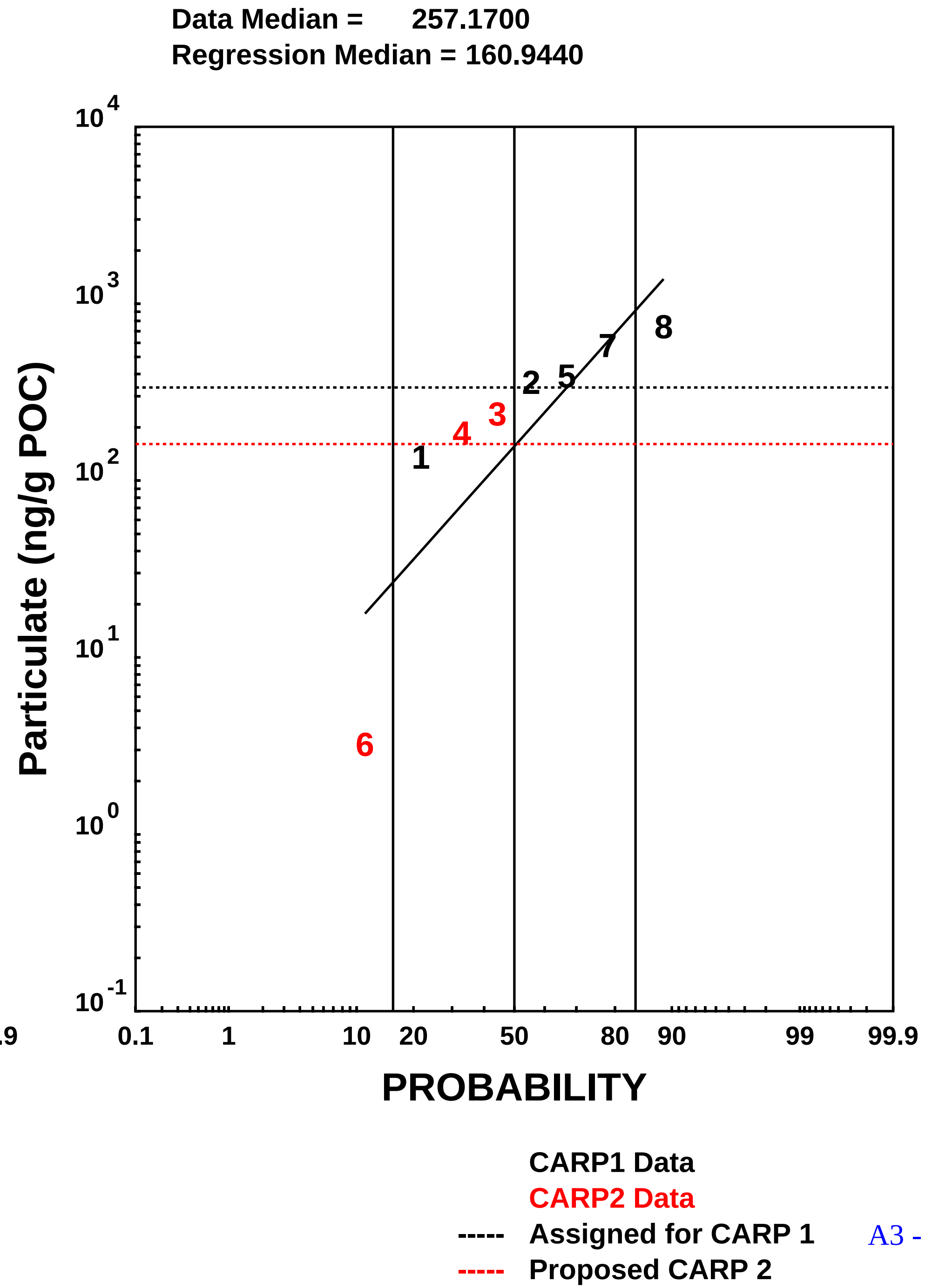
Data Median = 116.5146
Regression Median = 78.9493



CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2

RARITAN RIVER NEAR SOUTH BOUND BROOK -- penta-PCB

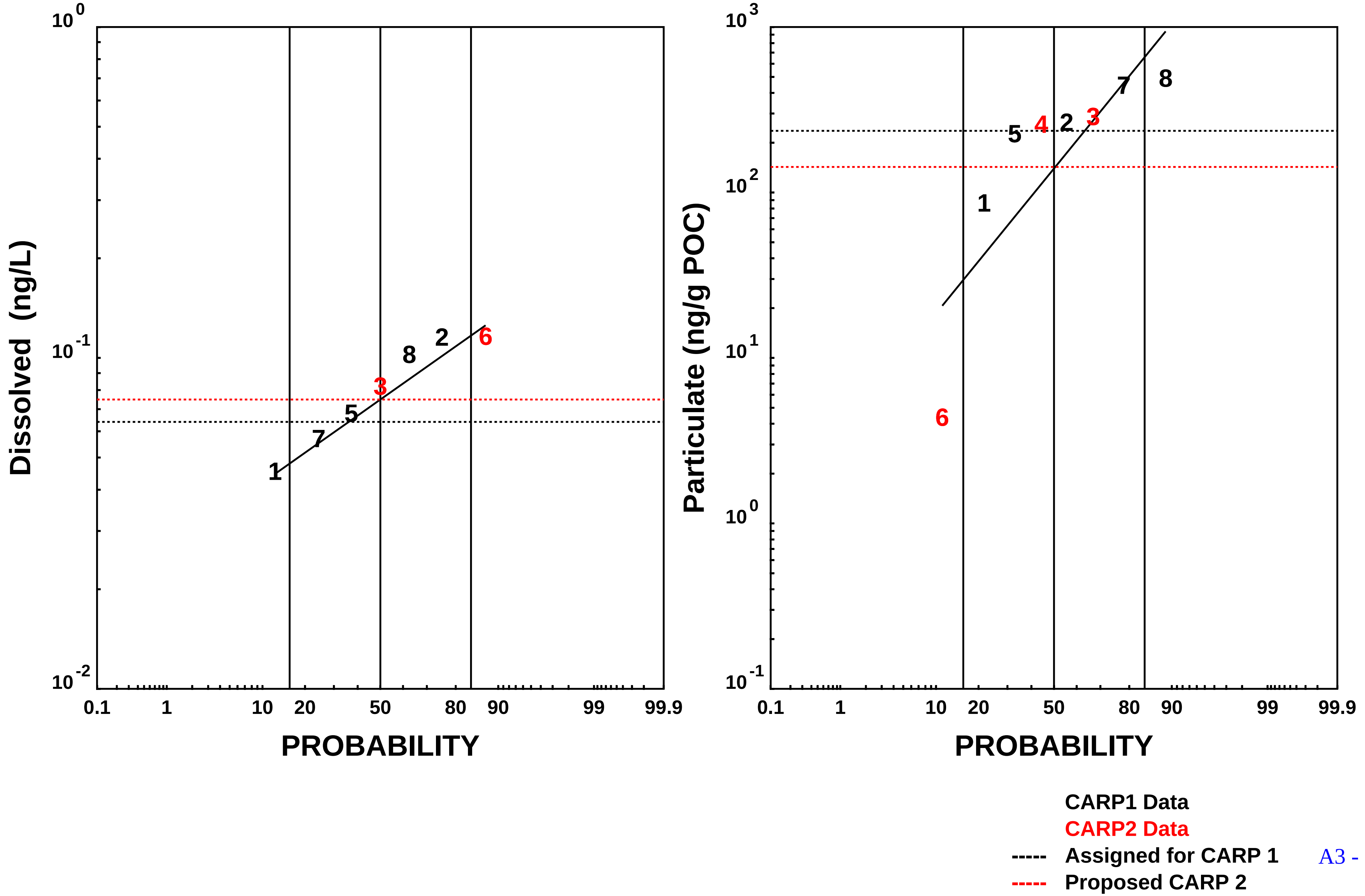




RARITAN RIVER NEAR SOUTH BOUND BROOK -- hexa-PCB

Data Median = 0.0774
Regression Median = 0.0749

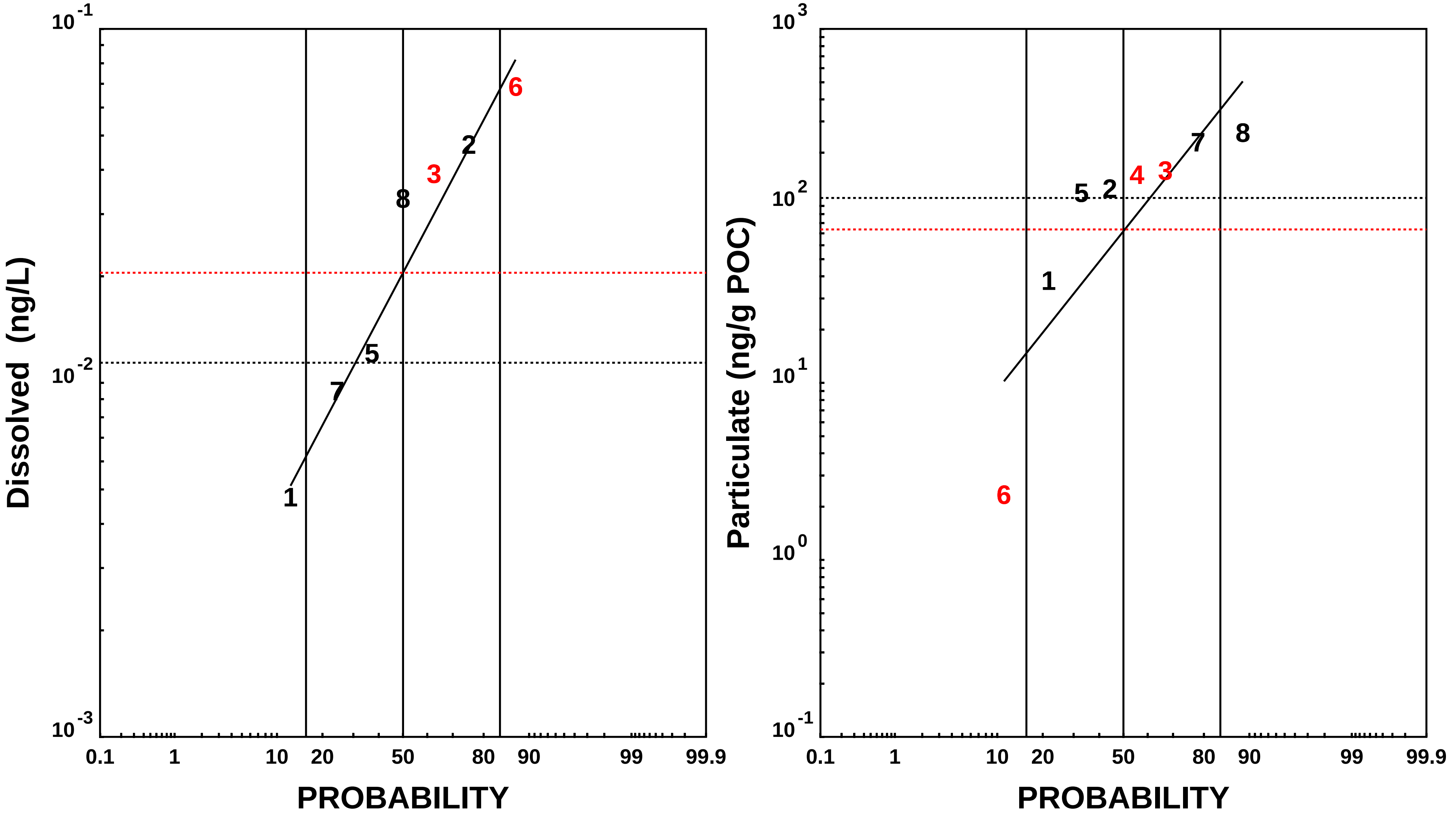
Data Median = 232.7345
Regression Median = 142.7928



RARITAN RIVER NEAR SOUTH BOUND BROOK -- hepta-PCB

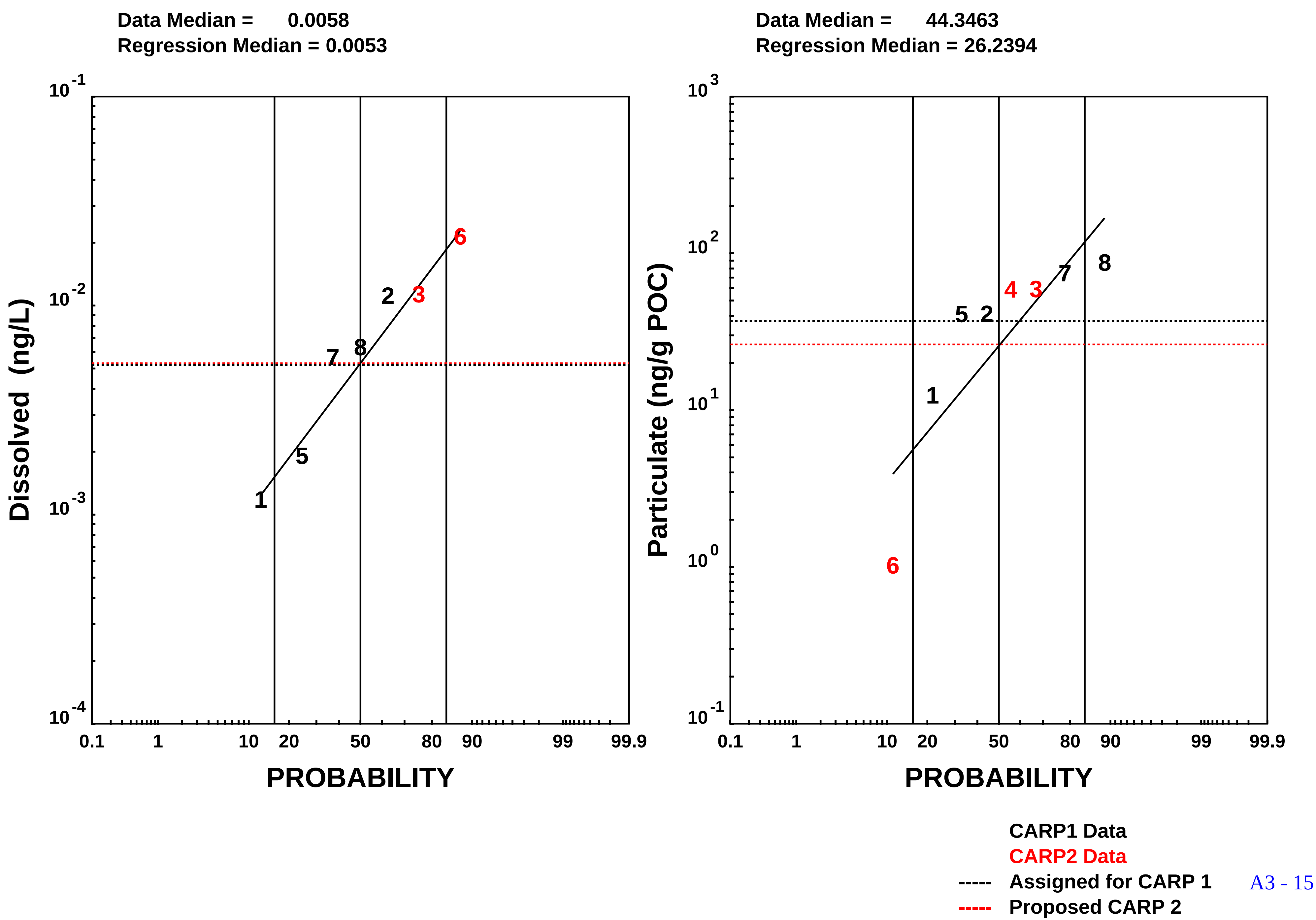
Data Median = 0.0313
Regression Median = 0.0205

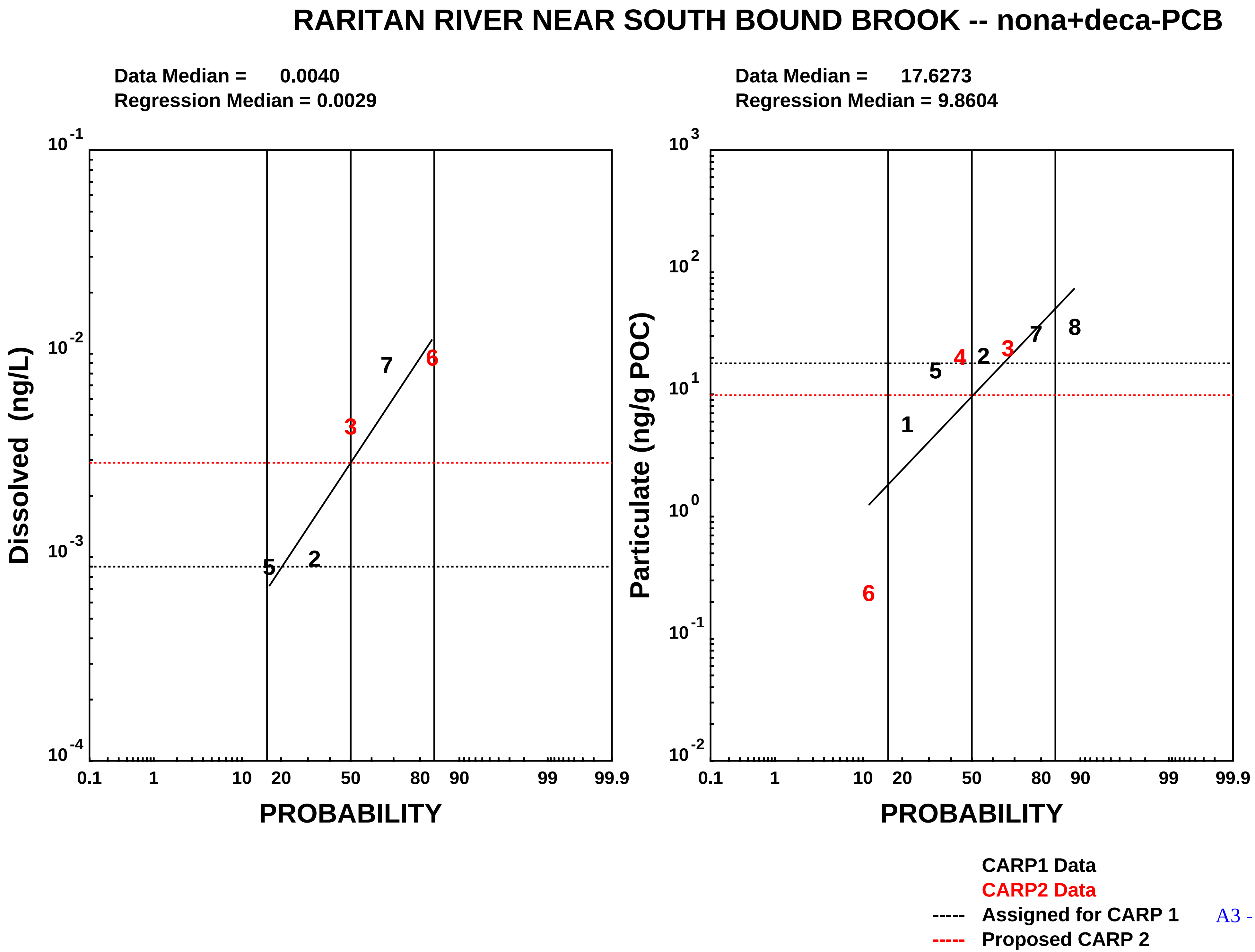
Data Median = 122.0574
Regression Median = 73.6548



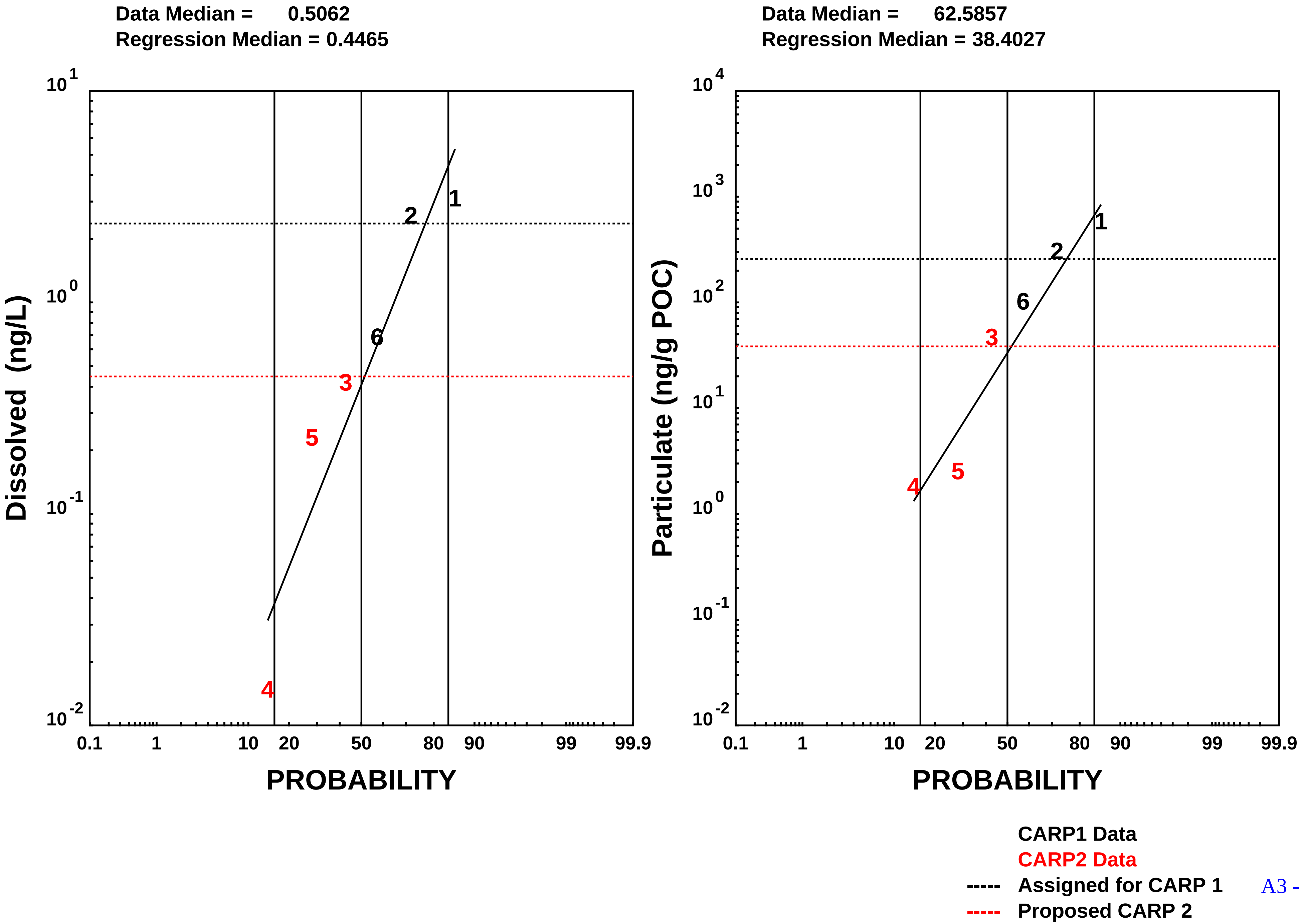
CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2

RARITAN RIVER NEAR SOUTH BOUND BROOK -- octa-PCB

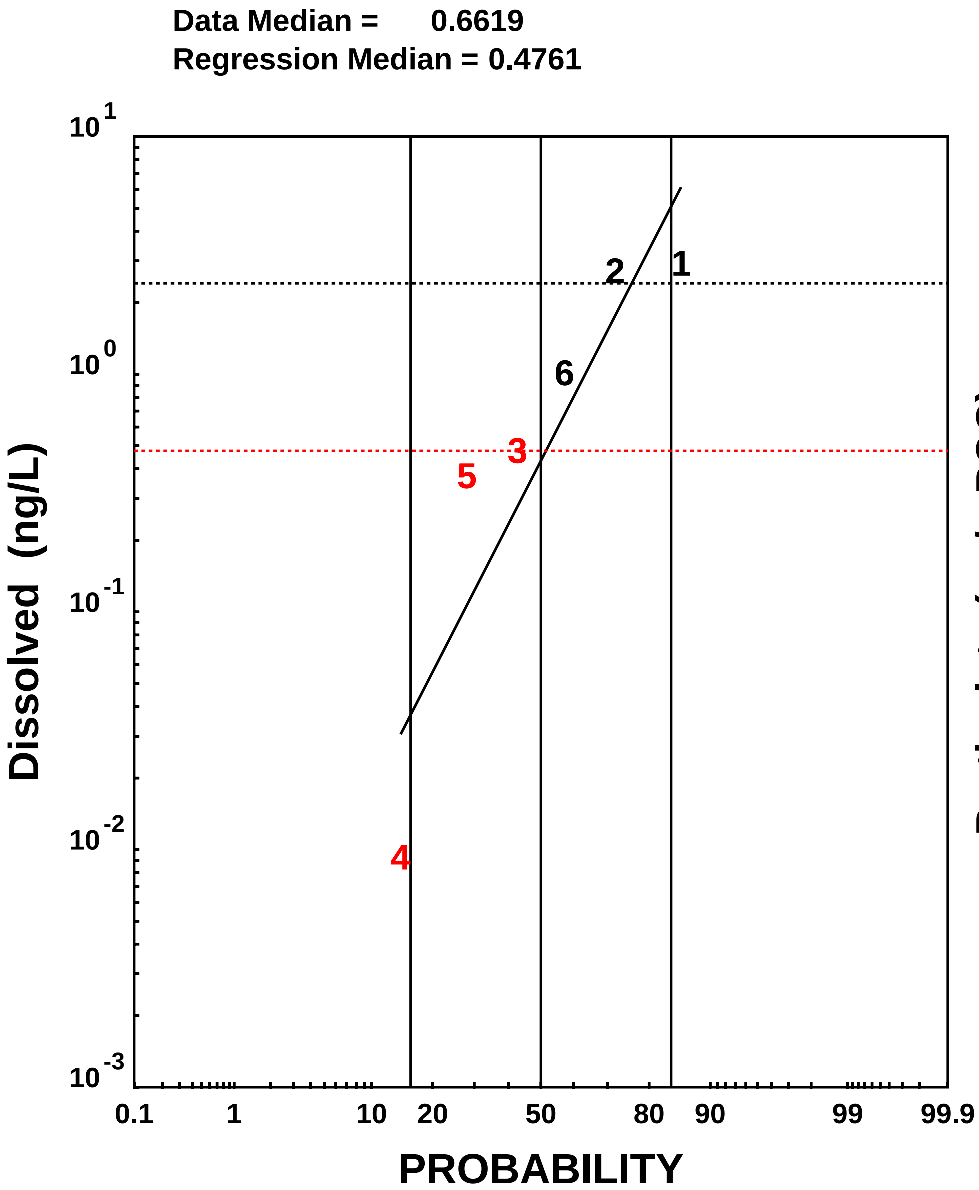


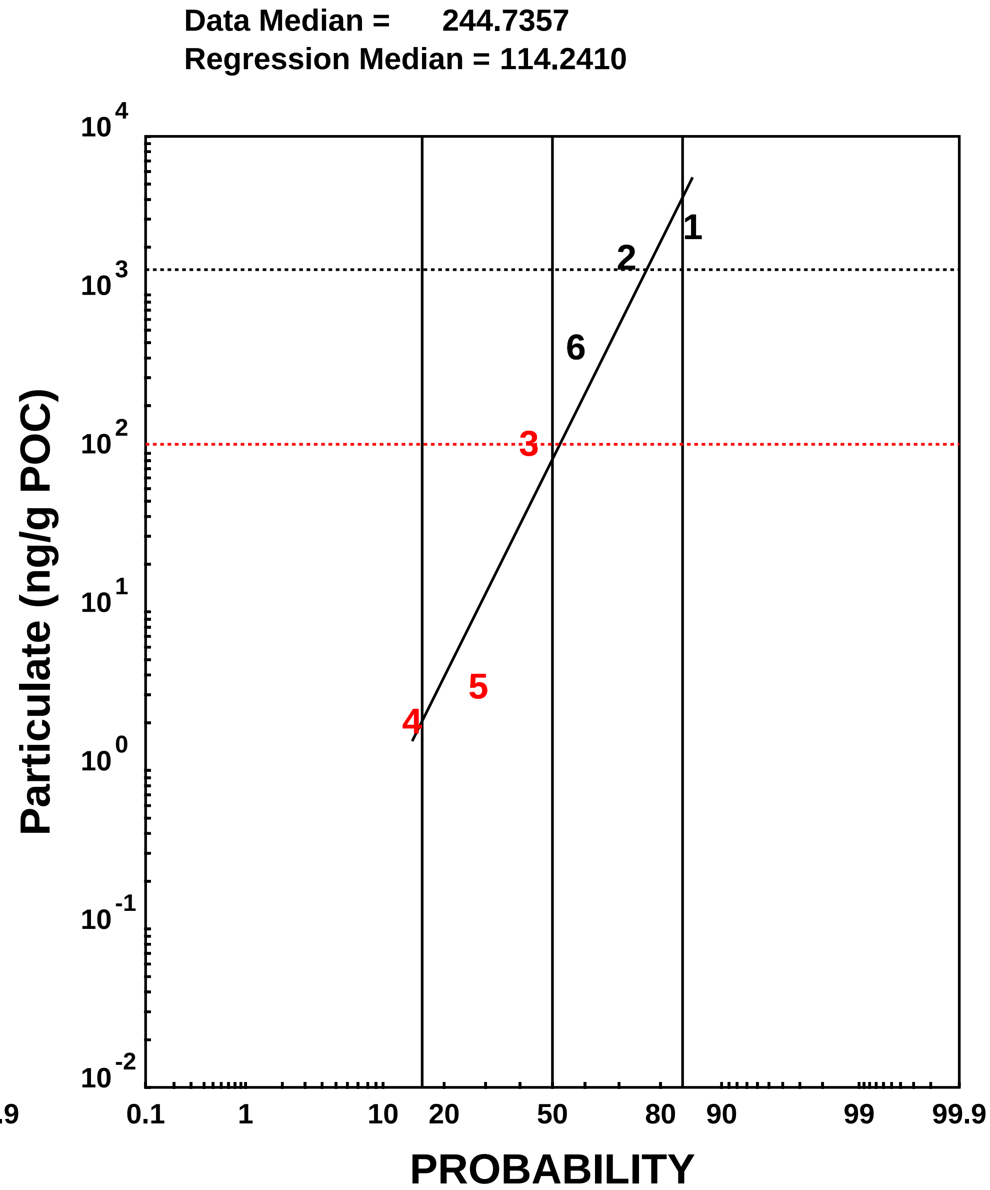

RARITAN RIVER NEAR SOUTH BOUND BROOK -- nona+deca-PCB
Data Median = 0.0040
Regression Median = 0.0029
Dissolved (ng/L)
PROBABILITY
Data Median = 17.6273
Regression Median = 9.8604
Particulate (ng/g POC)
PROBABILITY
CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2

ELIZABETH RIVER AT HILLSIDE -- mono+di-PCB



ELIZABETH RIVER AT HILLSIDE -- tri-PCB



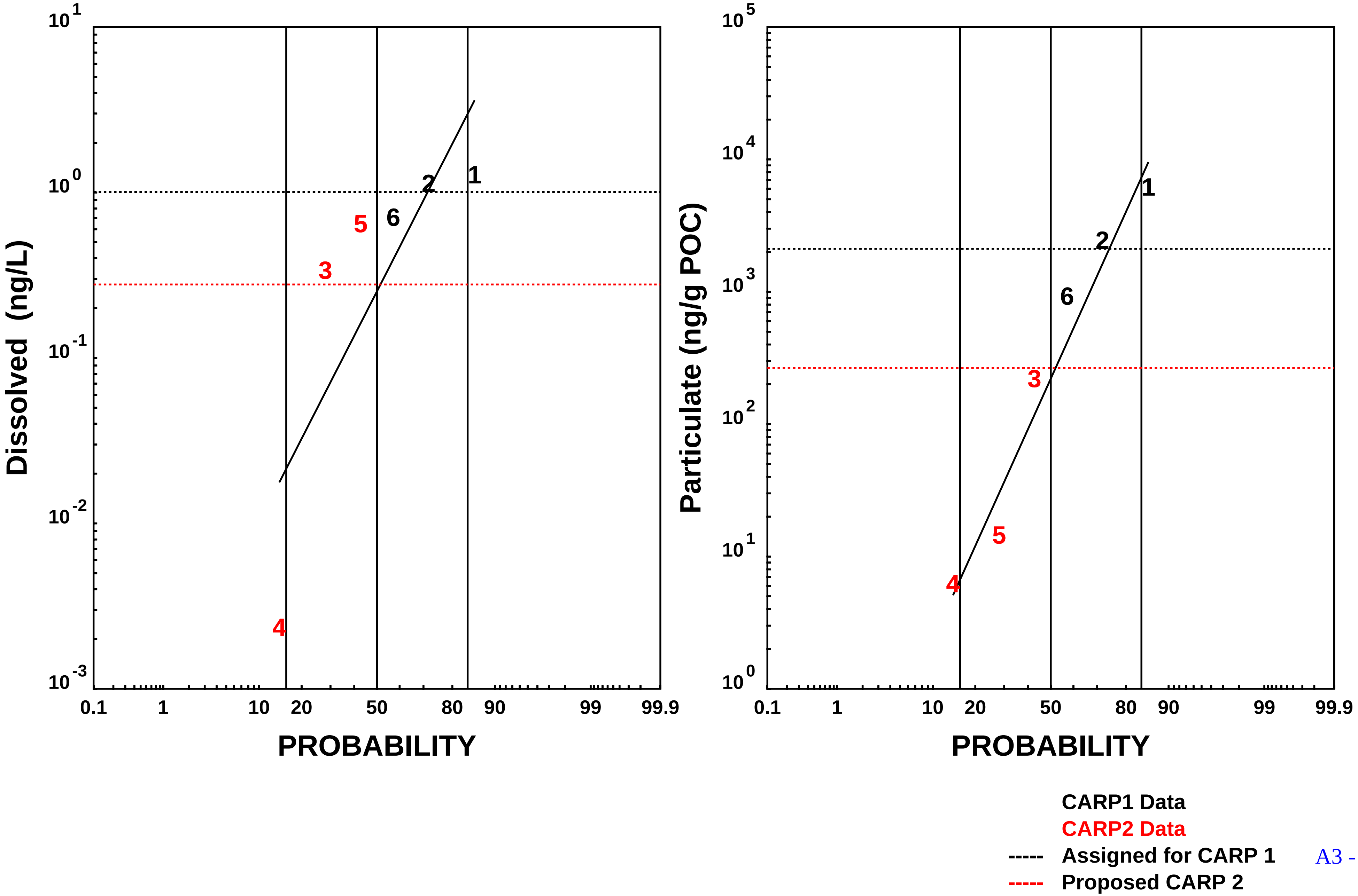


CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2

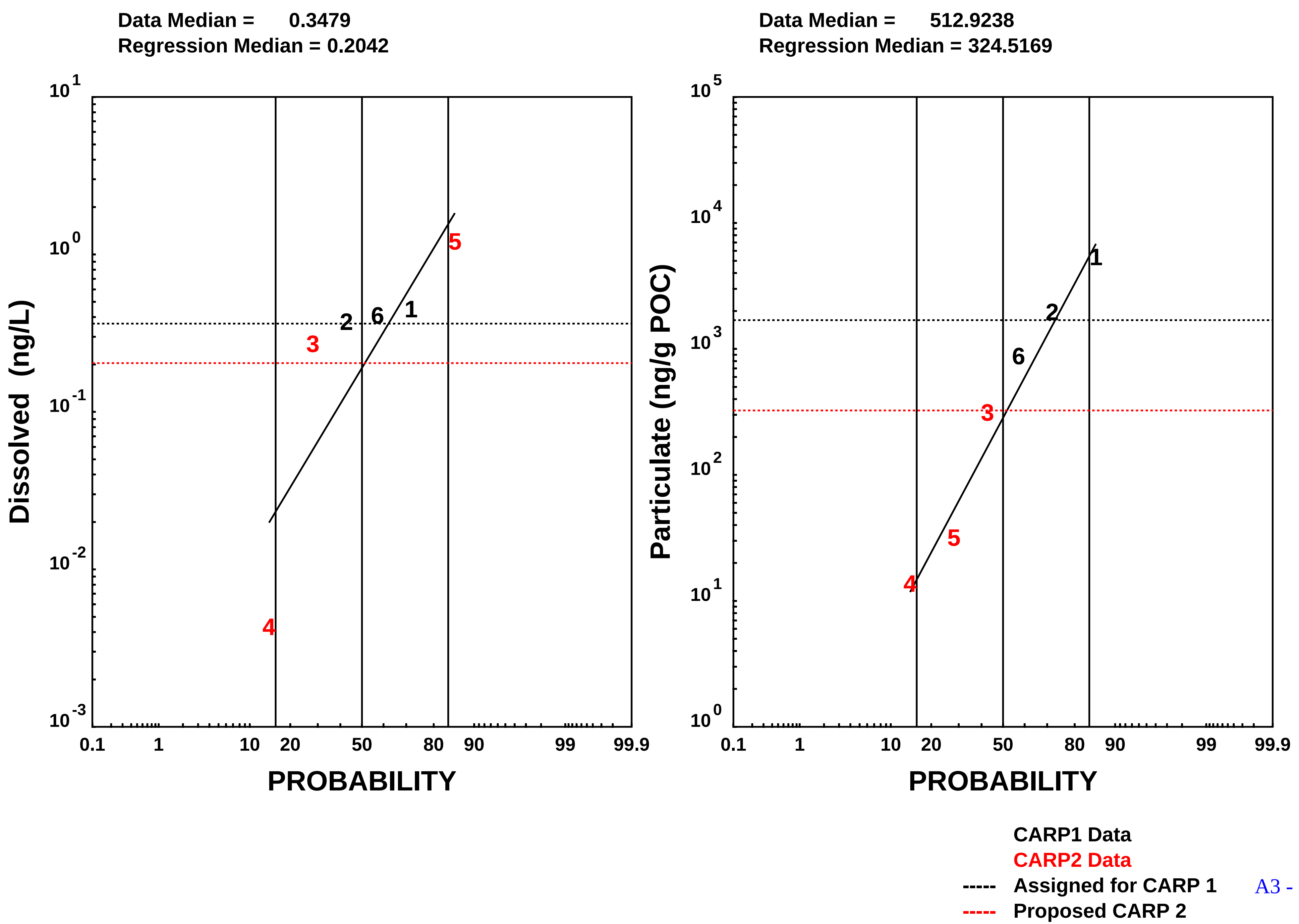
ELIZABETH RIVER AT HILLSIDE -- tetra-PCB

Data Median = 0.6020
Regression Median = 0.2782

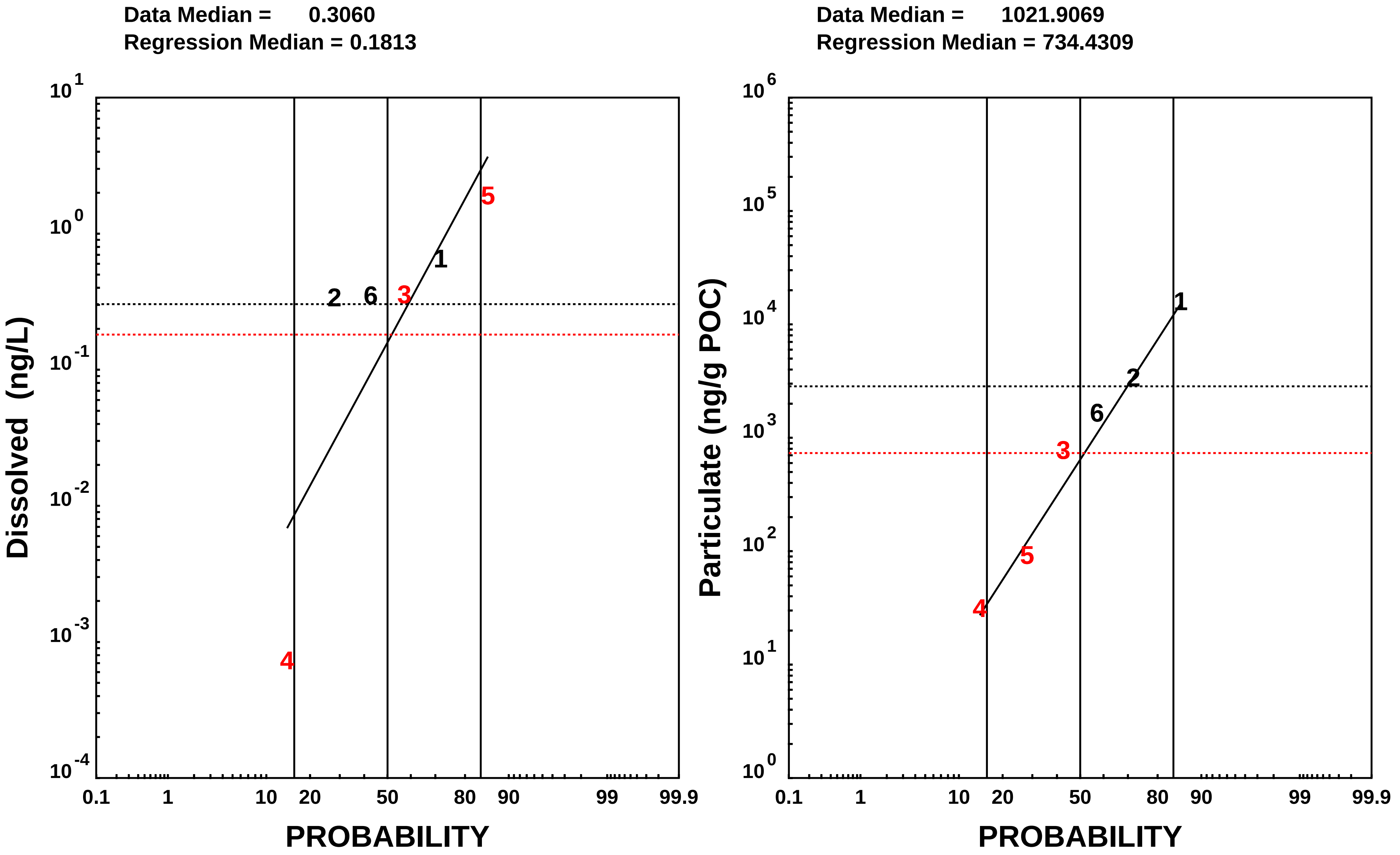
Data Median = 494.1262
Regression Median = 265.7617



ELIZABETH RIVER AT HILLSIDE -- penta-PCB

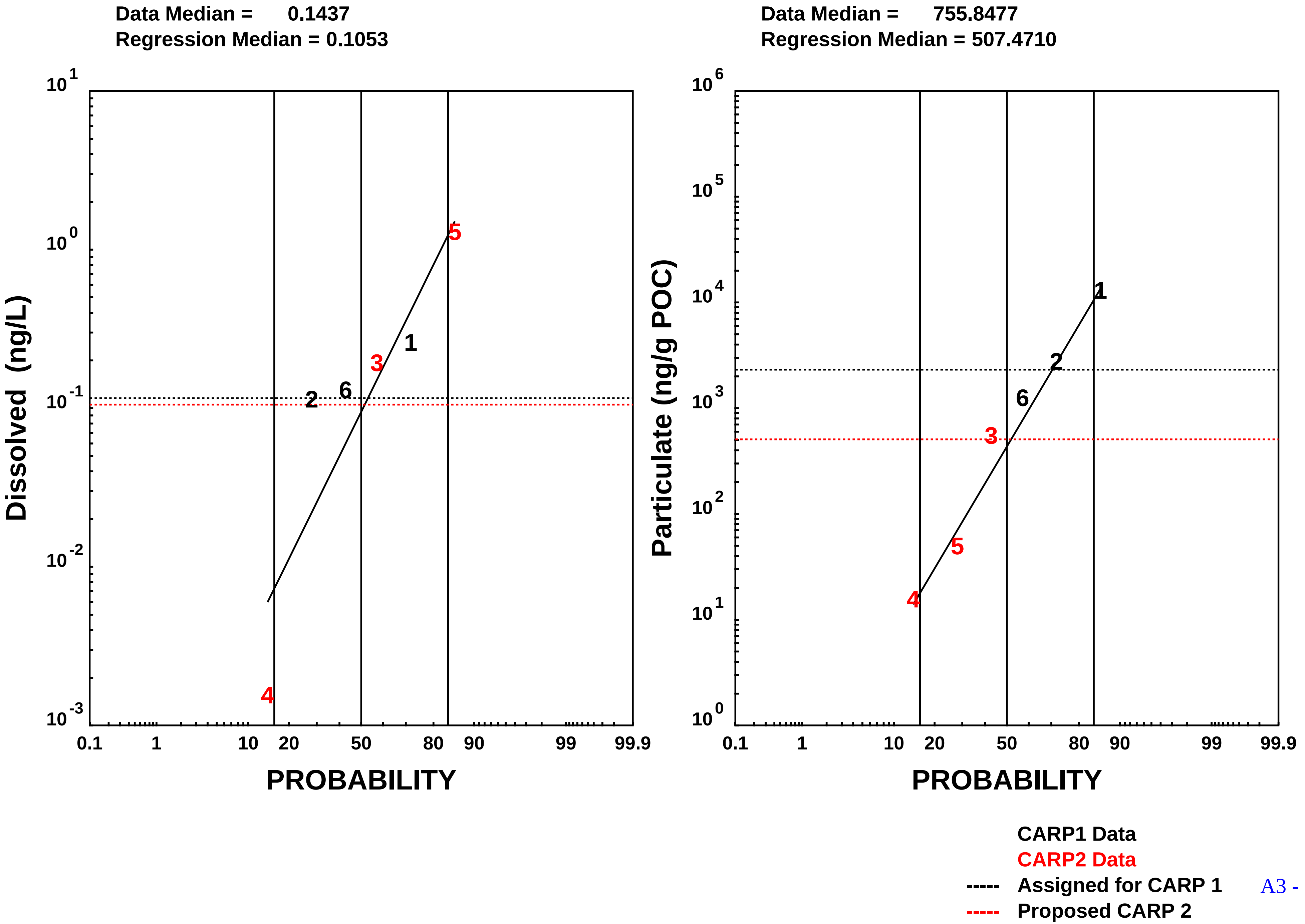


ELIZABETH RIVER AT HILLSIDE -- hexa-PCB

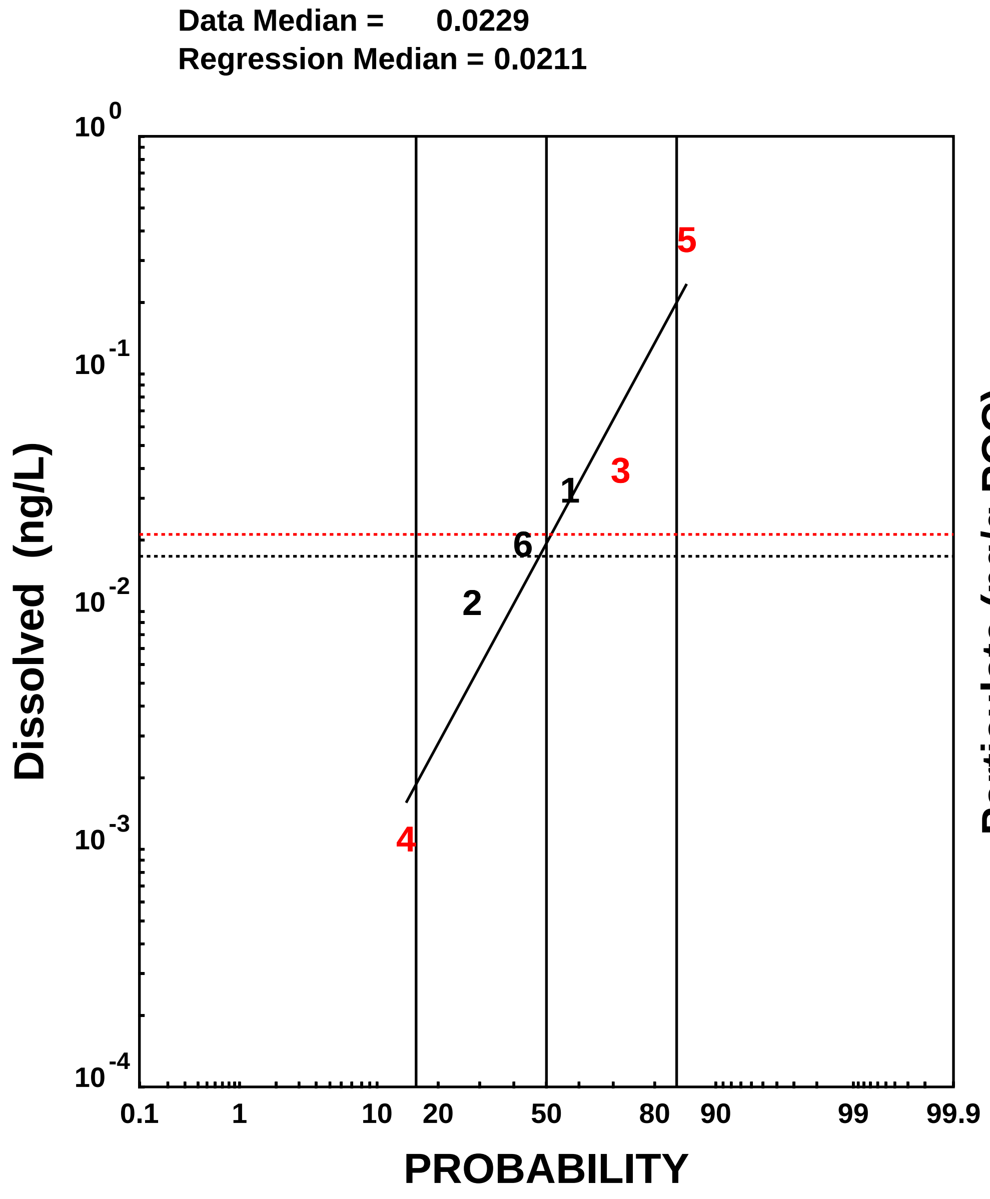


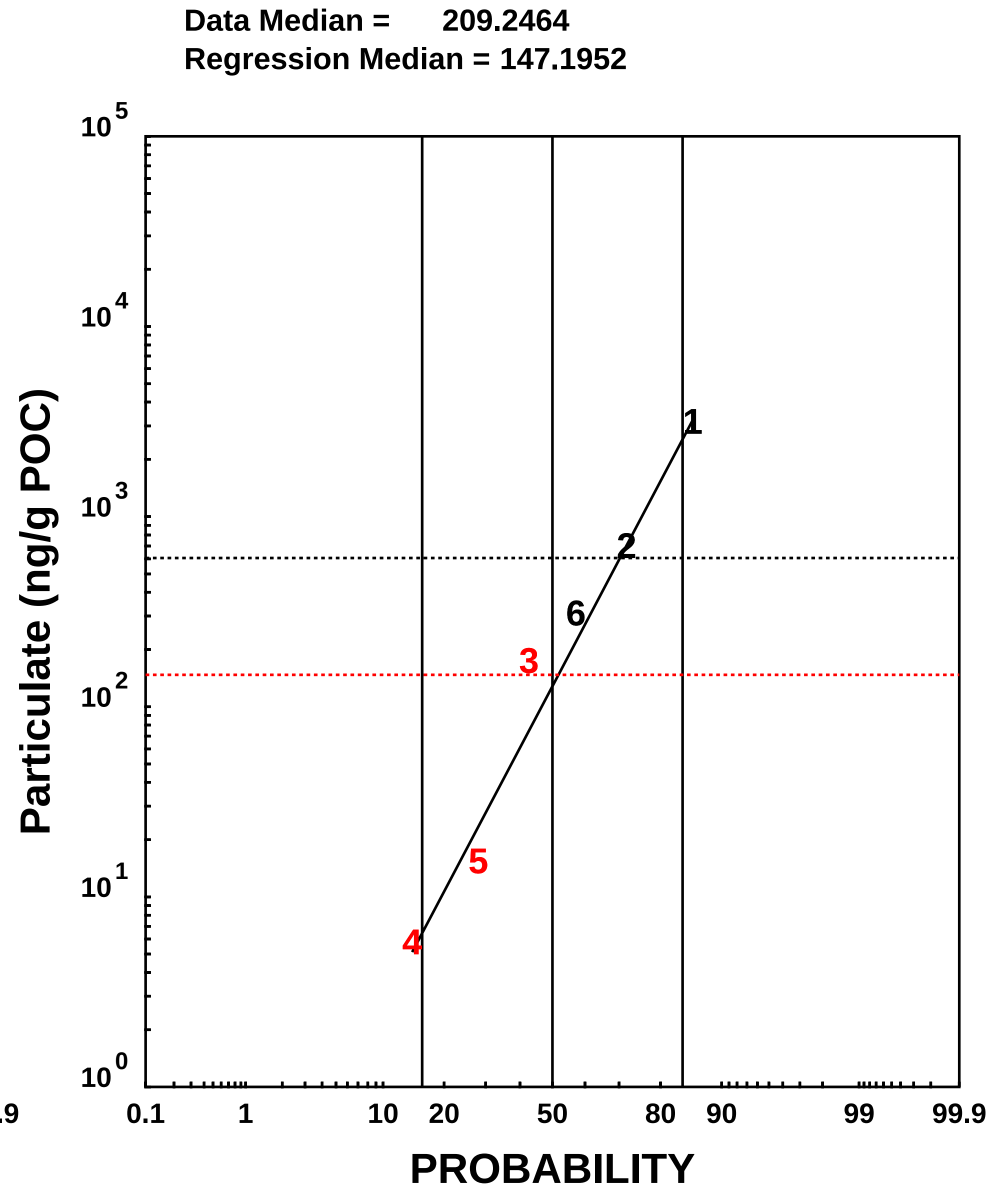
CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2

ELIZABETH RIVER AT HILLSIDE -- hepta-PCB



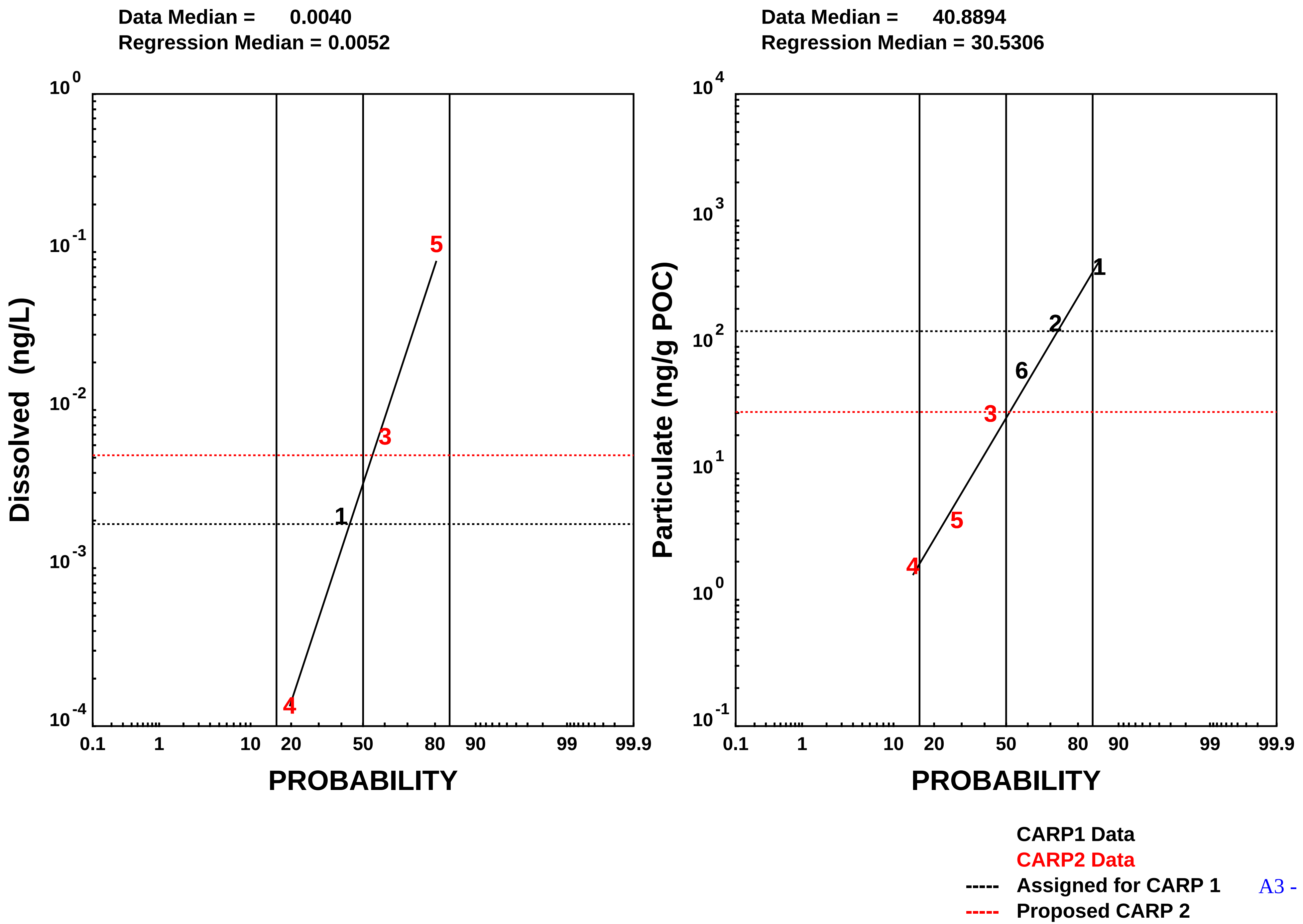
ELIZABETH RIVER AT HILLSIDE -- octa-PCB



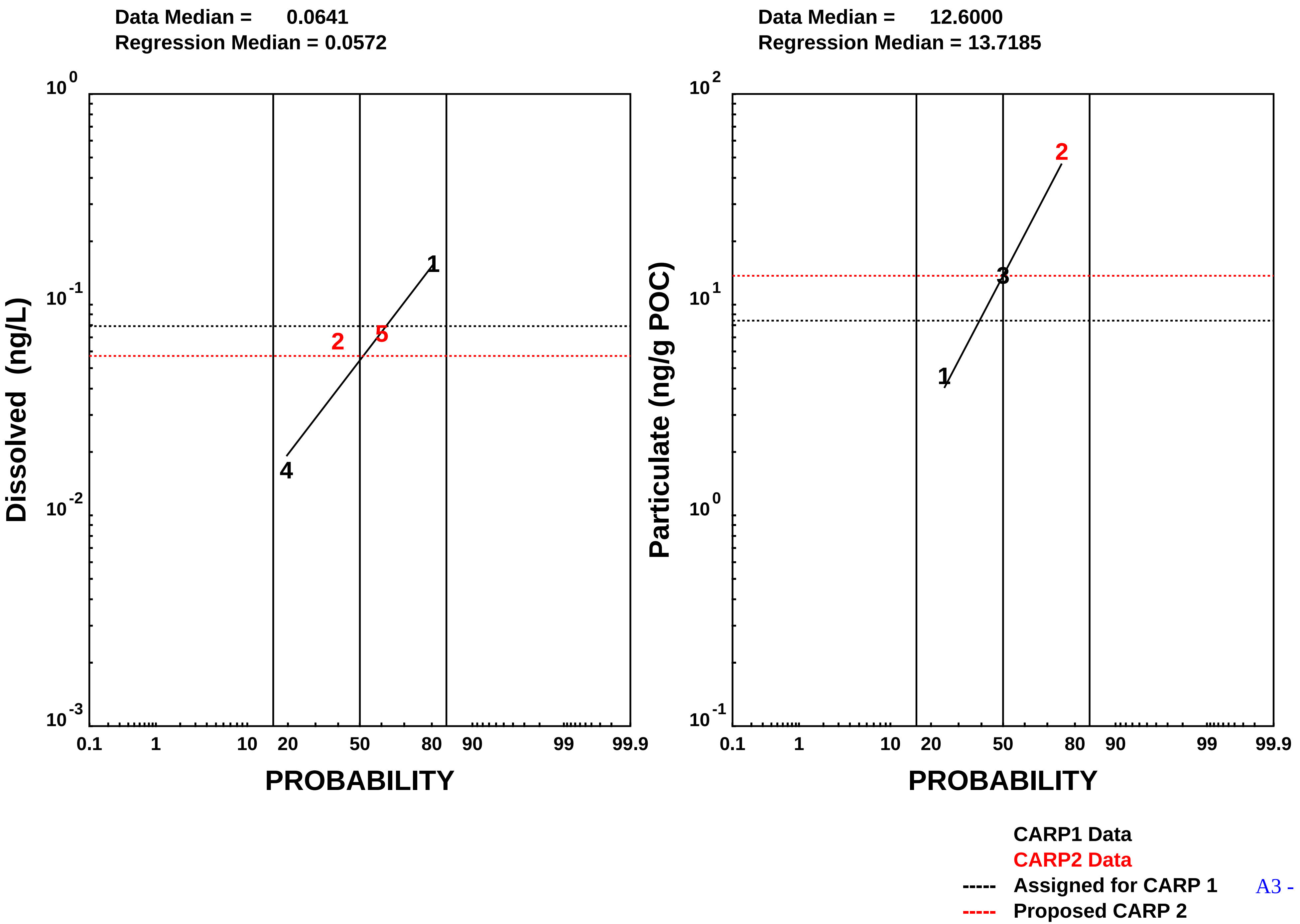


CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2

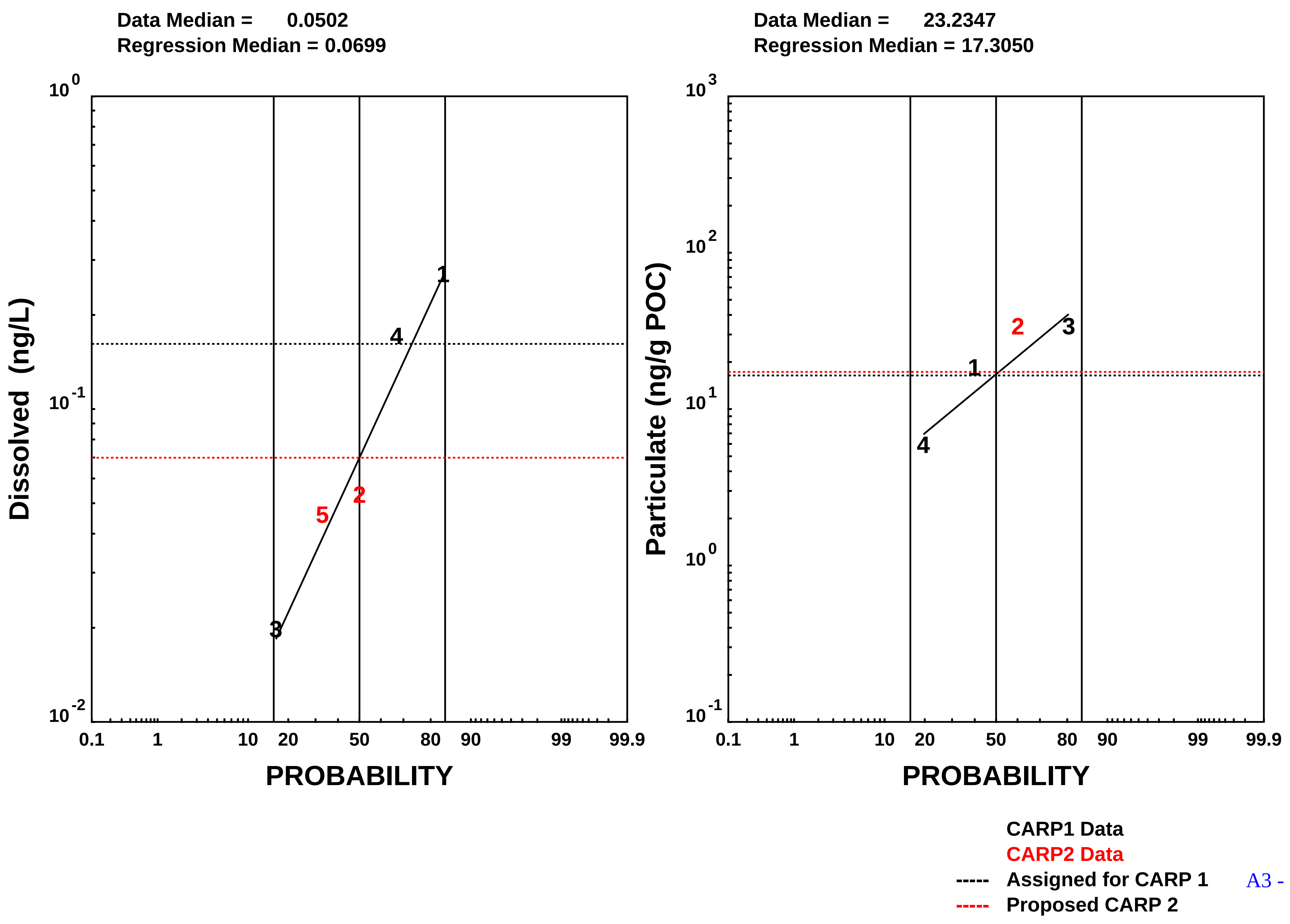
ELIZABETH RIVER AT HILLSIDE -- nona+deca-PCB



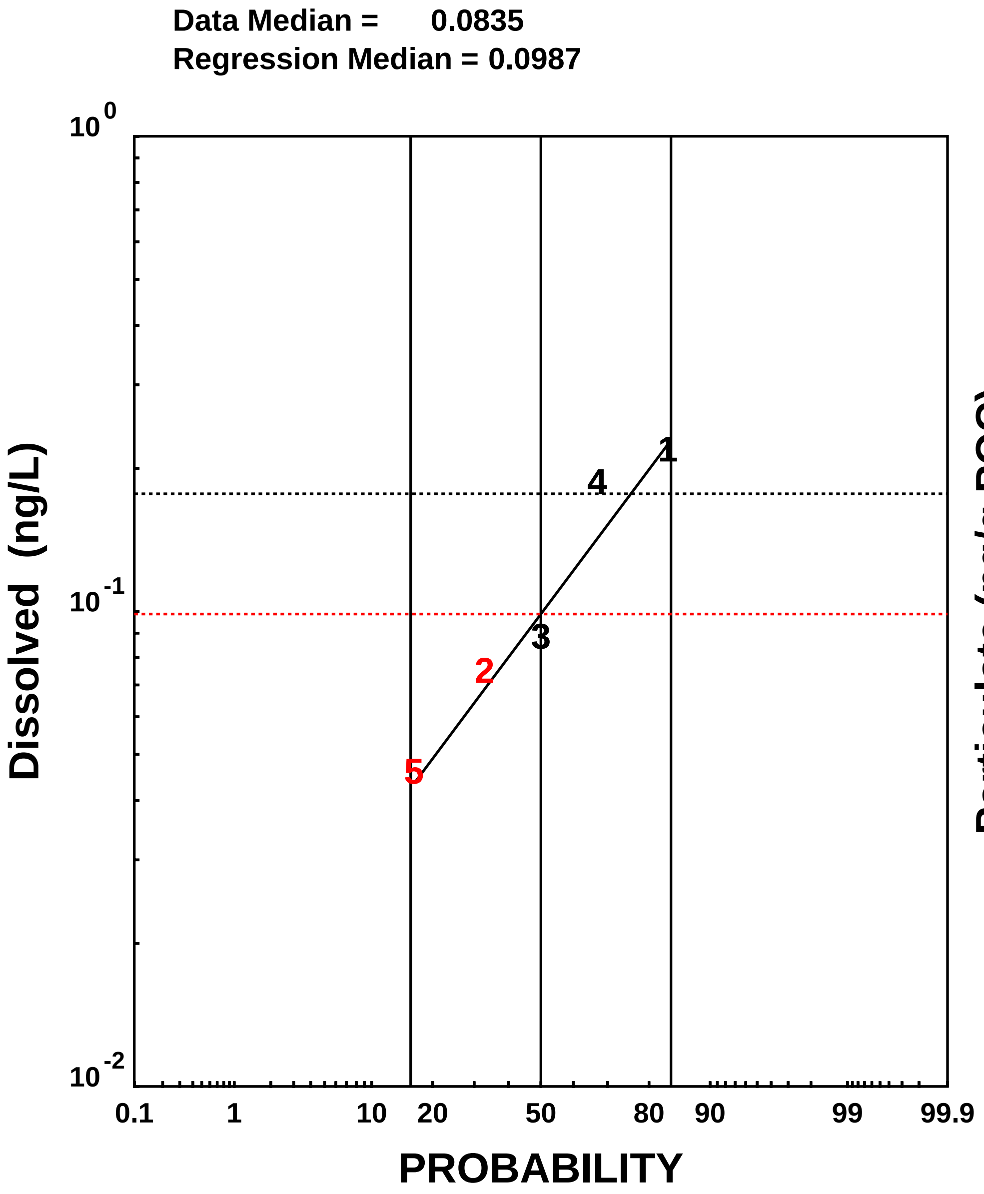
HACKENSACK RIVER AT NEW MILFORD -- mono+di-PCB

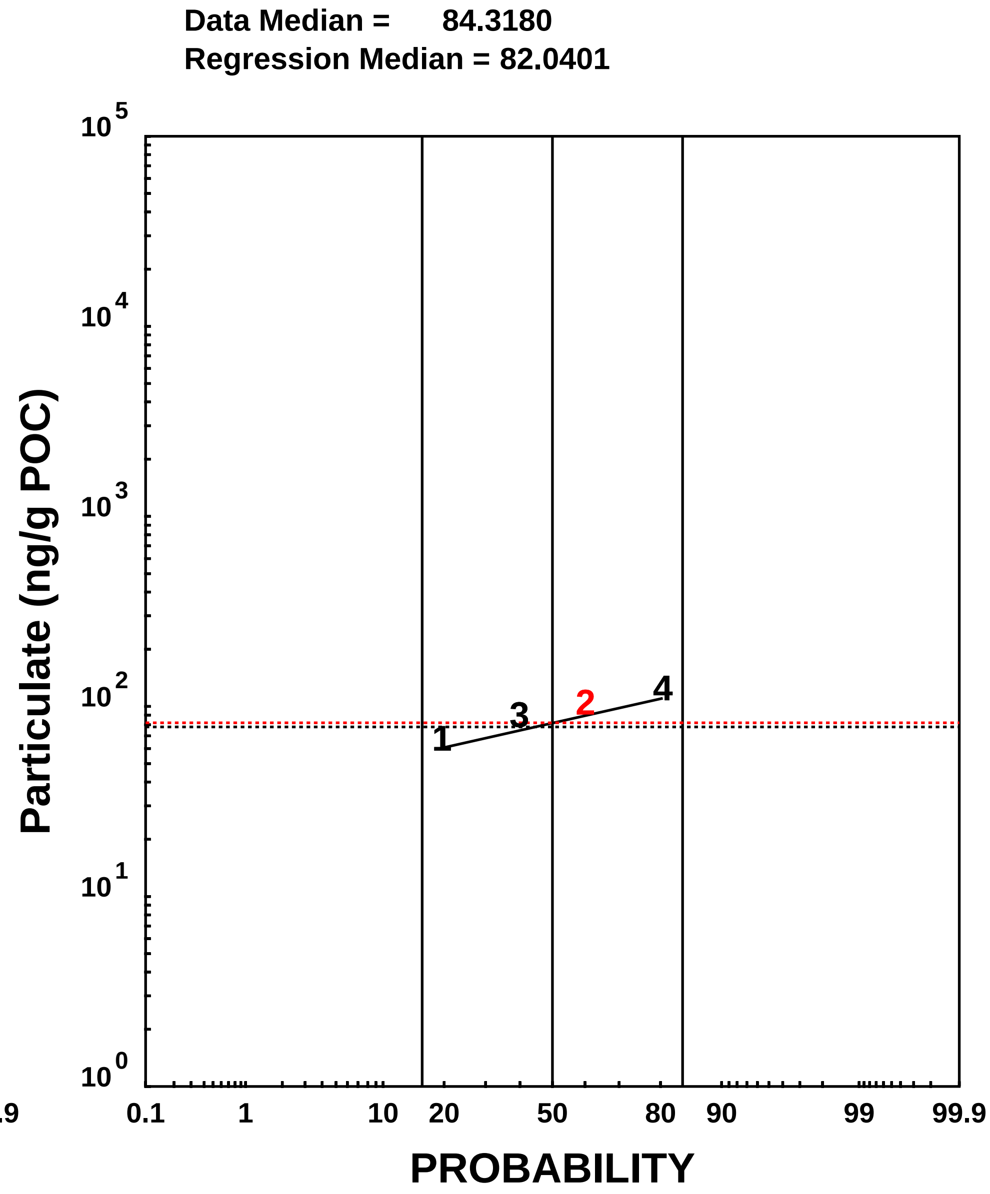


HACKENSACK RIVER AT NEW MILFORD -- tri-PCB



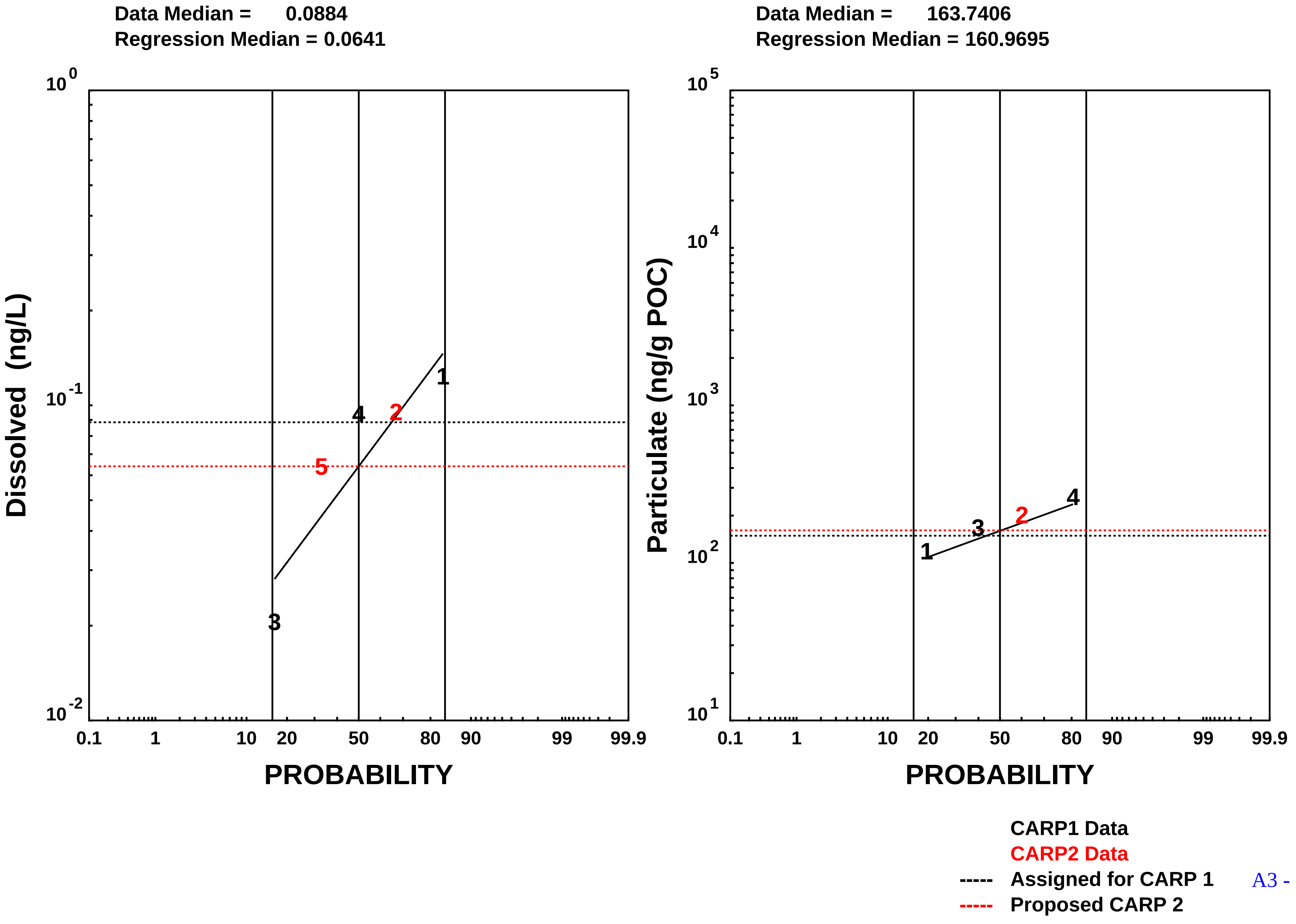
HACKENSACK RIVER AT NEW MILFORD -- tetra-PCB



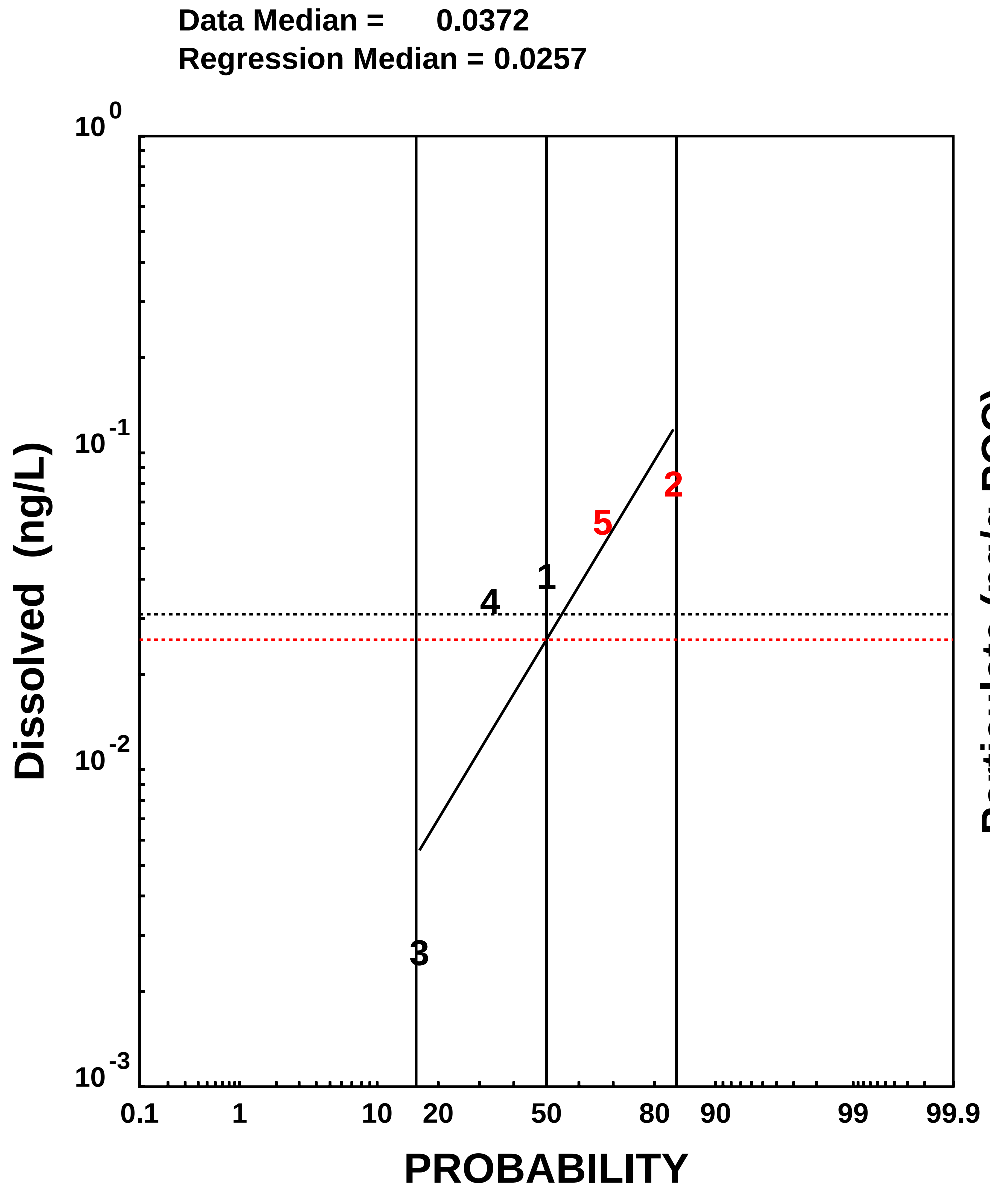


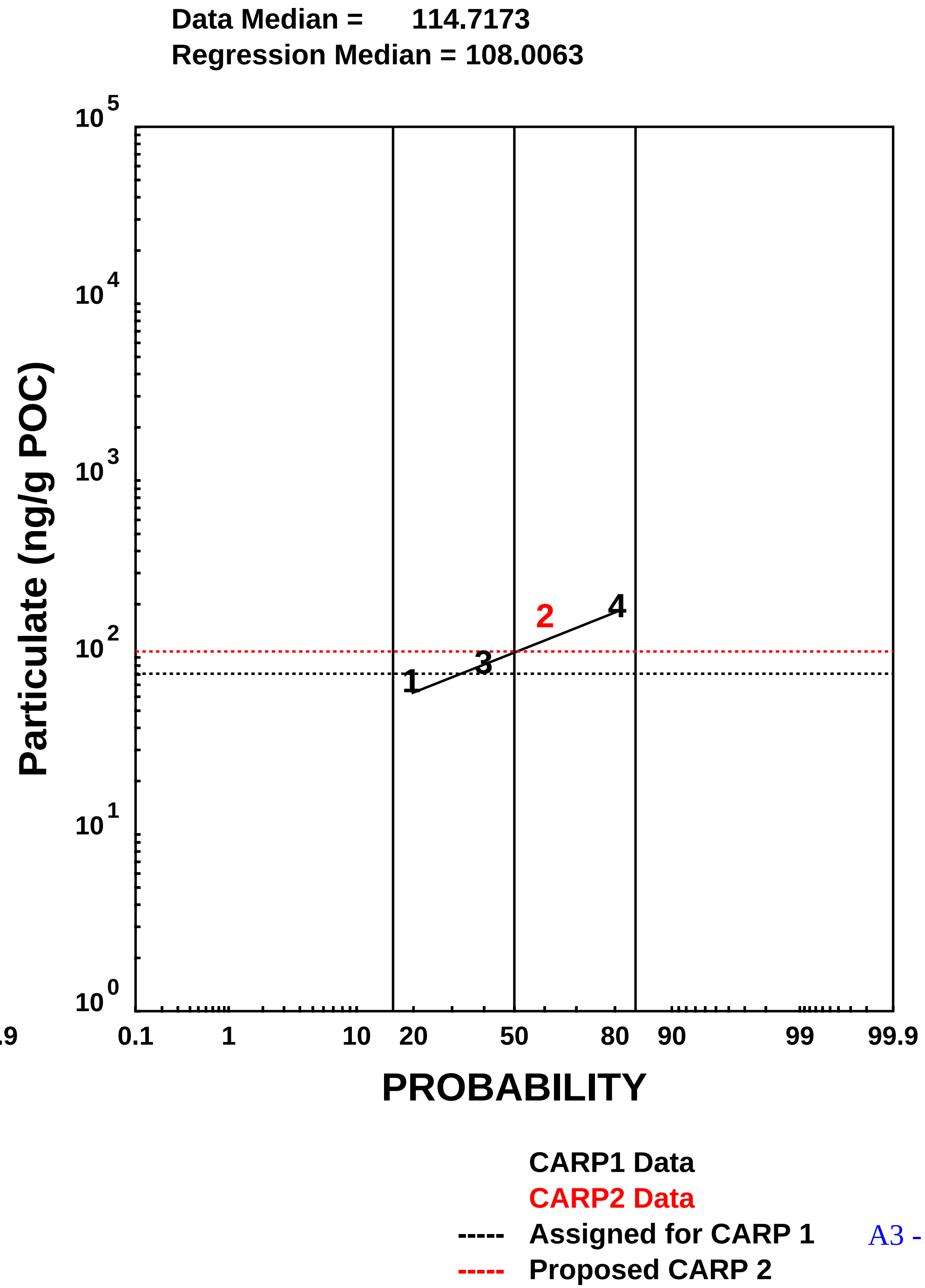
CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2

HACKENSACK RIVER AT NEW MILFORD -- penta-PCB

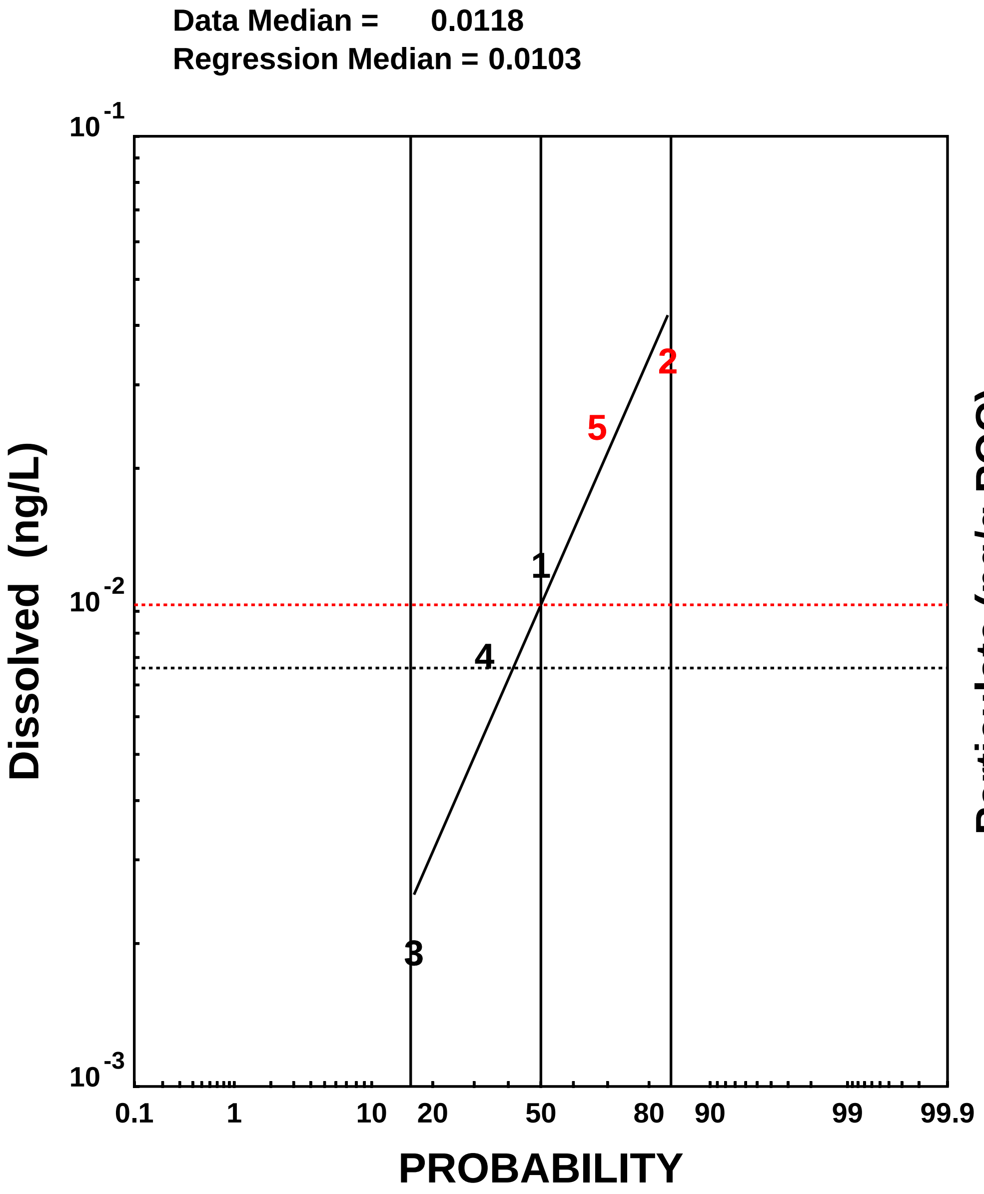


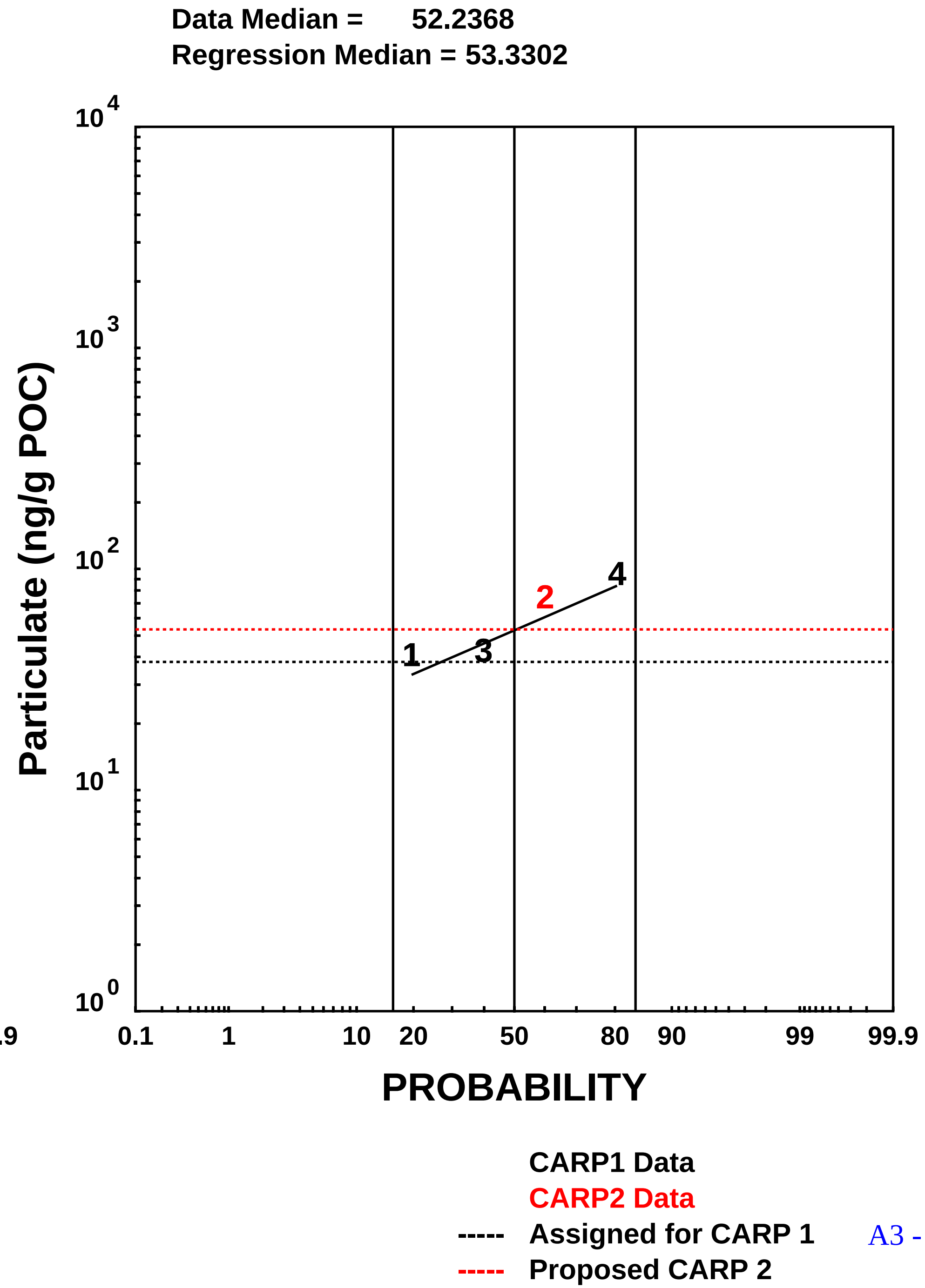
HACKENSACK RIVER AT NEW MILFORD -- hexa-PCB



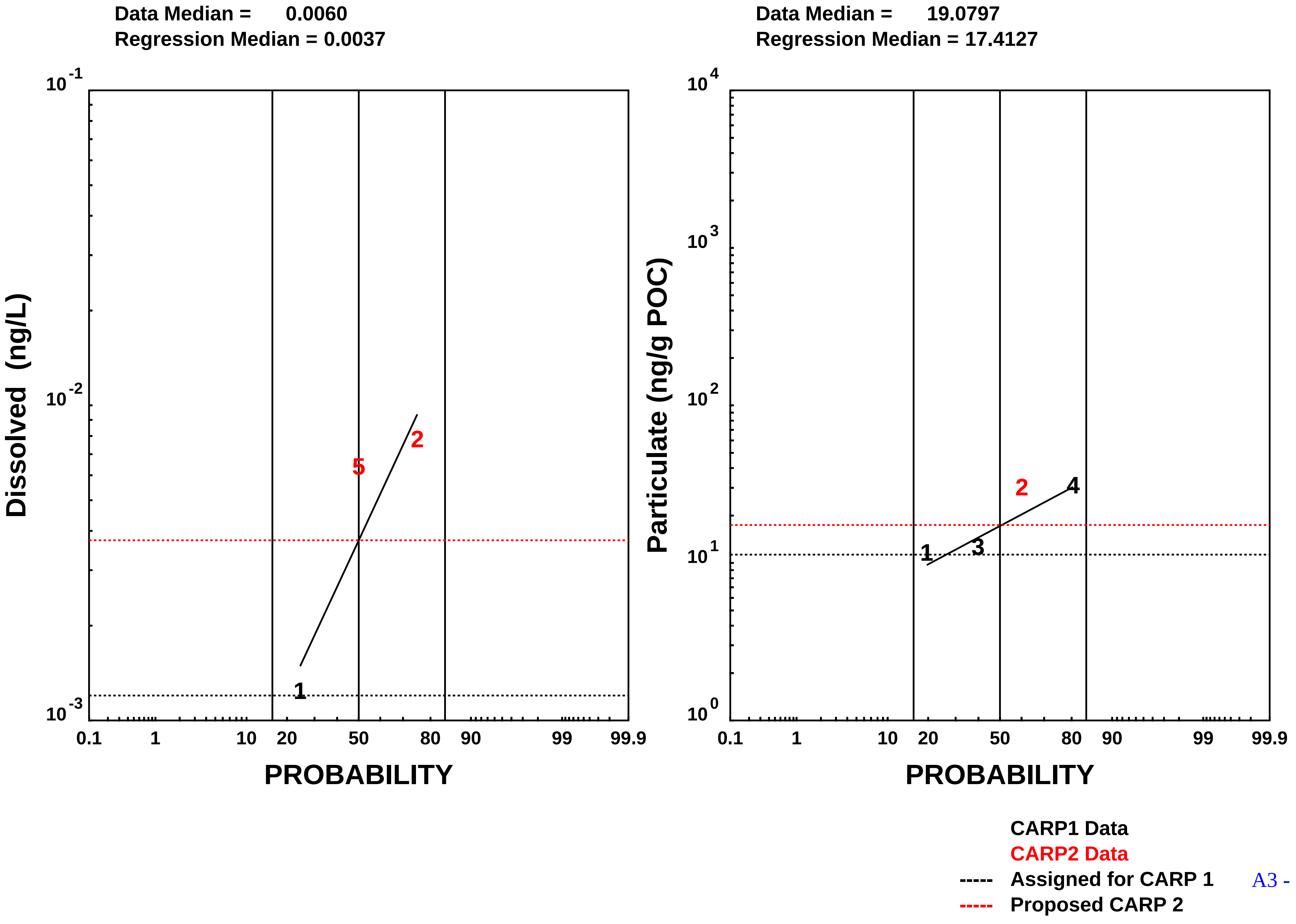


HACKENSACK RIVER AT NEW MILFORD -- hepta-PCB



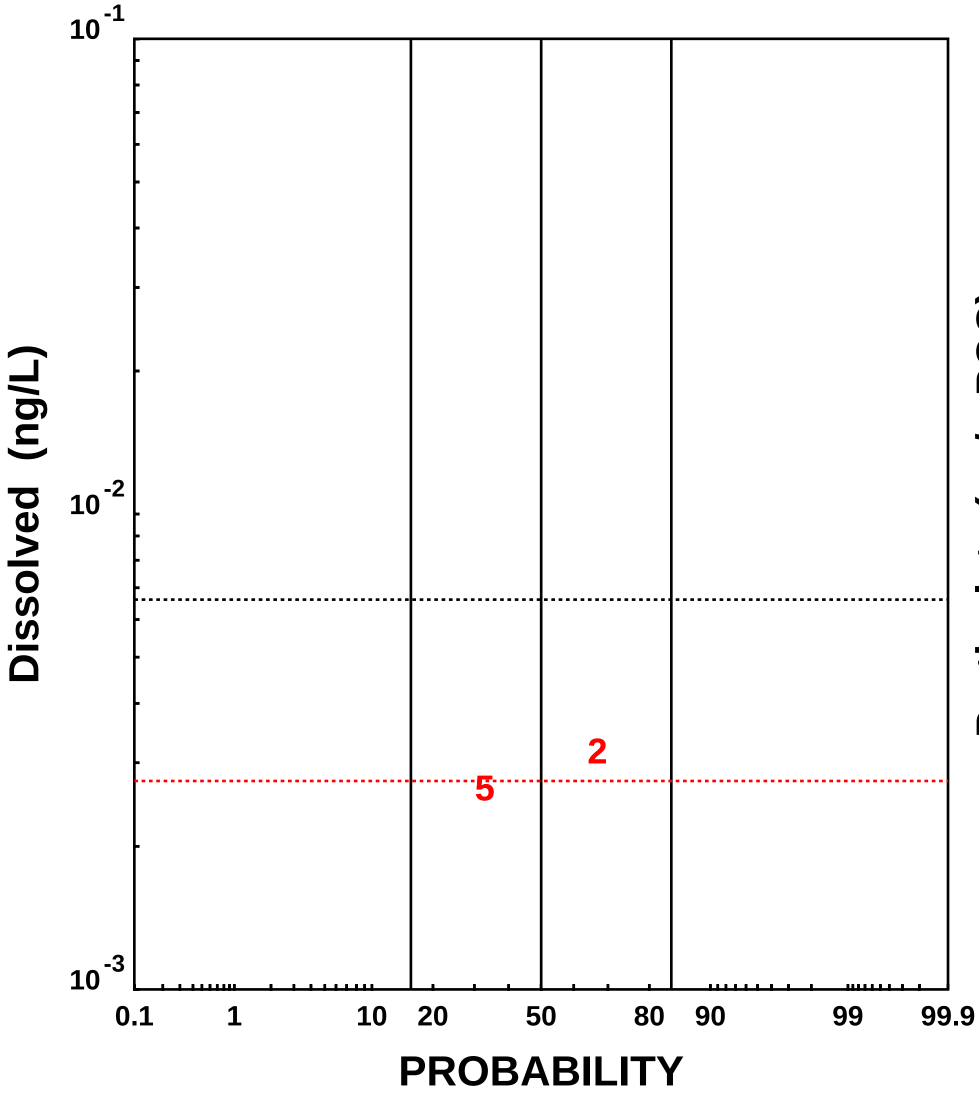


HACKENSACK RIVER AT NEW MILFORD -- octa-PCB

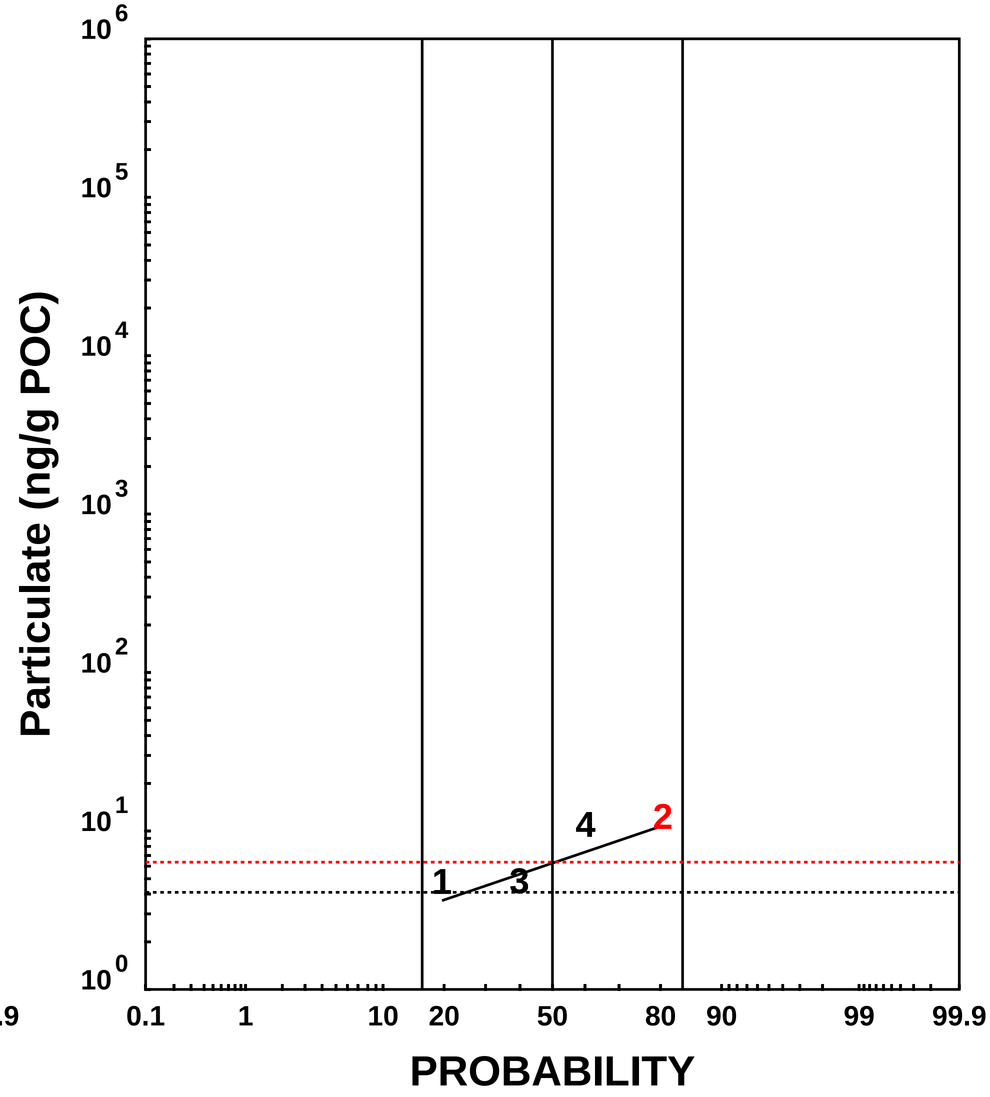


HACKENSACK RIVER AT NEW MILFORD -- nona+deca-PCB

Data Median = 0.0027
Regression Median =



Data Median = 6.6263
Regression Median = 6.3540

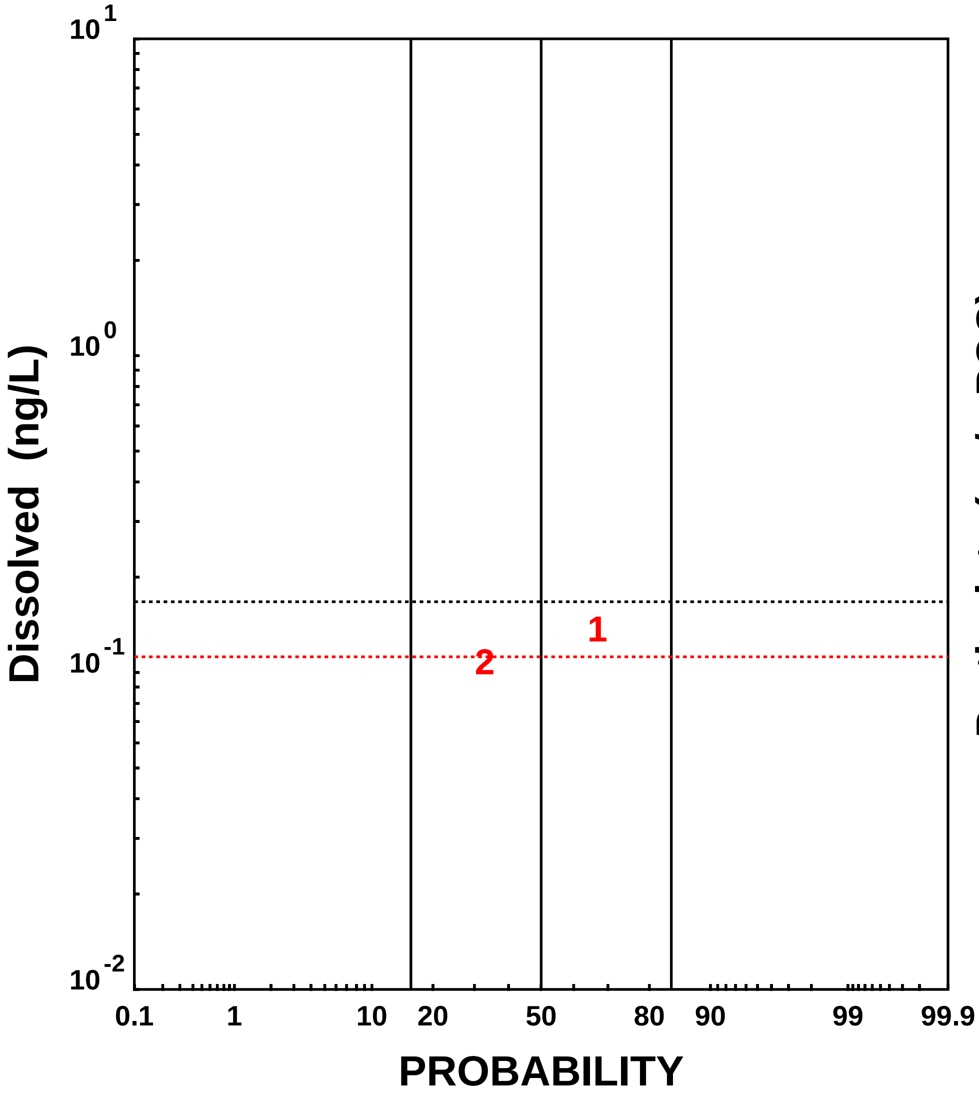


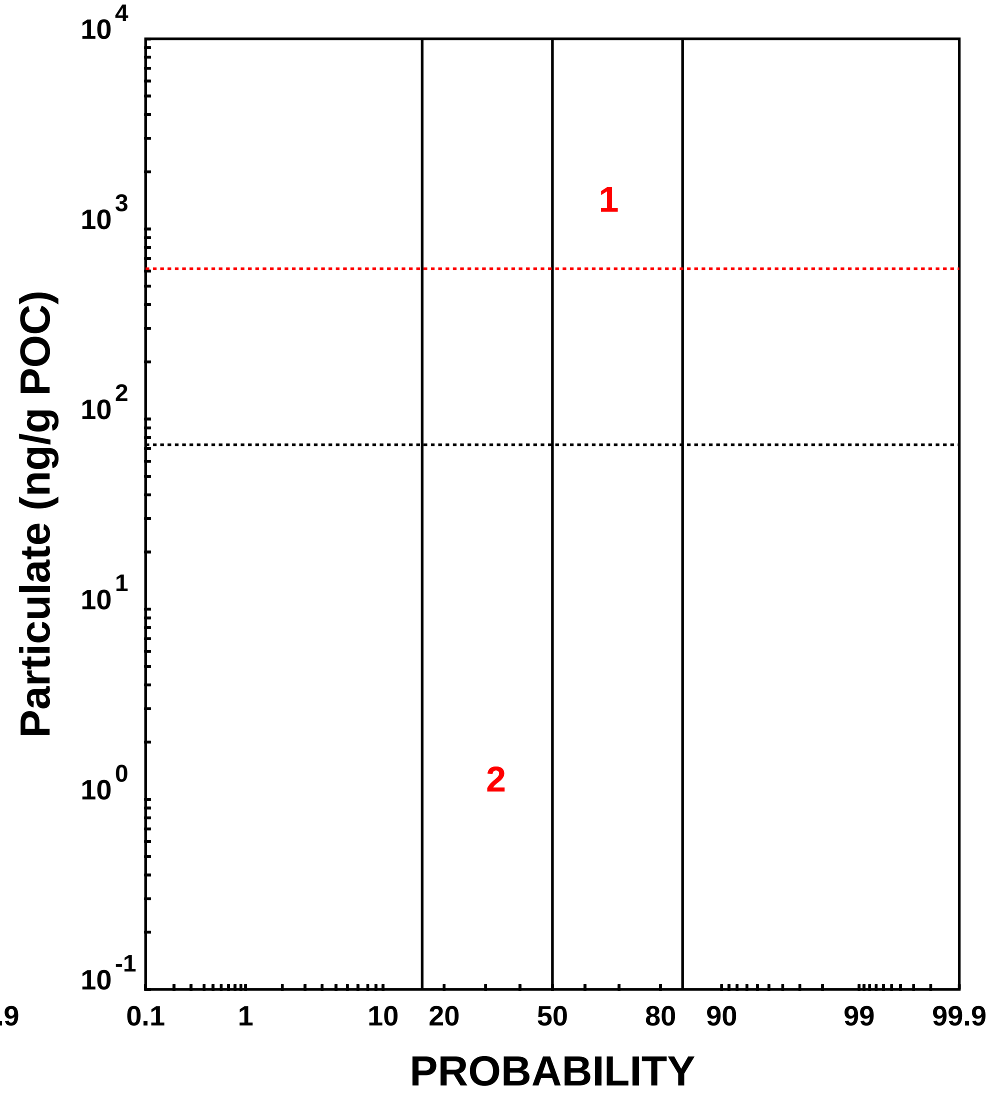
CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2

SADDLE RIVER -- mono+di-PCB

Data Median = 0.1121
Regression Median =

Data Median = 617.5045
Regression Median =

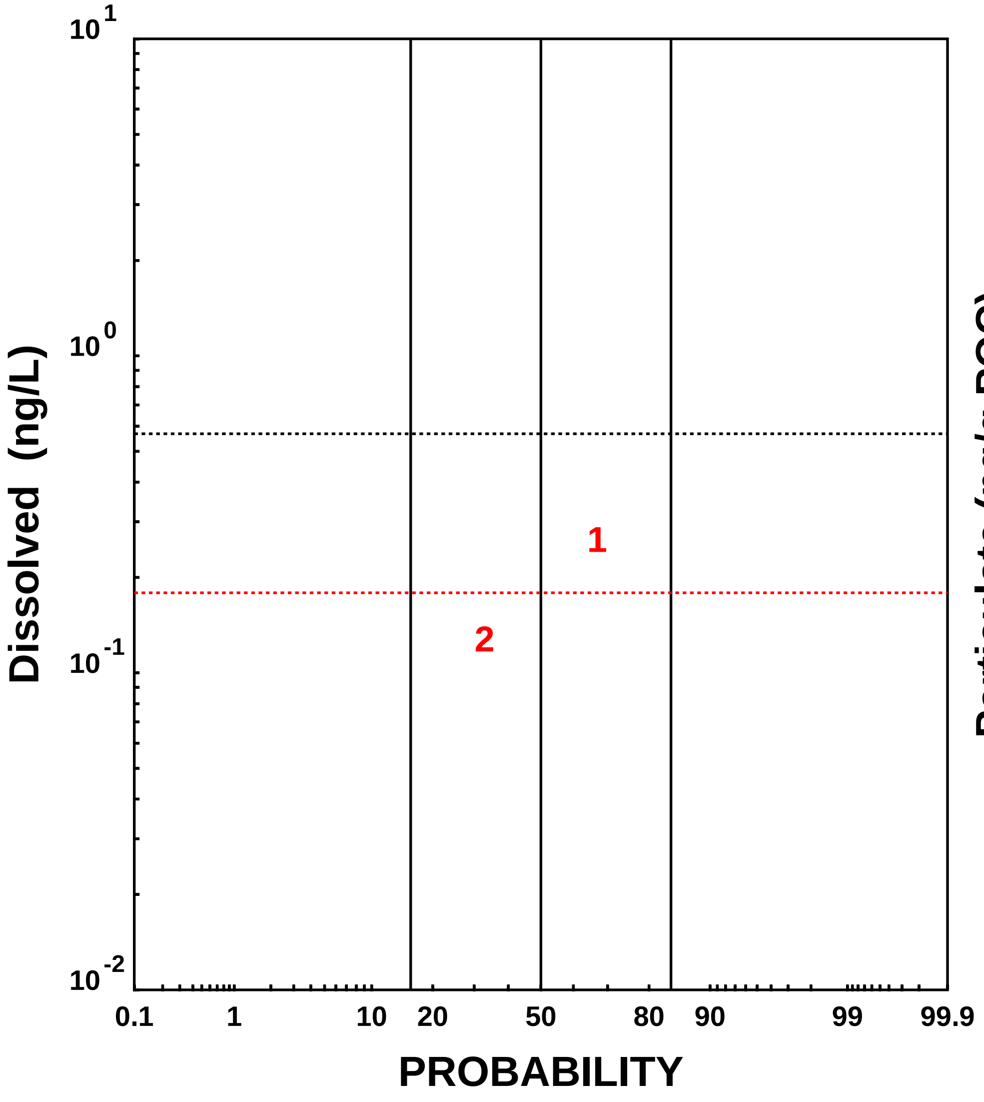




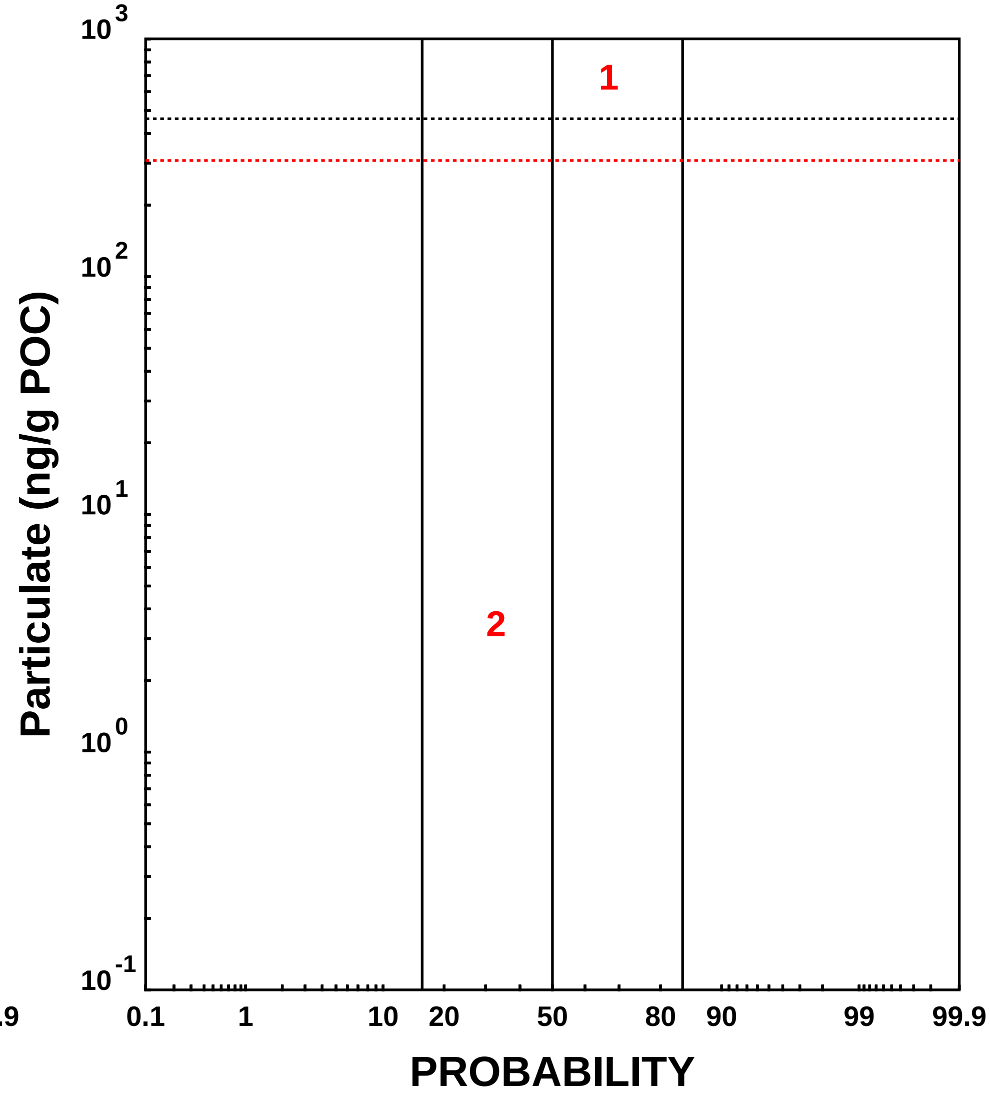
CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2

SADDLE RIVER -- tri-PCB

Data Median = 0.1789
Regression Median =

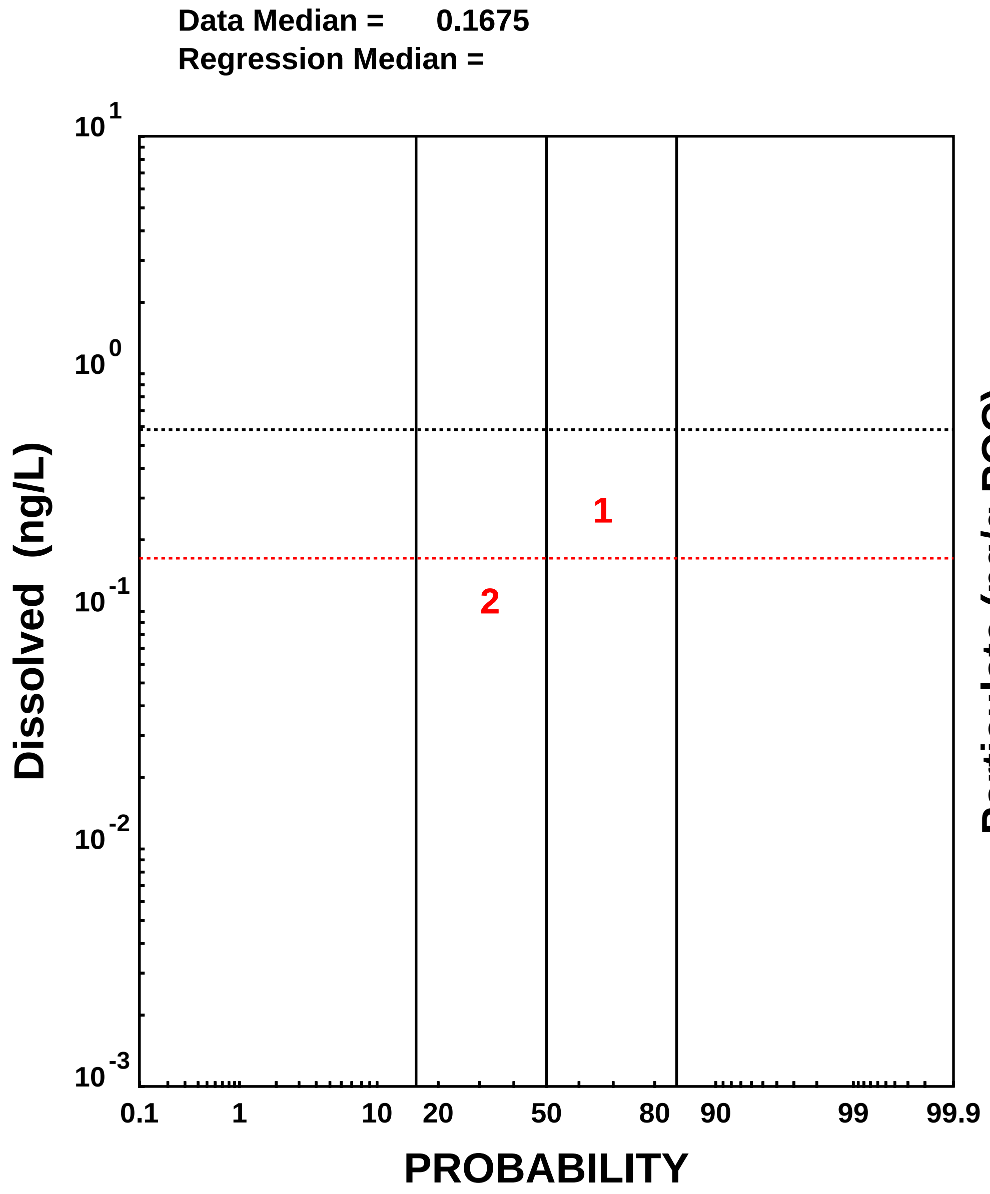


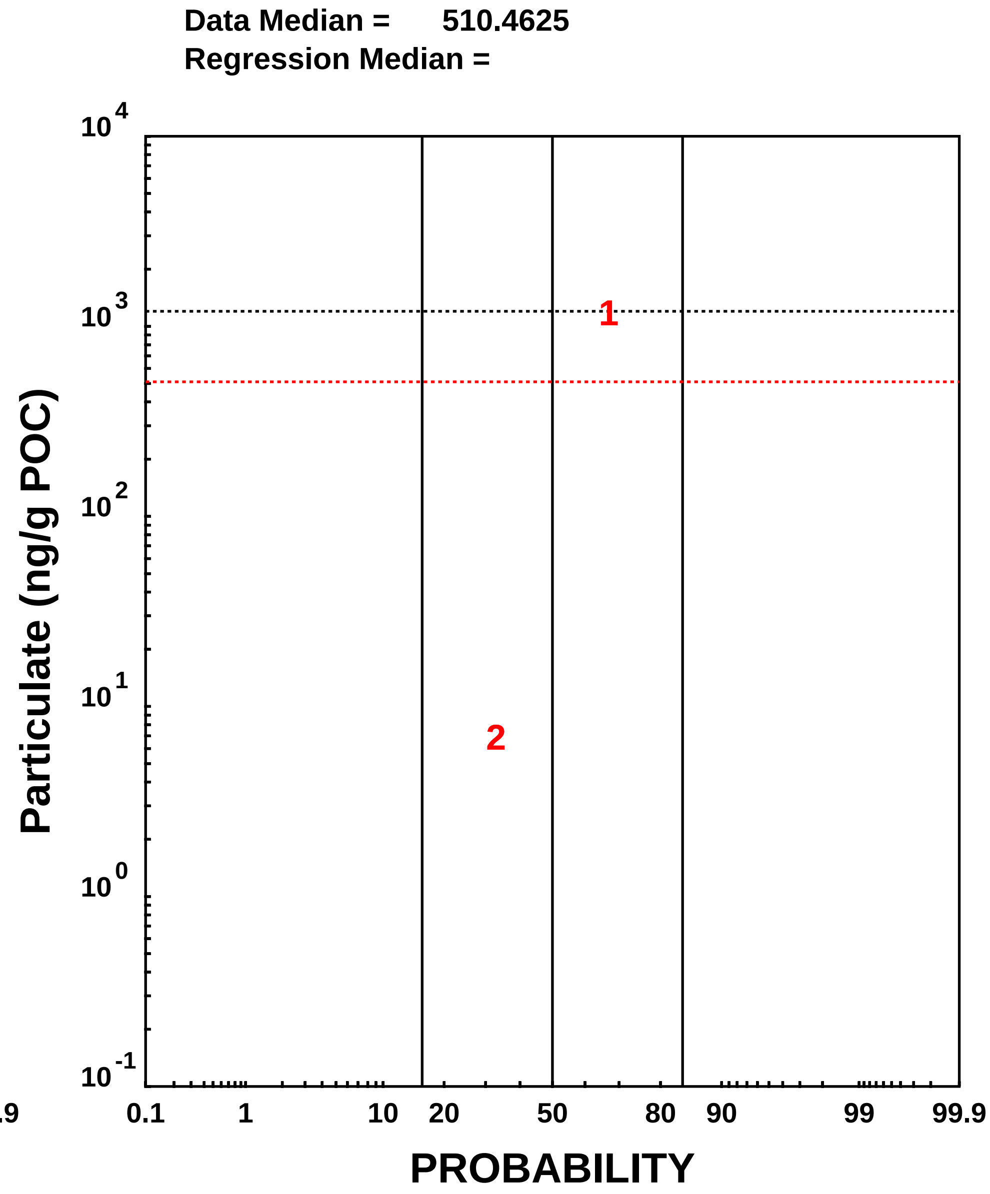
Data Median = 307.8557
Regression Median =



CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2

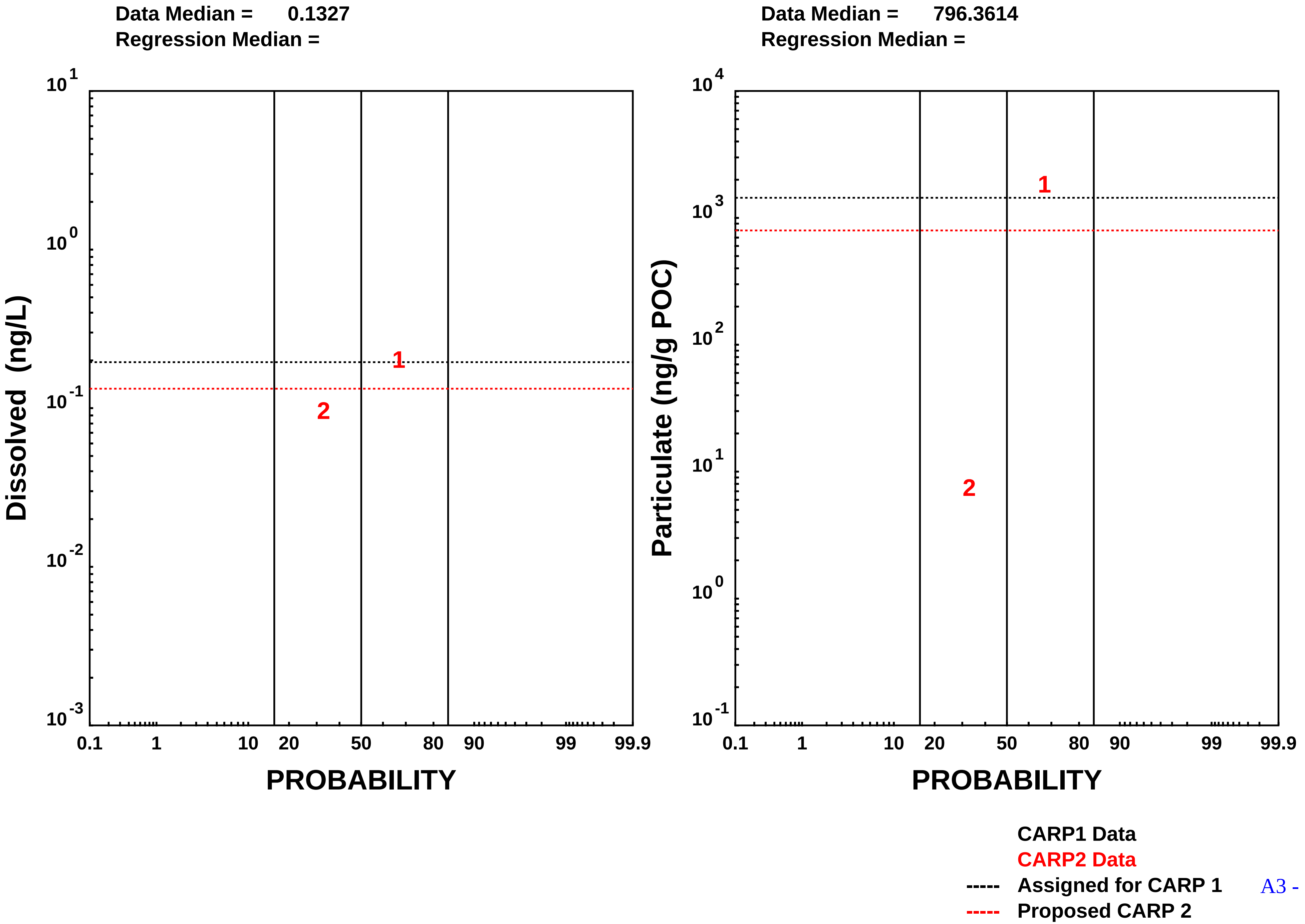
SADDLE RIVER -- tetra-PCB





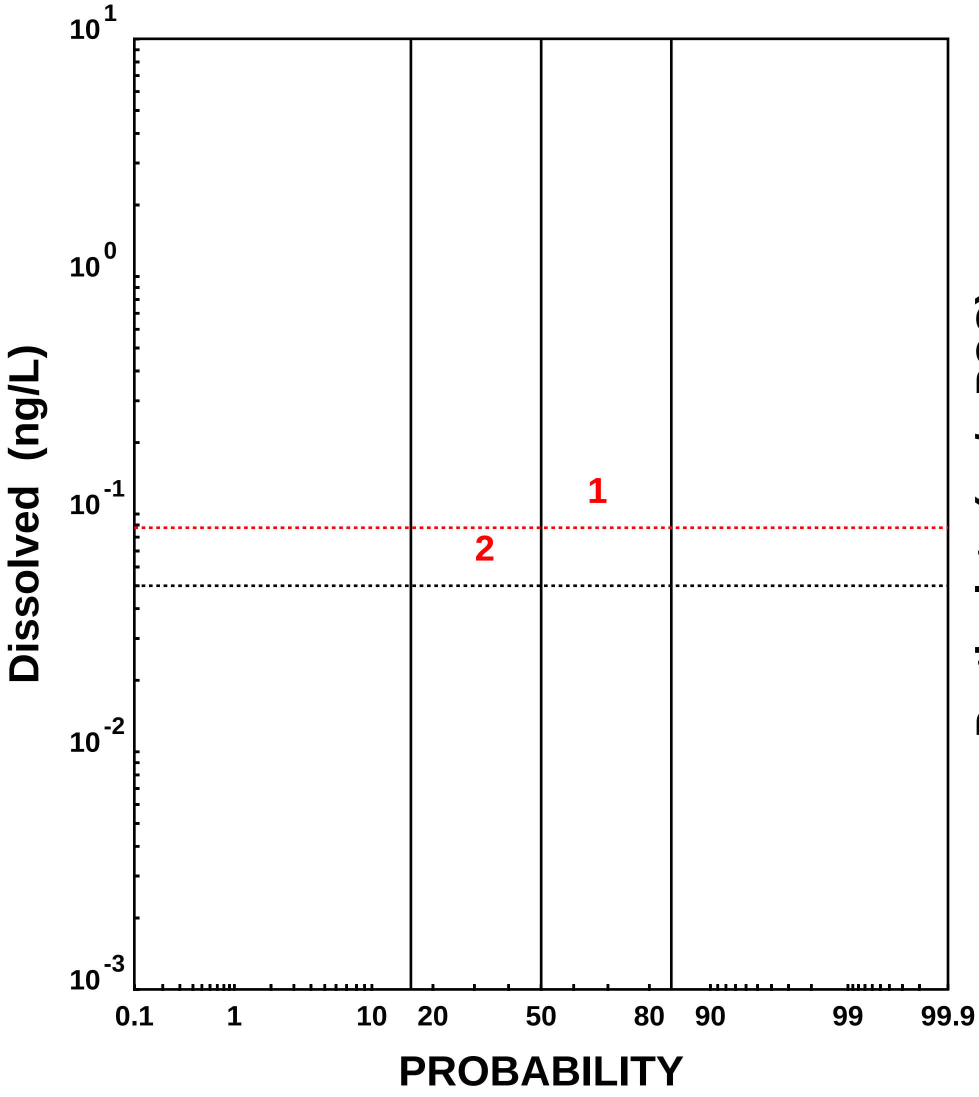
CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2

SADDLE RIVER -- penta-PCB

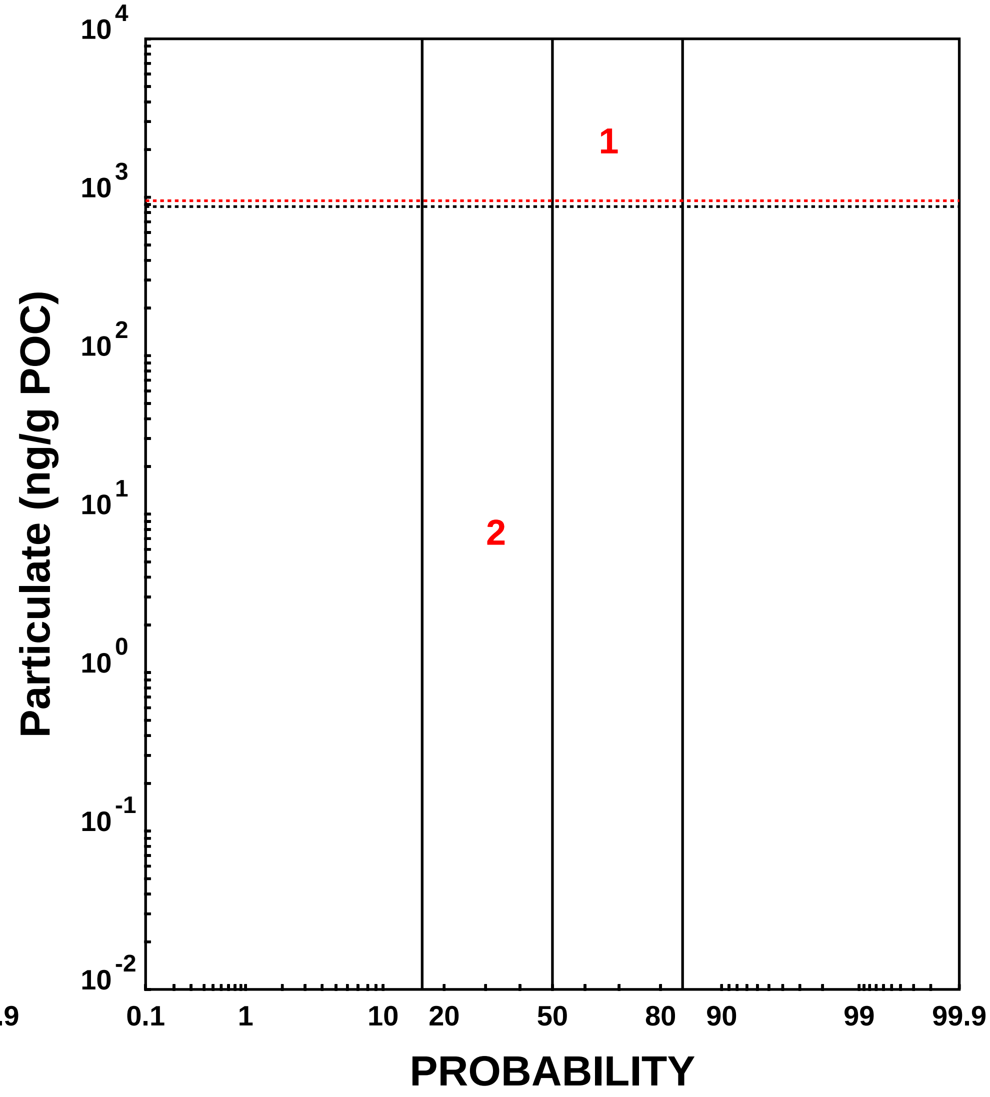


SADDLE RIVER -- hexa-PCB

Data Median = 0.0877
Regression Median =

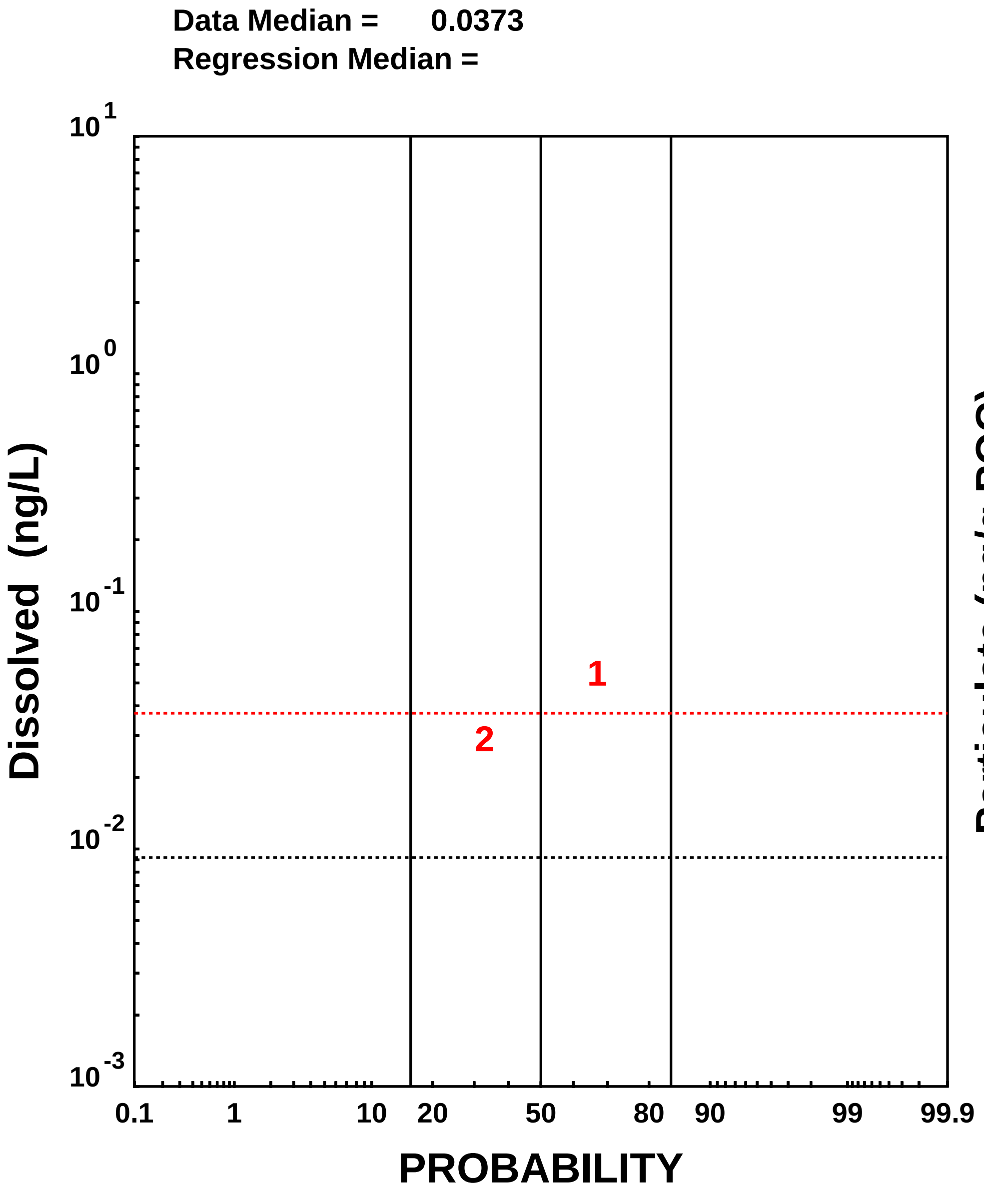


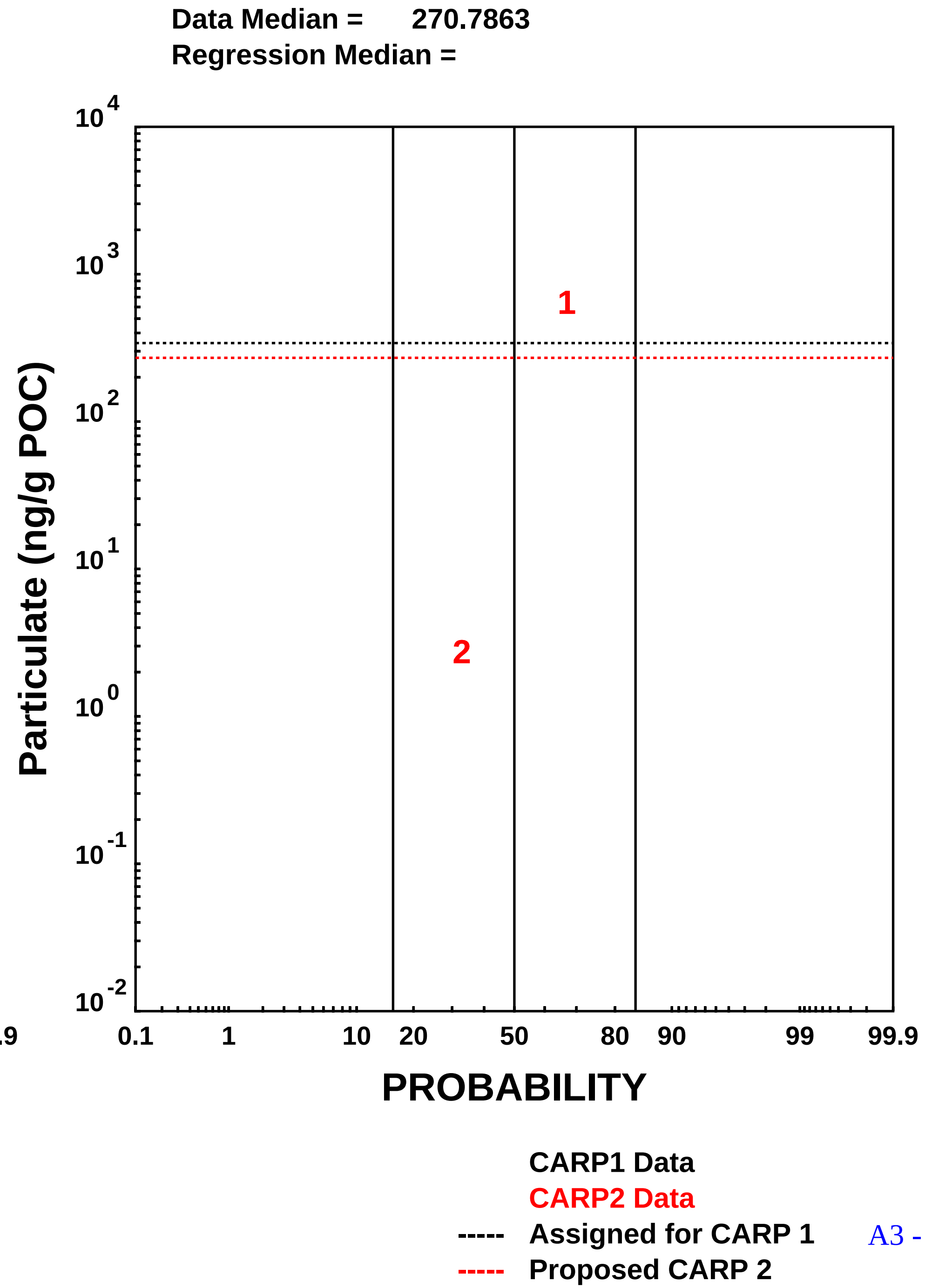
Data Median = 952.1671
Regression Median =

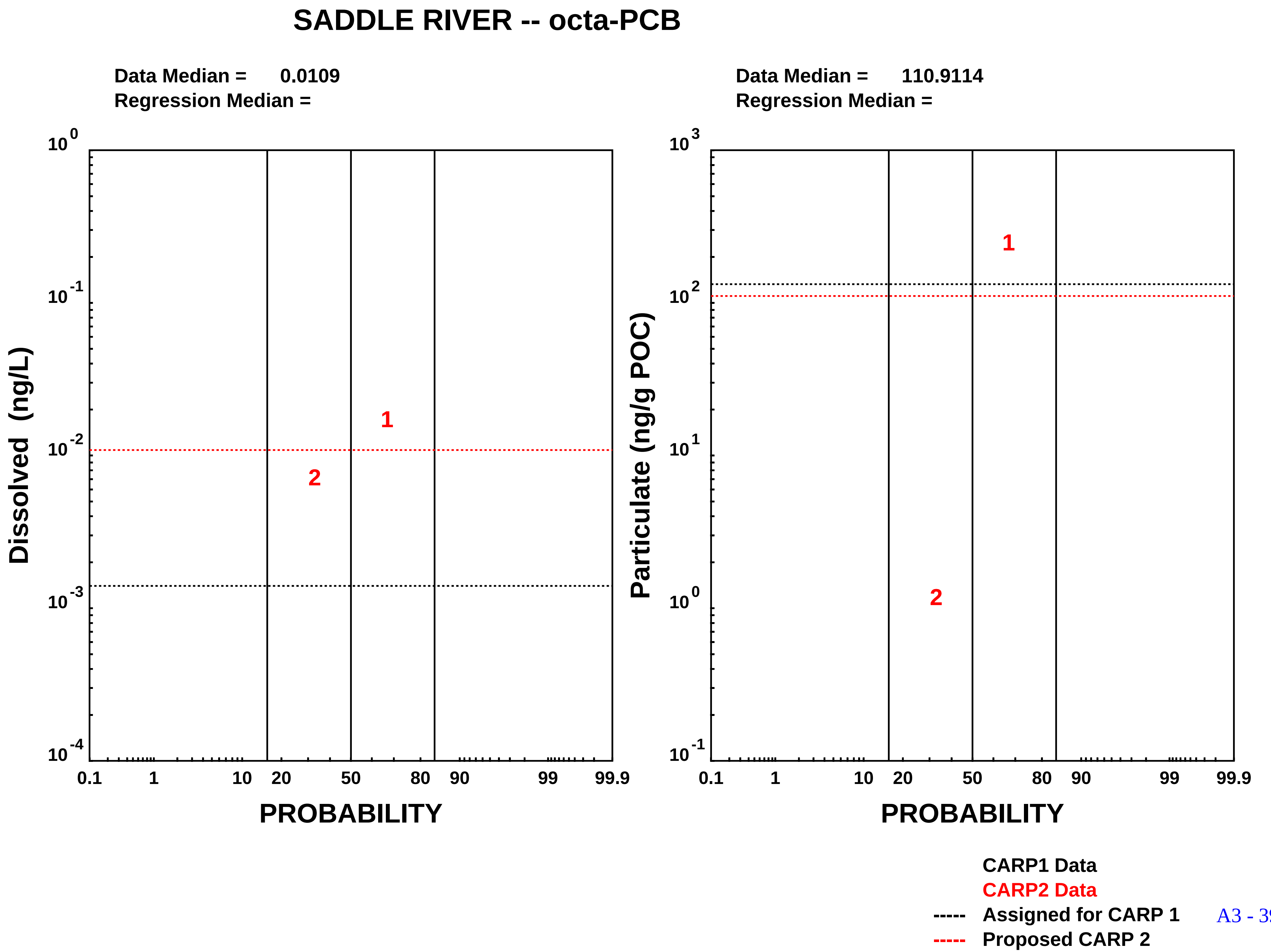


CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2

SADDLE RIVER -- hepta-PCB

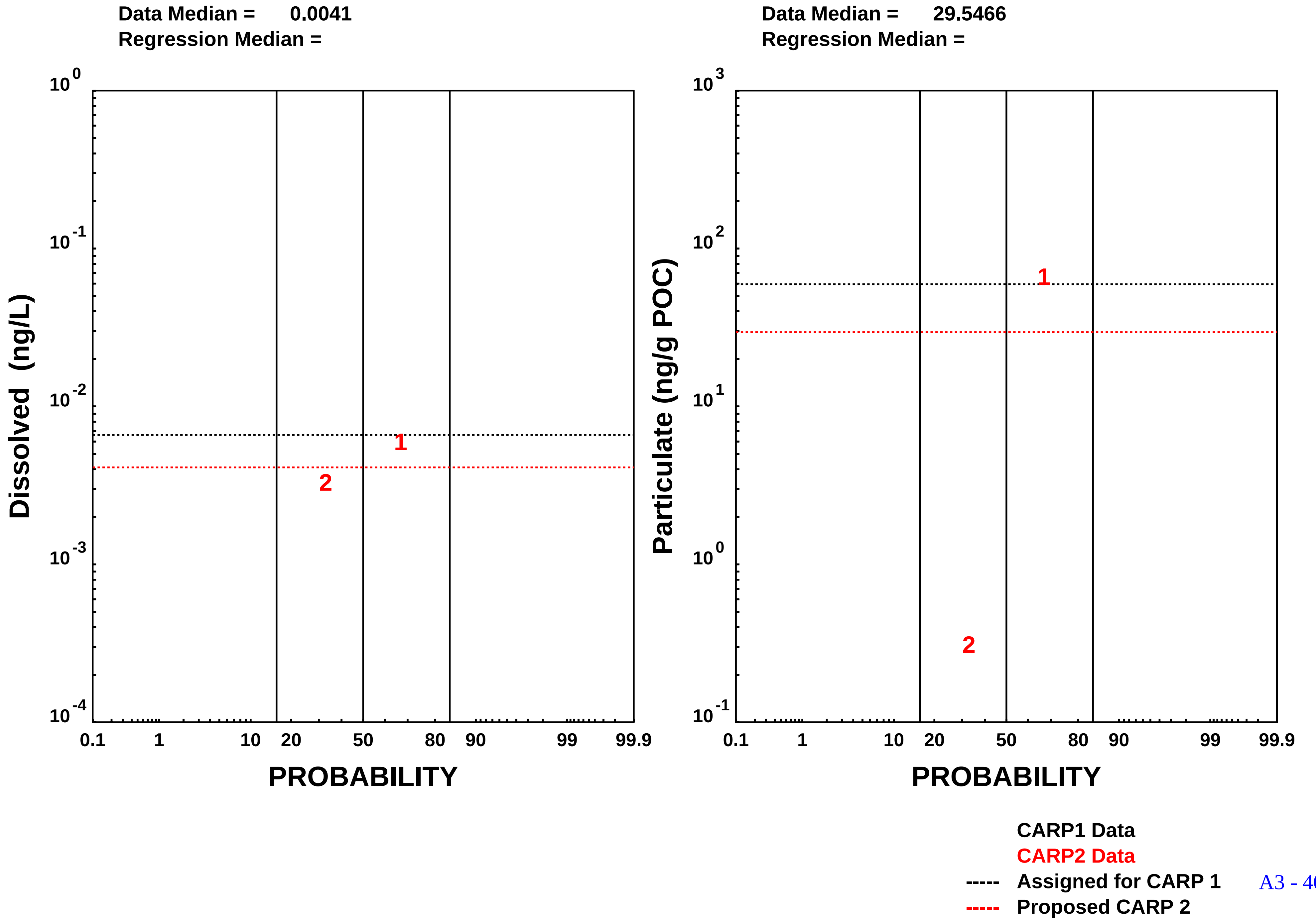




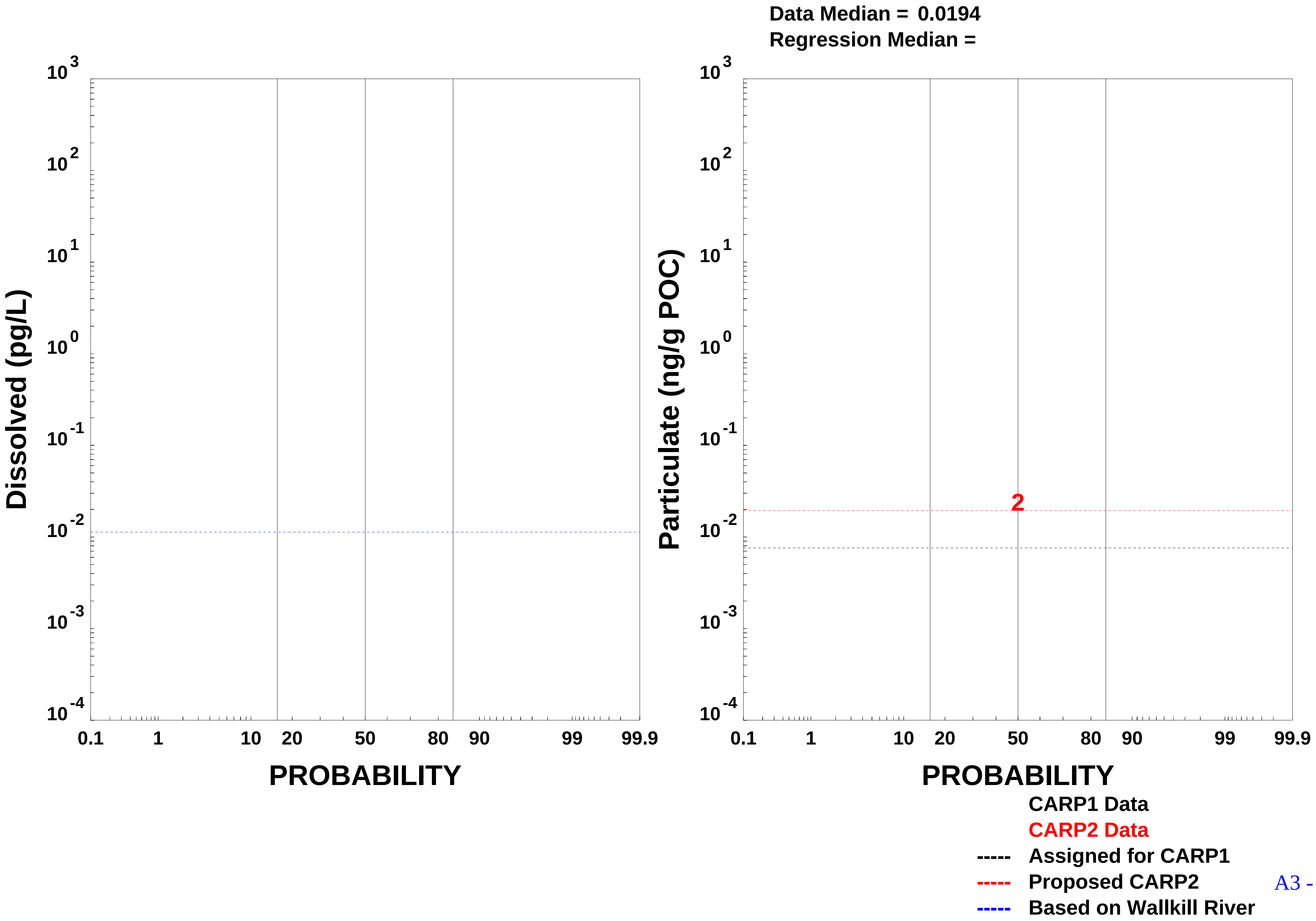


SADDLE RIVER -- octa-PCB
Data Median = 0.0109
Regression Median =
Data Median = 110.9114
Regression Median =
Dissolved (ng/L)
Particulate (ng/g POC)
PROBABILITY
PROBABILITY
CARP1 Data
CARP2 Data
----- Assigned for CARP 1
----- Proposed CARP 2

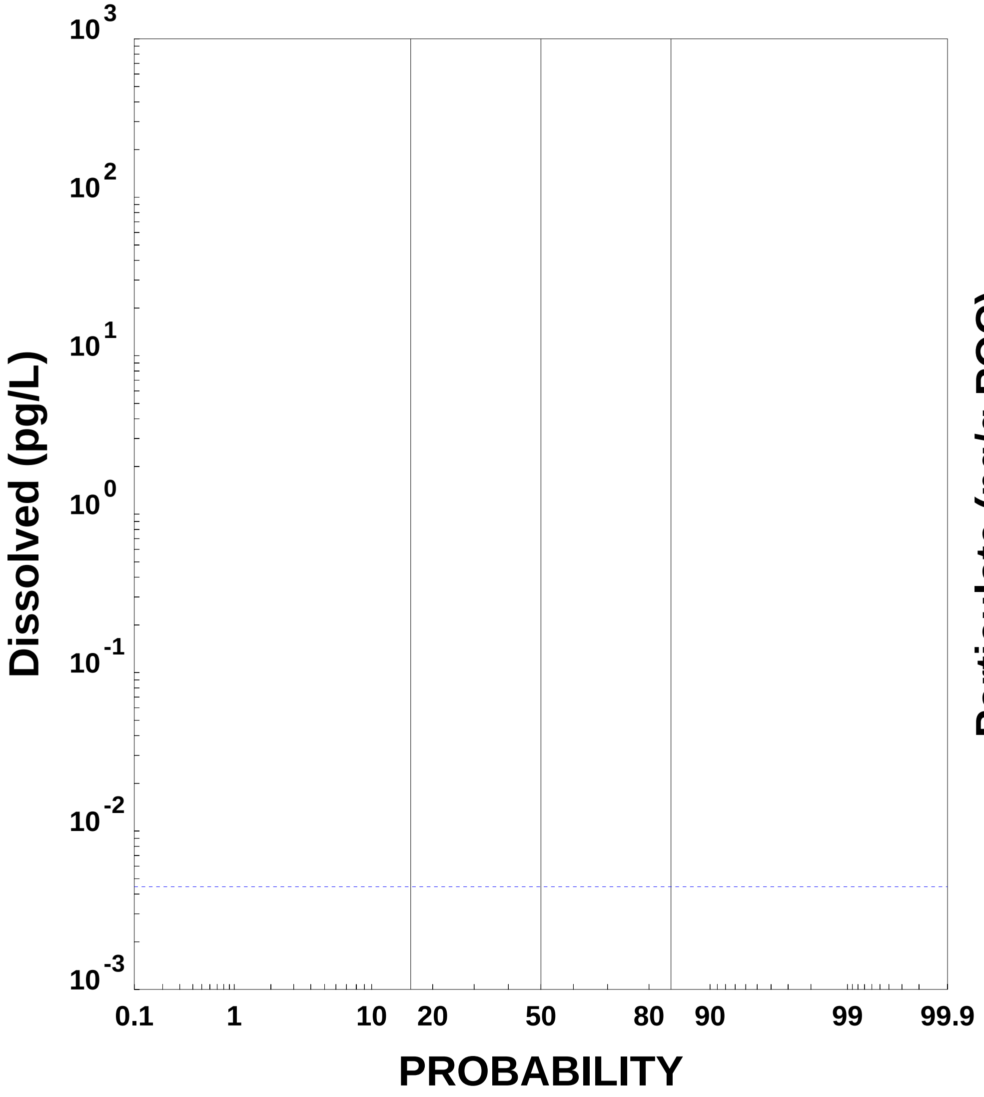
SADDLE RIVER -- nona+deca-PCB

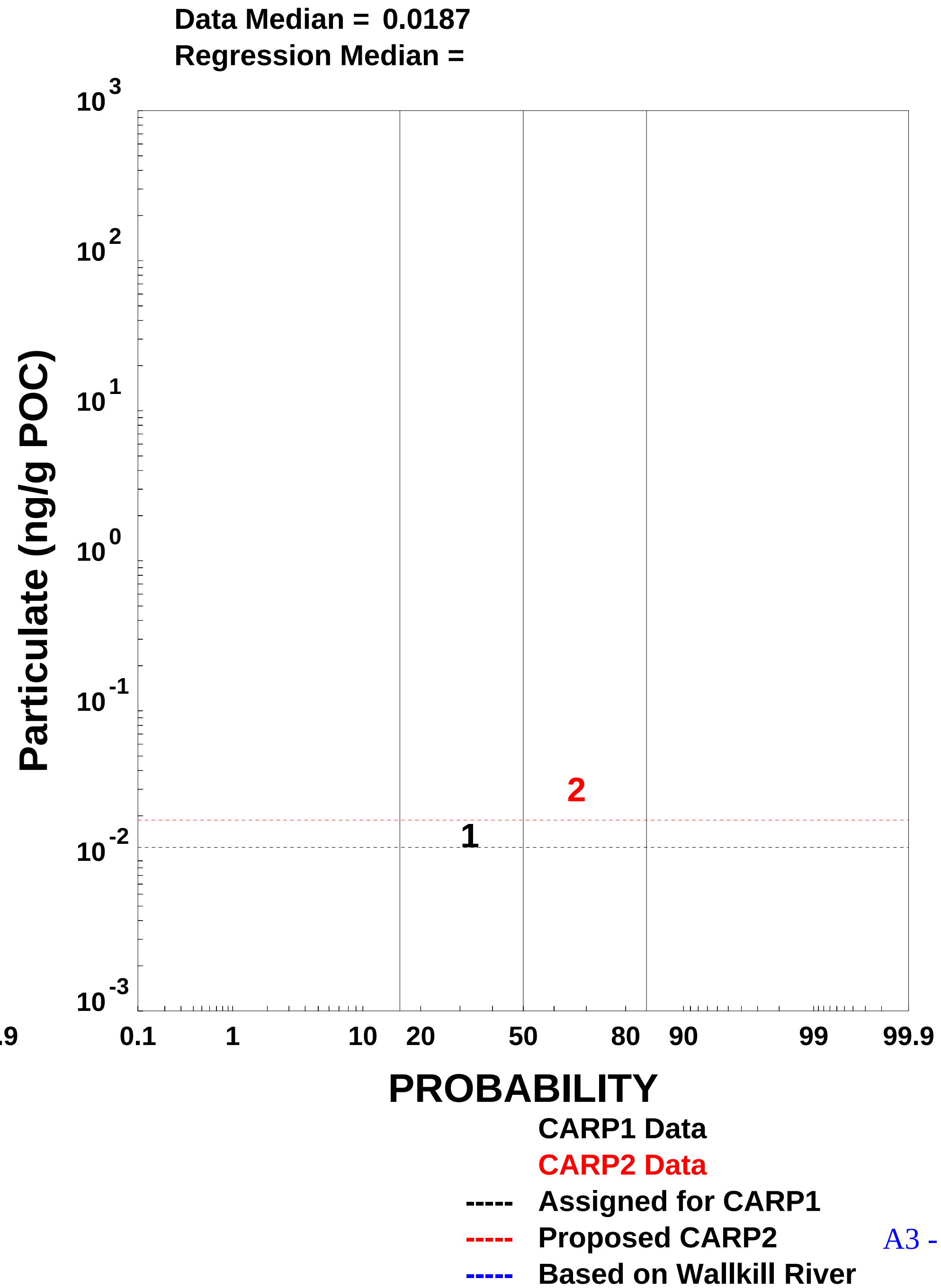


HACKENSACK RIVER AT NEW MILFORD -- 2,3,7,8-TCDD

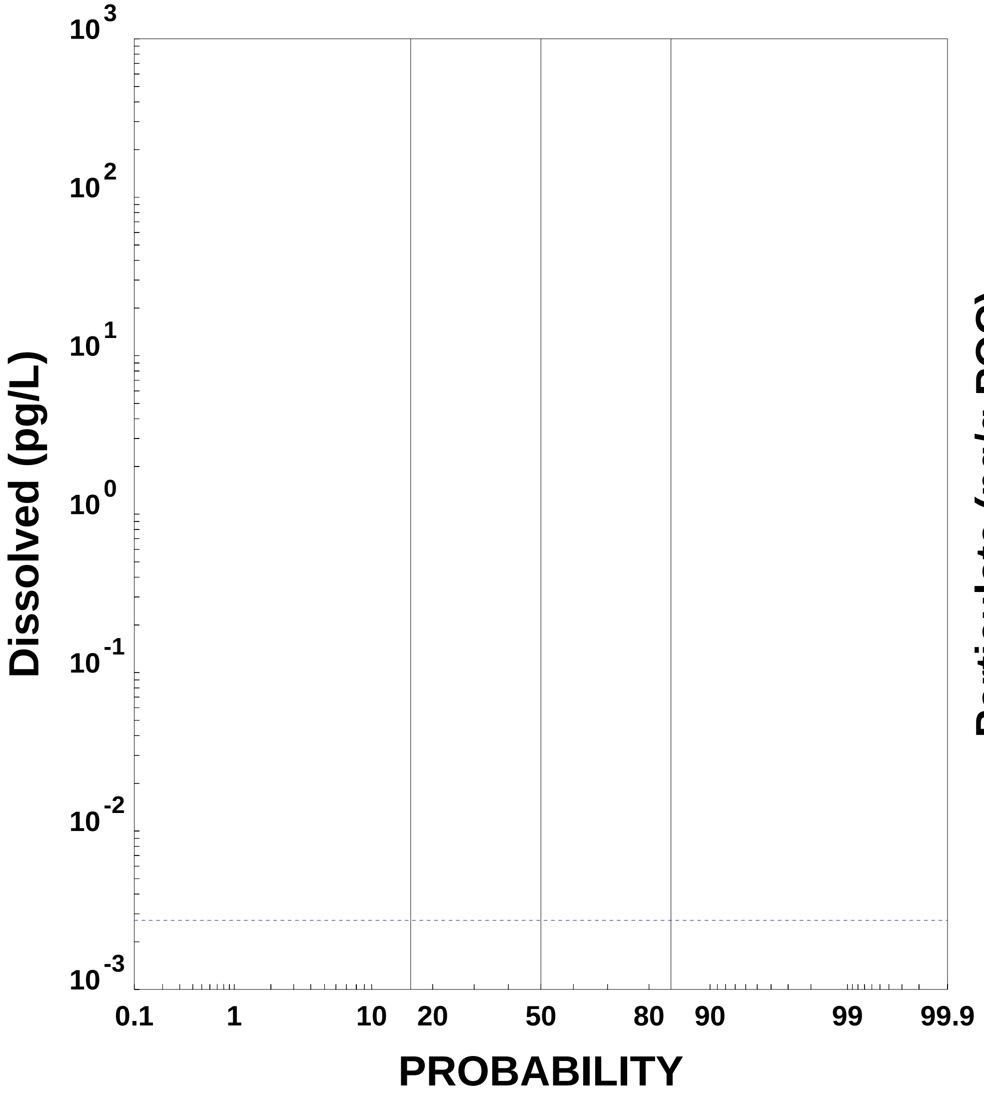


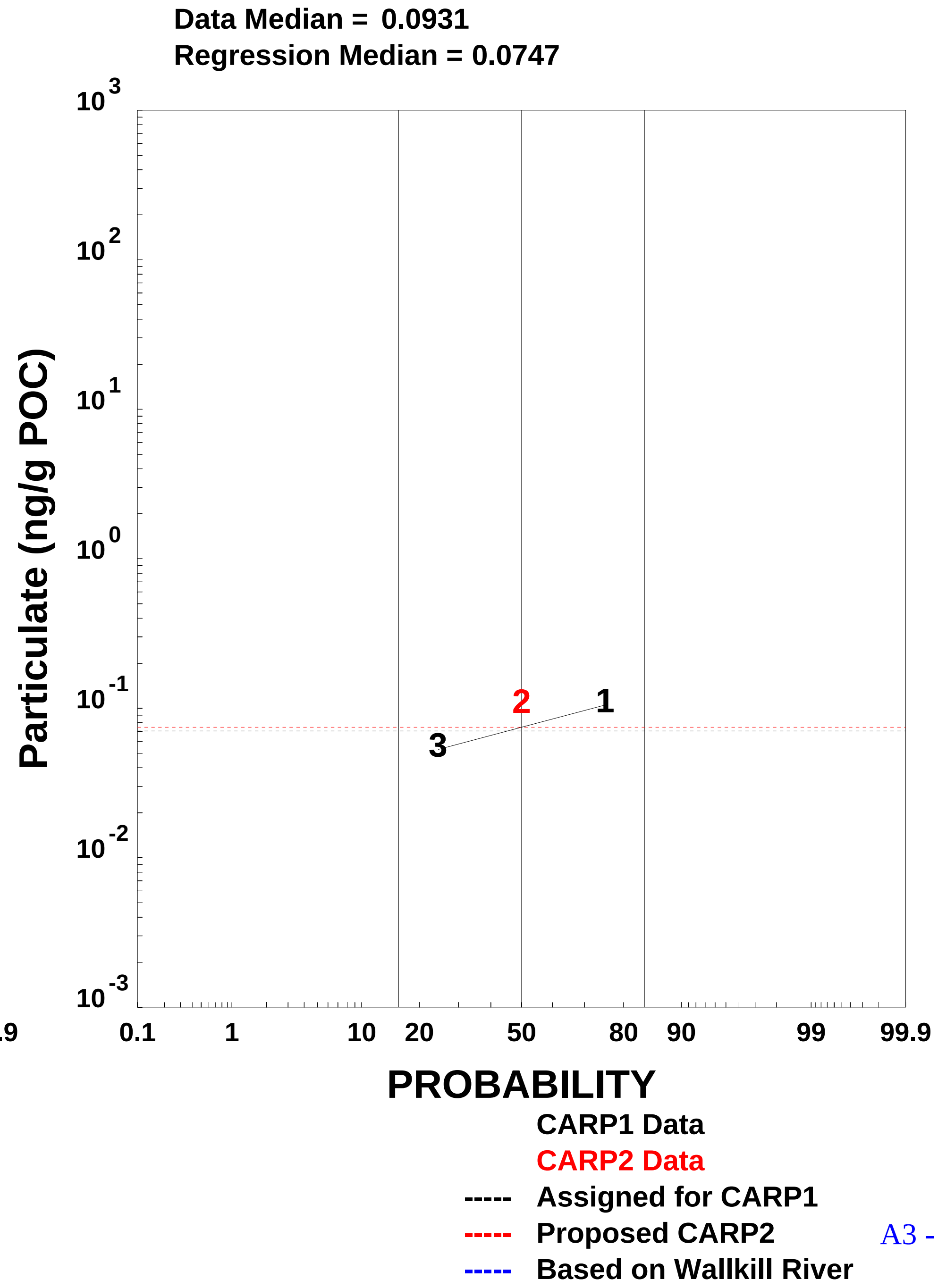
HACKENSACK RIVER AT NEW MILFORD -- 1,2,3,7,8-PeCDD



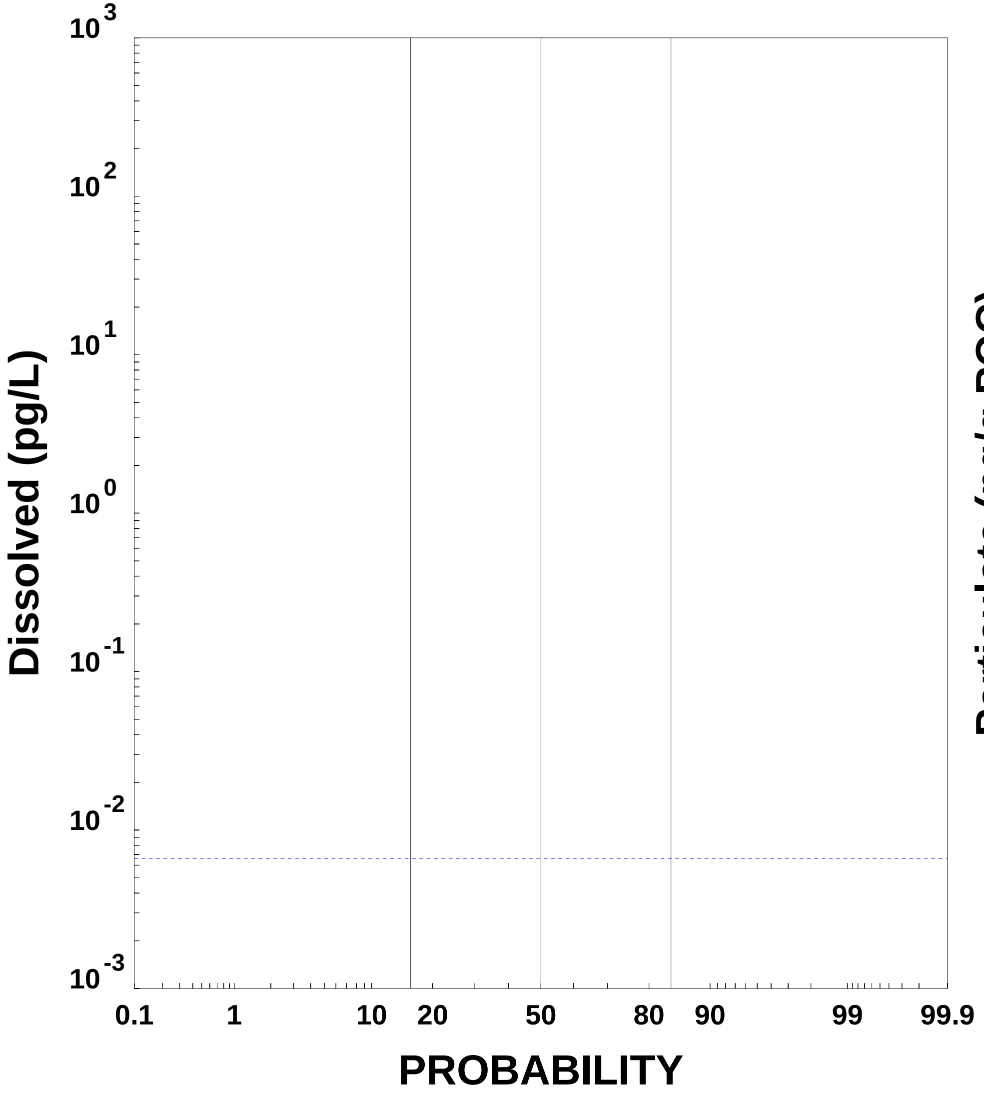


HACKENSACK RIVER AT NEW MILFORD -- 1,2,3,7,8,9-HxCDD

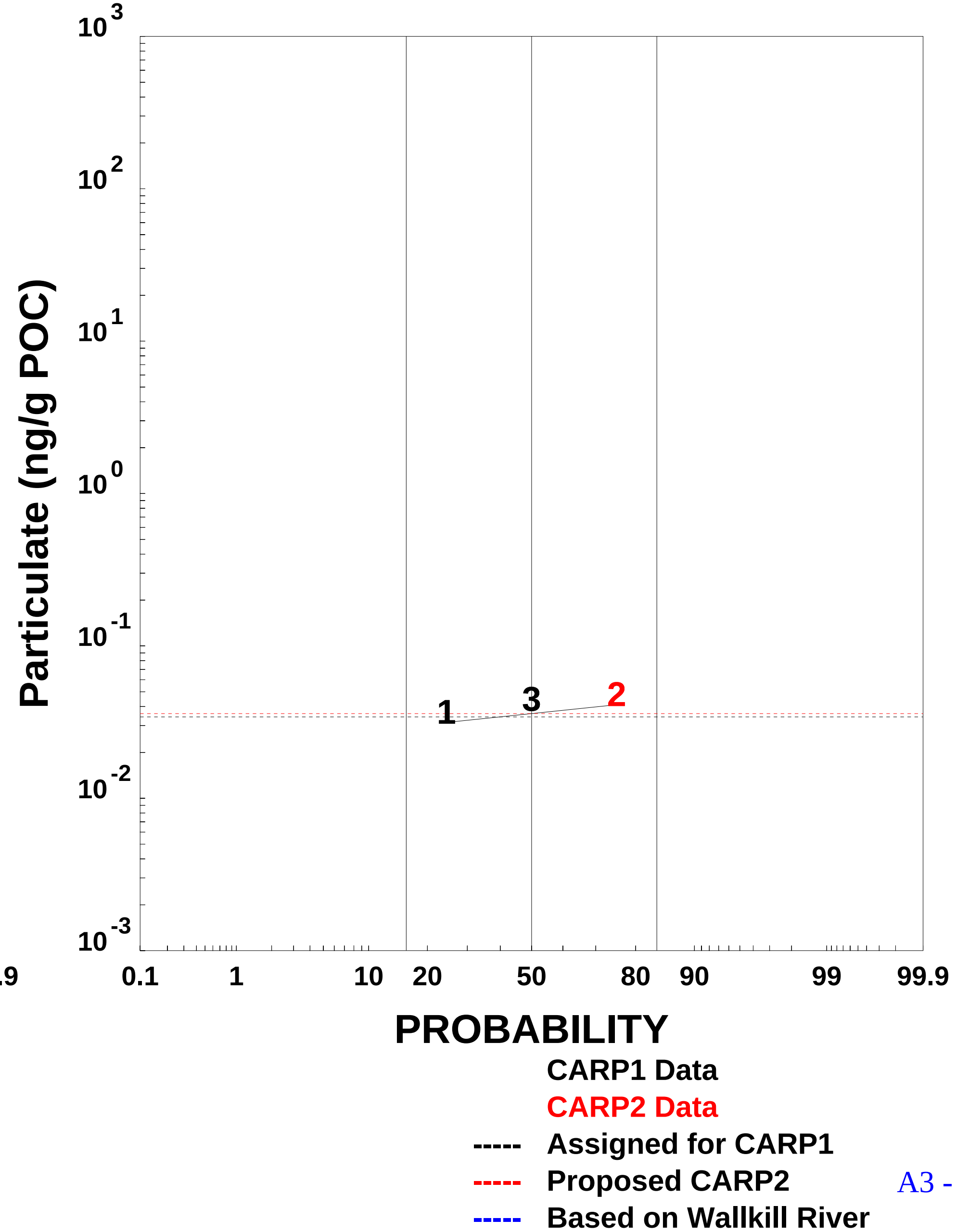




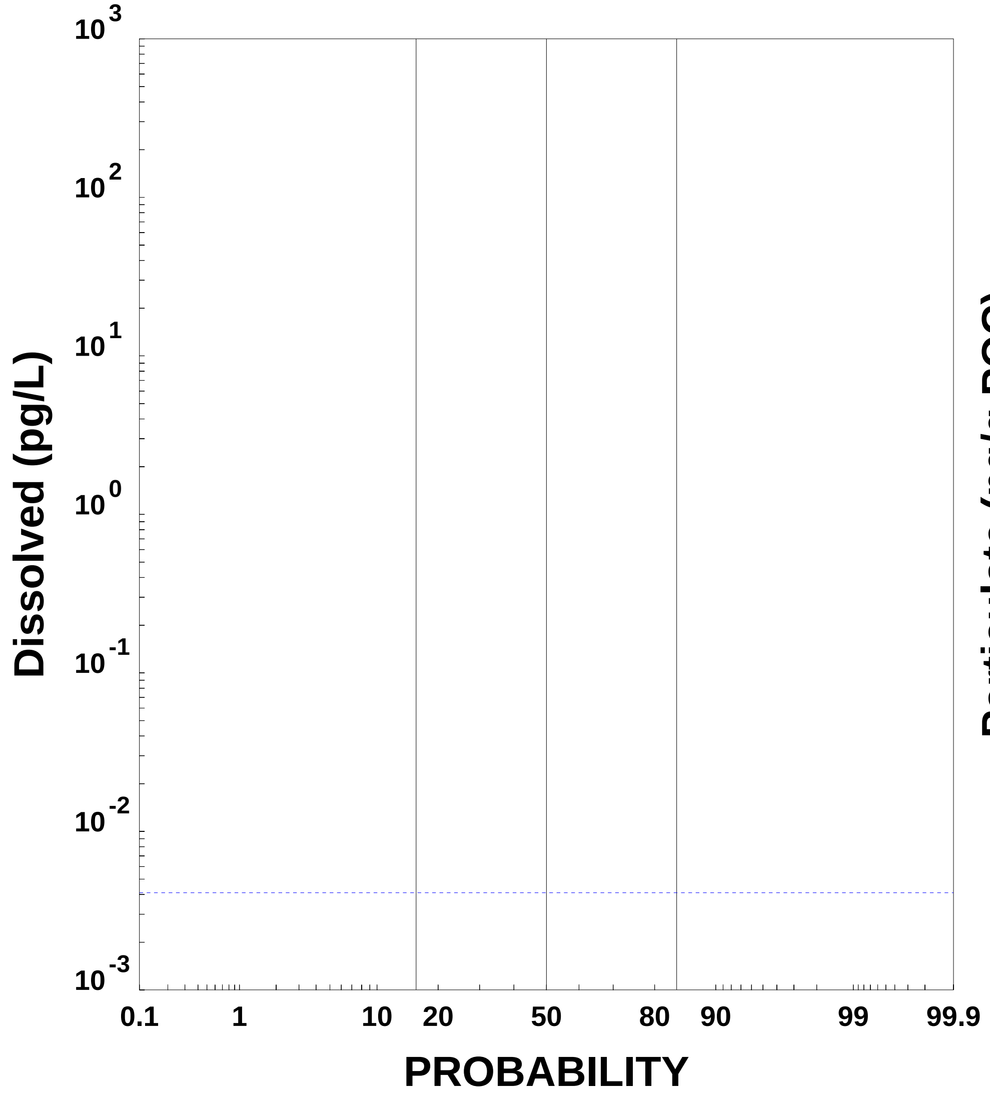
HACKENSACK RIVER AT NEW MILFORD -- 1,2,3,4,7,8-HxCDD

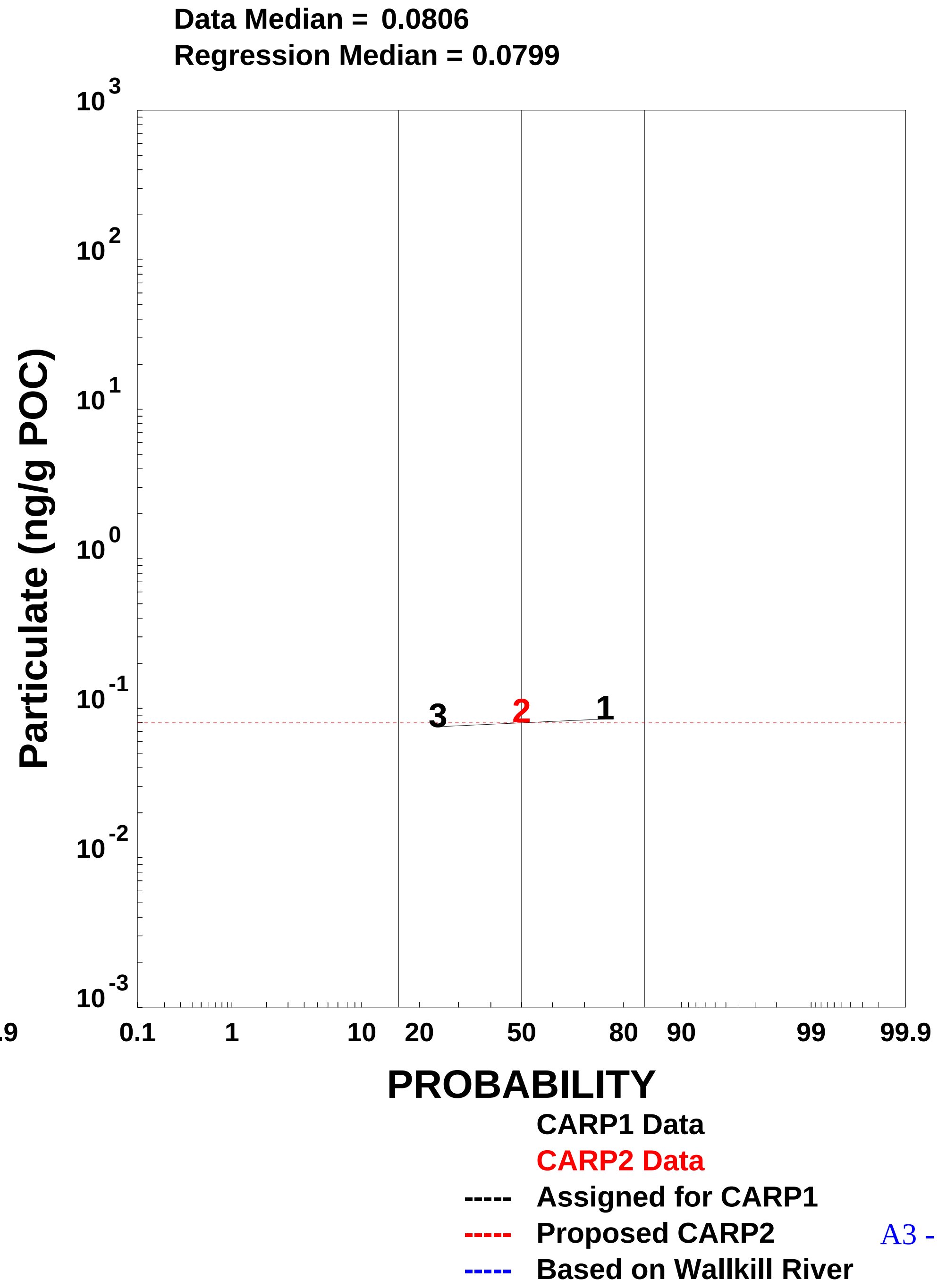


Data Median = 0.0375
Regression Median = 0.0360

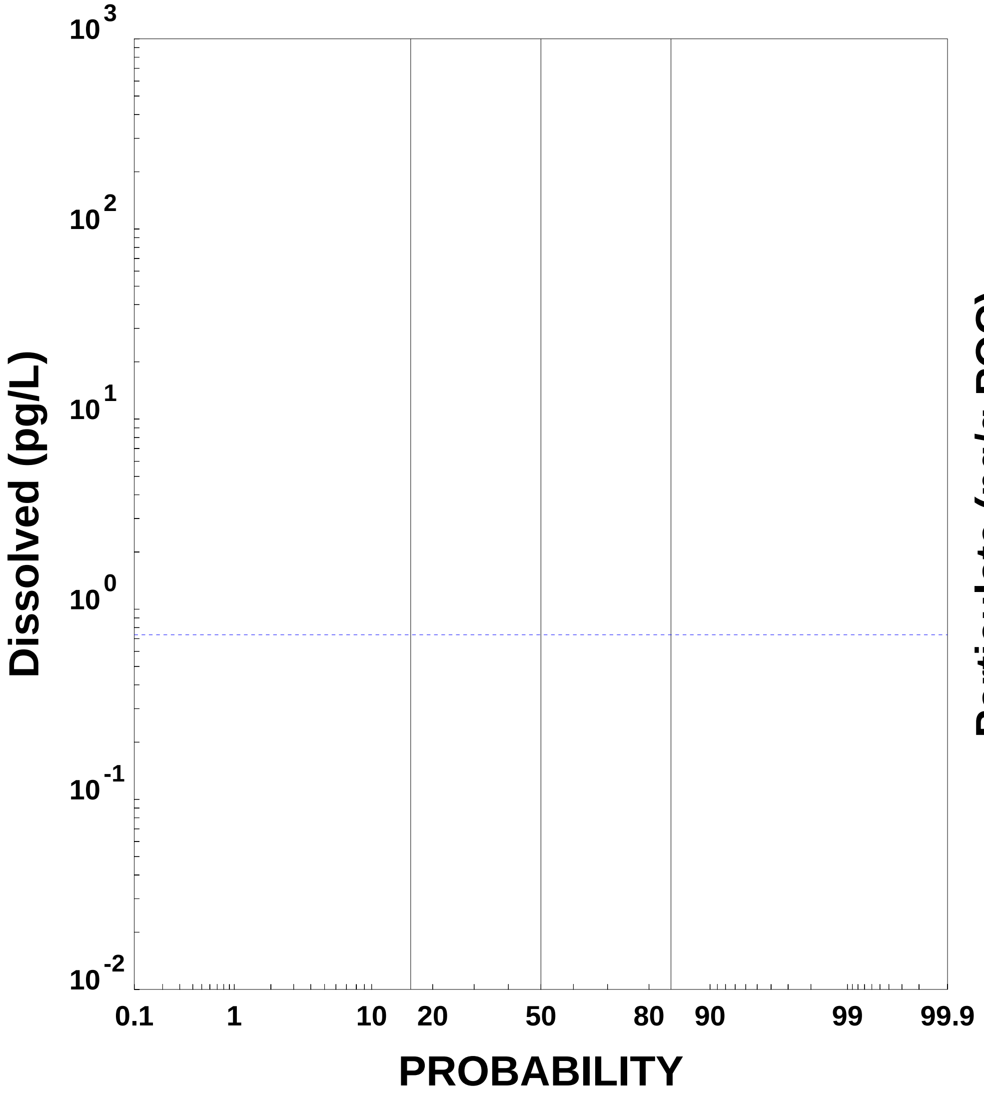


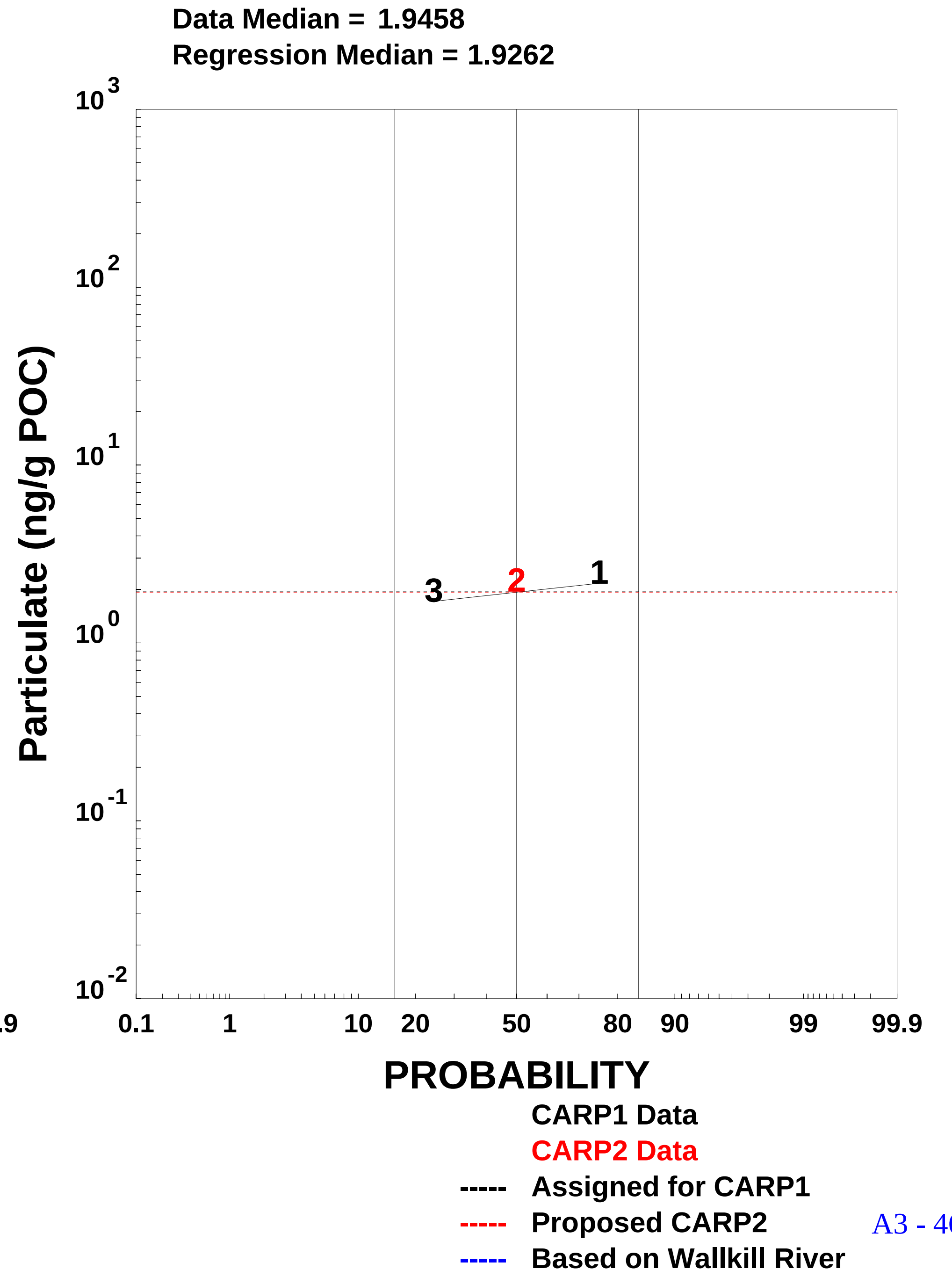
HACKENSACK RIVER AT NEW MILFORD -- 1,2,3,6,7,8-HxCDD



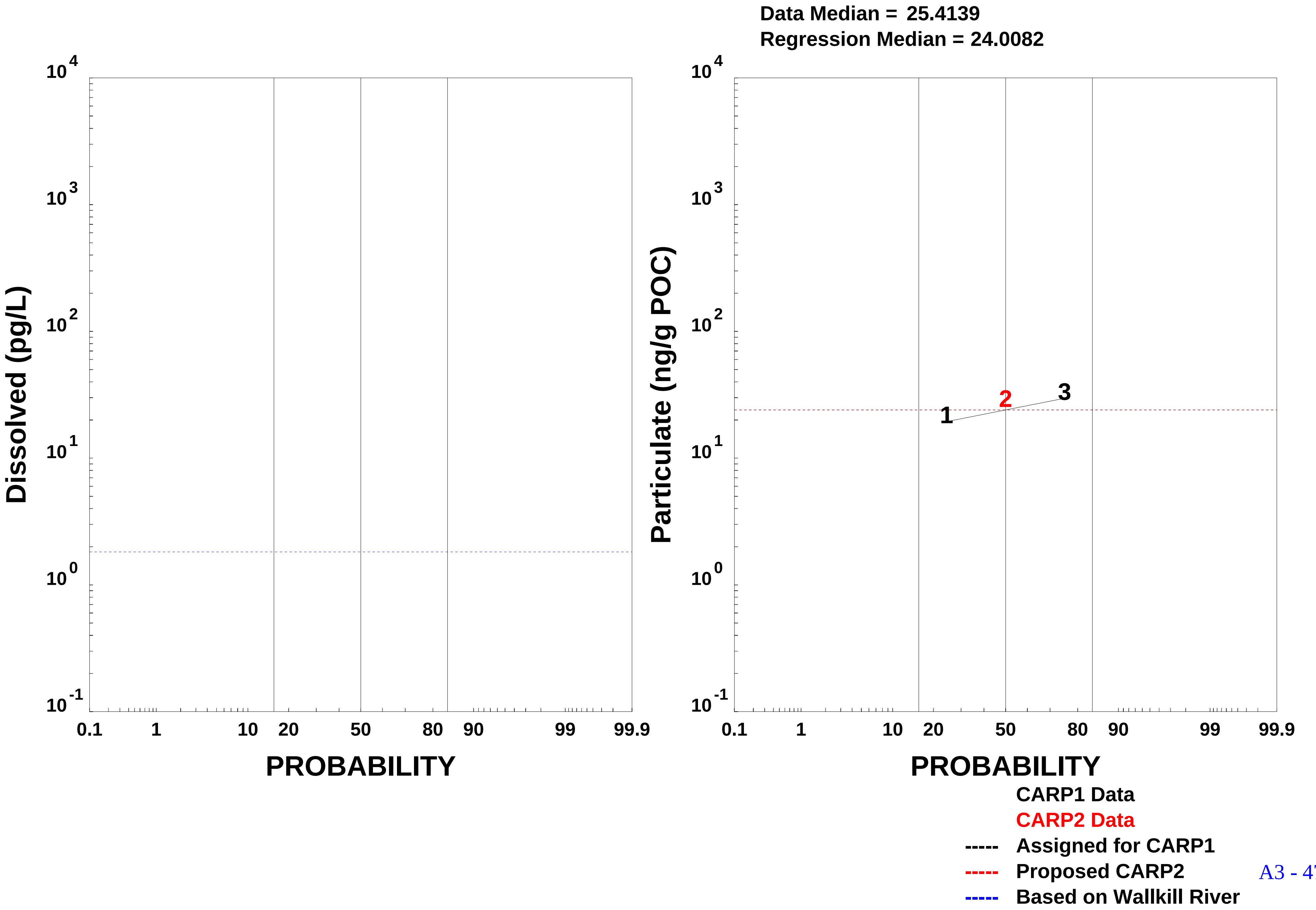


HACKENSACK RIVER AT NEW MILFORD -- 1,2,3,4,6,7,8-HpCDD

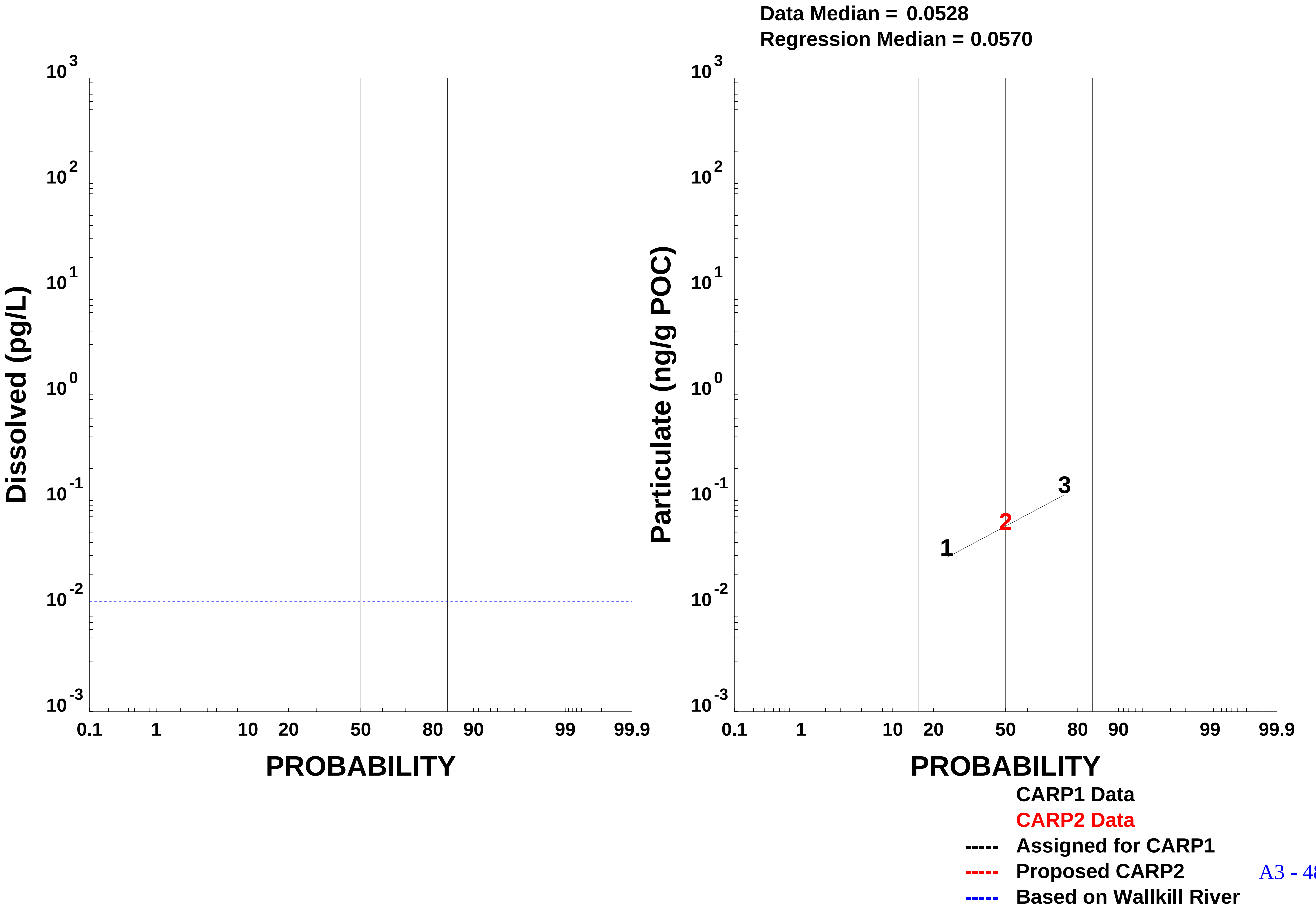




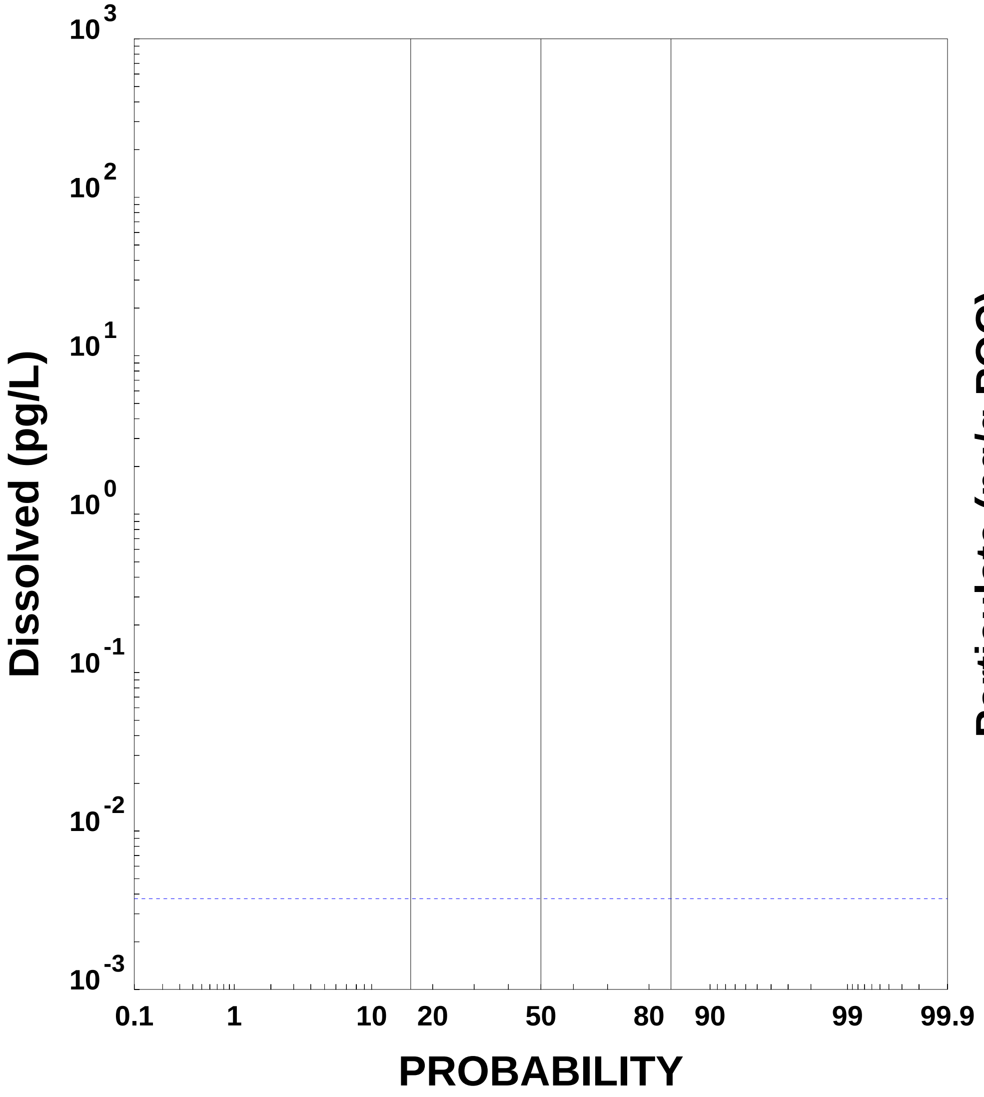
HACKENSACK RIVER AT NEW MILFORD -- OCDD

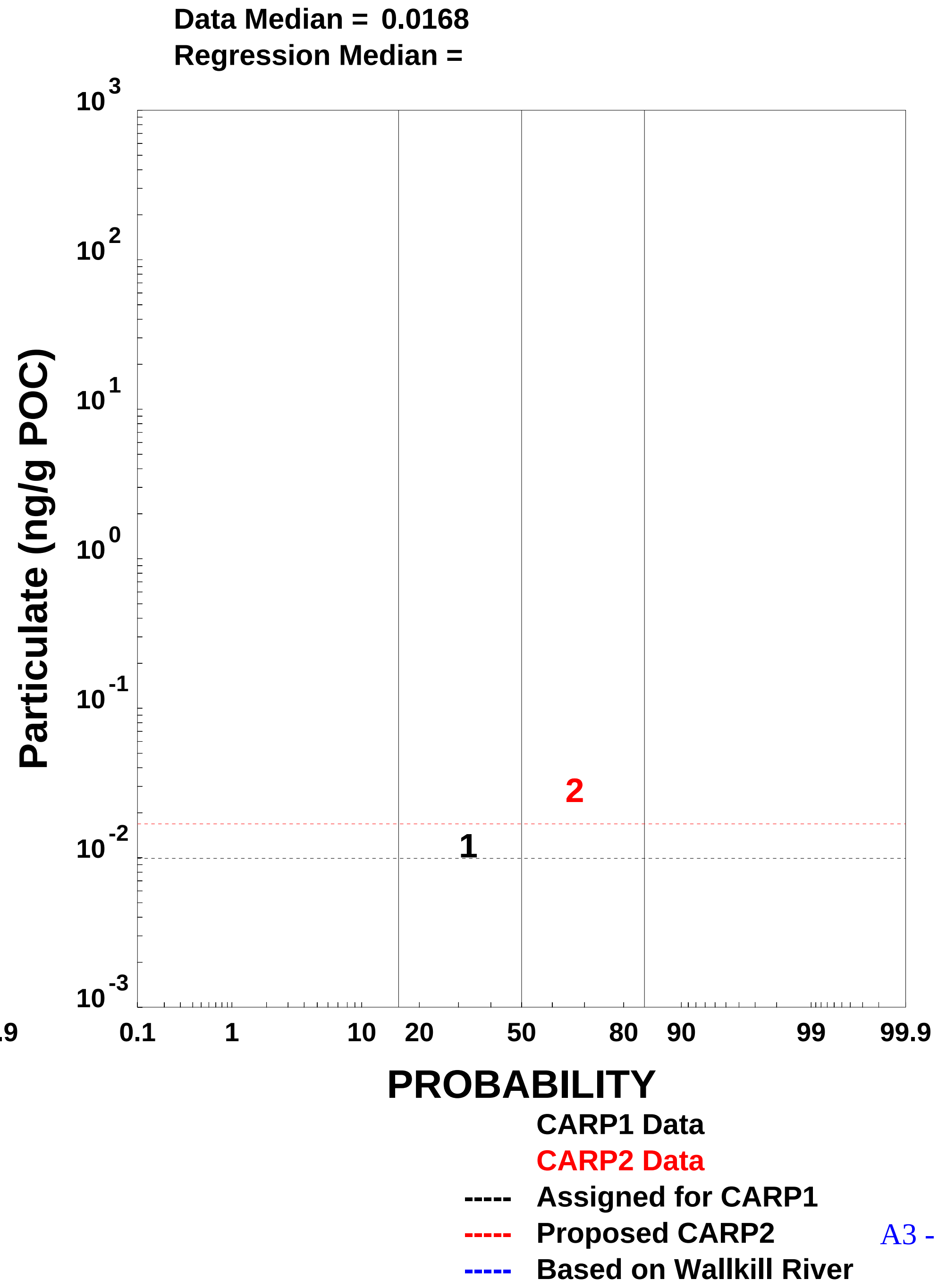


HACKENSACK RIVER AT NEW MILFORD -- 2,3,7,8-TCDF

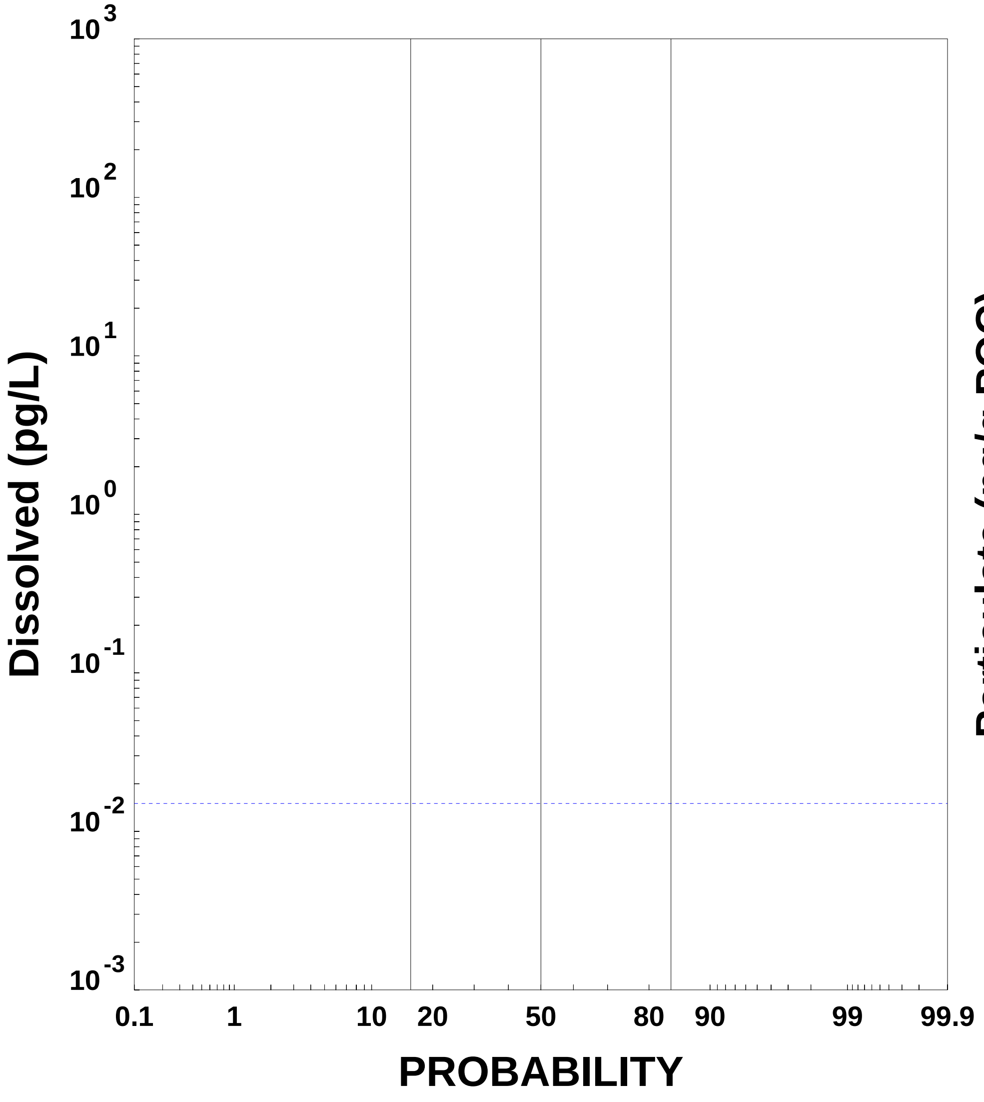


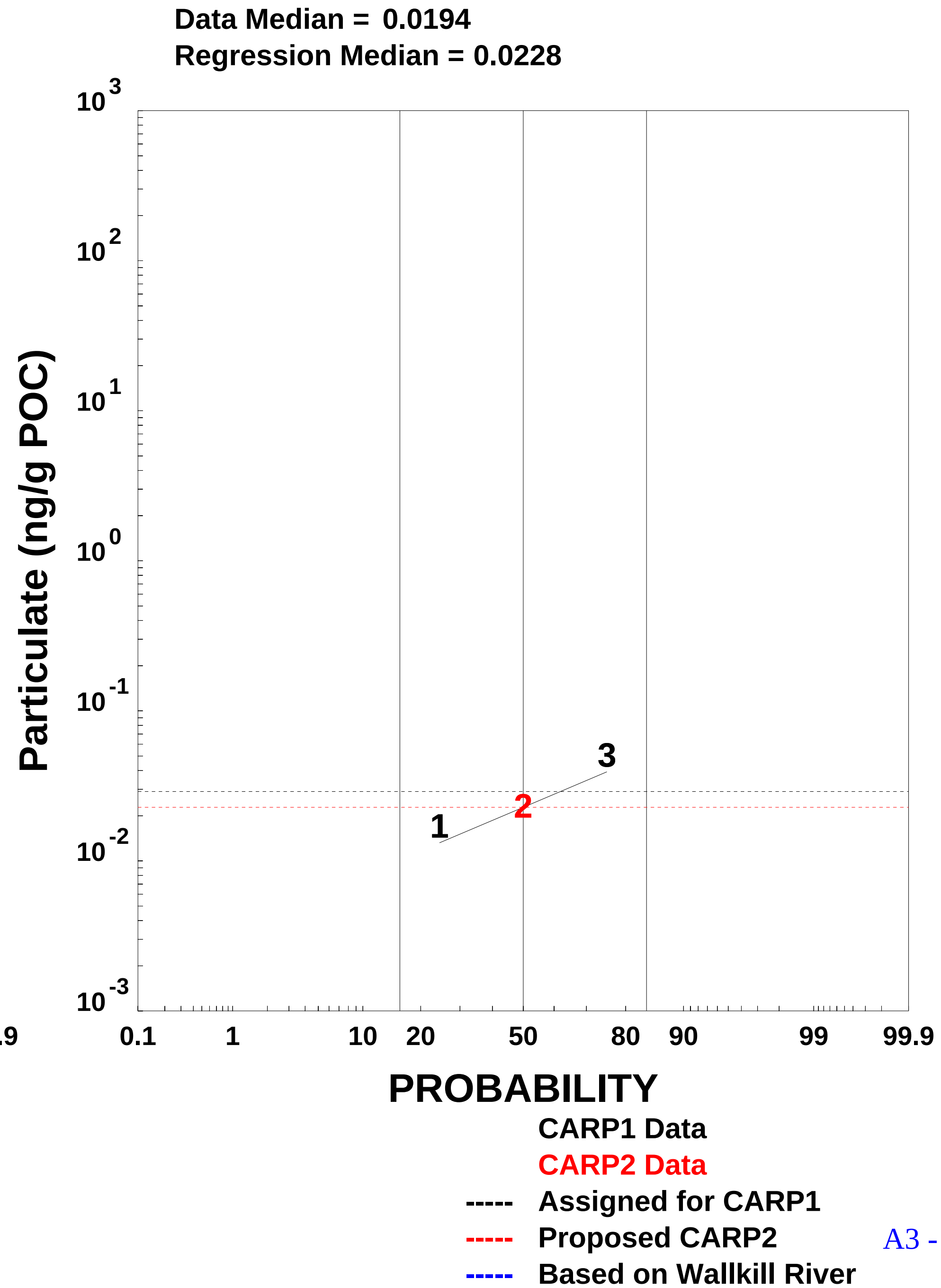
HACKENSACK RIVER AT NEW MILFORD -- 1,2,3,7,8-PeCDF



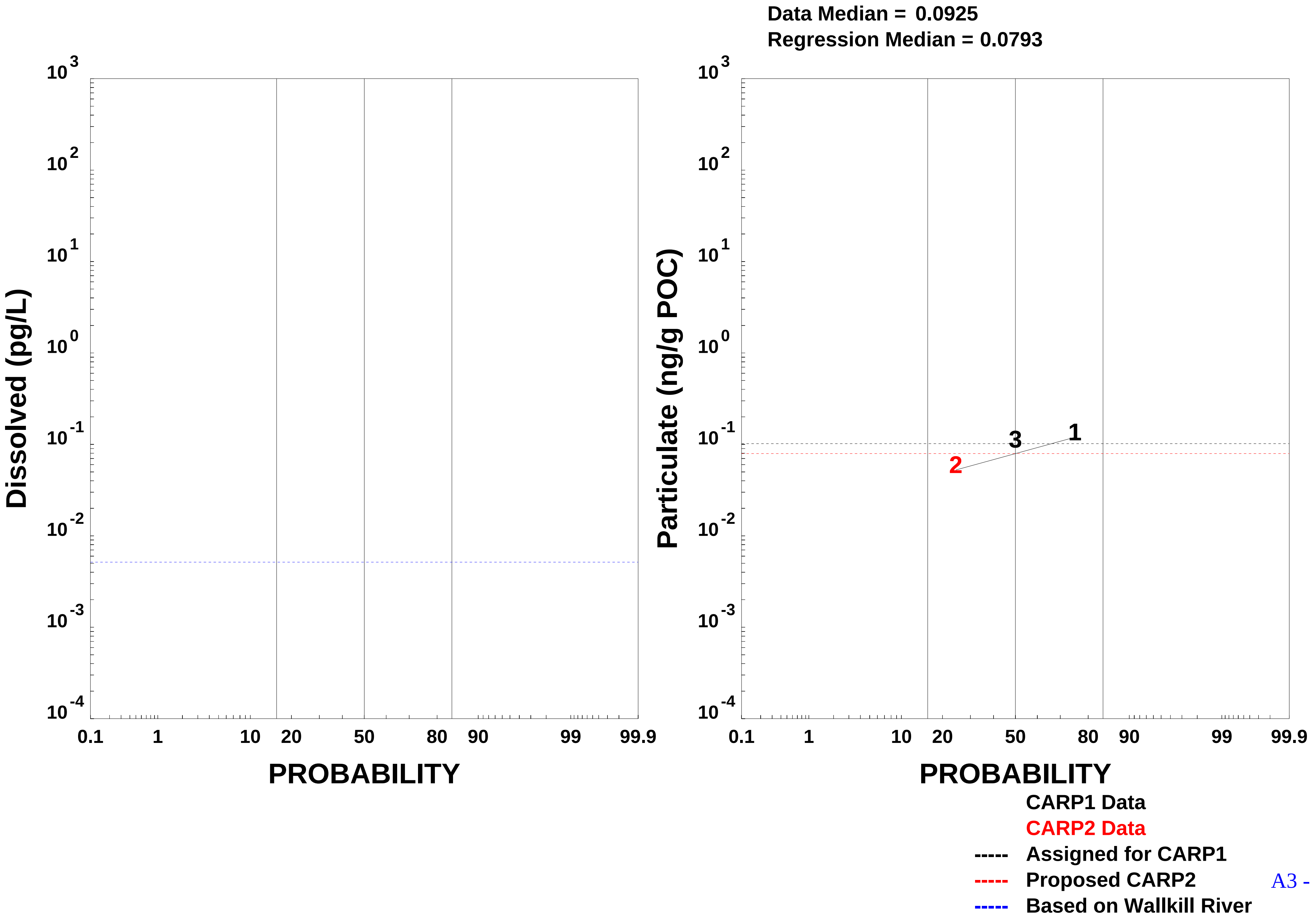


HACKENSACK RIVER AT NEW MILFORD -- 2,3,4,7,8-PeCDF

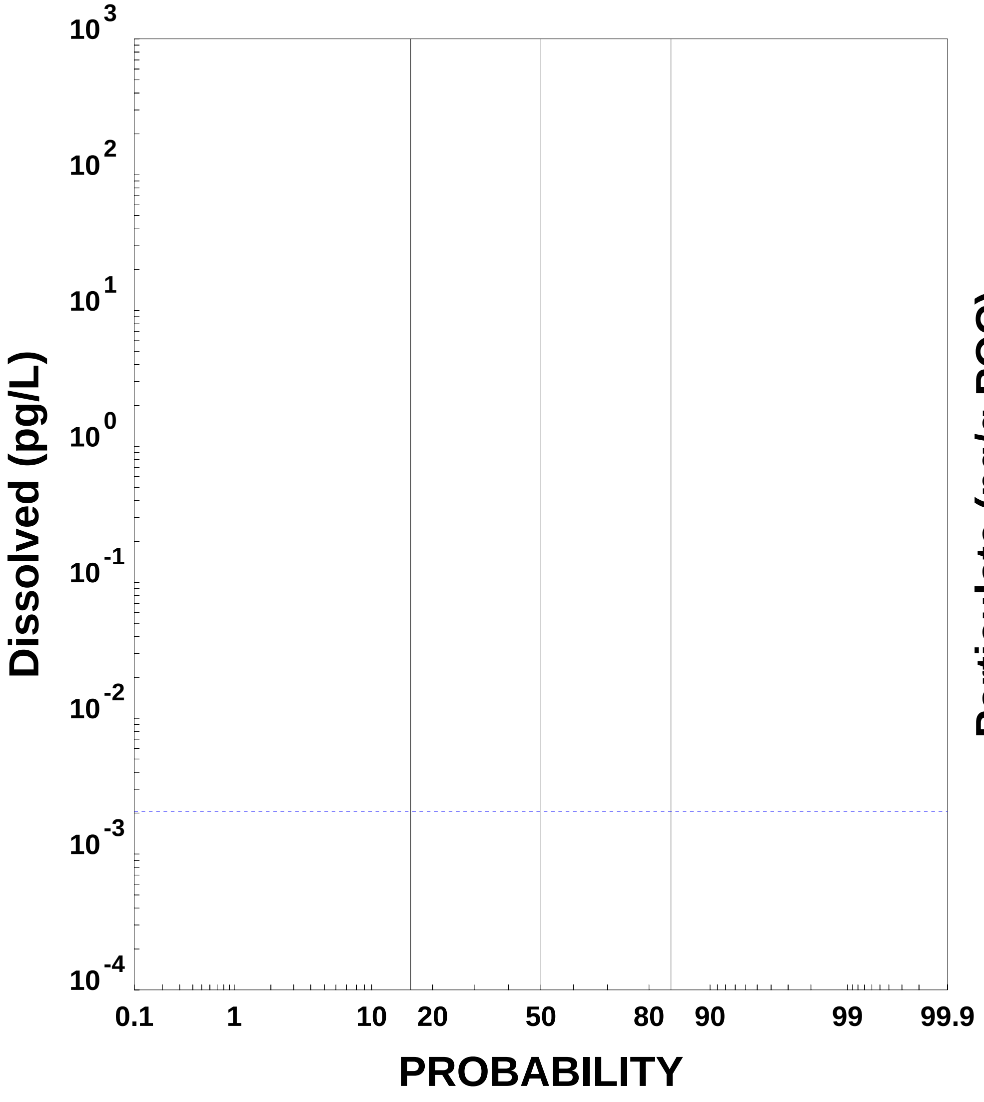


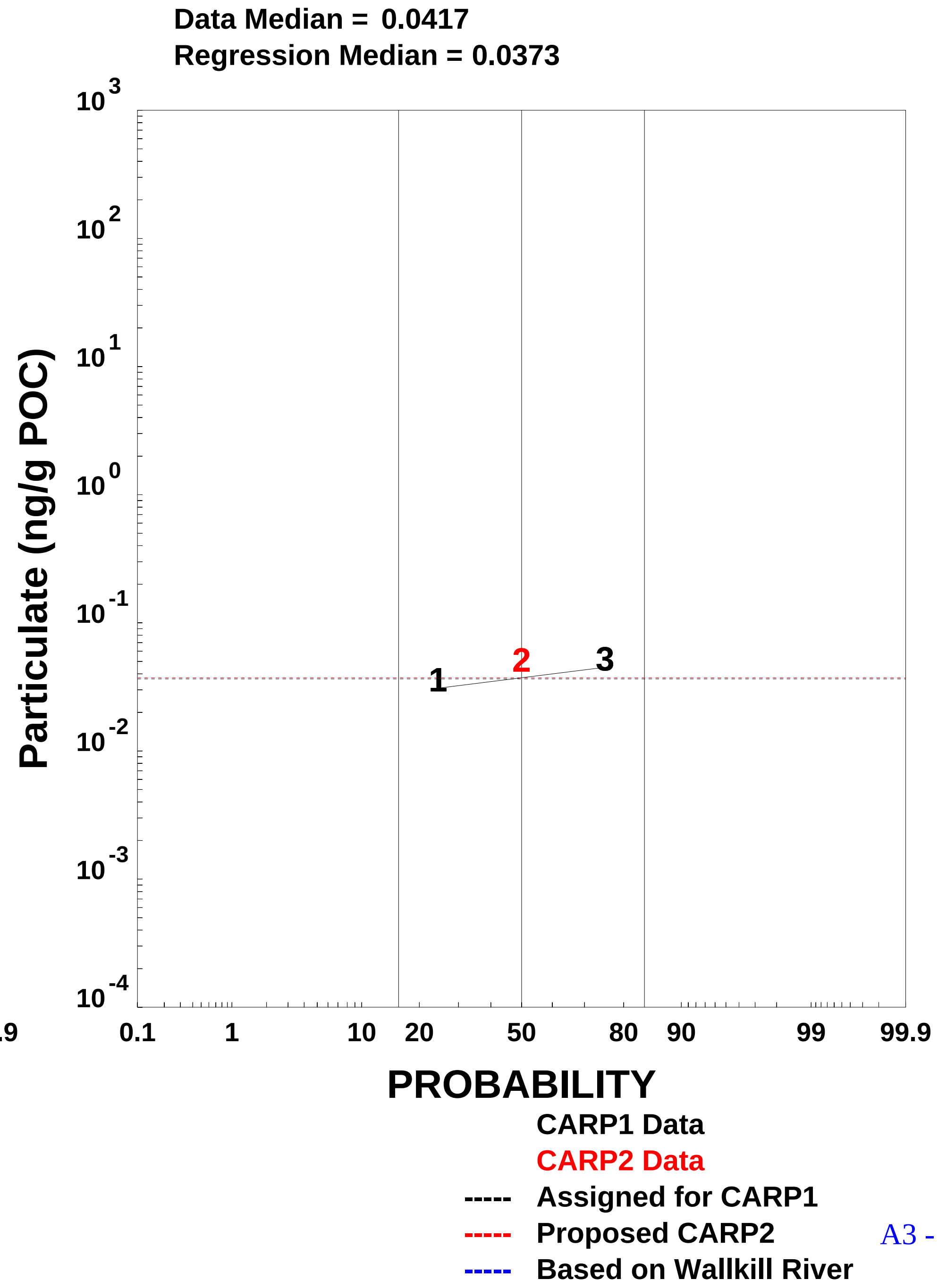


HACKENSACK RIVER AT NEW MILFORD -- 1,2,3,4,7,8-HxCDF

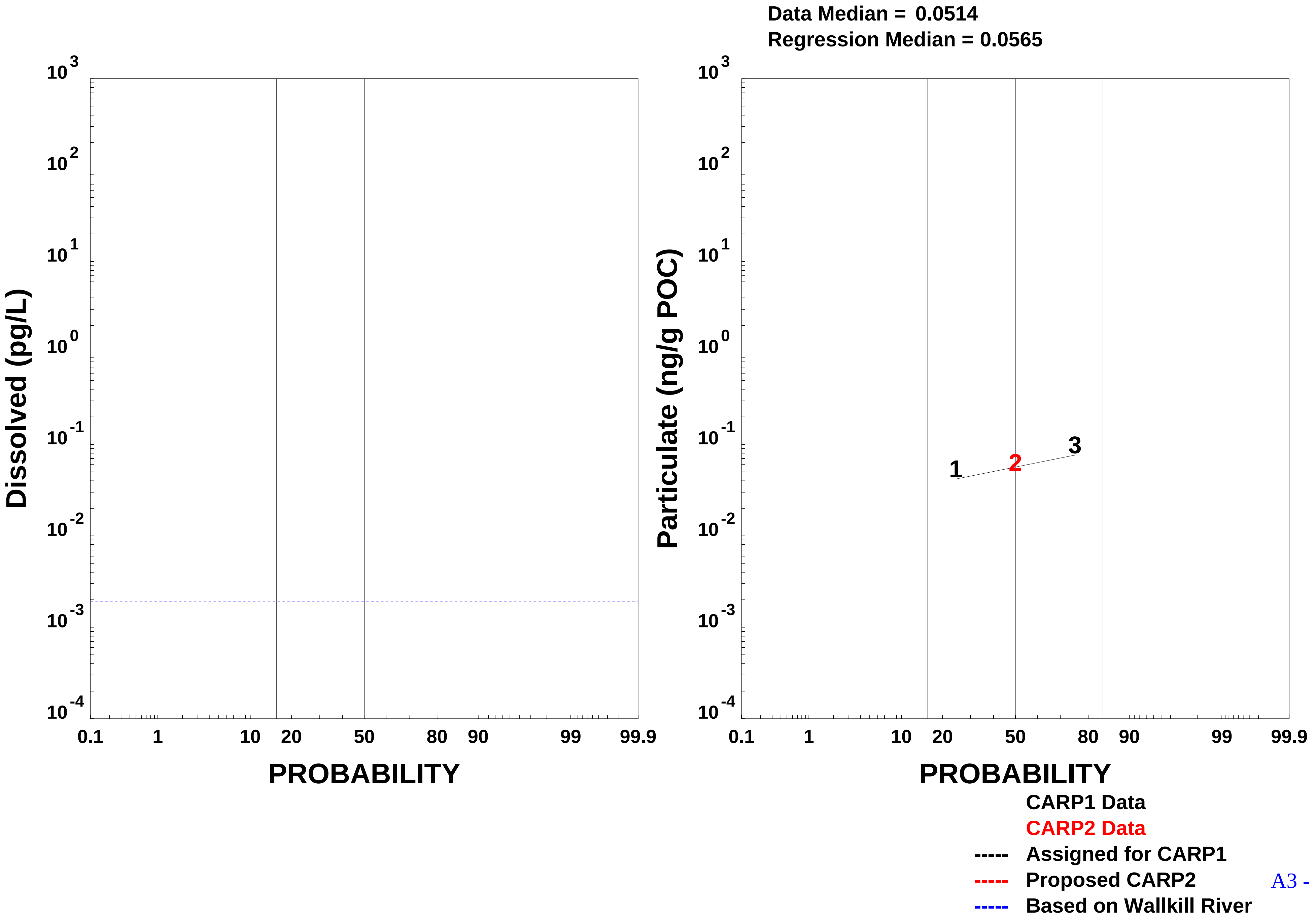


HACKENSACK RIVER AT NEW MILFORD -- 2,3,4,6,7,8-HxCDF

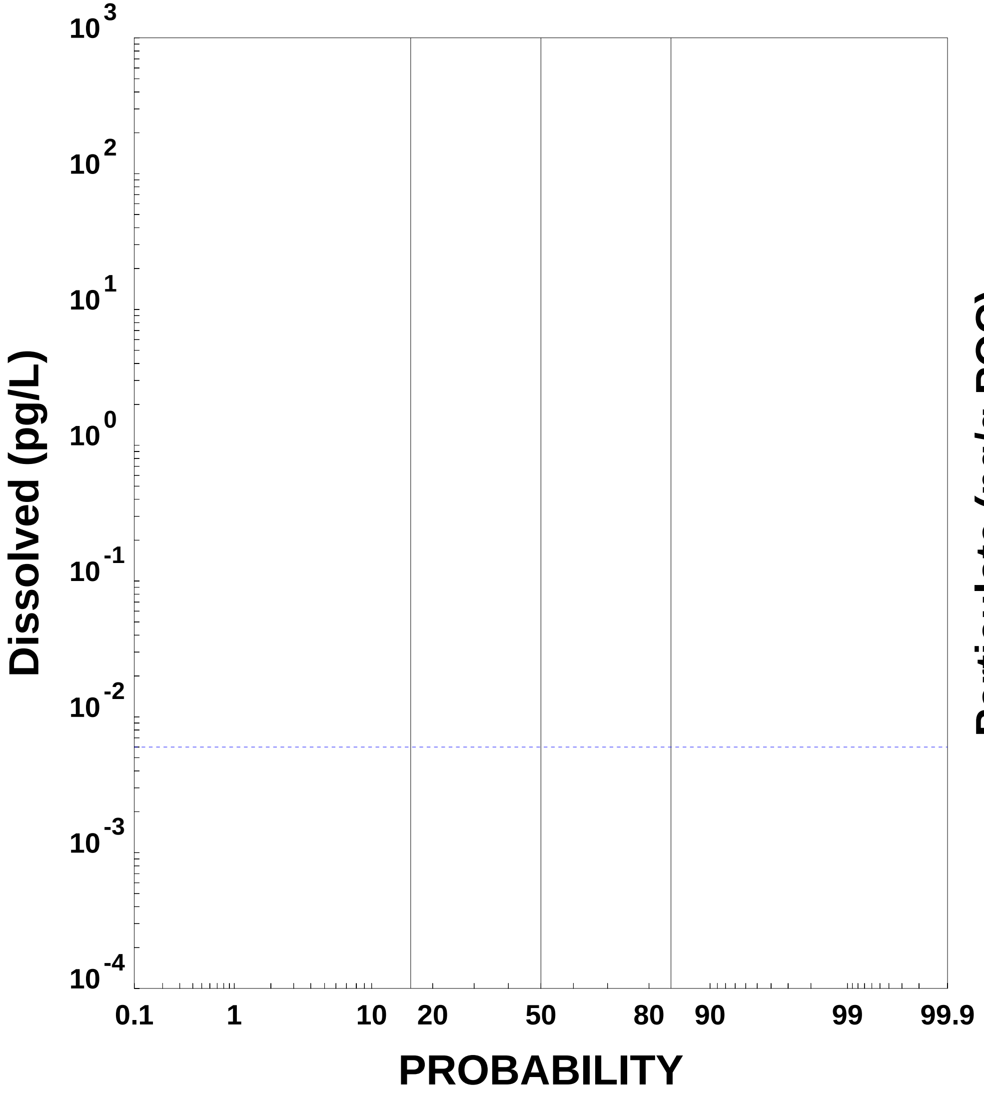


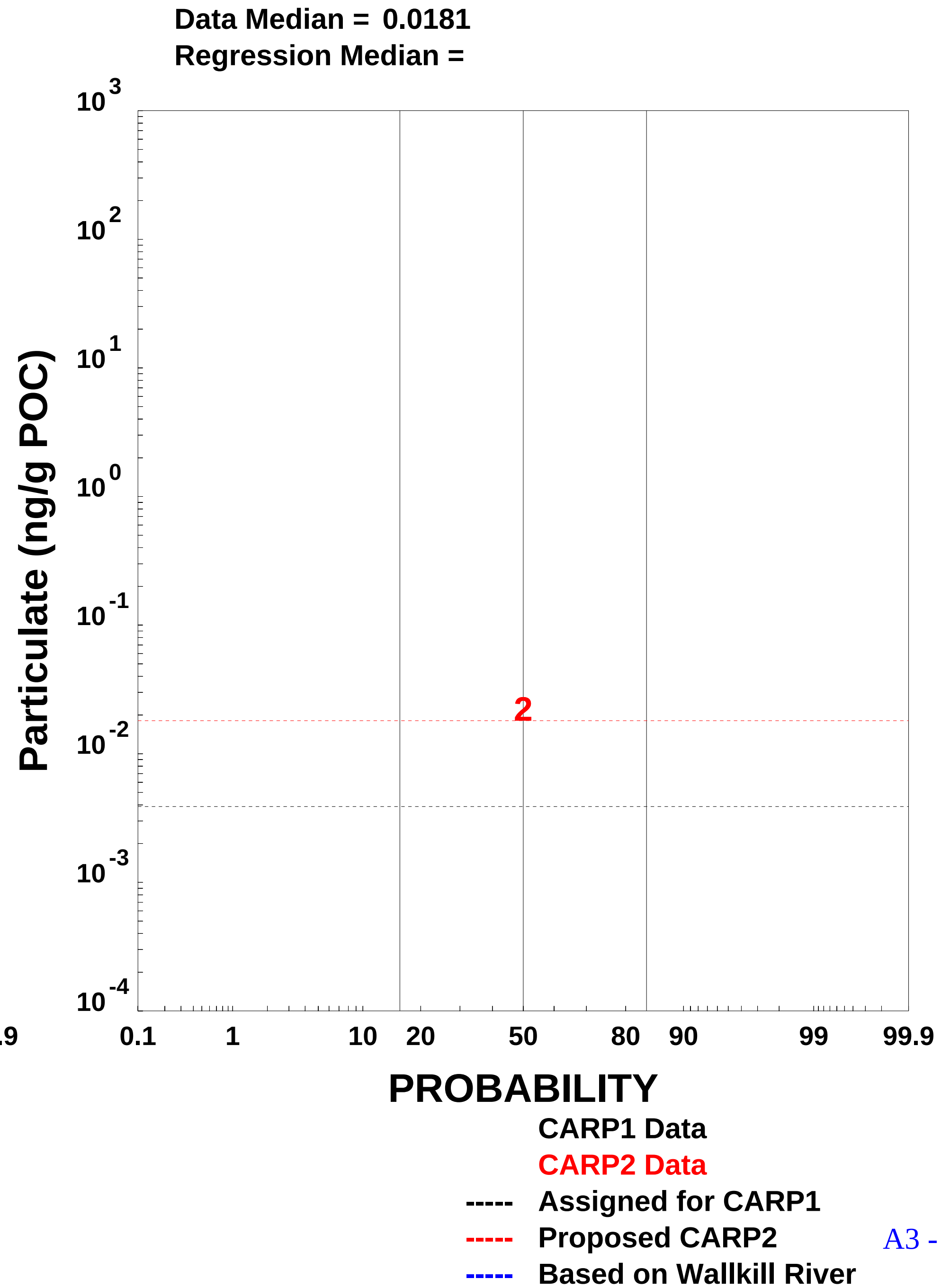


HACKENSACK RIVER AT NEW MILFORD -- 1,2,3,6,7,8-HxCDF

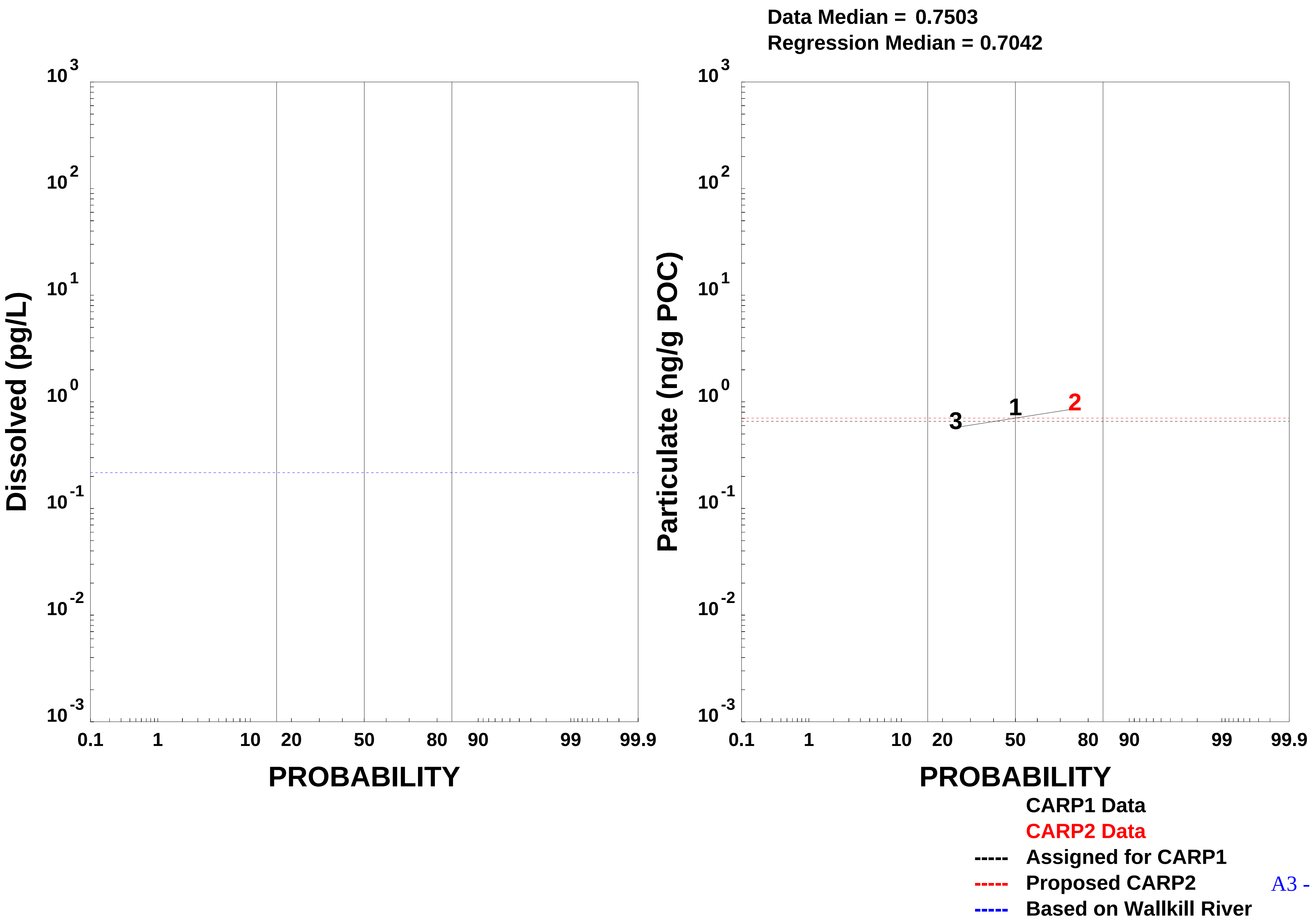


HACKENSACK RIVER AT NEW MILFORD -- 1,2,3,7,8,9-HxCDF

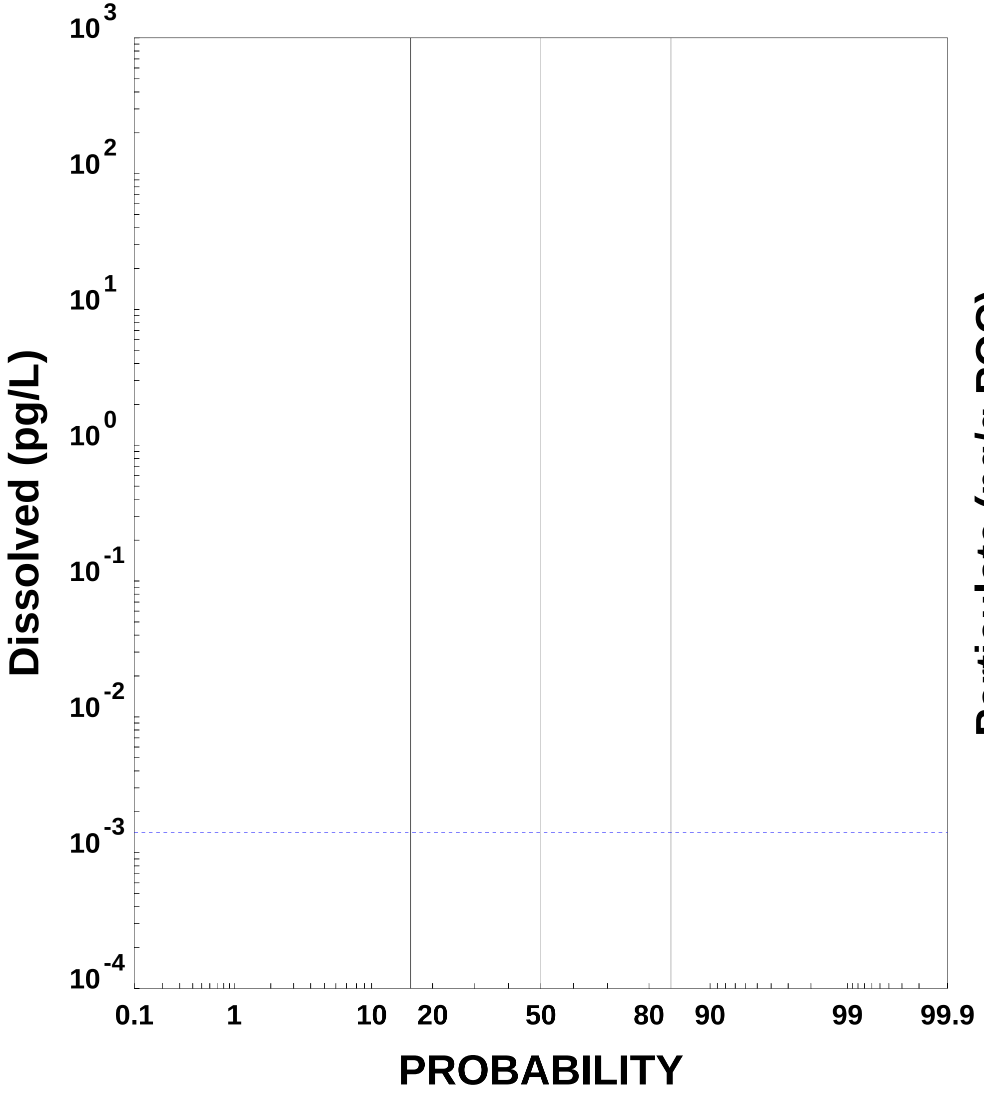




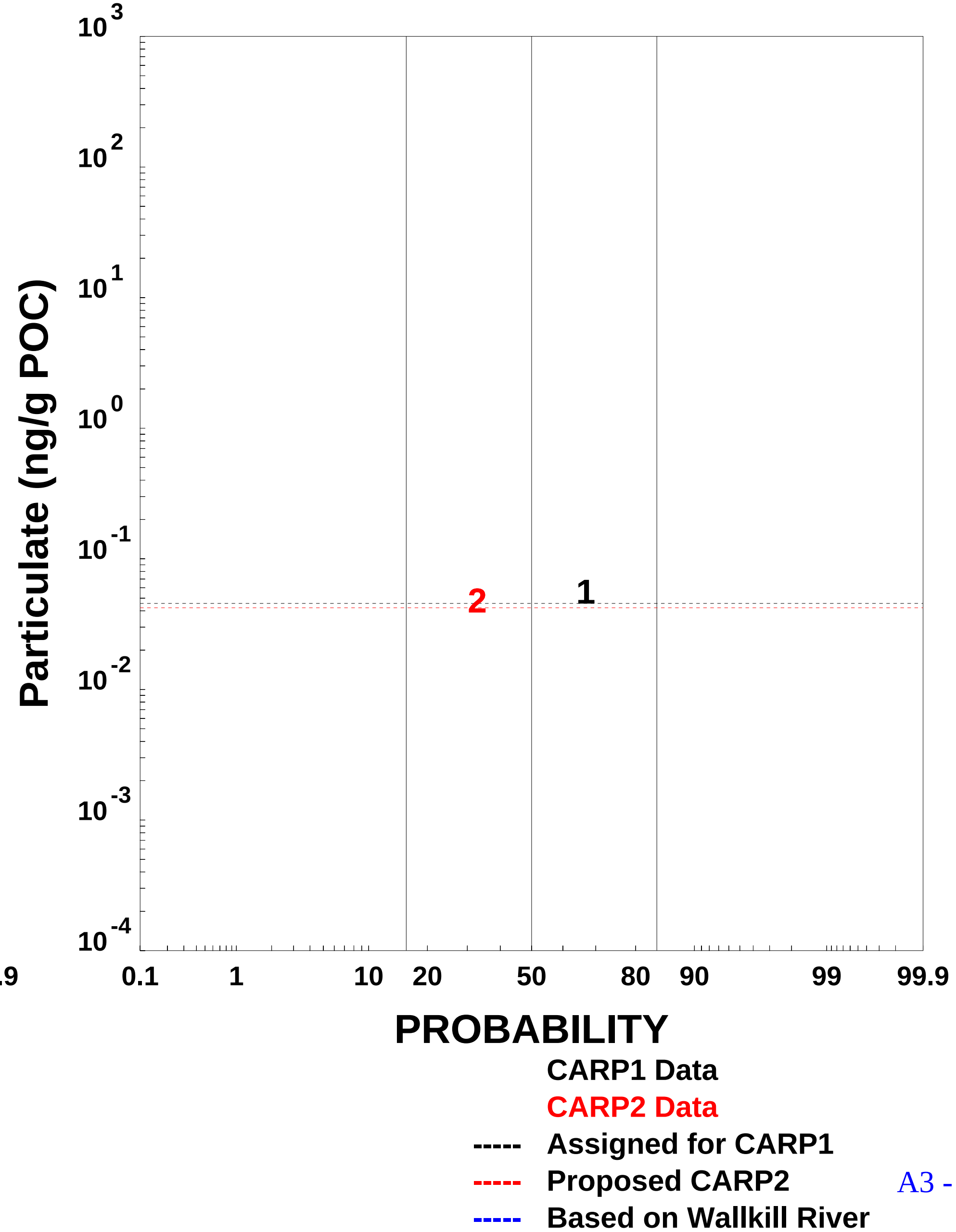
HACKENSACK RIVER AT NEW MILFORD -- 1,2,3,4,6,7,8-HpCDF



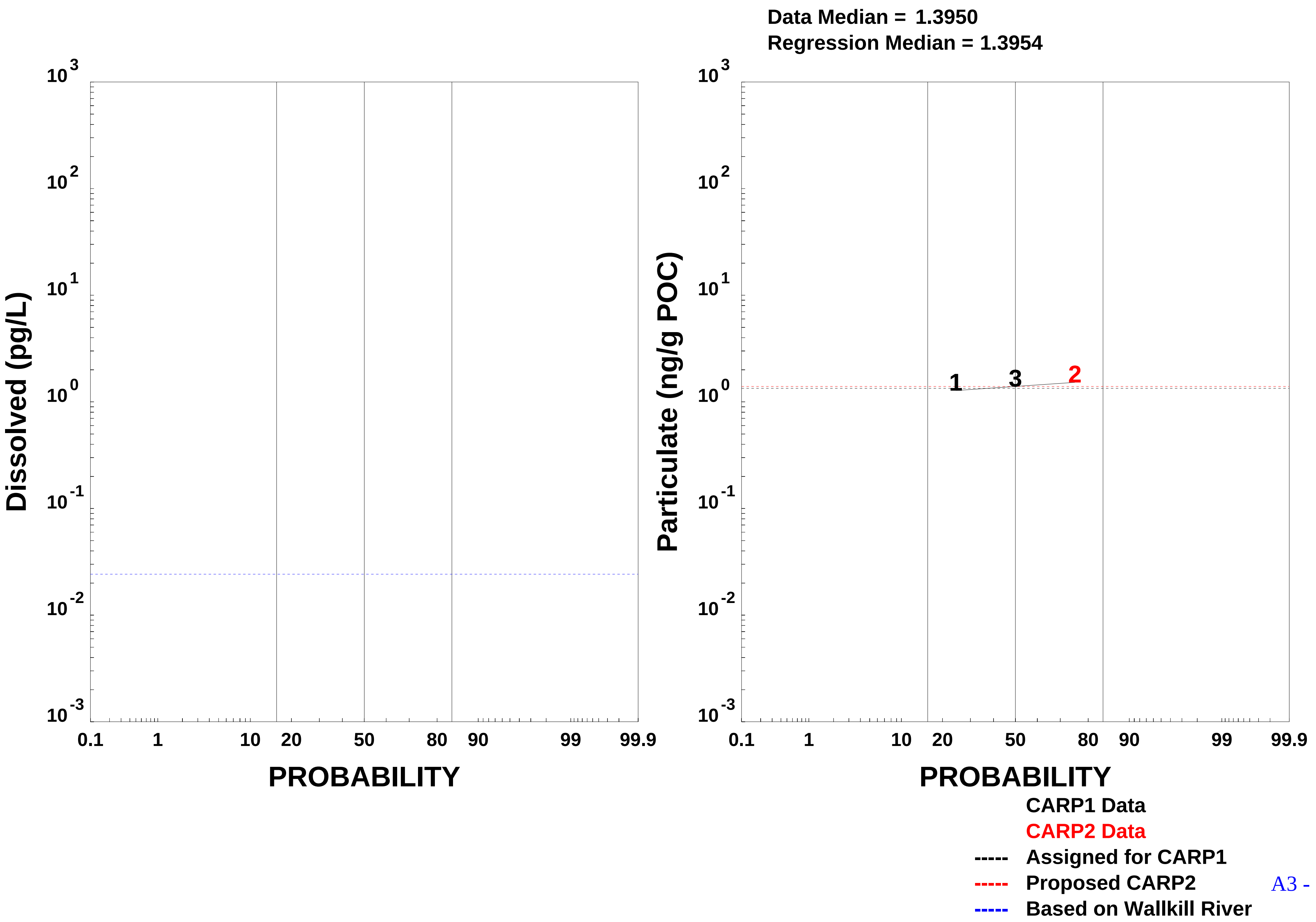
HACKENSACK RIVER AT NEW MILFORD -- 1,2,3,4,7,8,9-HpCDF



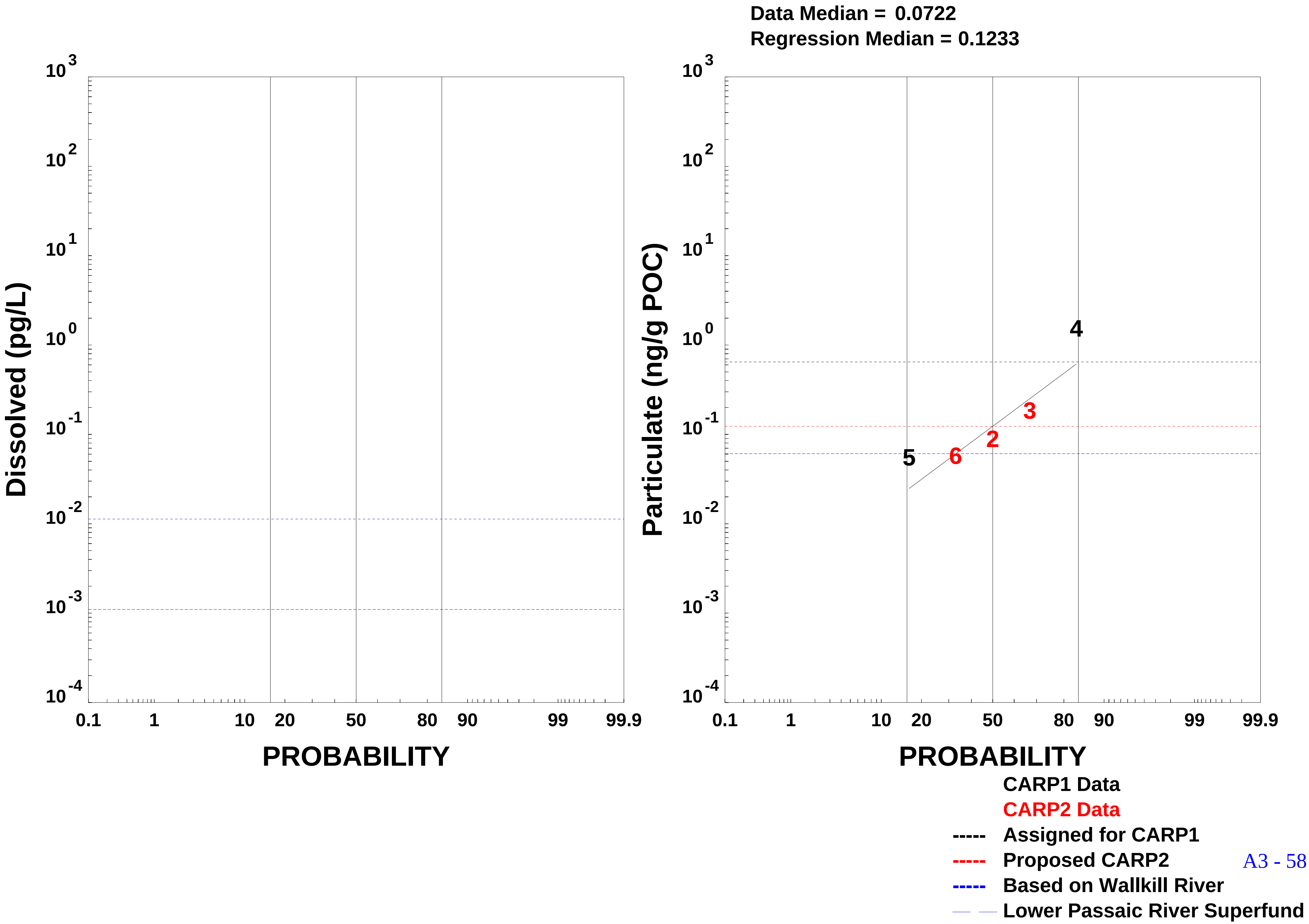
Data Median = 0.0422
Regression Median =



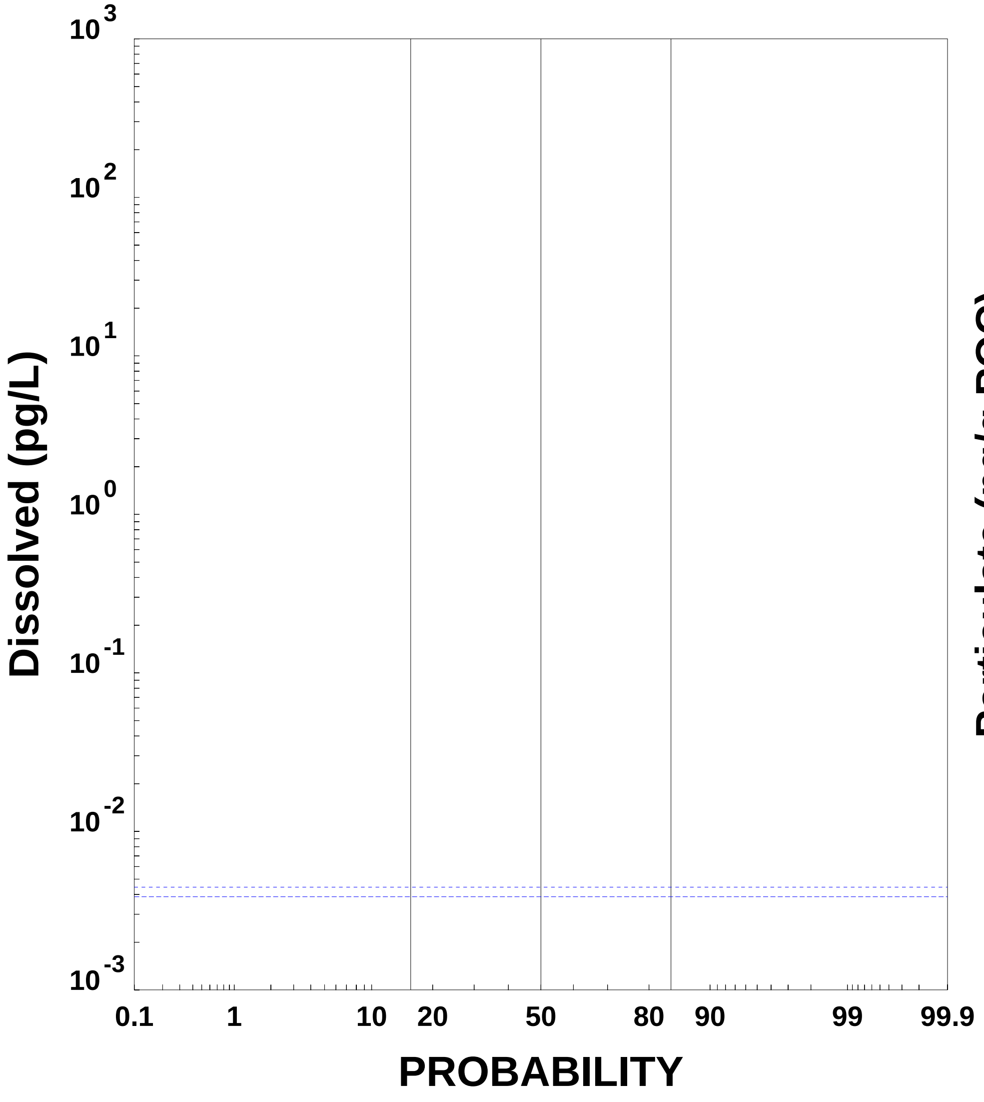
HACKENSACK RIVER AT NEW MILFORD -- OCDF

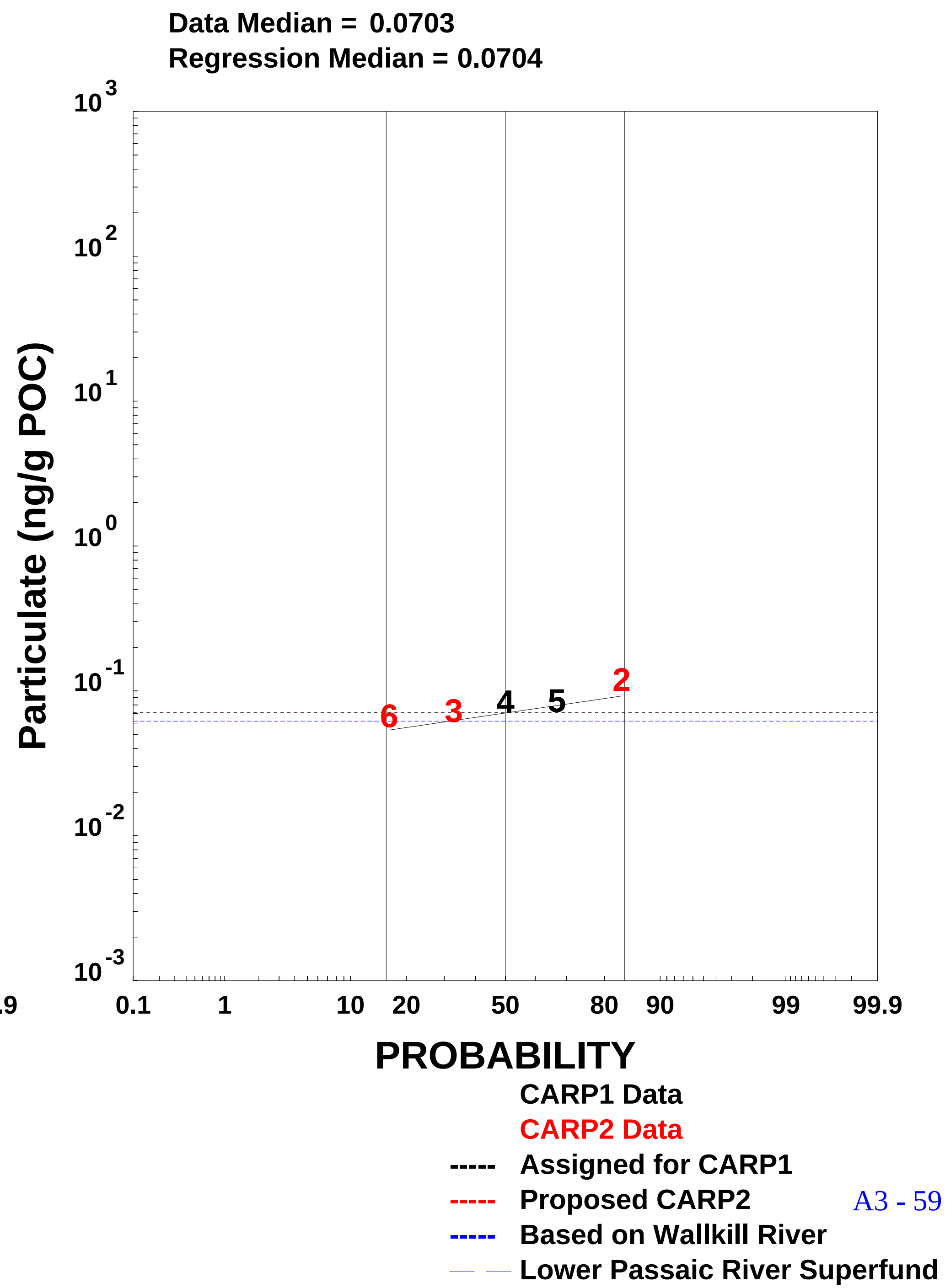


PASSAIC RIVER -- 2,3,7,8-TCDD

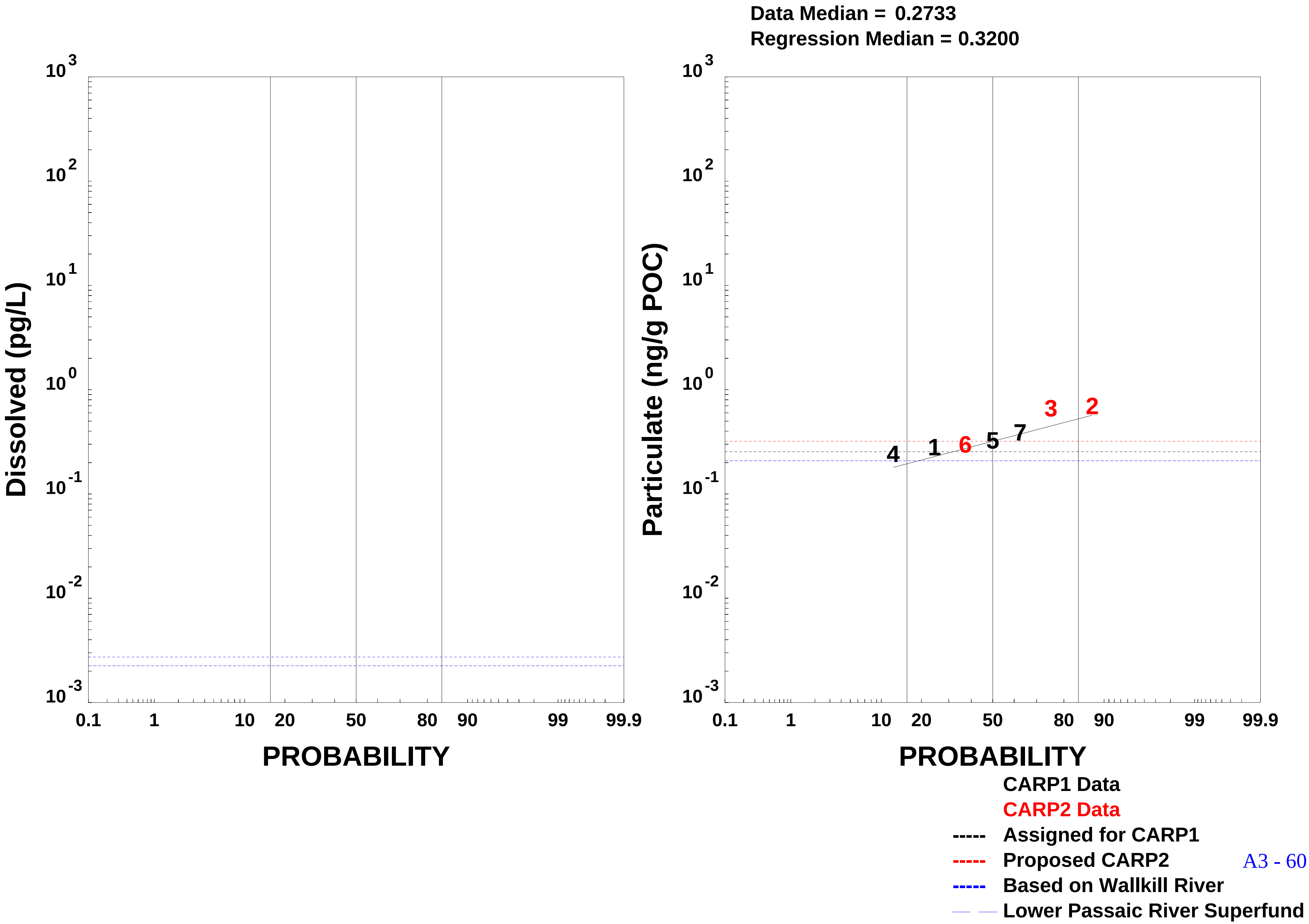


PASSAIC RIVER -- 1,2,3,7,8-PeCDD

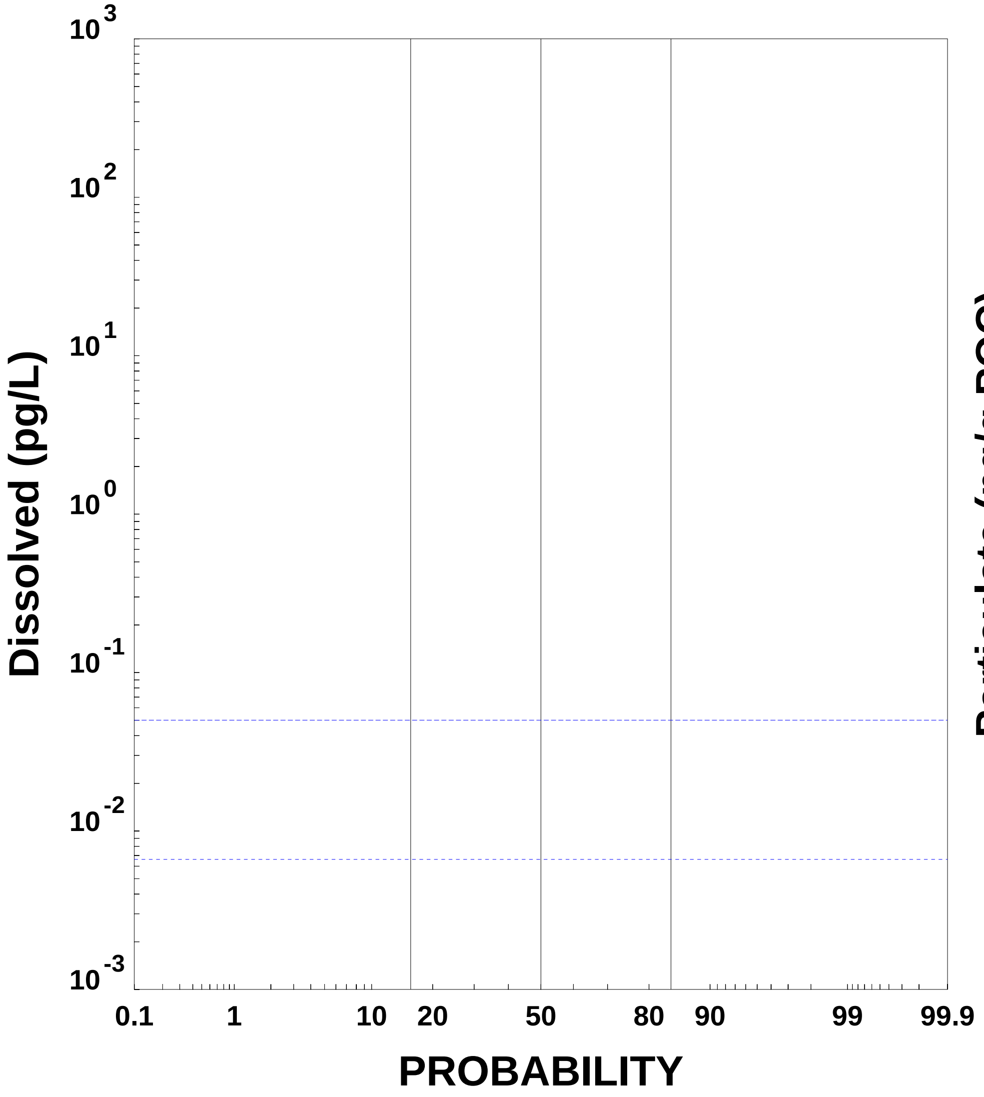


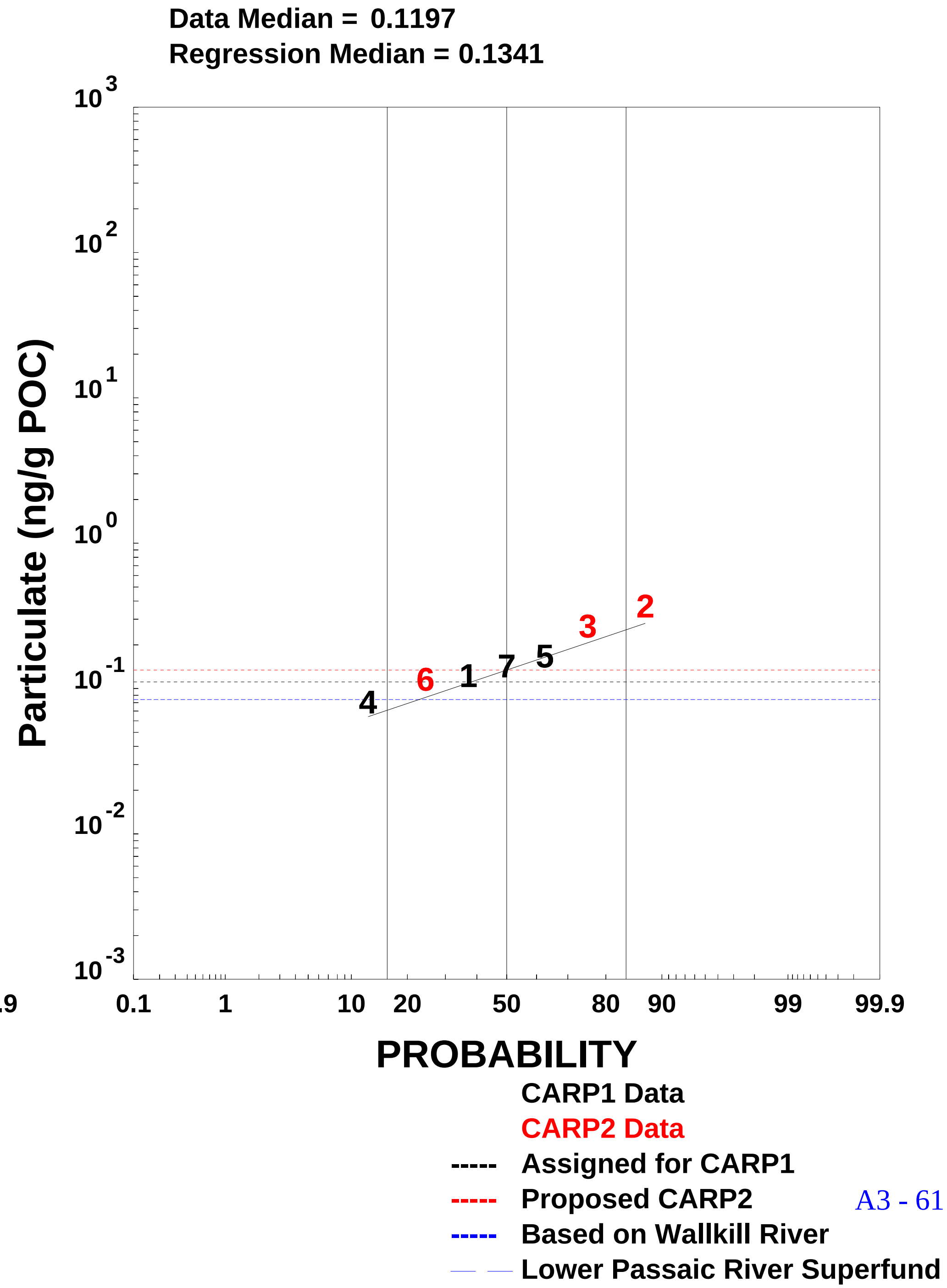


PASSAIC RIVER -- 1,2,3,7,8,9-HxCDD

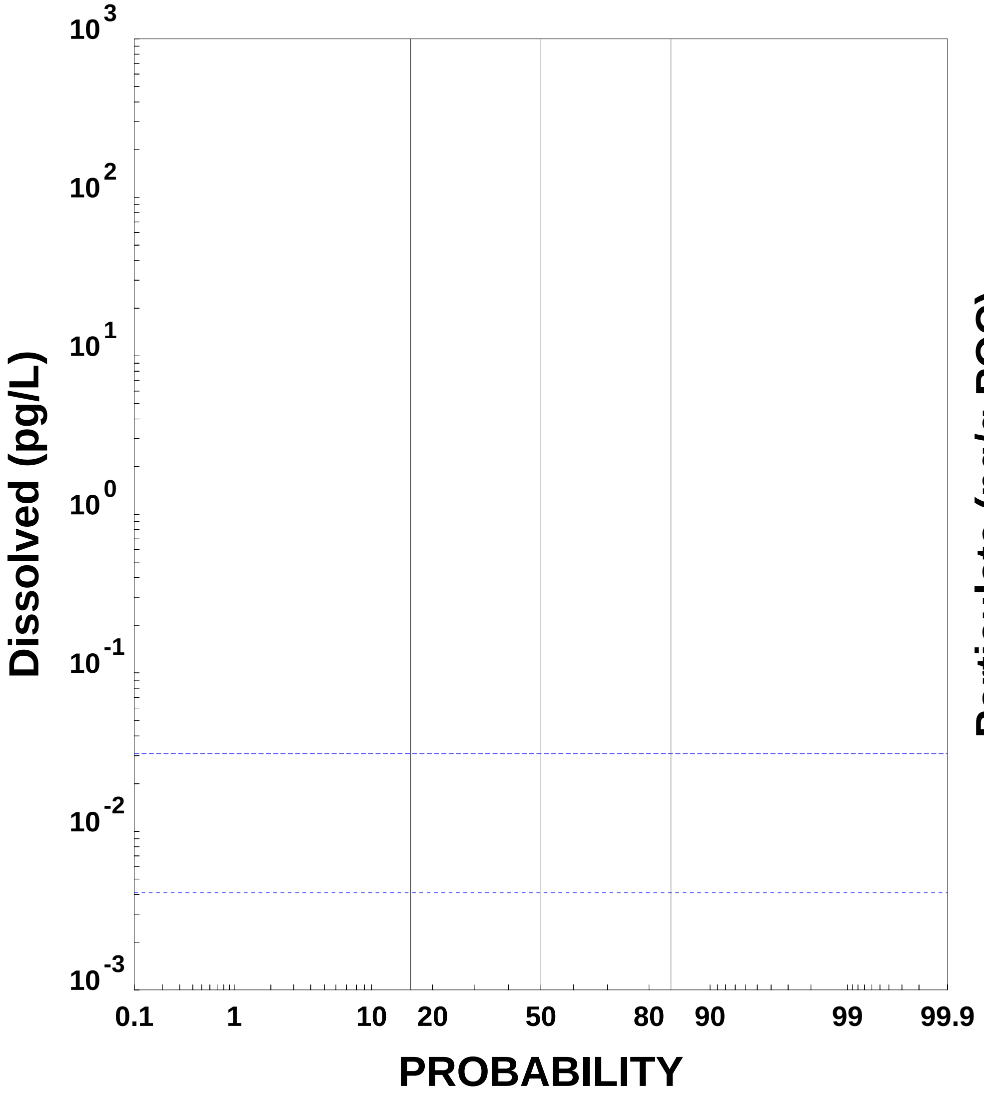


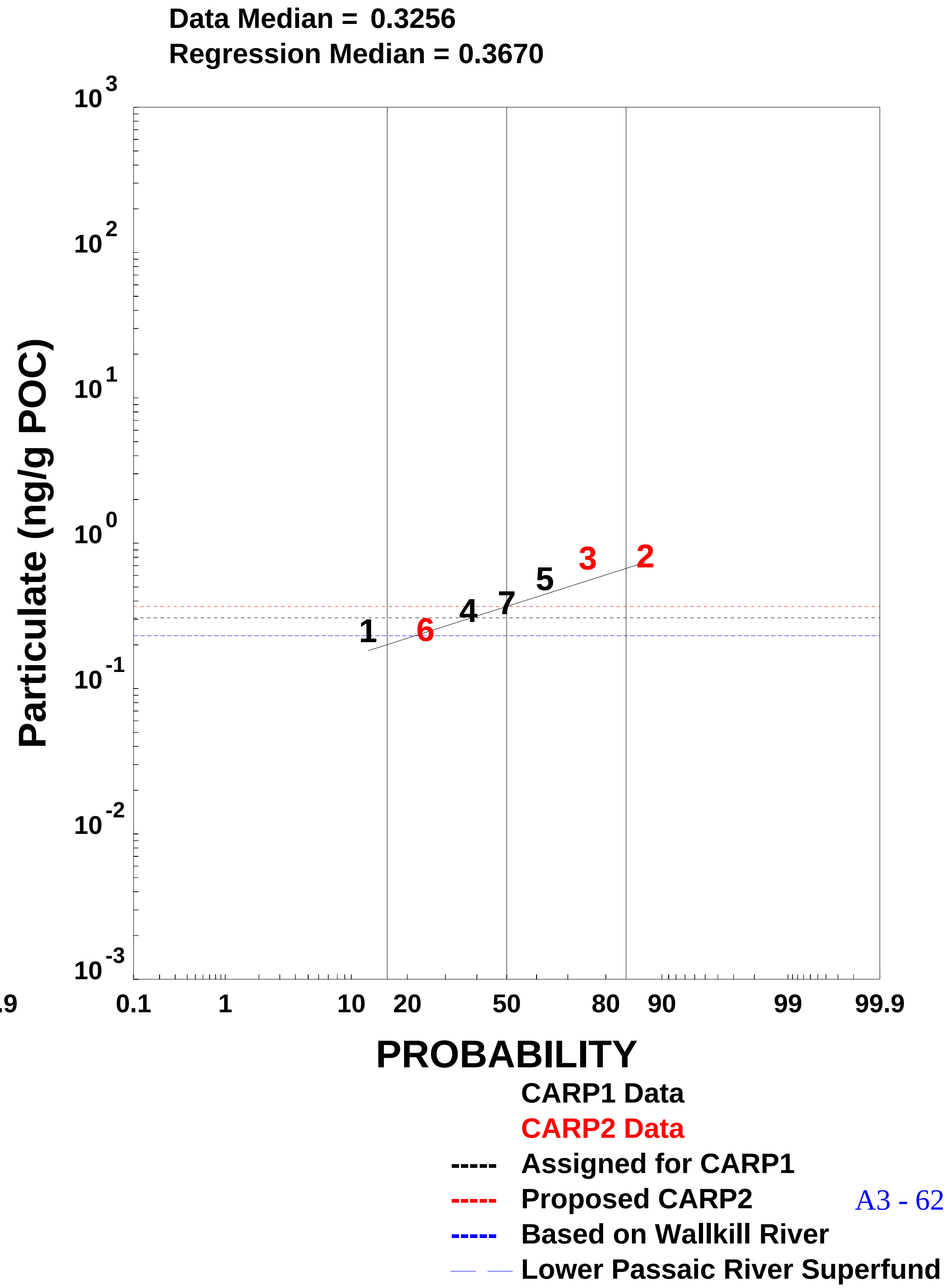
PASSAIC RIVER -- 1,2,3,4,7,8-HxCDD



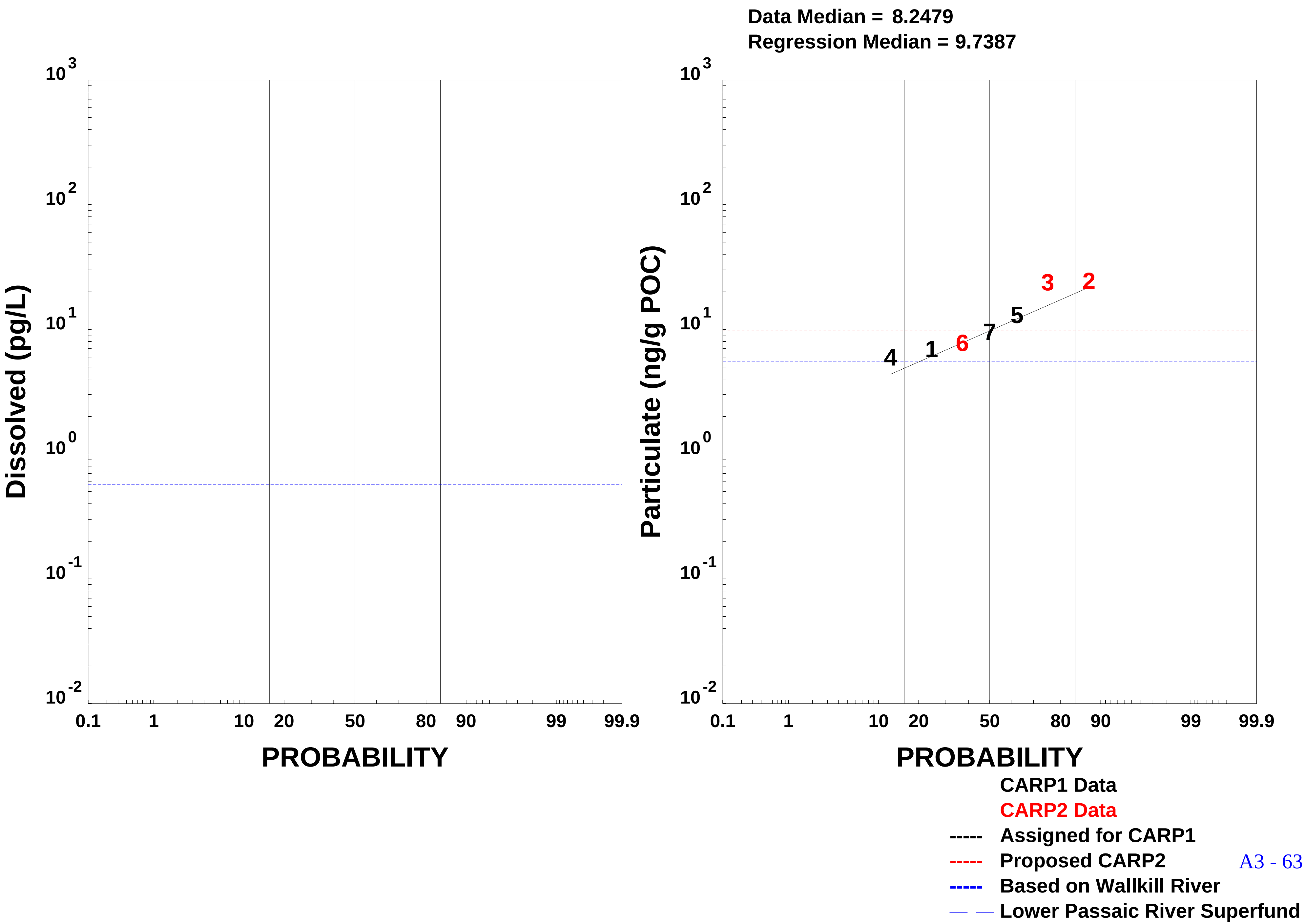


PASSAIC RIVER -- 1,2,3,6,7,8-HxCDD



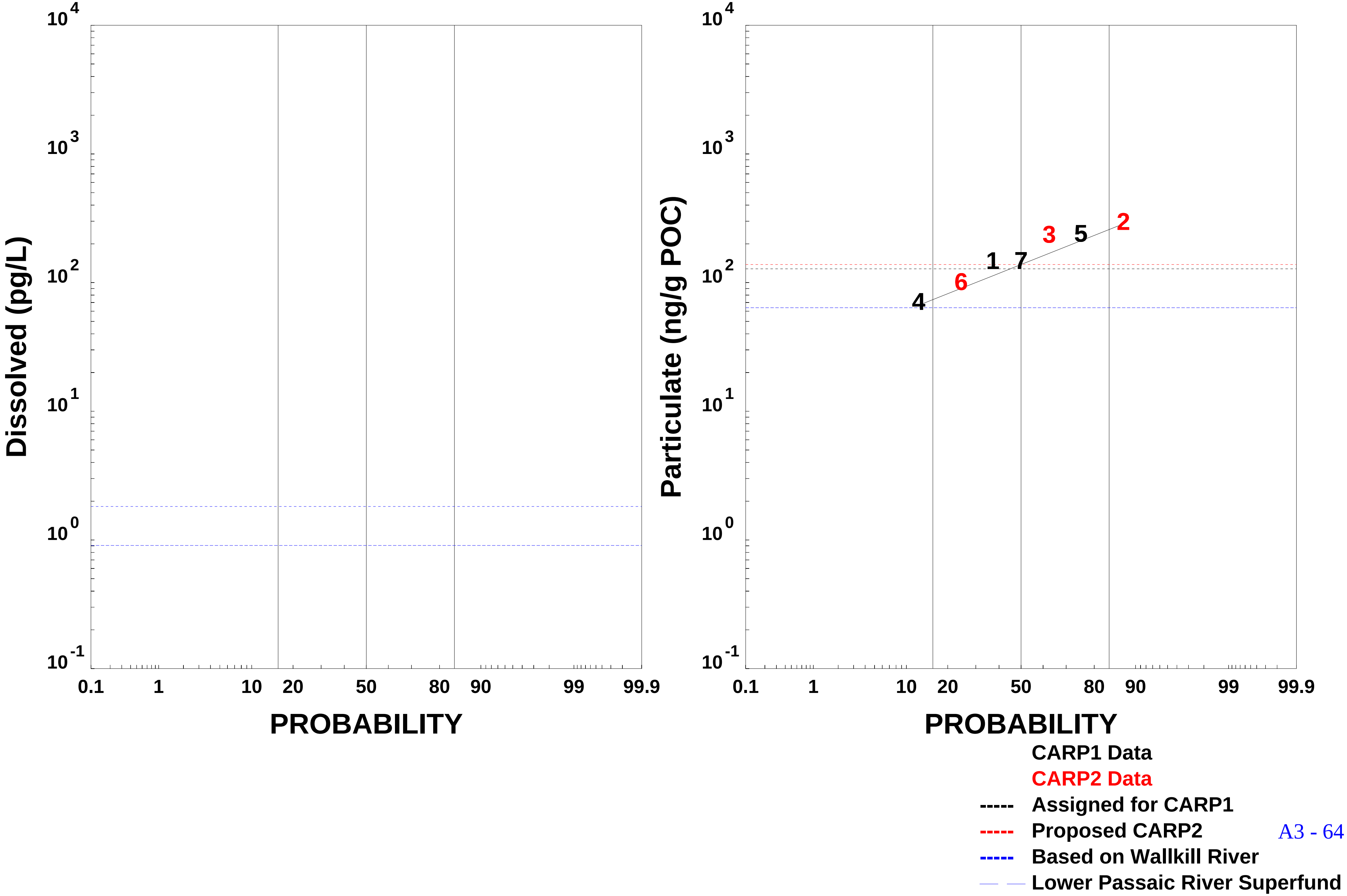


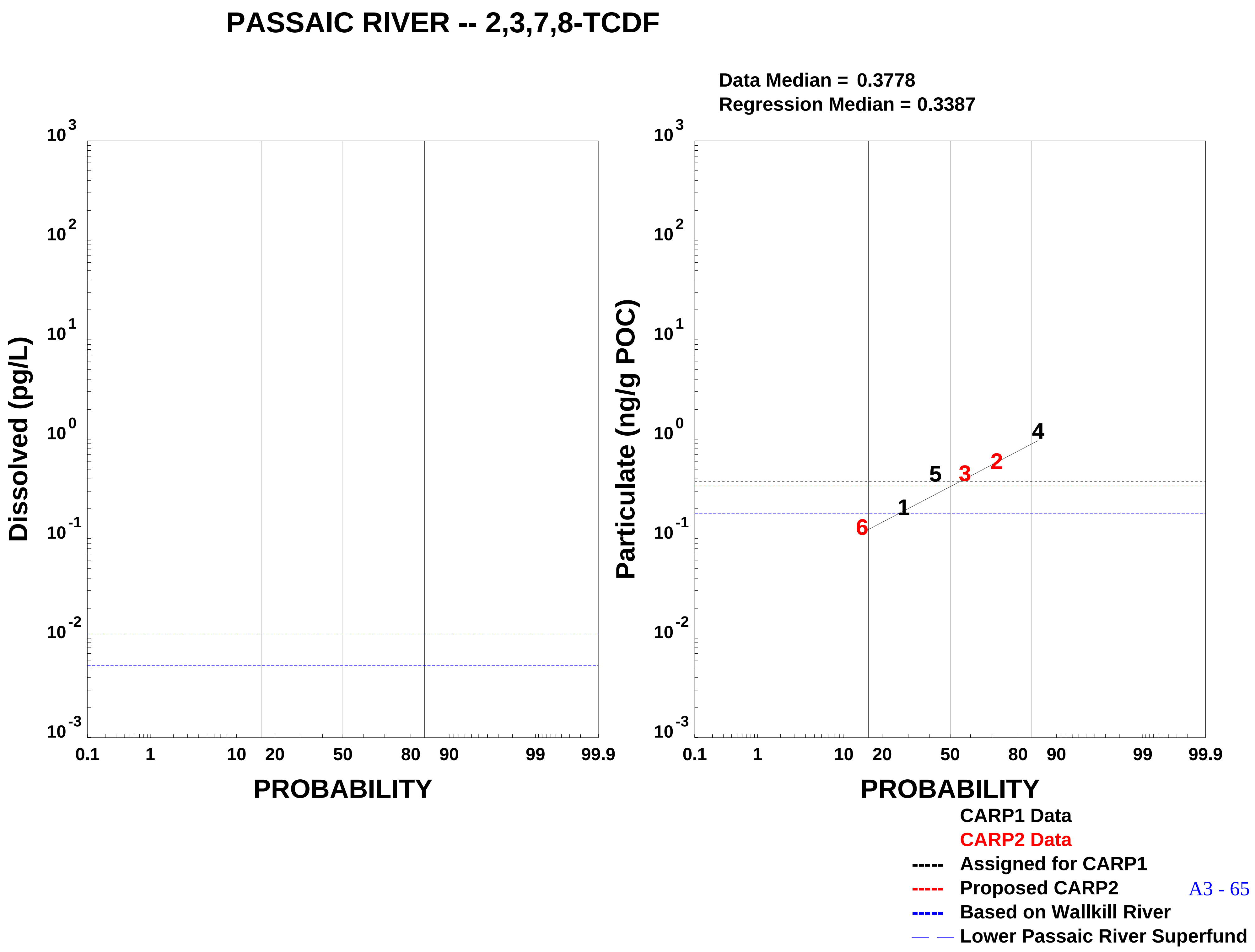
PASSAIC RIVER -- 1,2,3,4,6,7,8-HpCDD



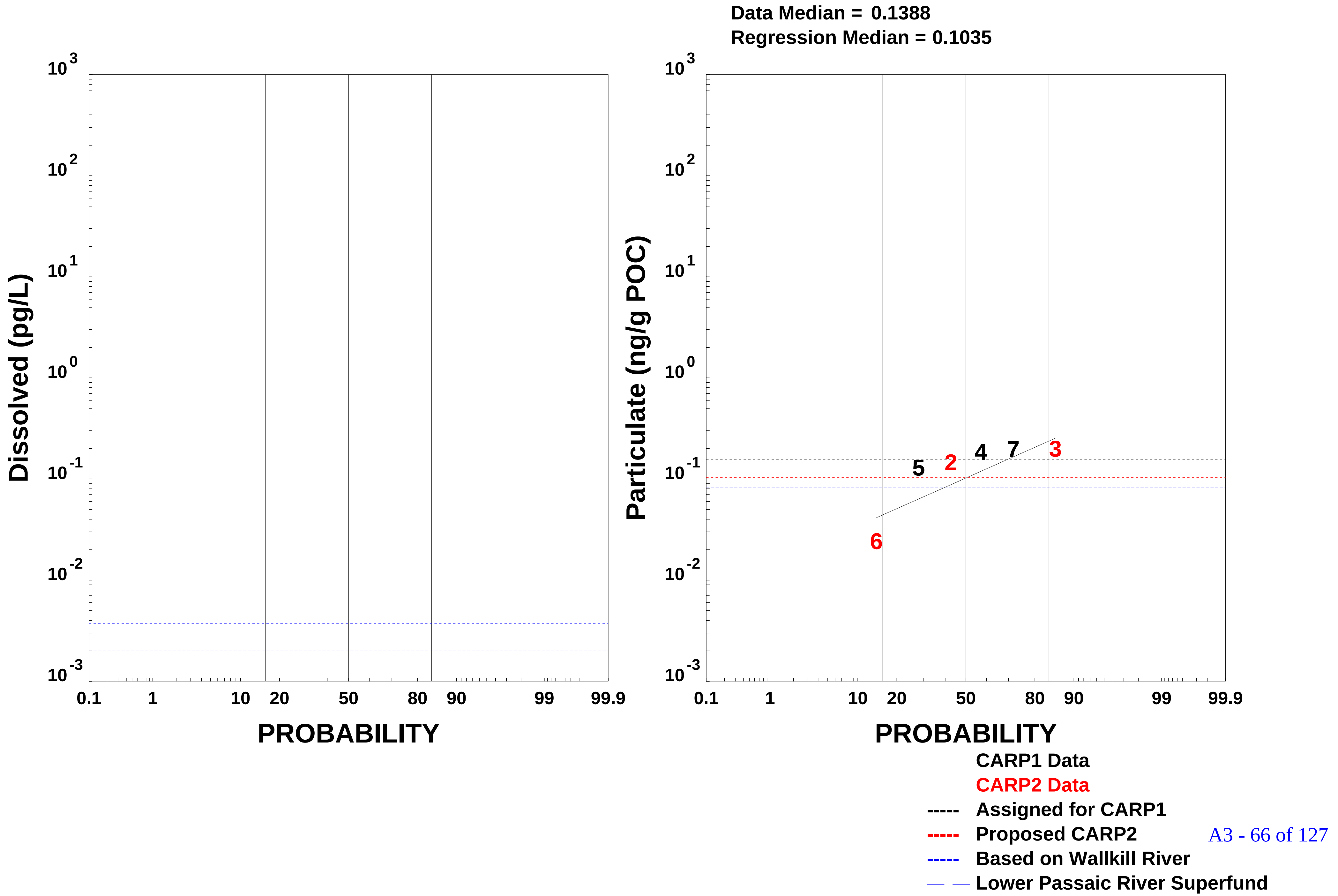
PASSAIC RIVER -- OCDD

Data Median = 128.0598
Regression Median = 138.1432

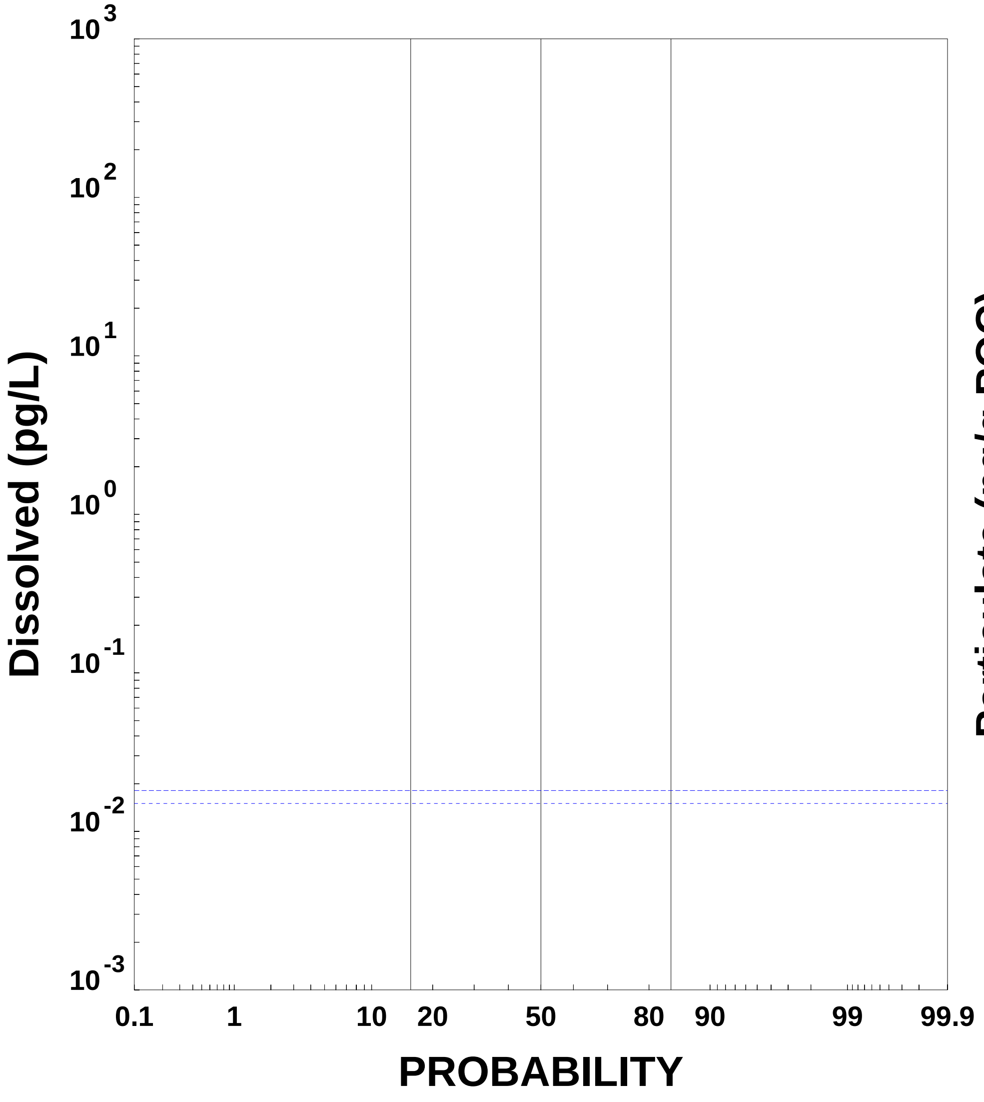


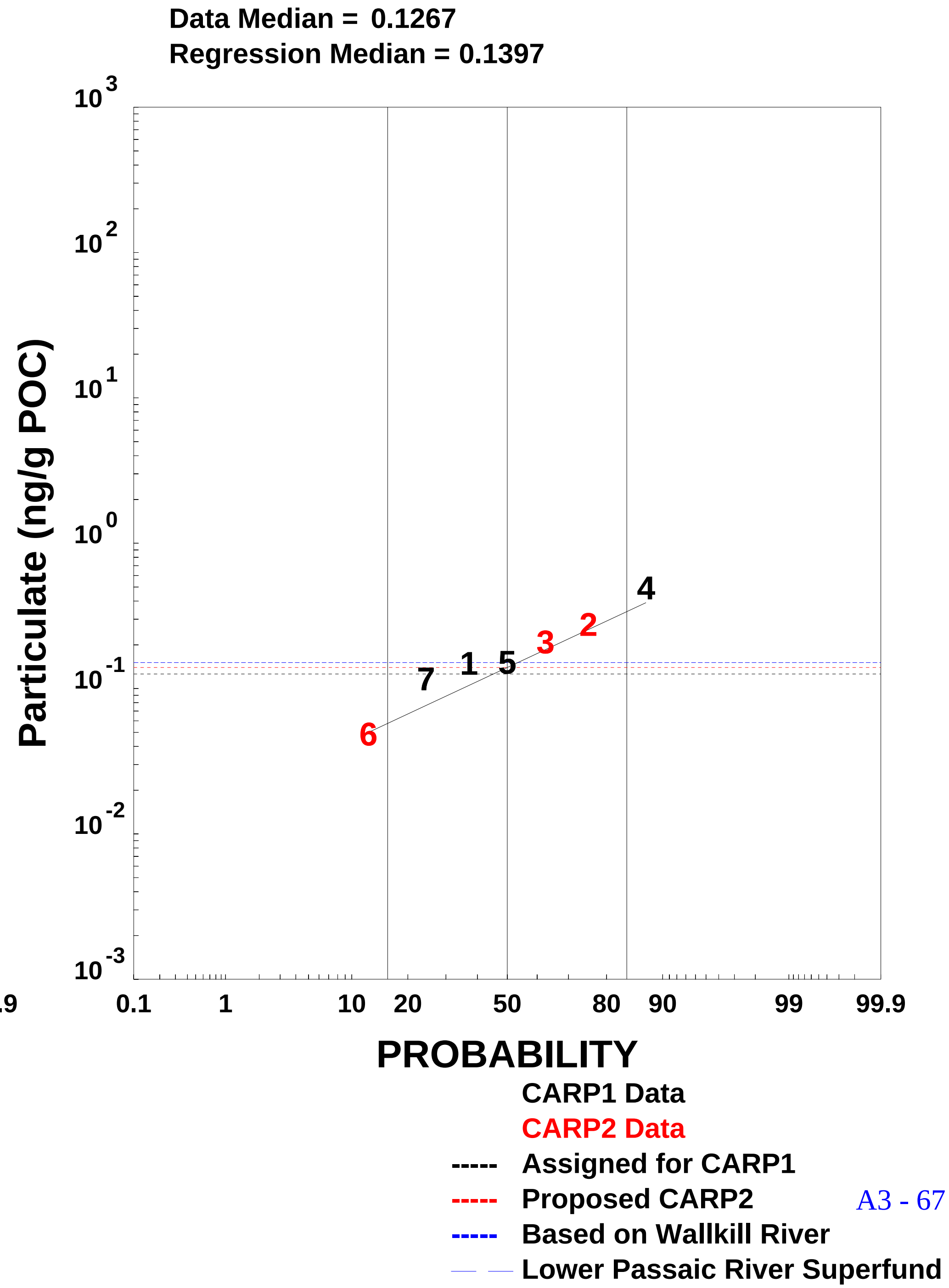

PASSAIC RIVER -- 2,3,7,8-TCDF
Data Median = 0.3778
Regression Median = 0.3387
Dissolved (pg/L)
Particulate (ng/g POC)
PROBABILITY
PROBABILITY
CARP1 Data
CARP2 Data
Assigned for CARP1
Proposed CARP2
Based on Wallkill River
Lower Passaic River Superfund

PASSAIC RIVER -- 1,2,3,7,8-PeCDF

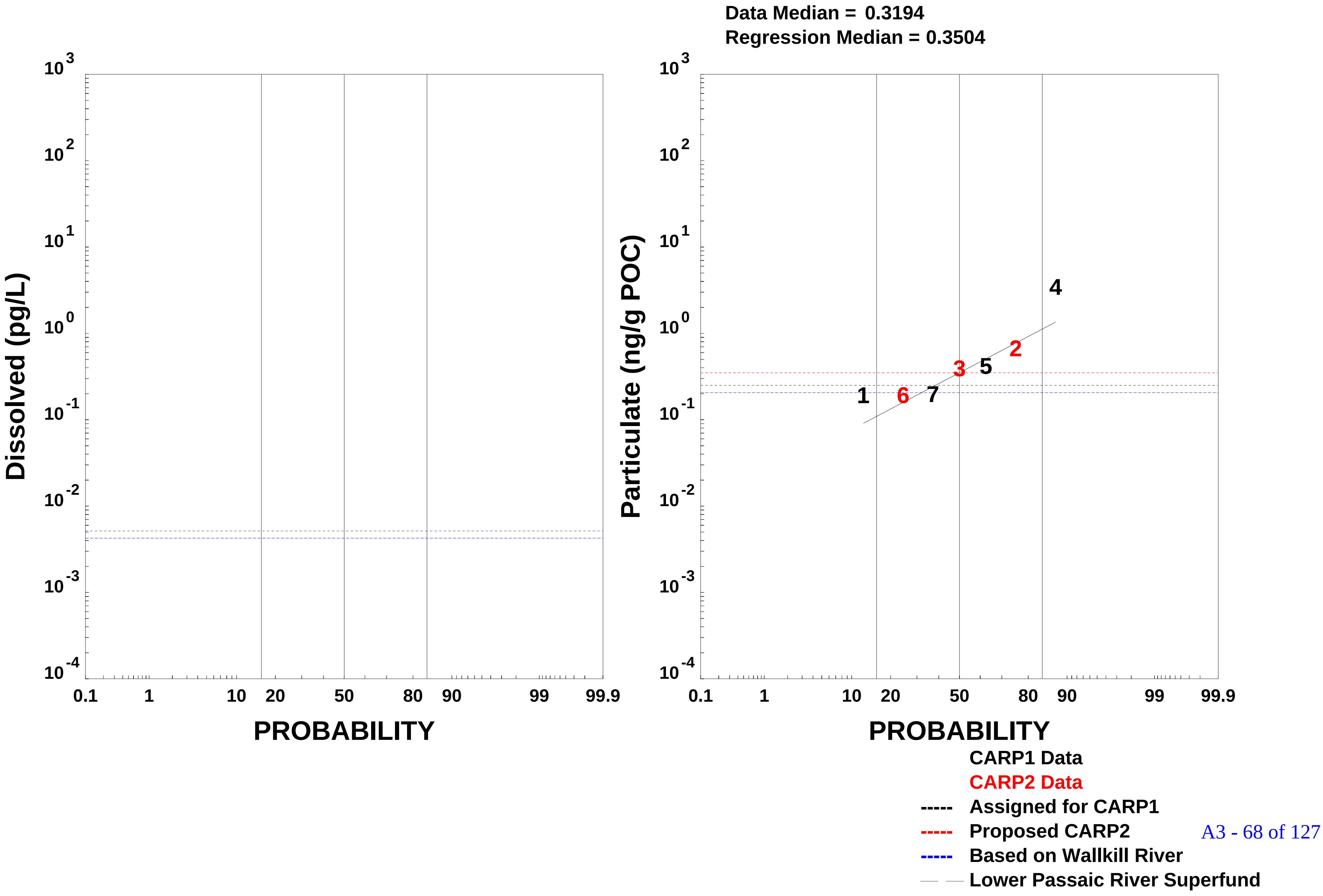


PASSAIC RIVER -- 2,3,4,7,8-PeCDF

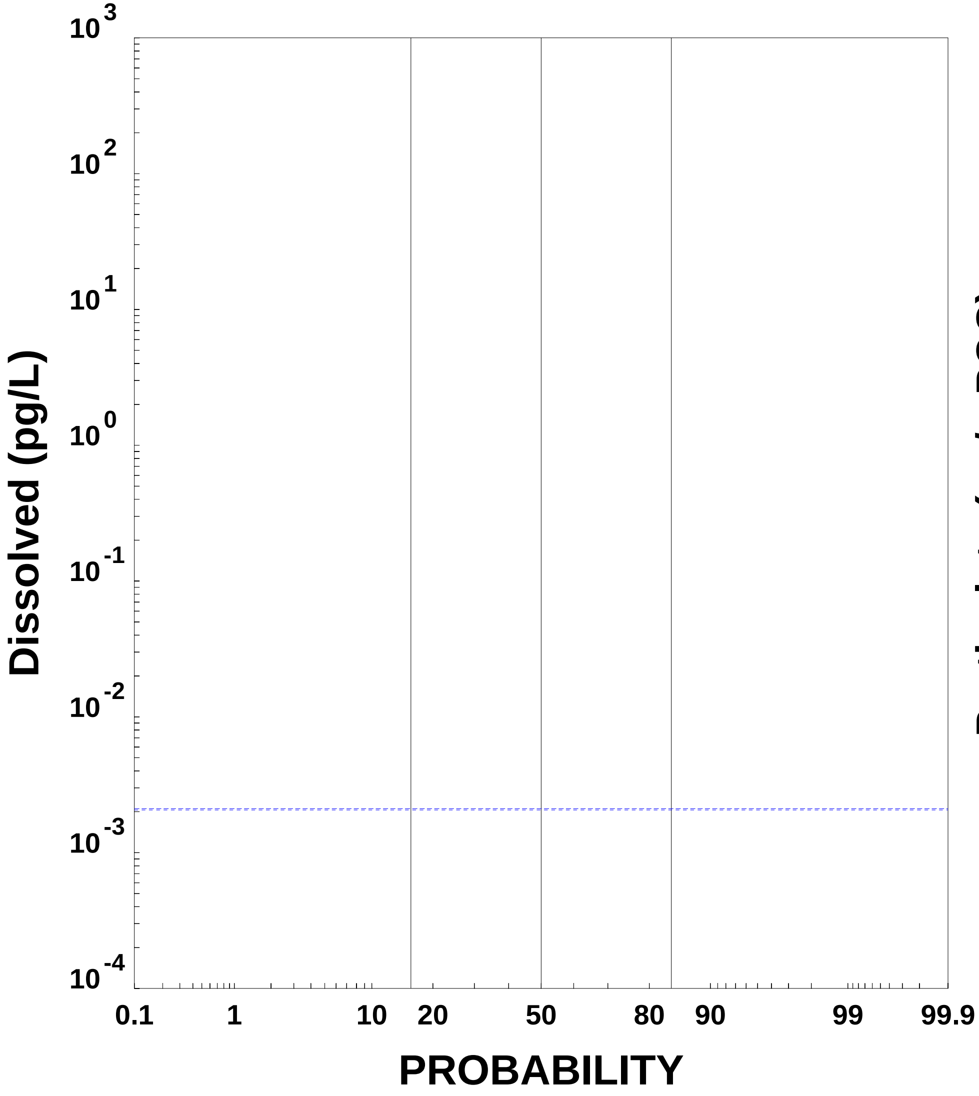


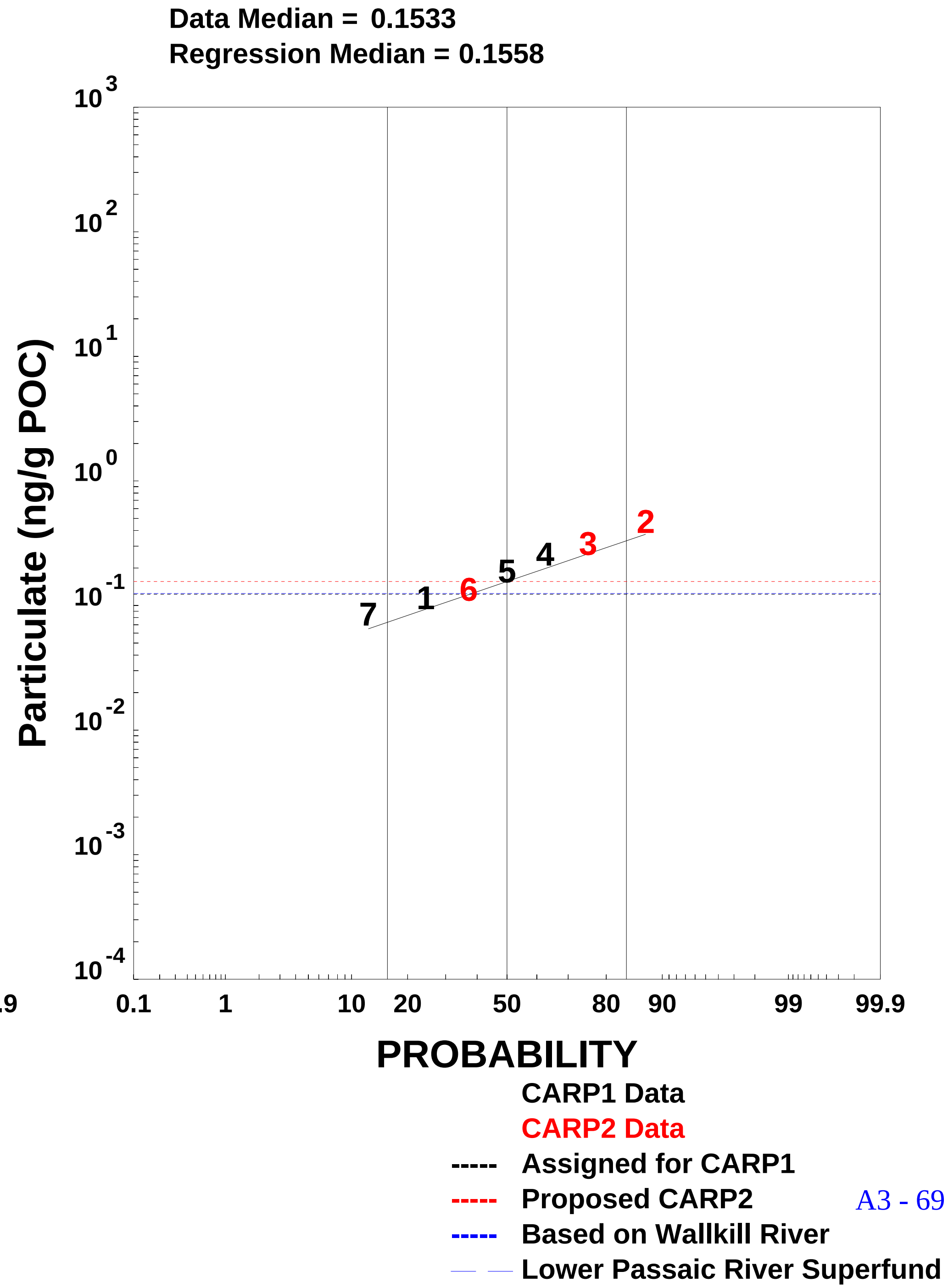


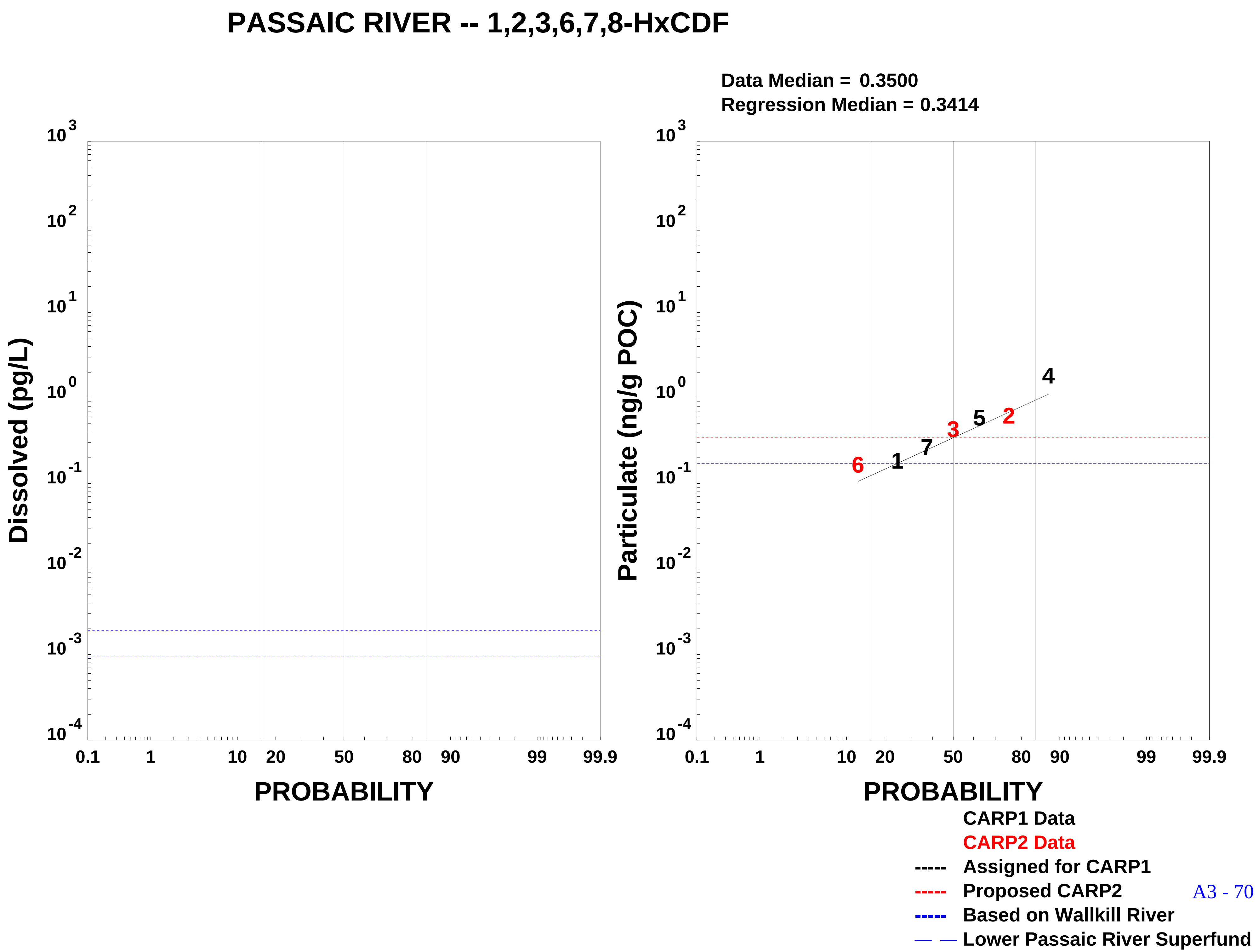
PASSAIC RIVER -- 1,2,3,4,7,8-HxCDF



PASSAIC RIVER -- 2,3,4,6,7,8-HxCDF

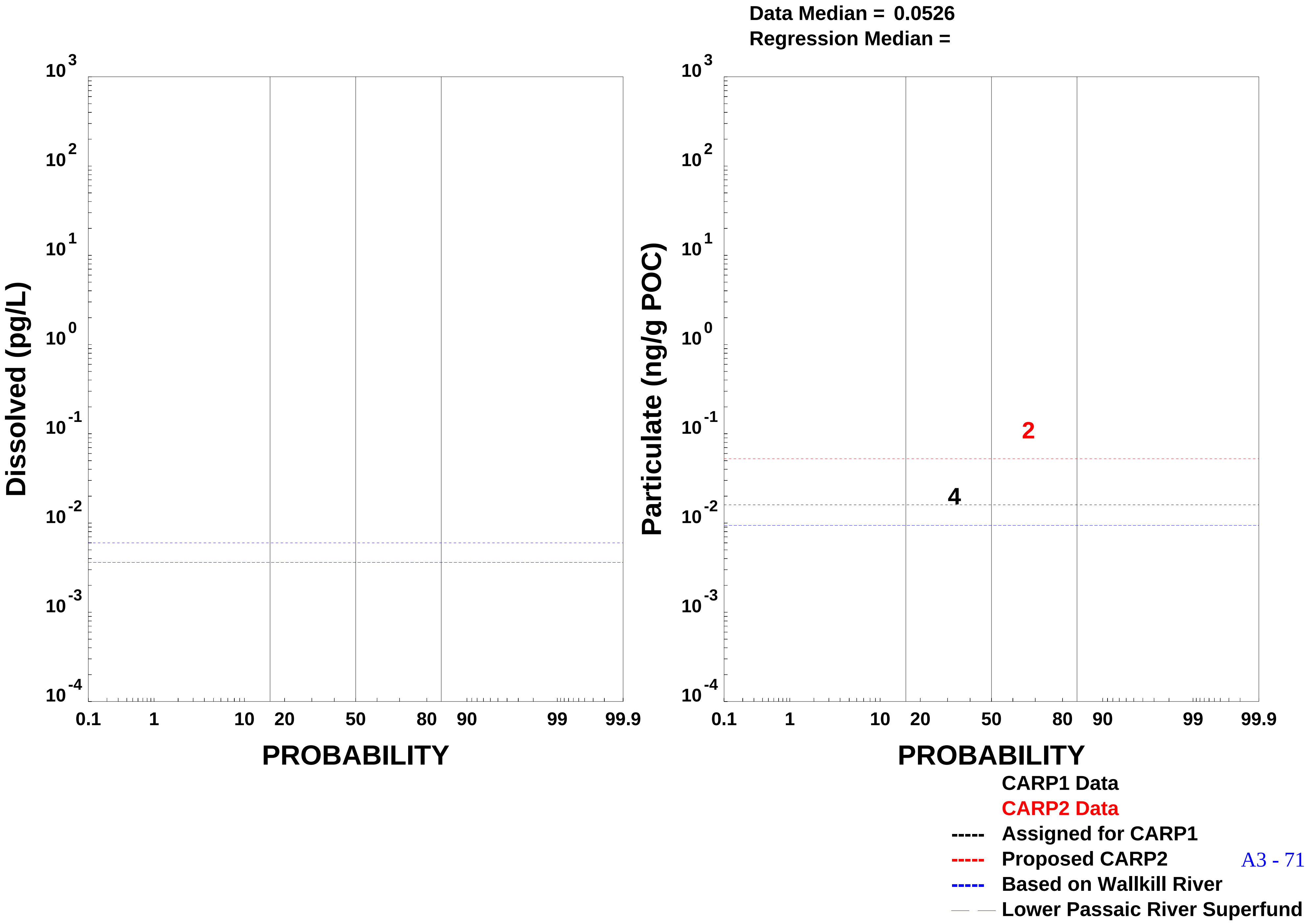




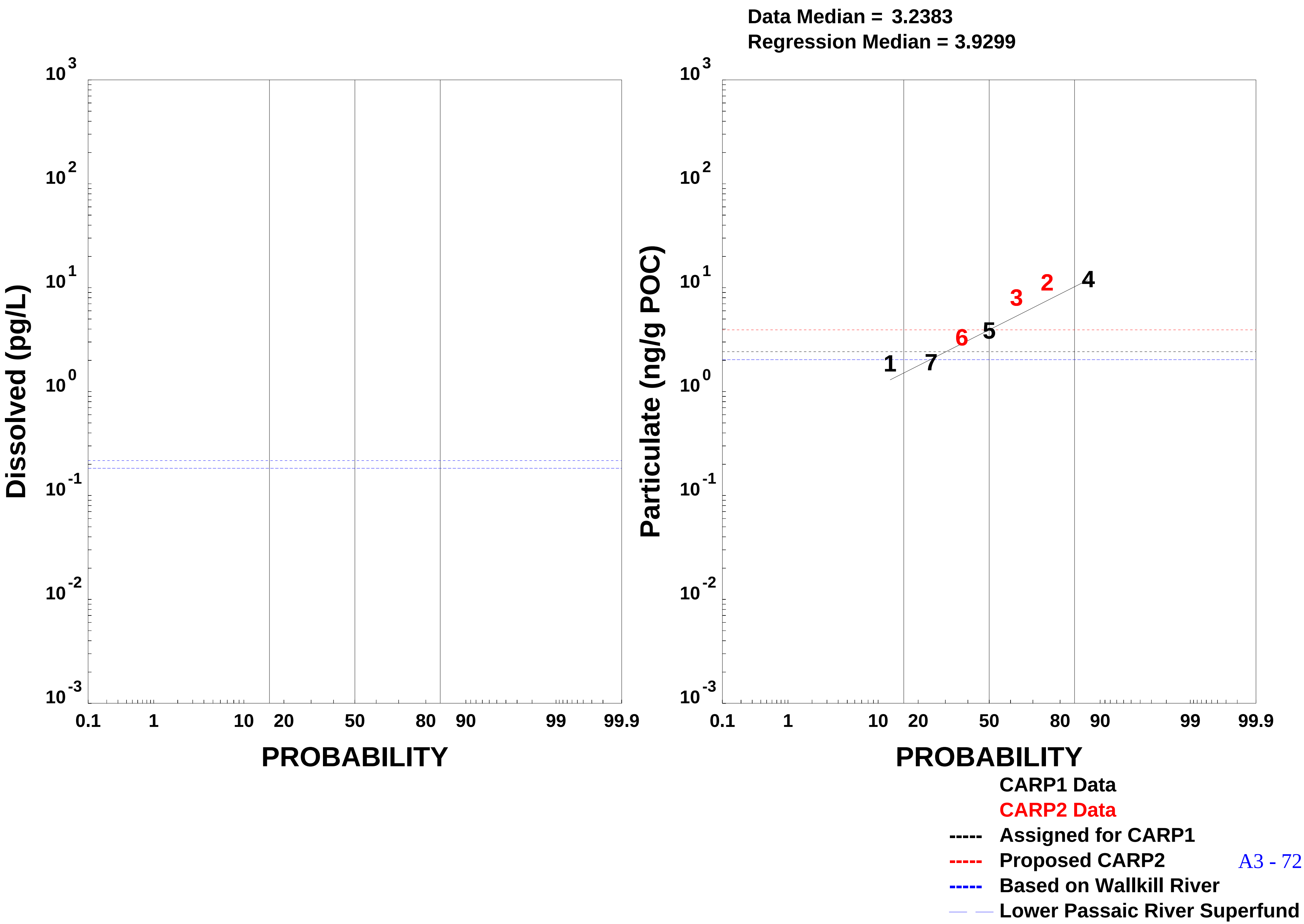


PASSAIC RIVER -- 1,2,3,6,7,8-HxCDF
Data Median = 0.3500
Regression Median = 0.3414
Dissolved (pg/L)
Particulate (ng/g POC)
PROBABILITY
PROBABILITY
CARP1 Data
CARP2 Data
----- Assigned for CARP1
----- Proposed CARP2
----- Based on Wallkill River
Lower Passaic River Superfund

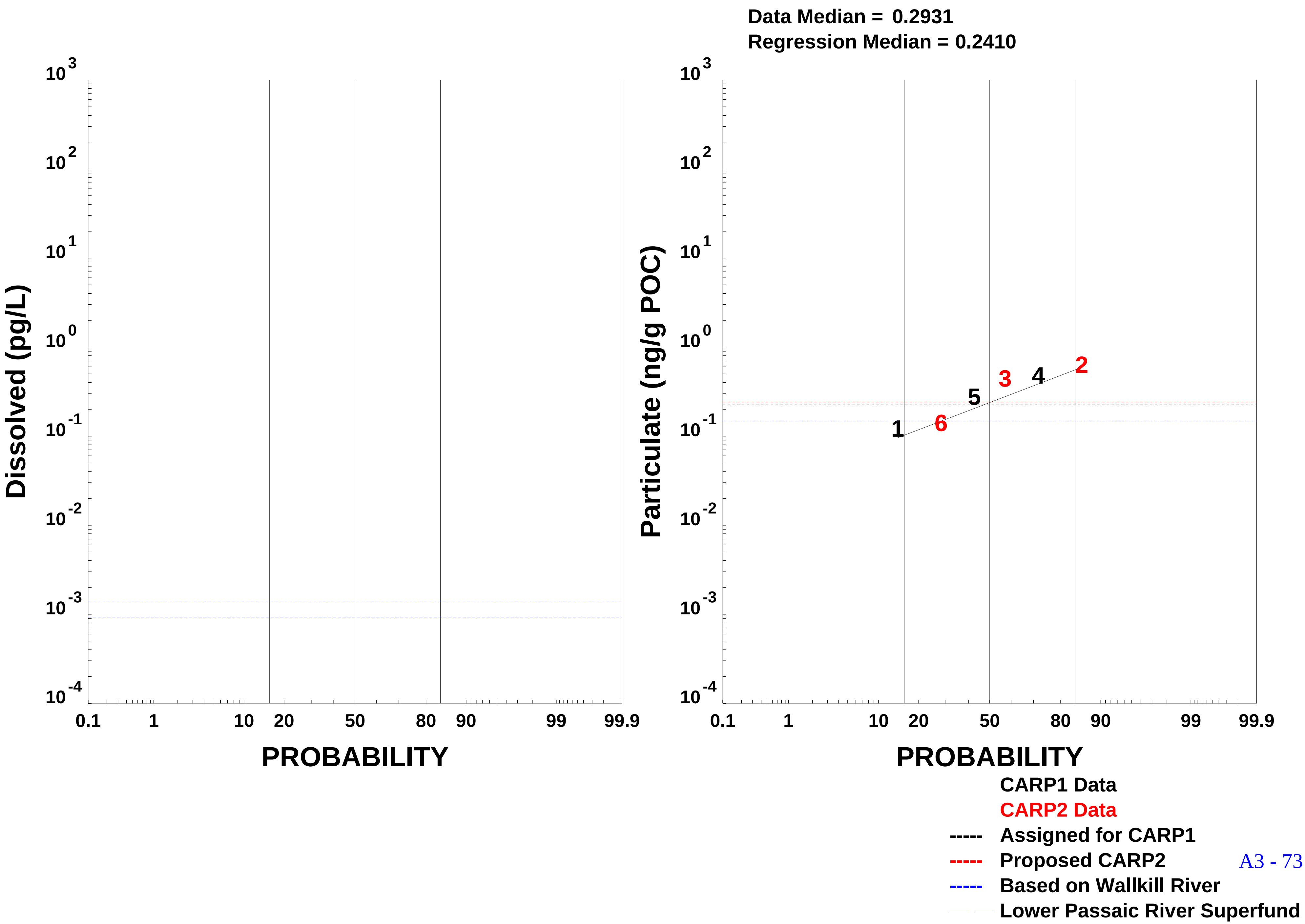
PASSAIC RIVER -- 1,2,3,7,8,9-HxCDF



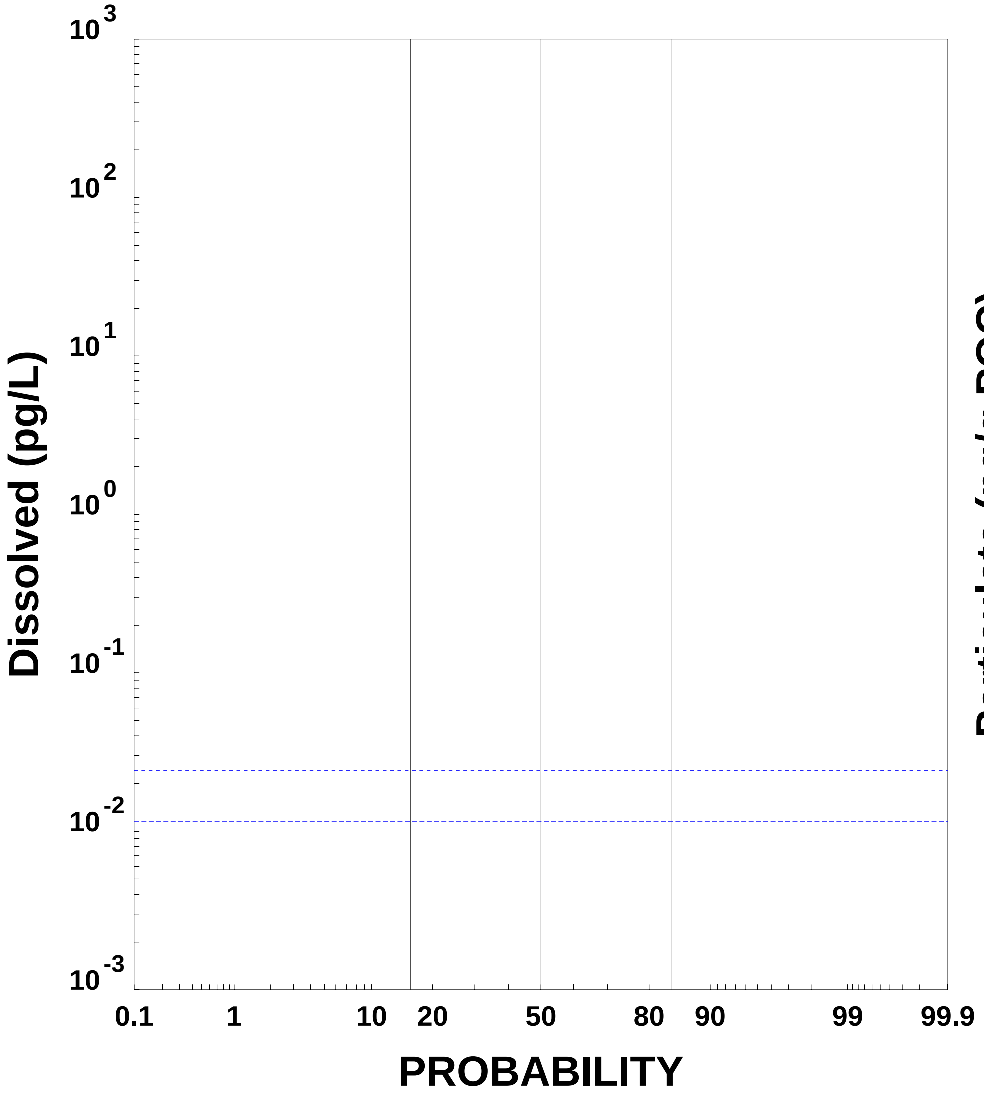
PASSAIC RIVER -- 1,2,3,4,6,7,8-HpCDF



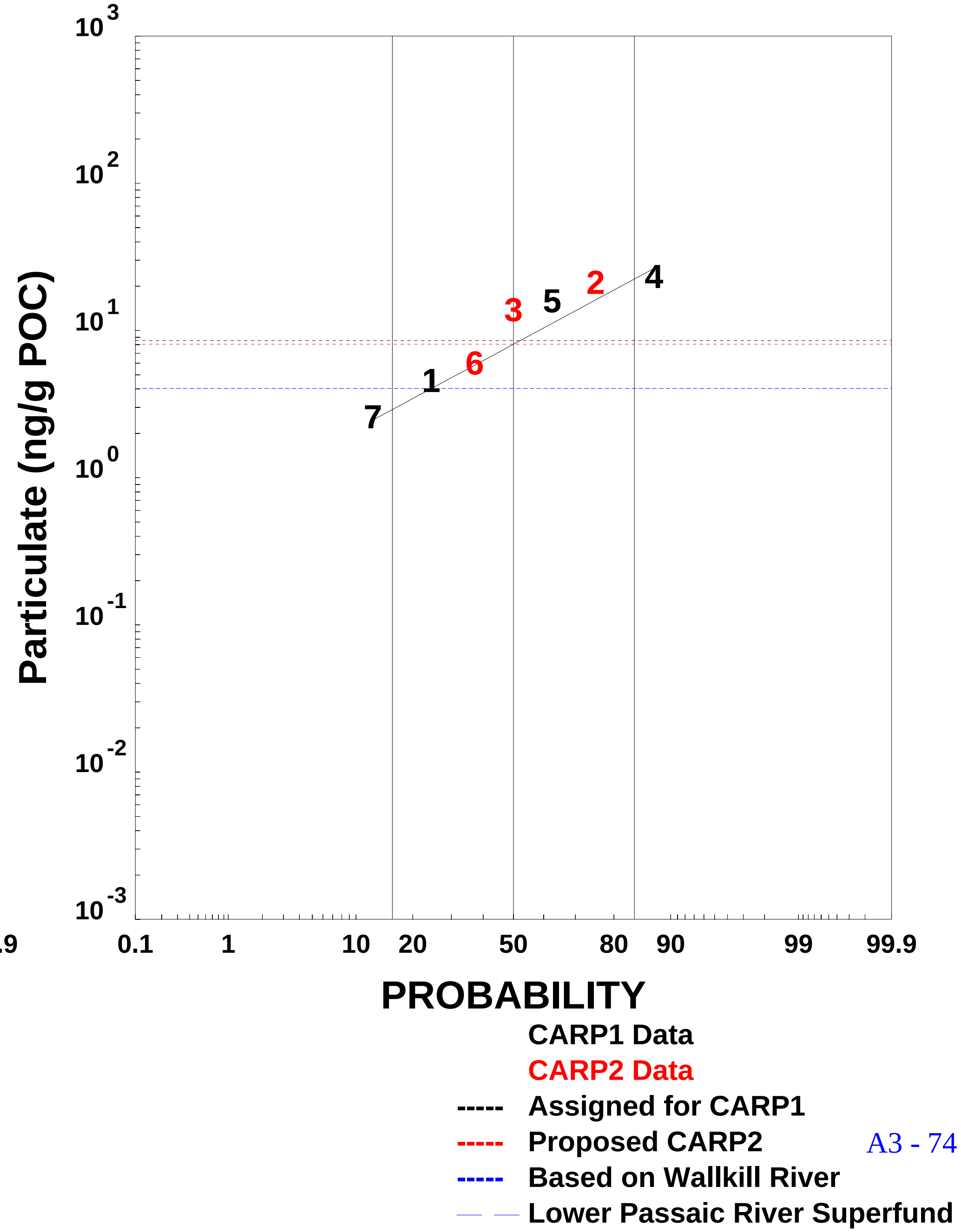
PASSAIC RIVER -- 1,2,3,4,7,8,9-HpCDF



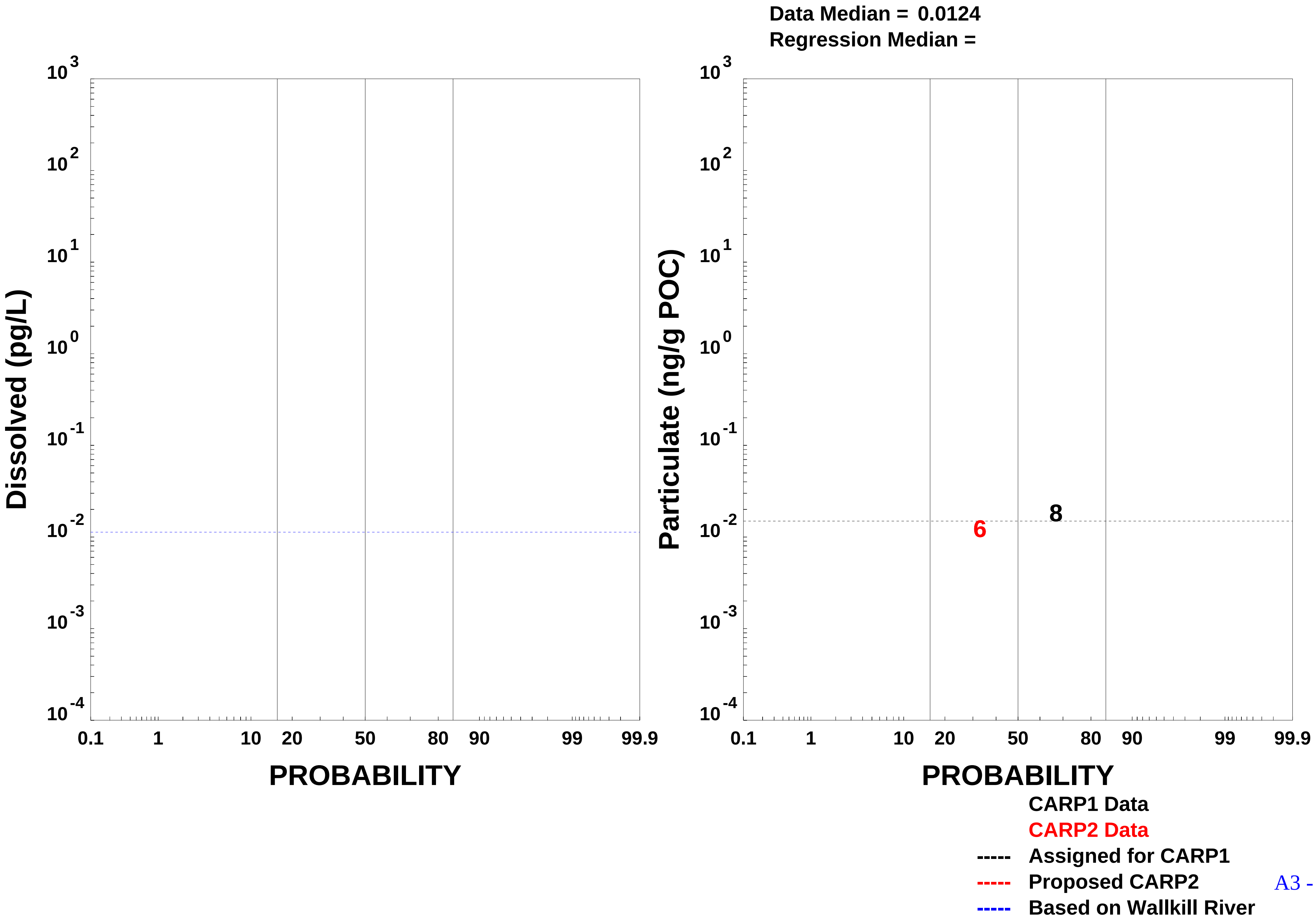
PASSAIC RIVER -- OCDF



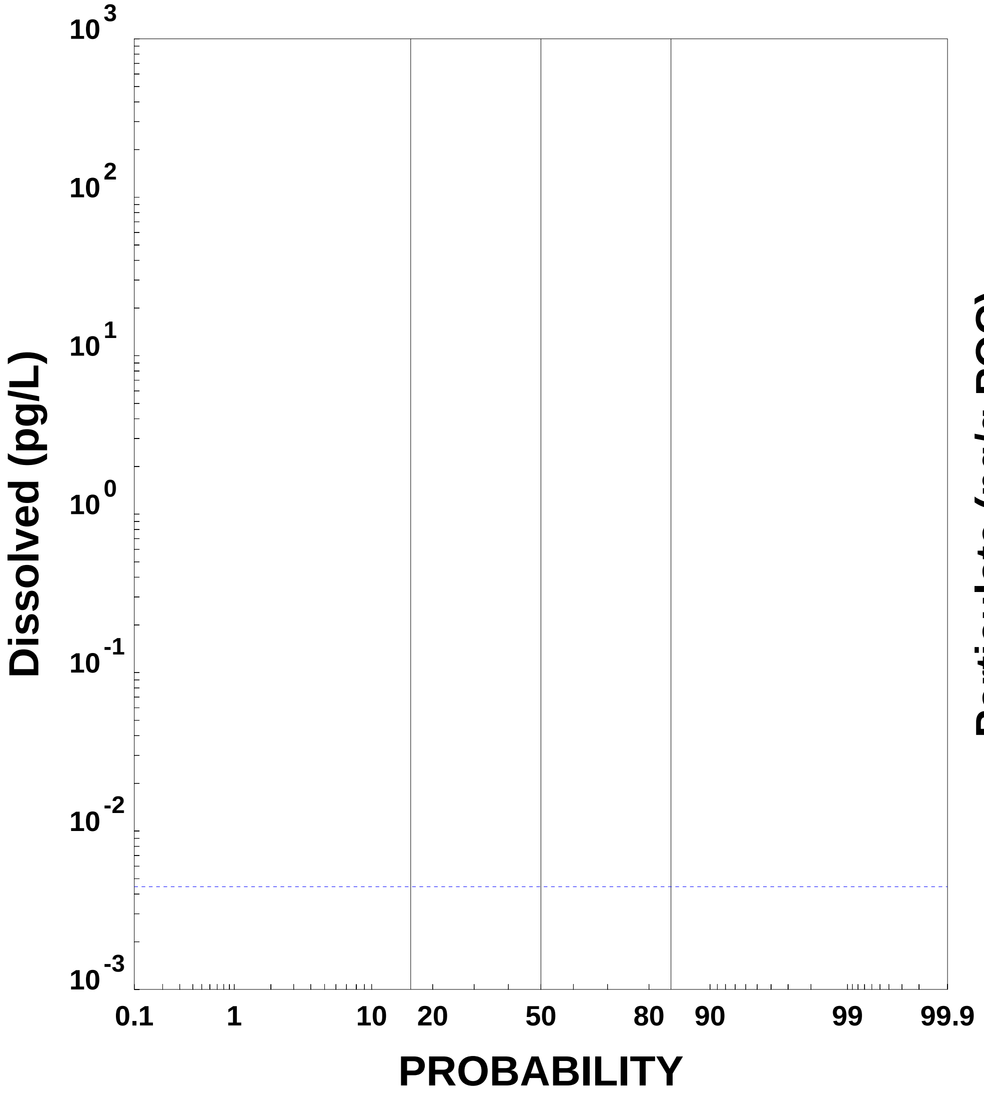
Data Median = 11.5778
Regression Median = 8.0631

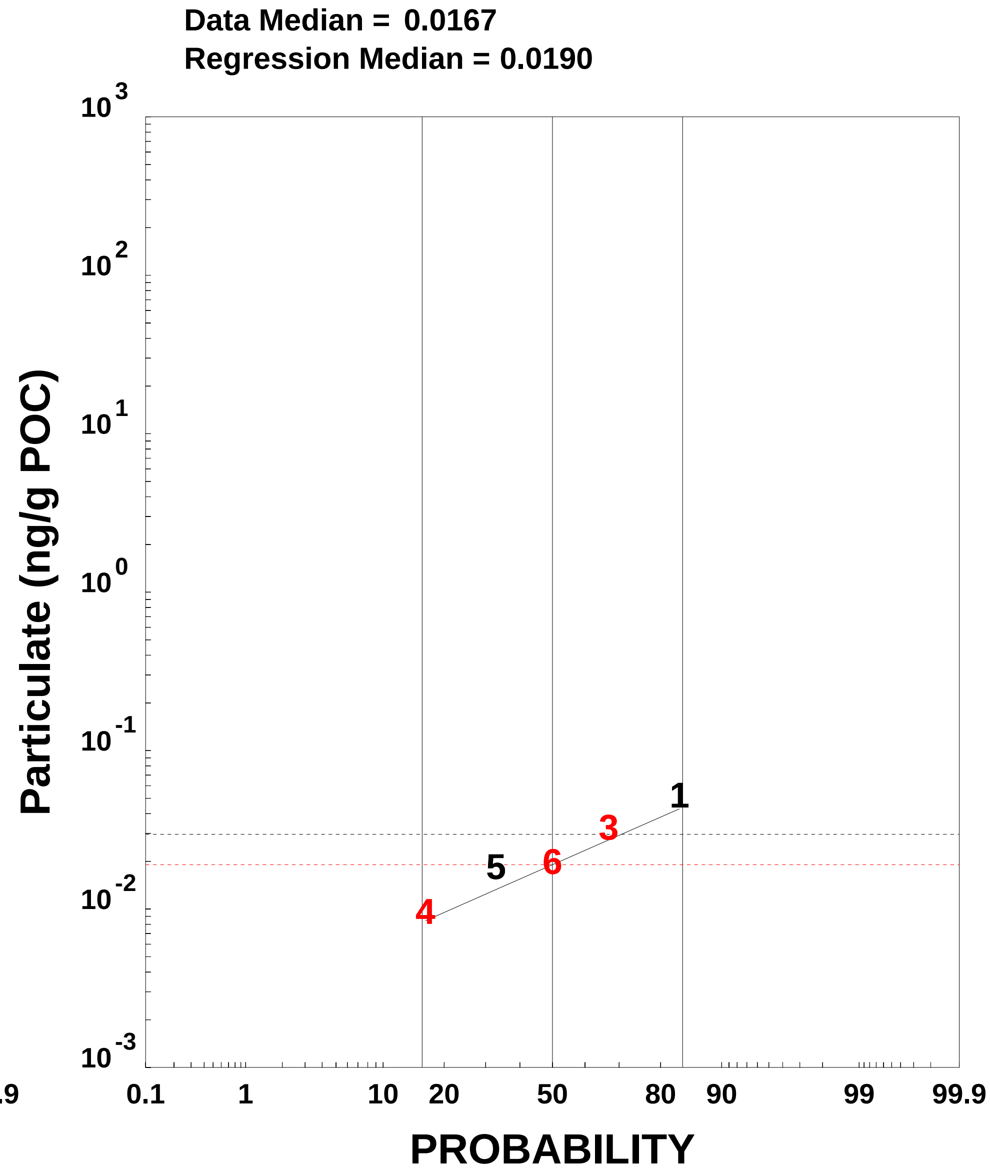


RARITAN RIVER NEAR SOUTH BOUND BROOK -- 2,3,7,8-TCDD

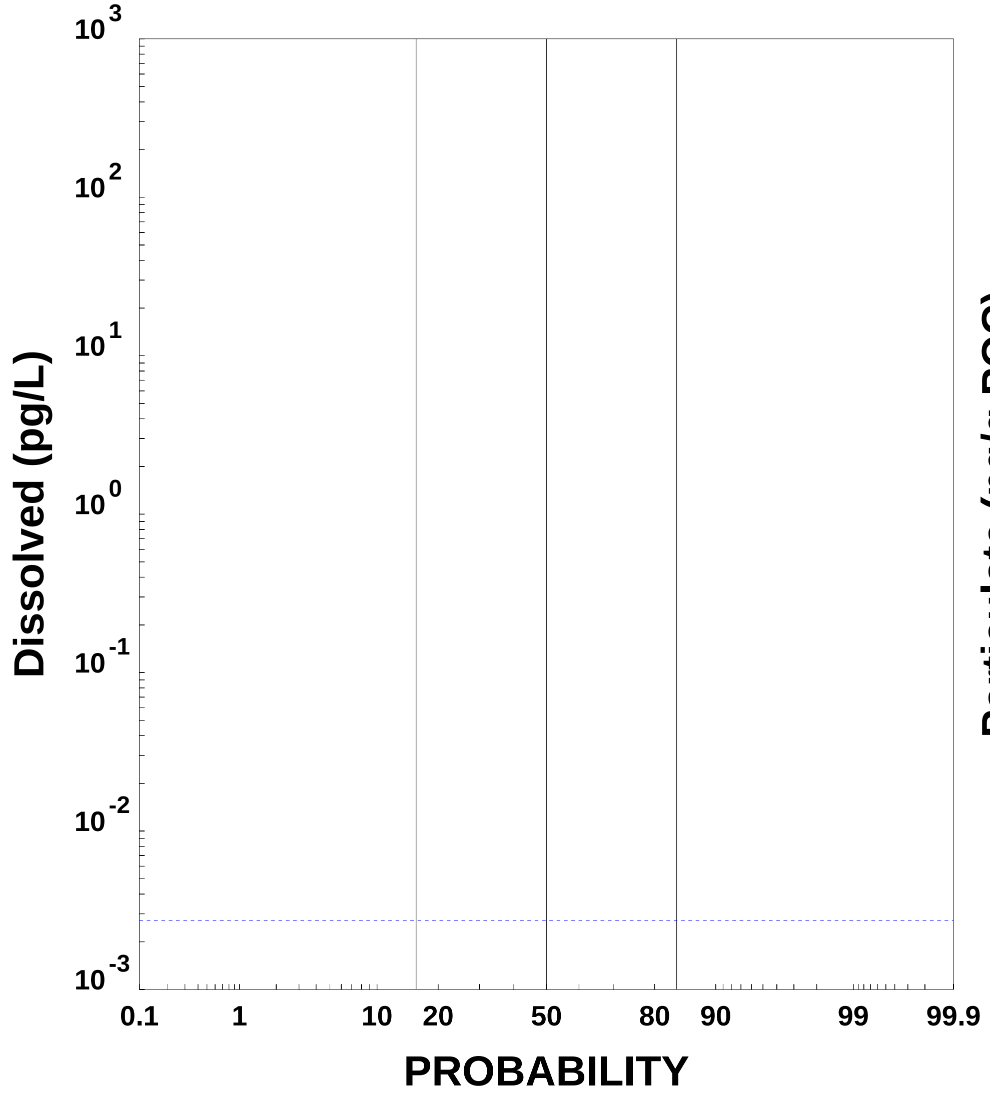


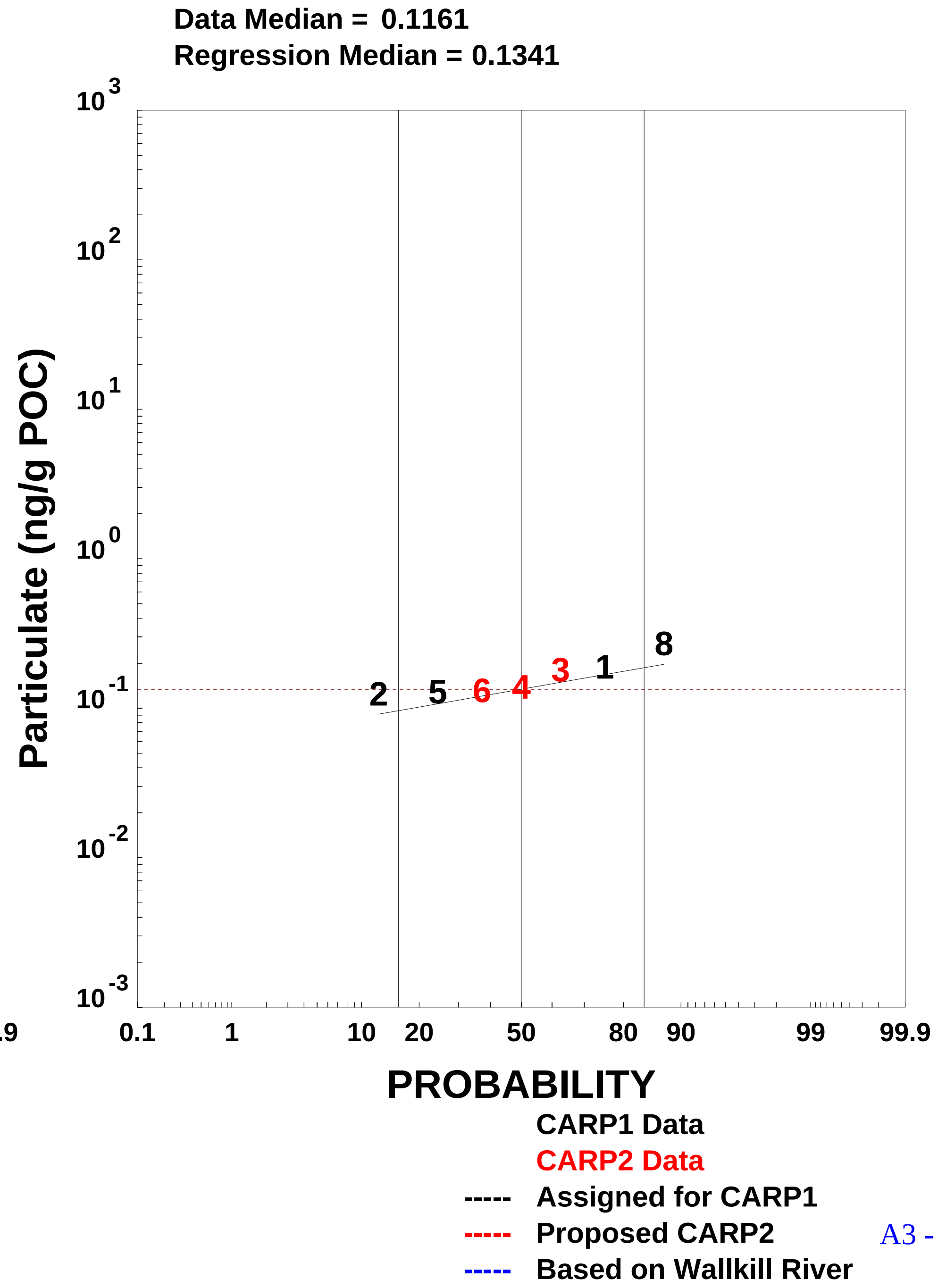
RARITAN RIVER NEAR SOUTH BOUND BROOK -- 1,2,3,7,8-PeCDD



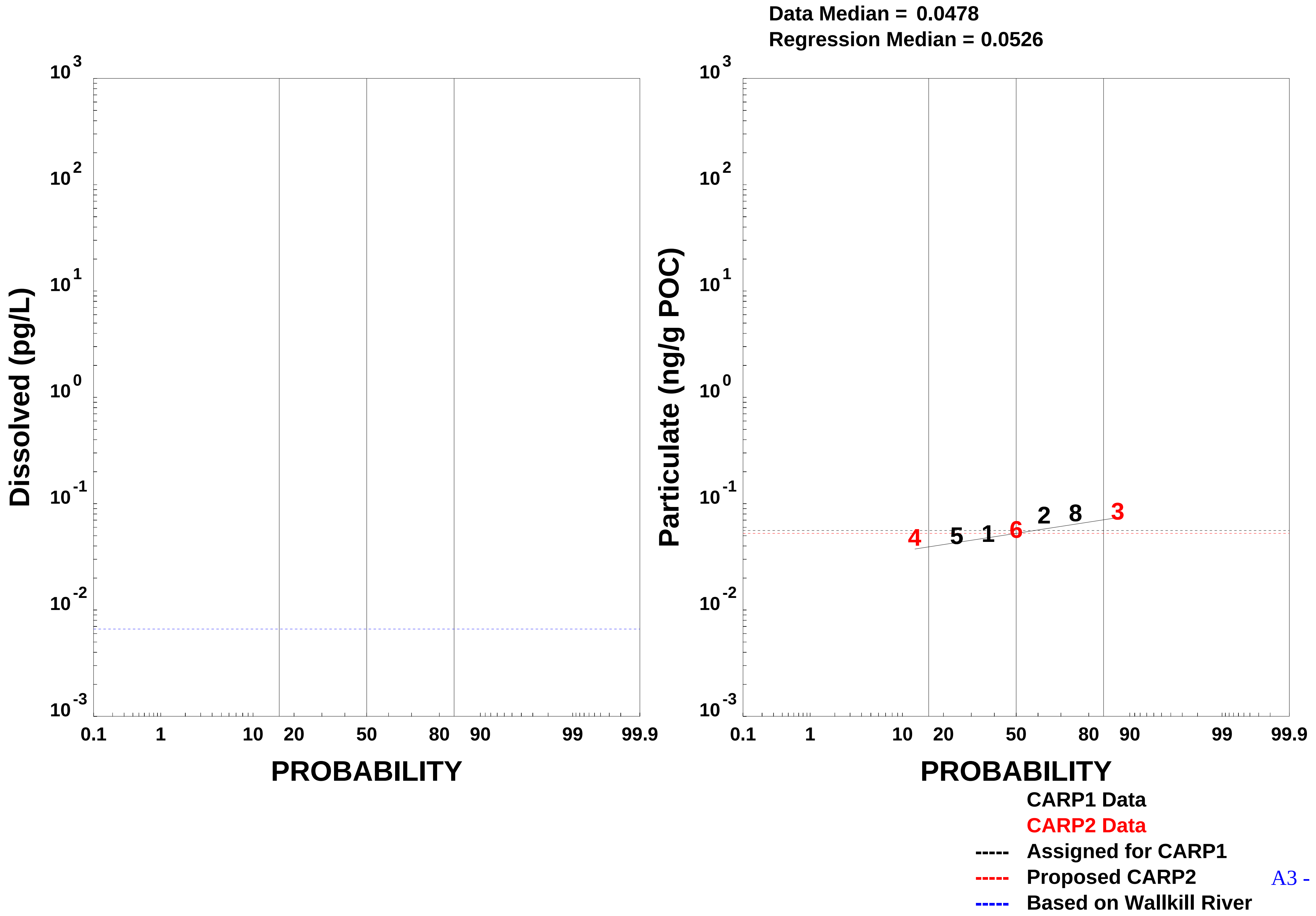


RARITAN RIVER NEAR SOUTH BOUND BROOK -- 1,2,3,7,8,9-HxCDD

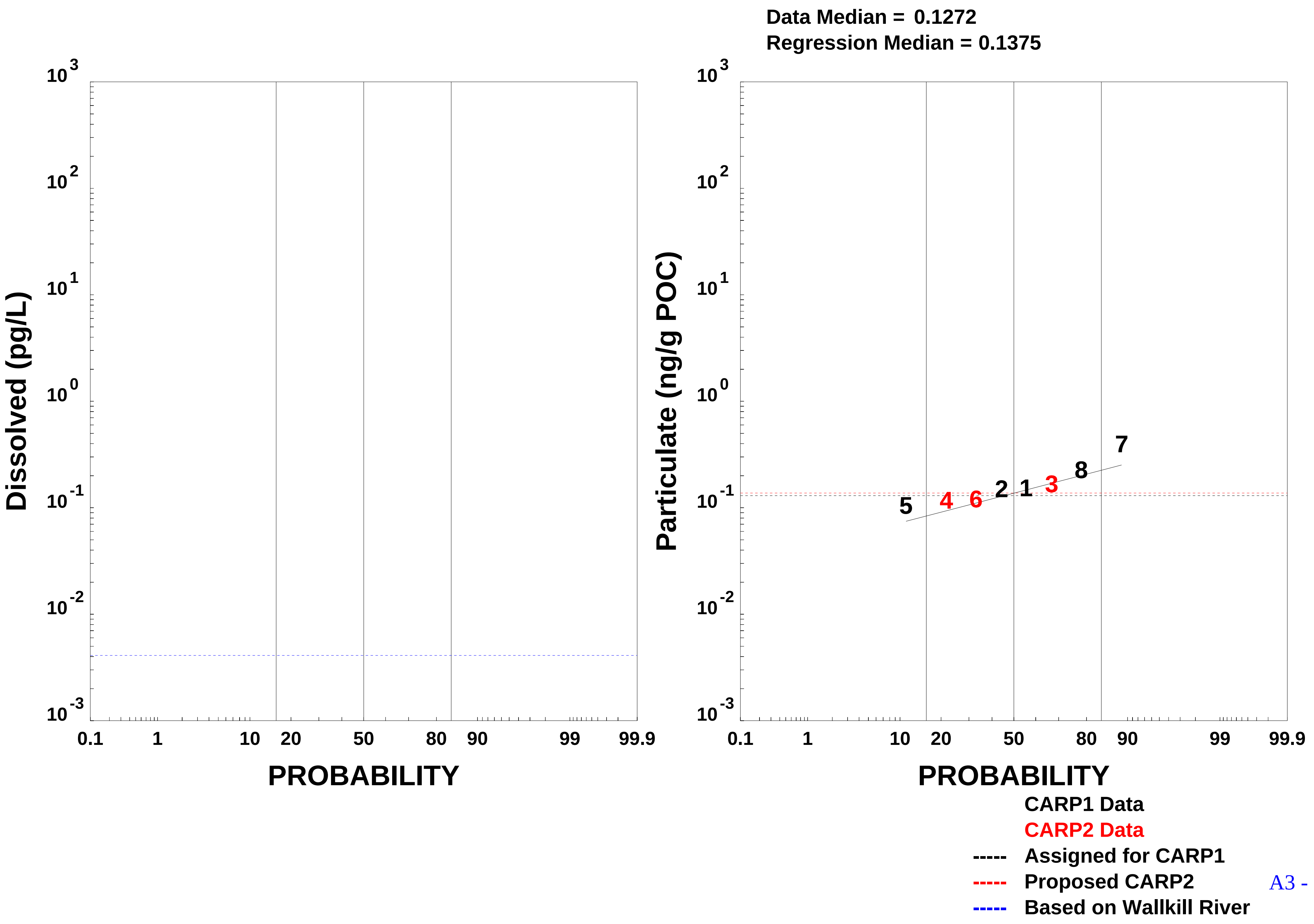




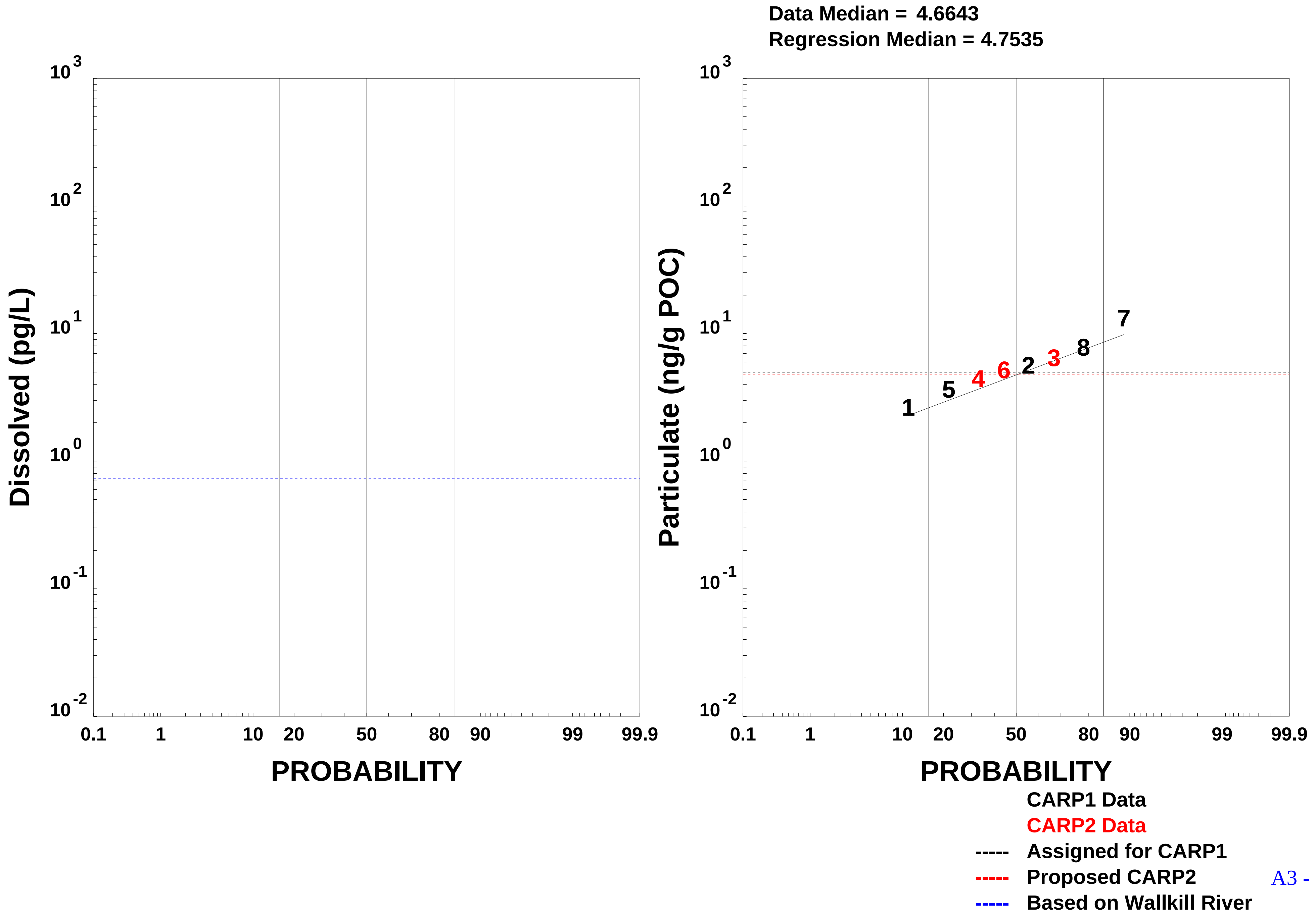
RARITAN RIVER NEAR SOUTH BOUND BROOK -- 1,2,3,4,7,8-HxCDD



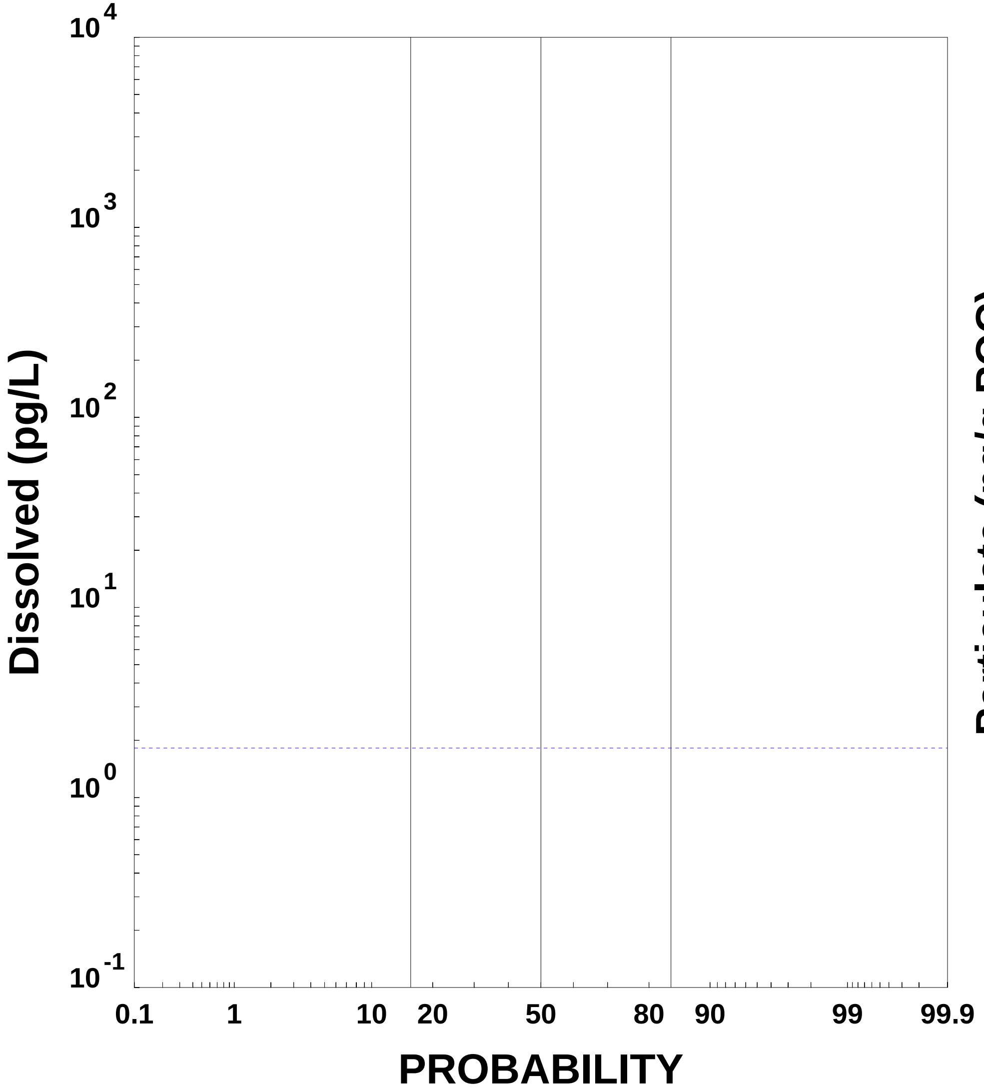
RARITAN RIVER NEAR SOUTH BOUND BROOK -- 1,2,3,6,7,8-HxCDD

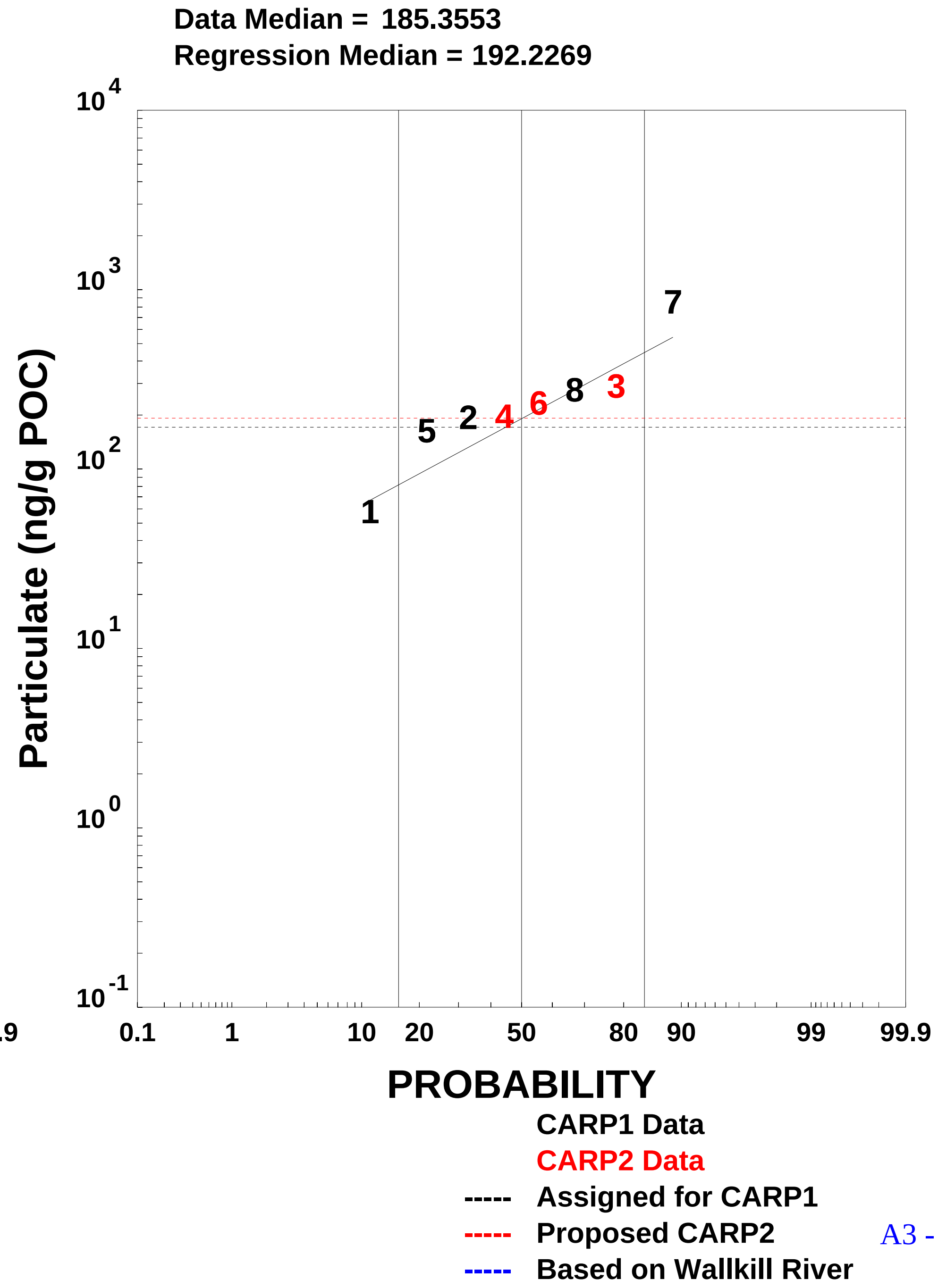


RARITAN RIVER NEAR SOUTH BOUND BROOK -- 1,2,3,4,6,7,8-HpCDD

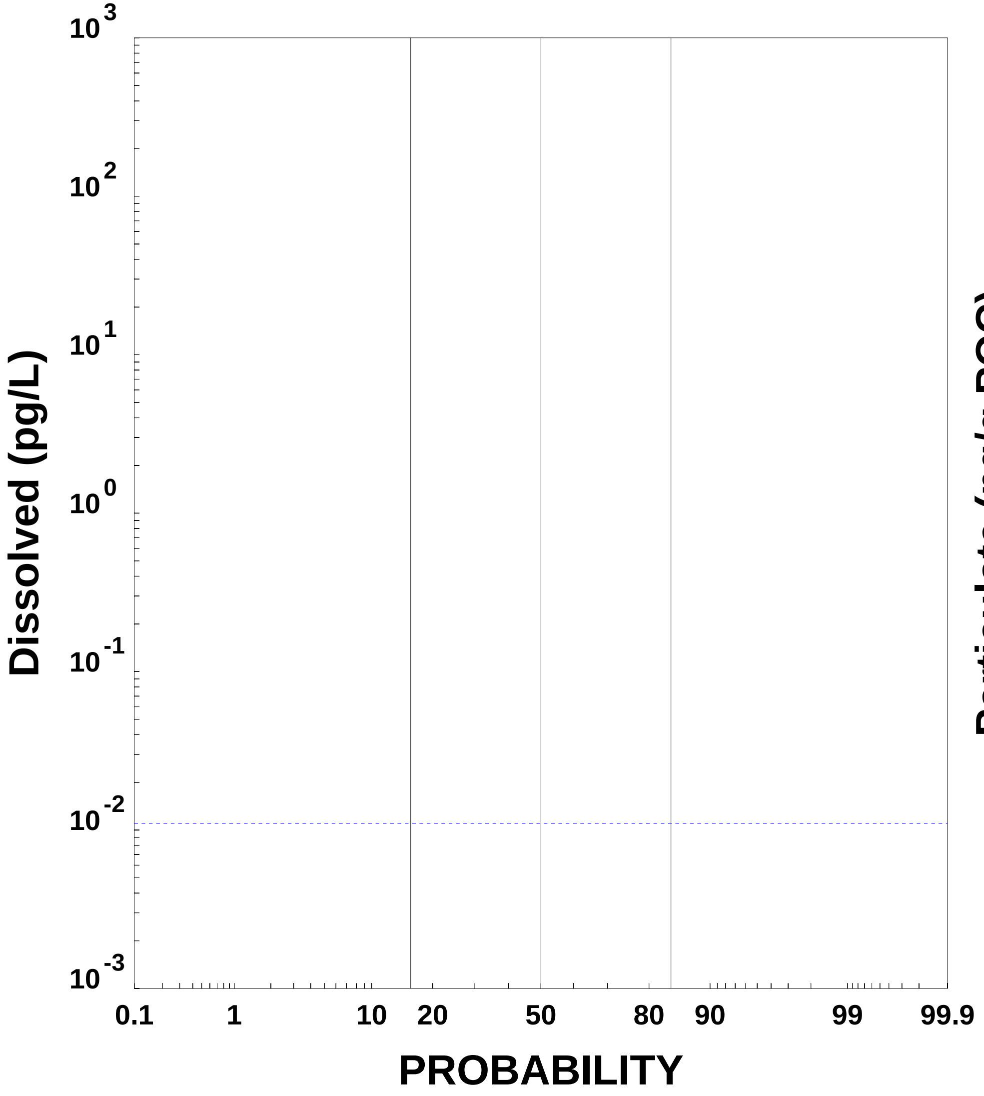


RARITAN RIVER NEAR SOUTH BOUND BROOK -- OCDD

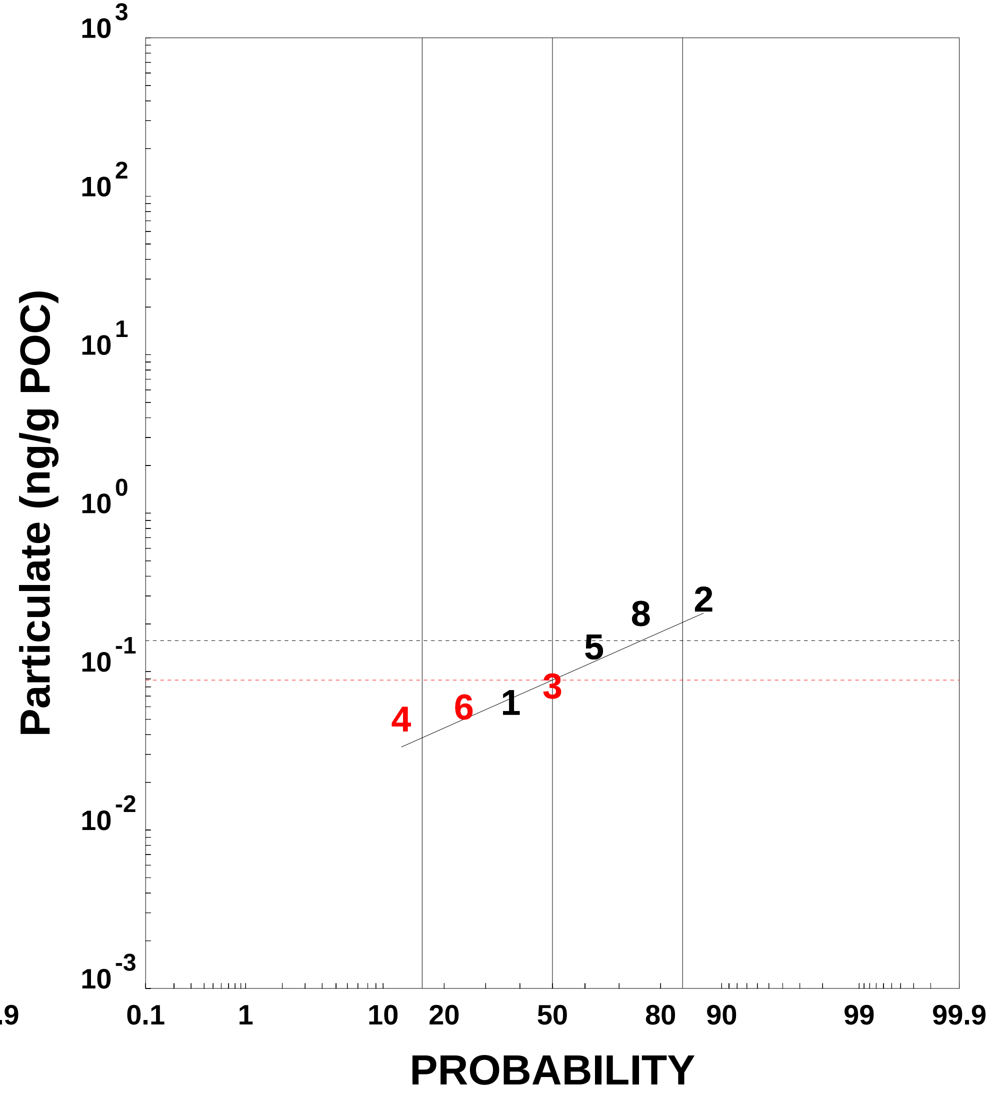




RARITAN RIVER NEAR SOUTH BOUND BROOK -- 2,3,7,8-TCDF

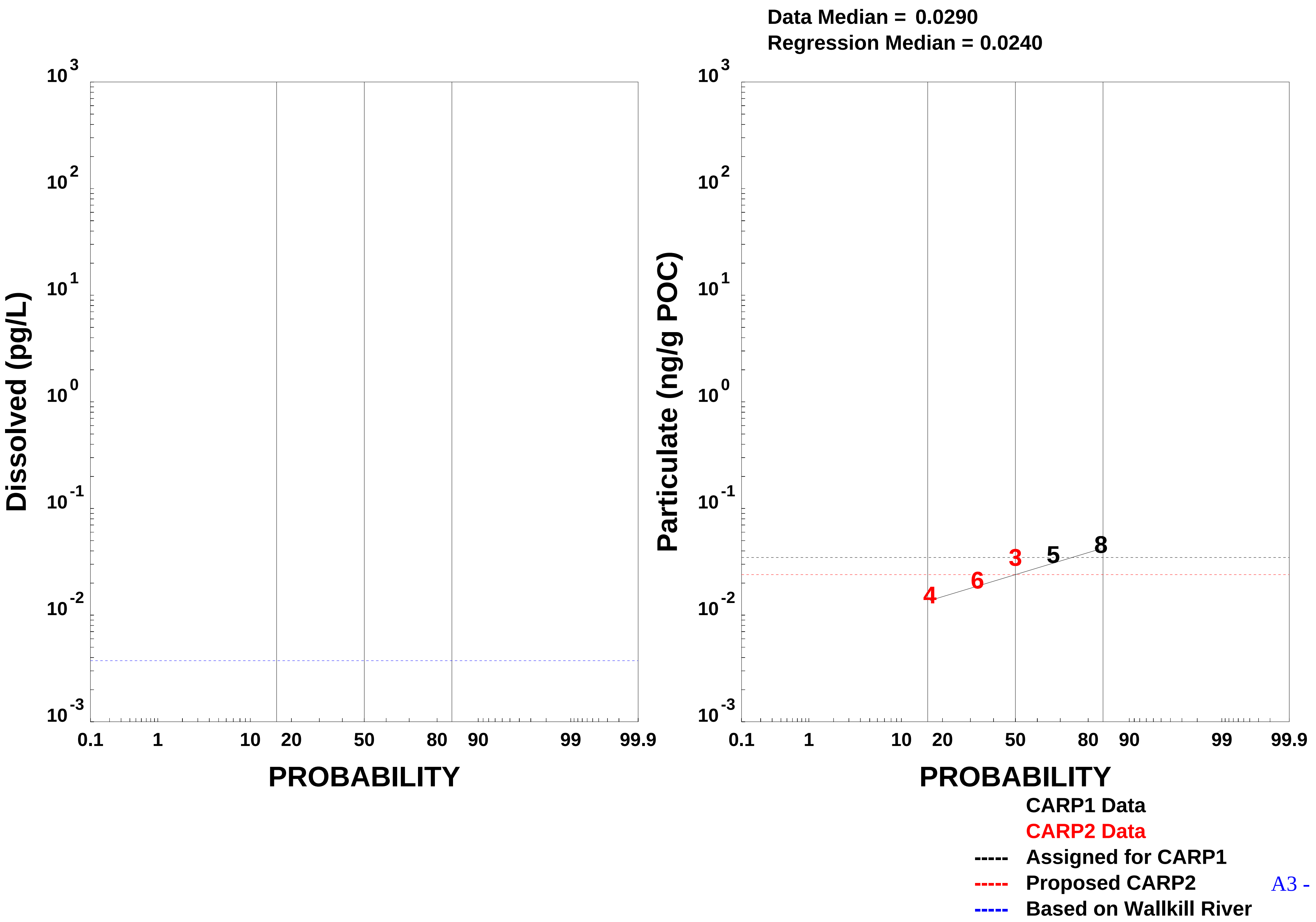


Data Median = 0.0677
Regression Median = 0.0884

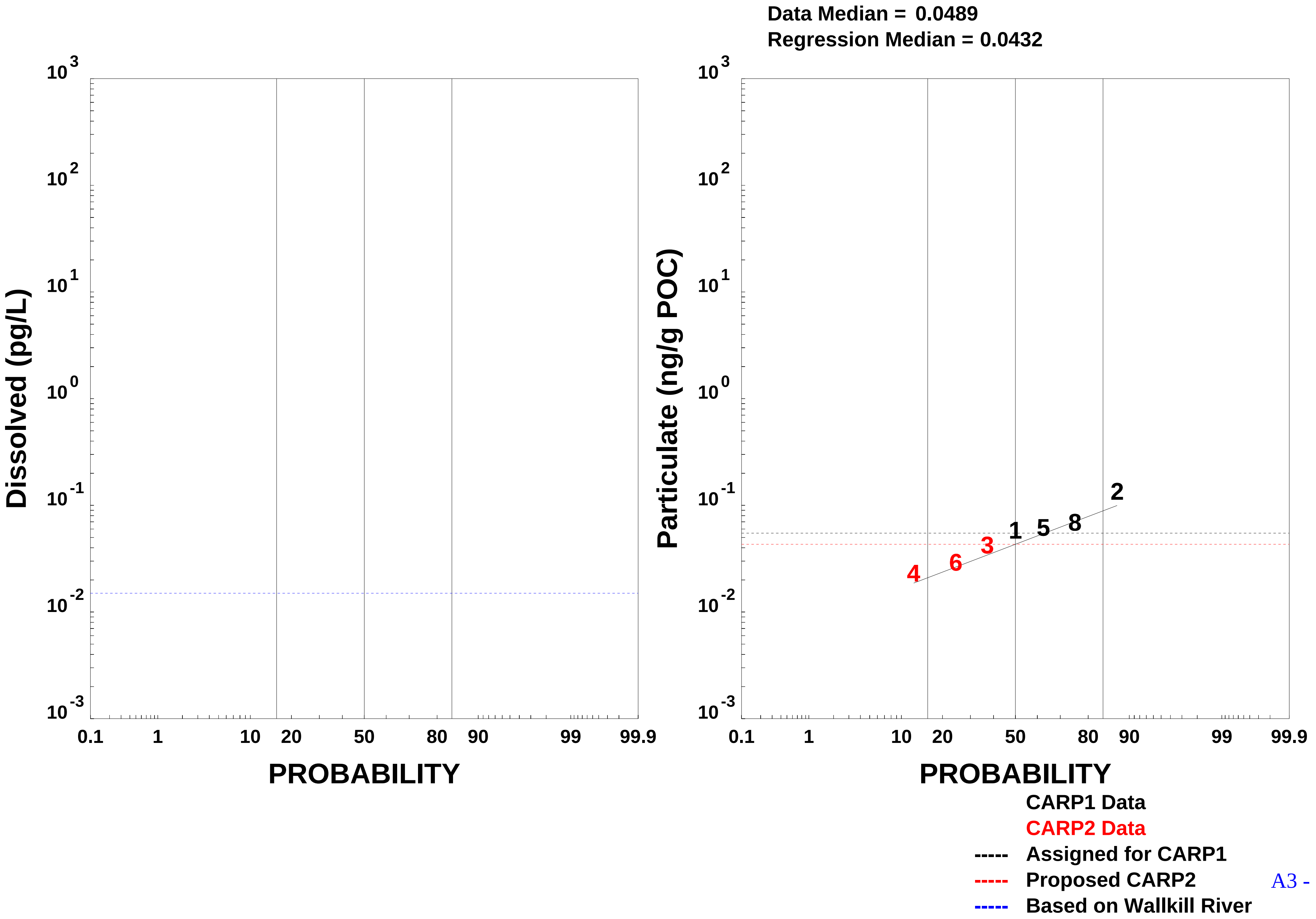


CARP1 Data
CARP2 Data
----- Assigned for CARP1
----- Proposed CARP2
----- Based on Wallkill River

RARITAN RIVER NEAR SOUTH BOUND BROOK -- 1,2,3,7,8-PeCDF

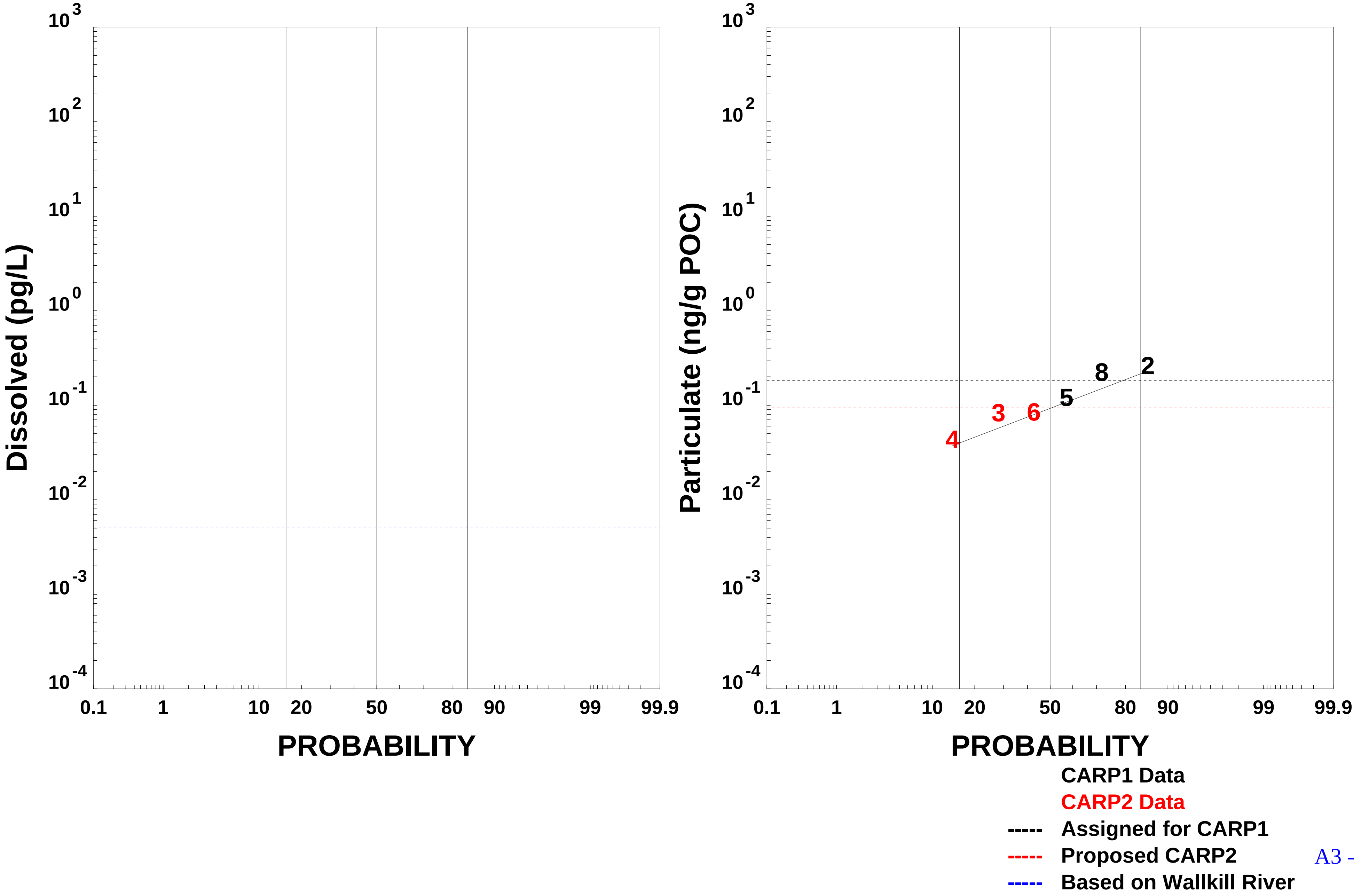


RARITAN RIVER NEAR SOUTH BOUND BROOK -- 2,3,4,7,8-PeCDF

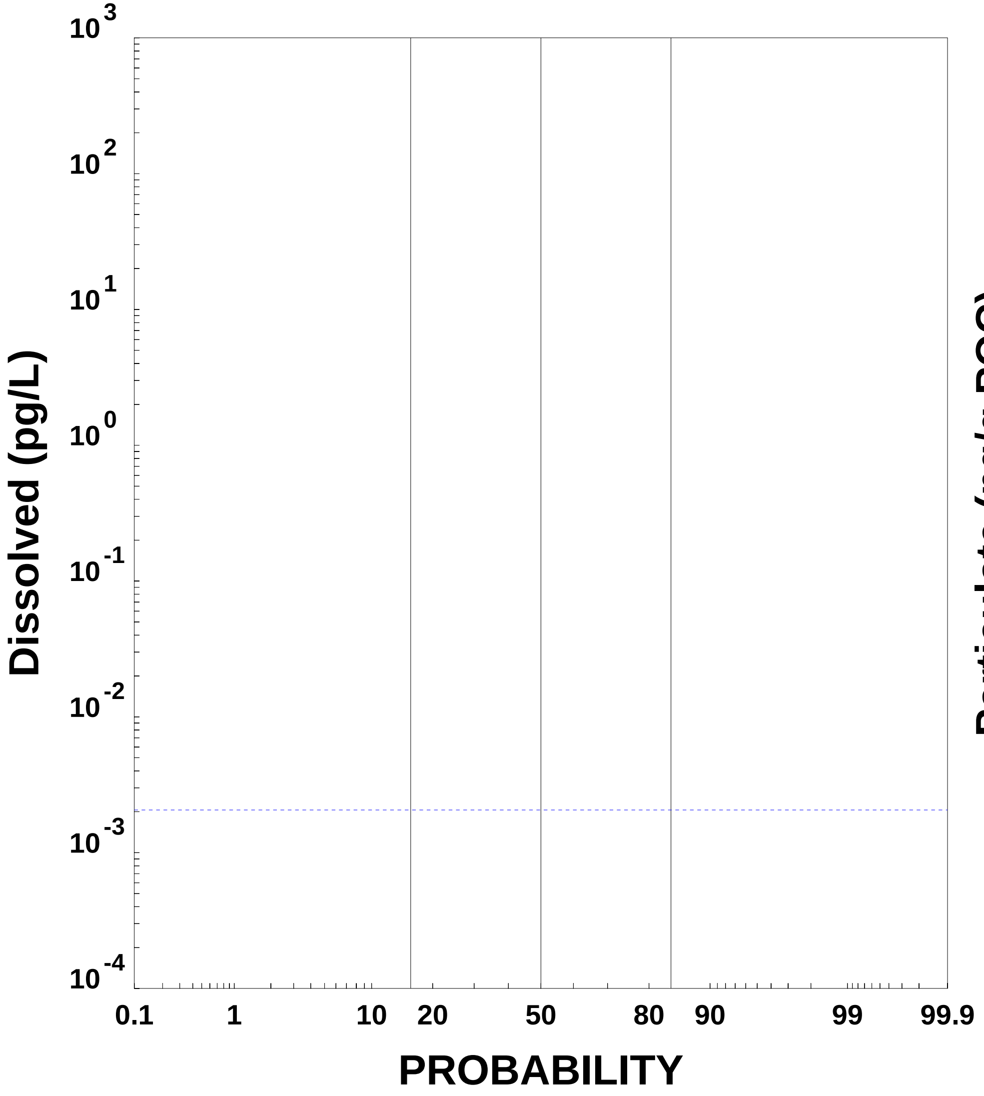


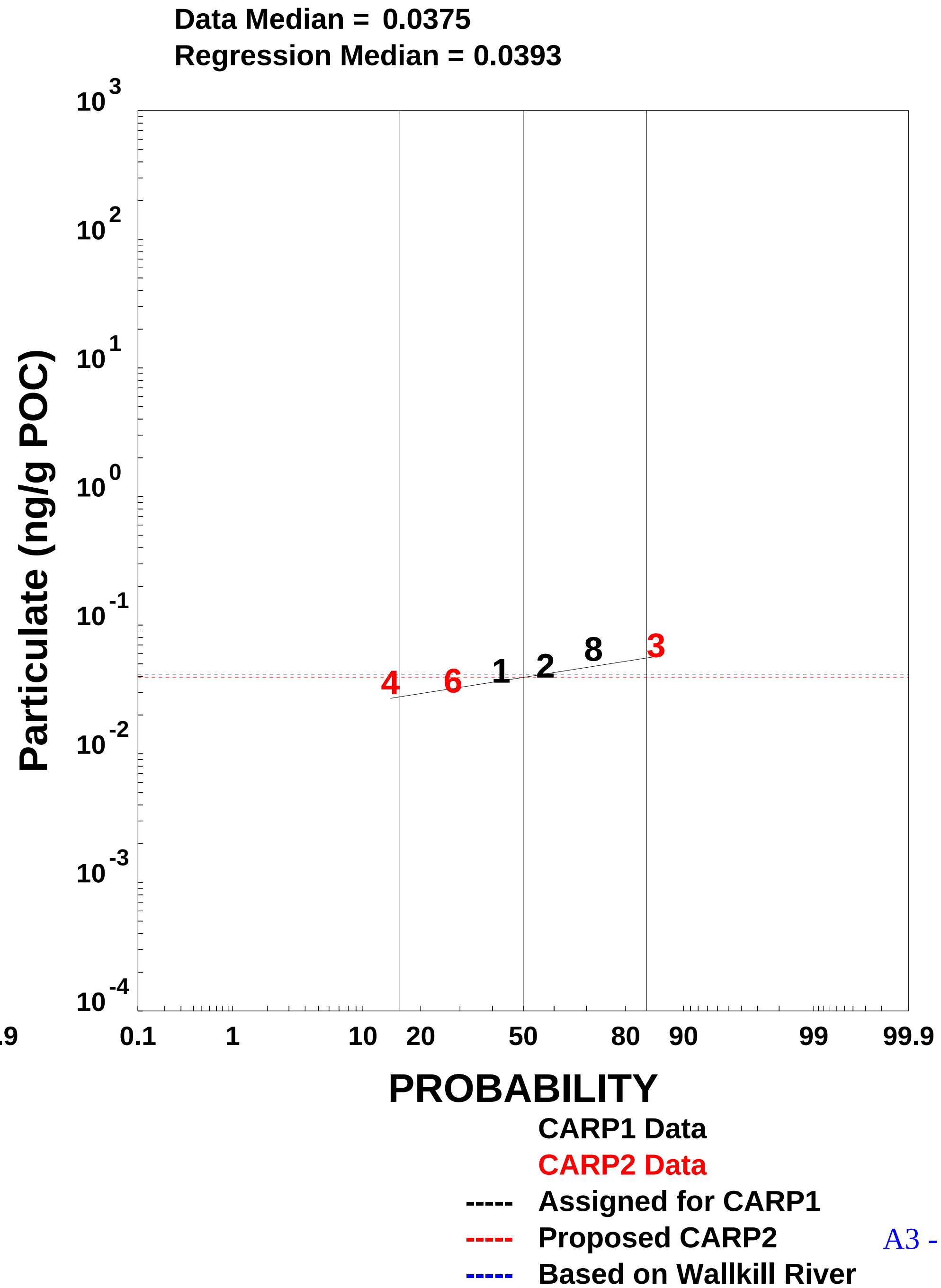
RARITAN RIVER NEAR SOUTH BOUND BROOK -- 1,2,3,4,7,8-HxCDF

Data Median = 0.0836
Regression Median = 0.0937

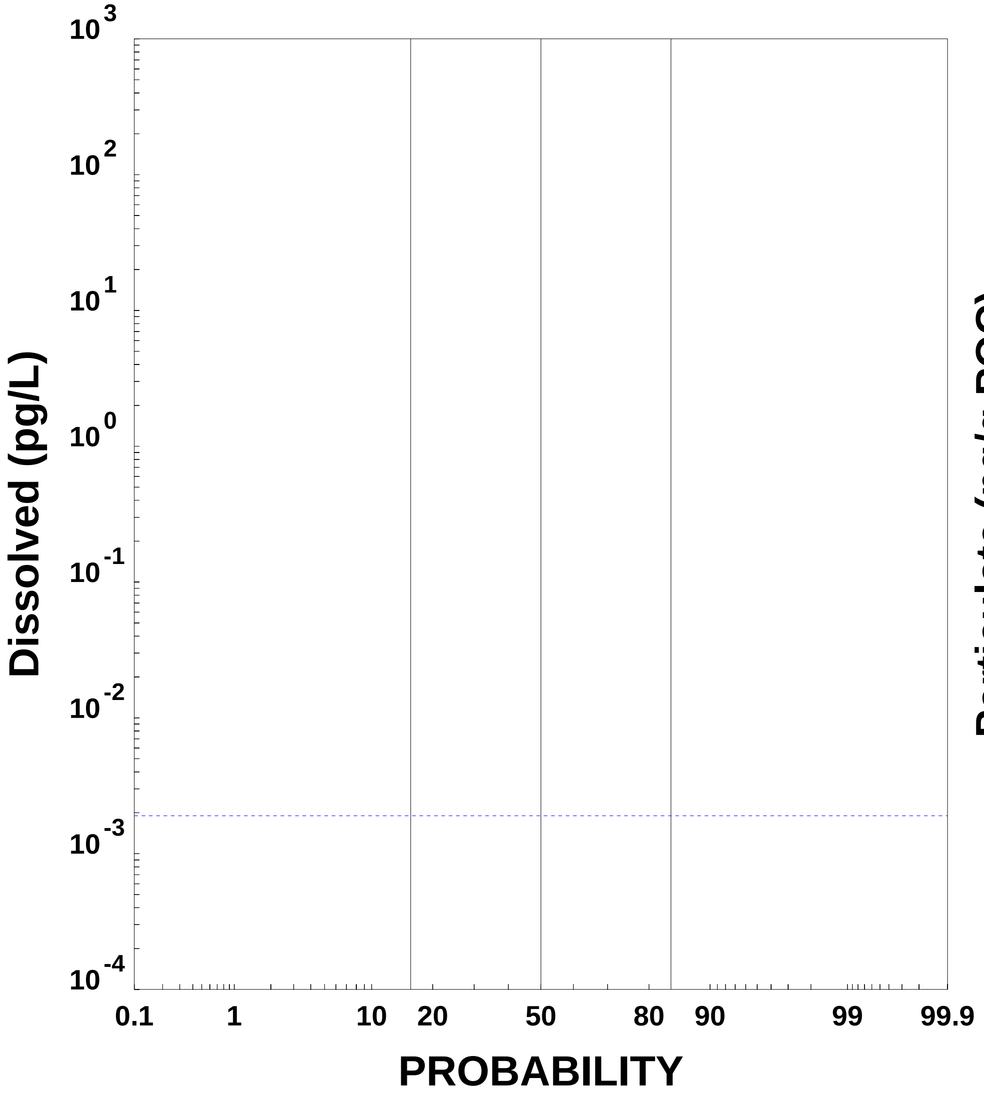


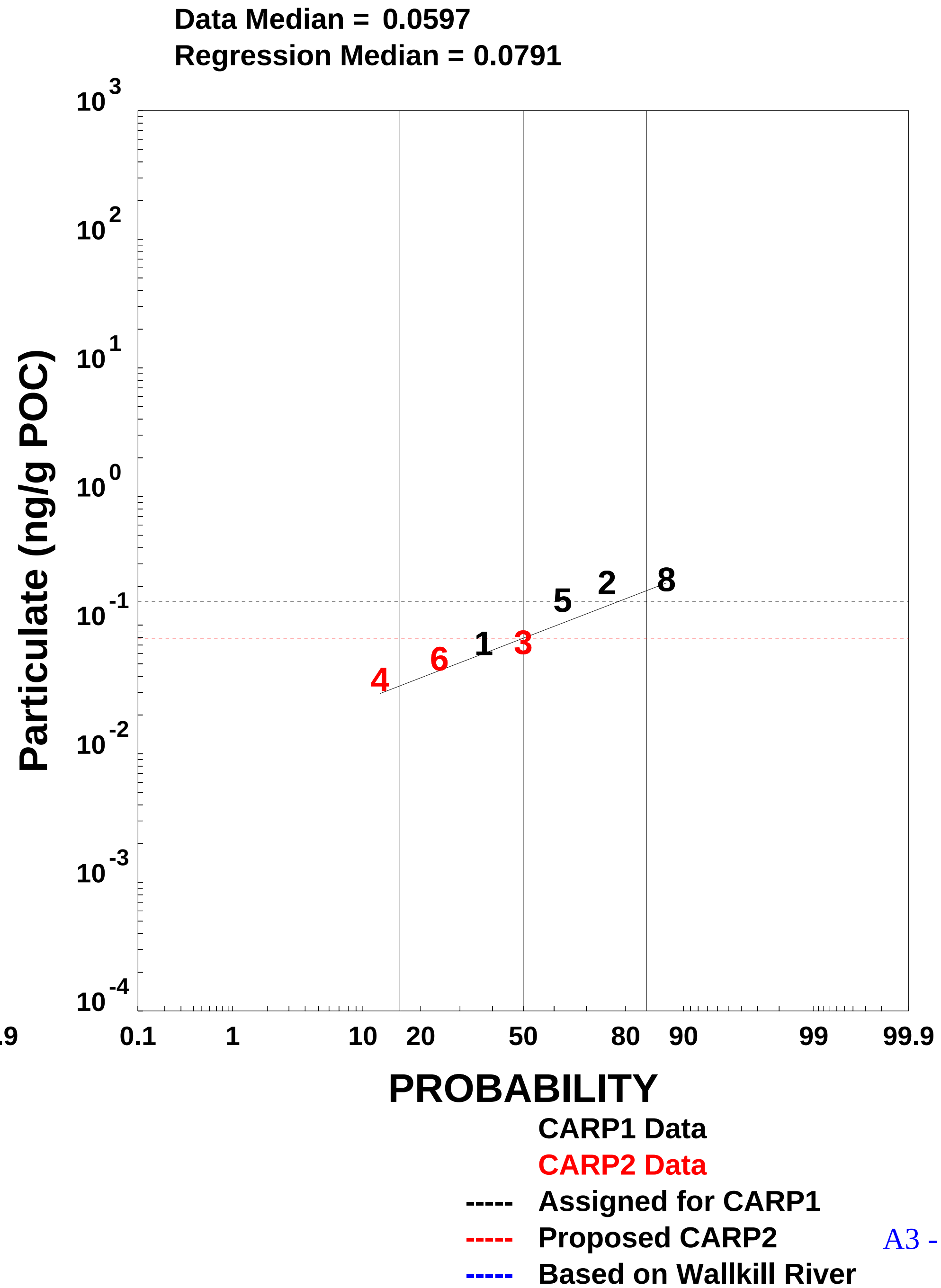
RARITAN RIVER NEAR SOUTH BOUND BROOK -- 2,3,4,6,7,8-HxCDF



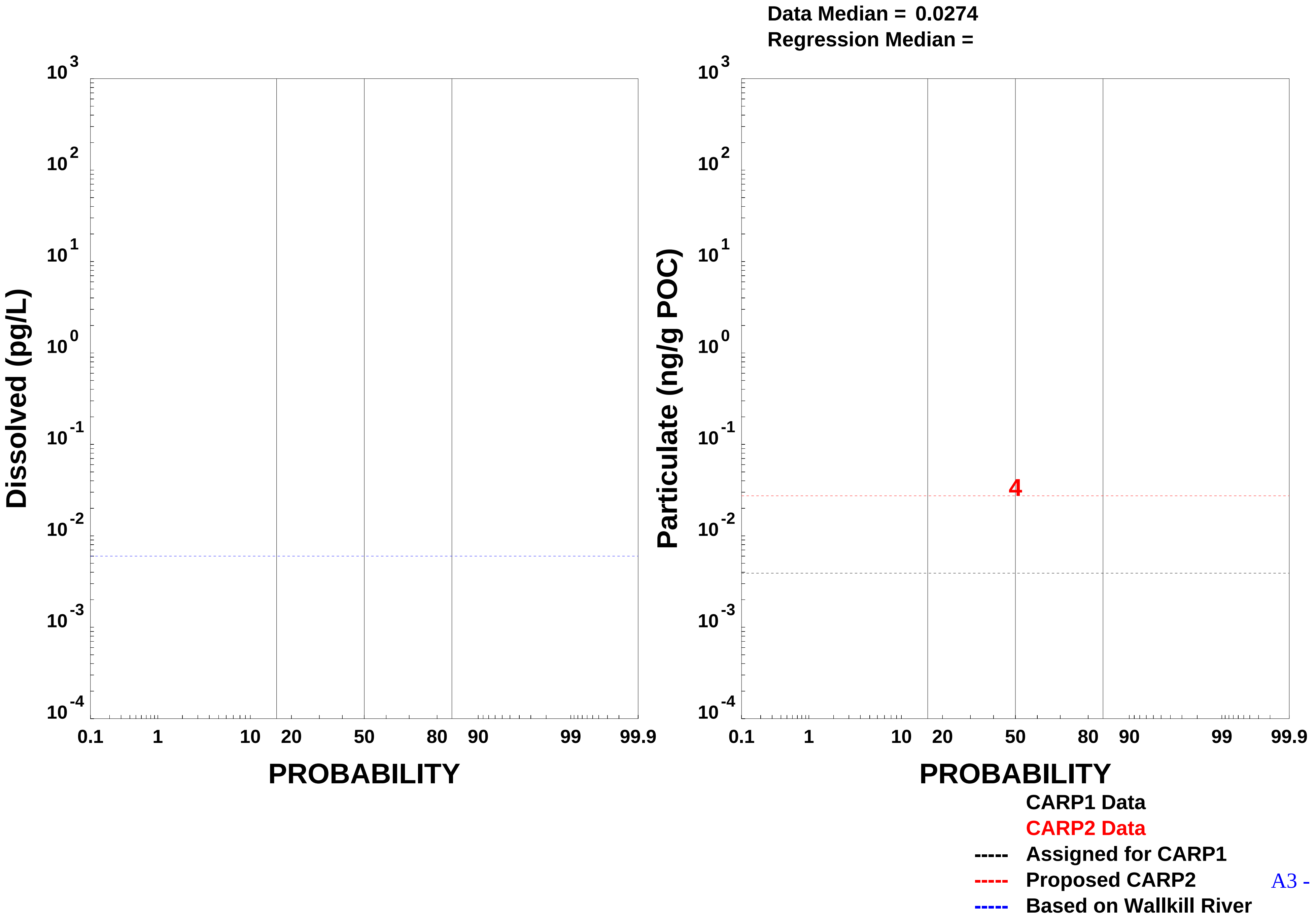


RARITAN RIVER NEAR SOUTH BOUND BROOK -- 1,2,3,6,7,8-HxCDF

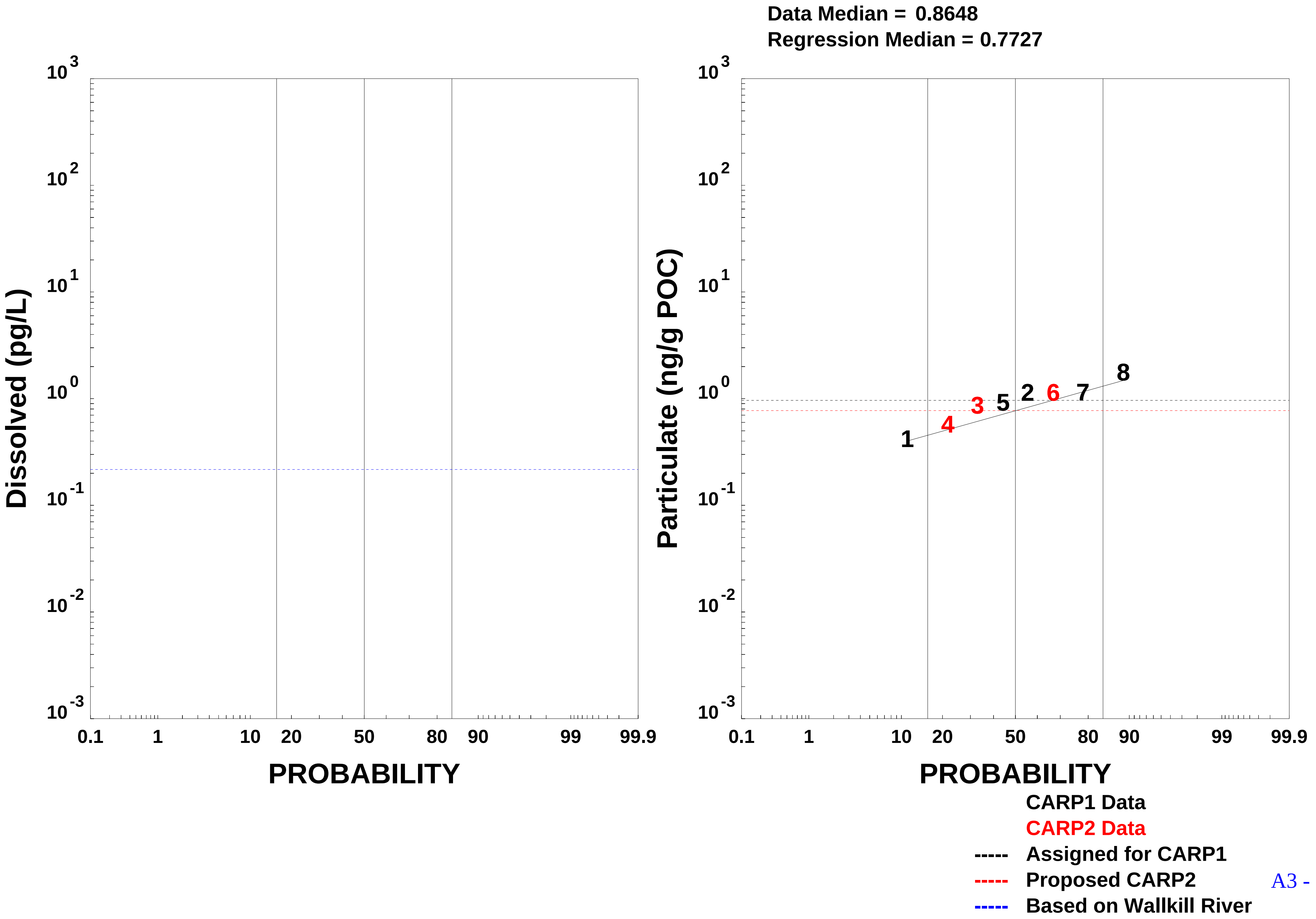




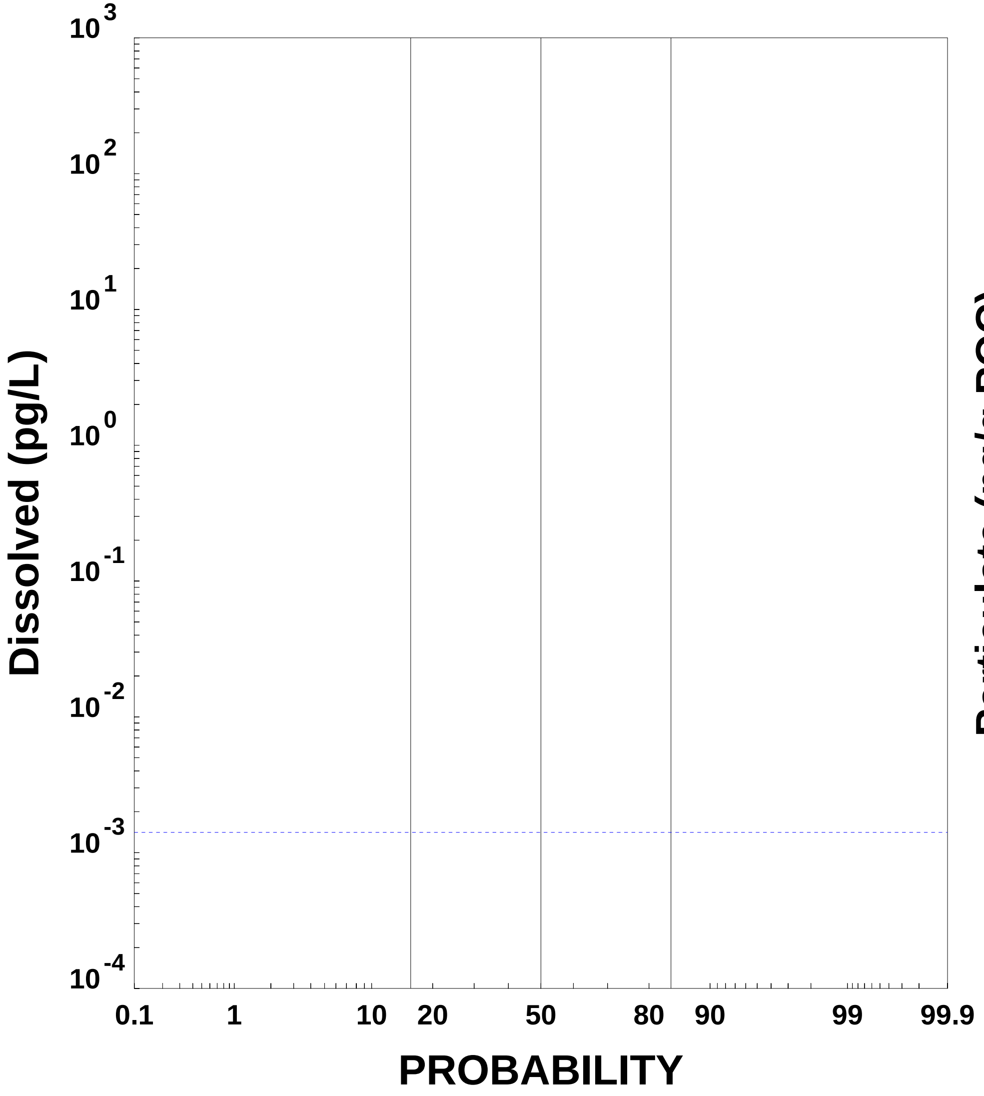
RARITAN RIVER NEAR SOUTH BOUND BROOK -- 1,2,3,7,8,9-HxCDF

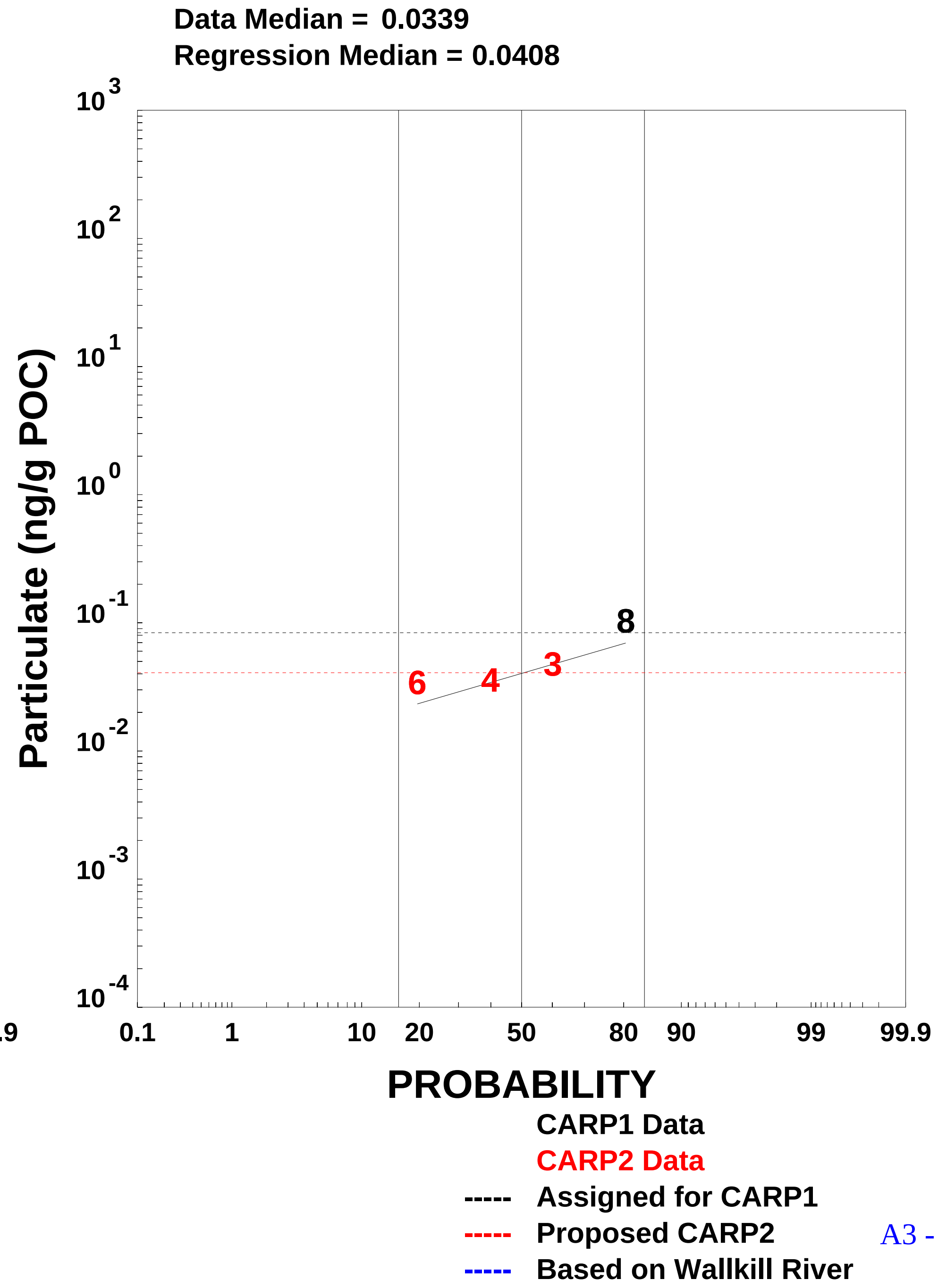


RARITAN RIVER NEAR SOUTH BOUND BROOK -- 1,2,3,4,6,7,8-HpCDF

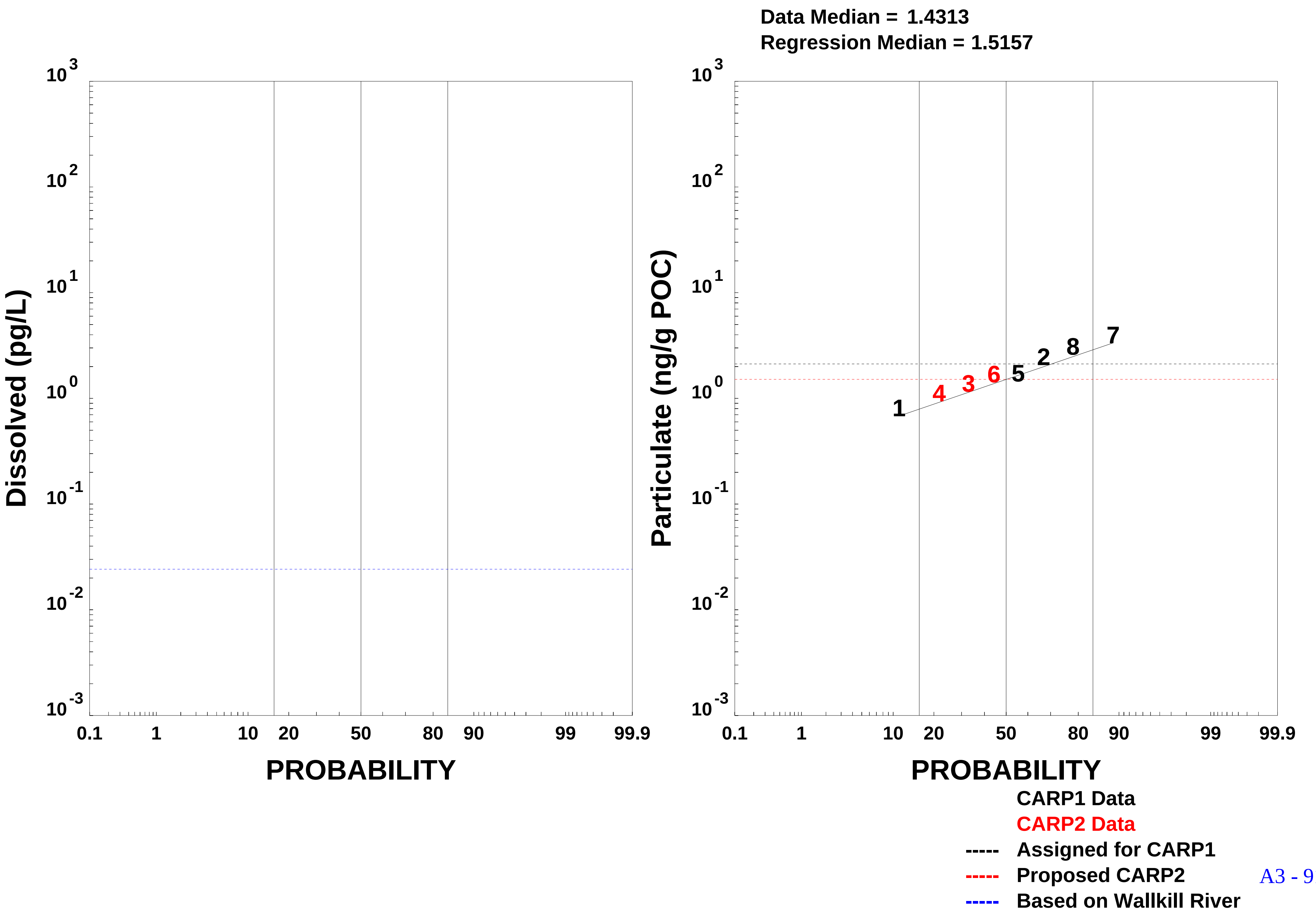


RARITAN RIVER NEAR SOUTH BOUND BROOK -- 1,2,3,4,7,8,9-HpCDF

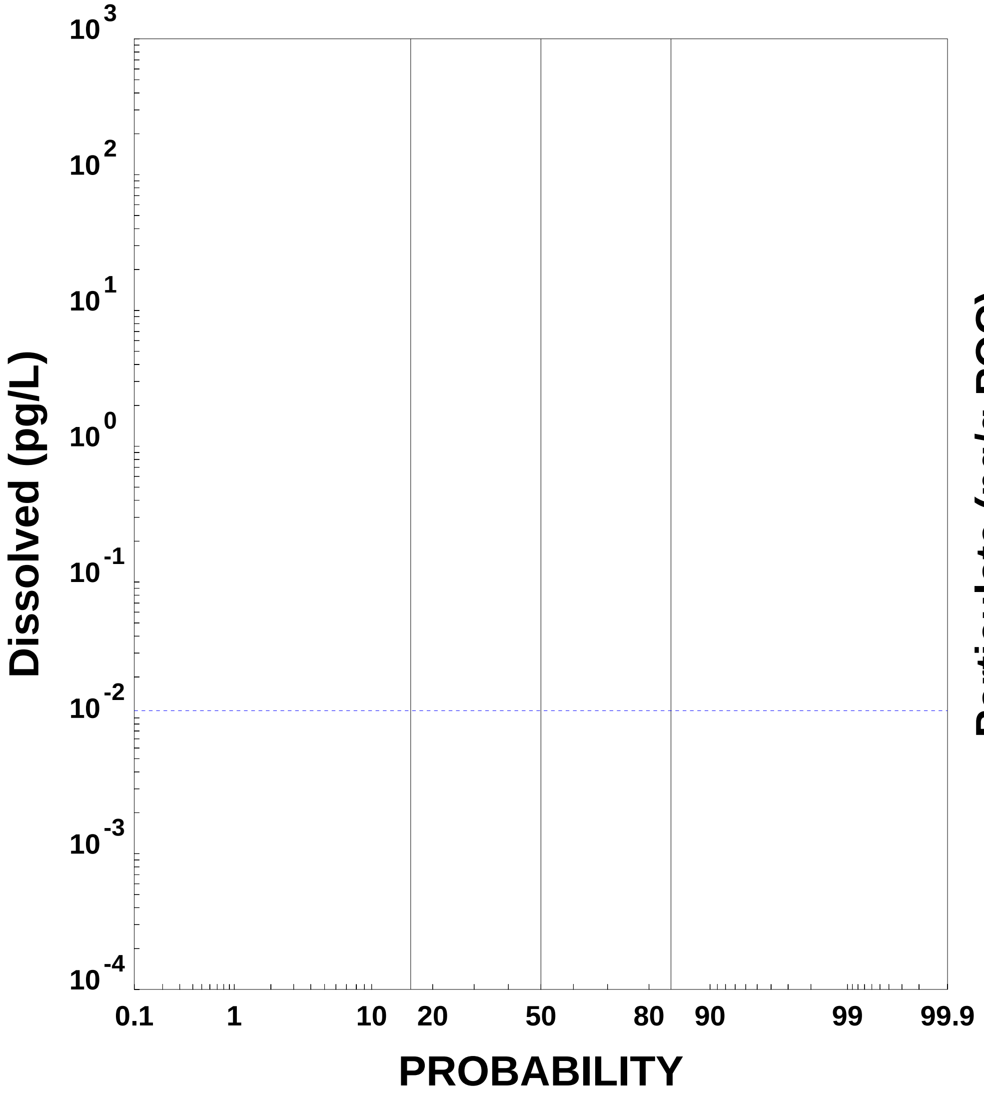


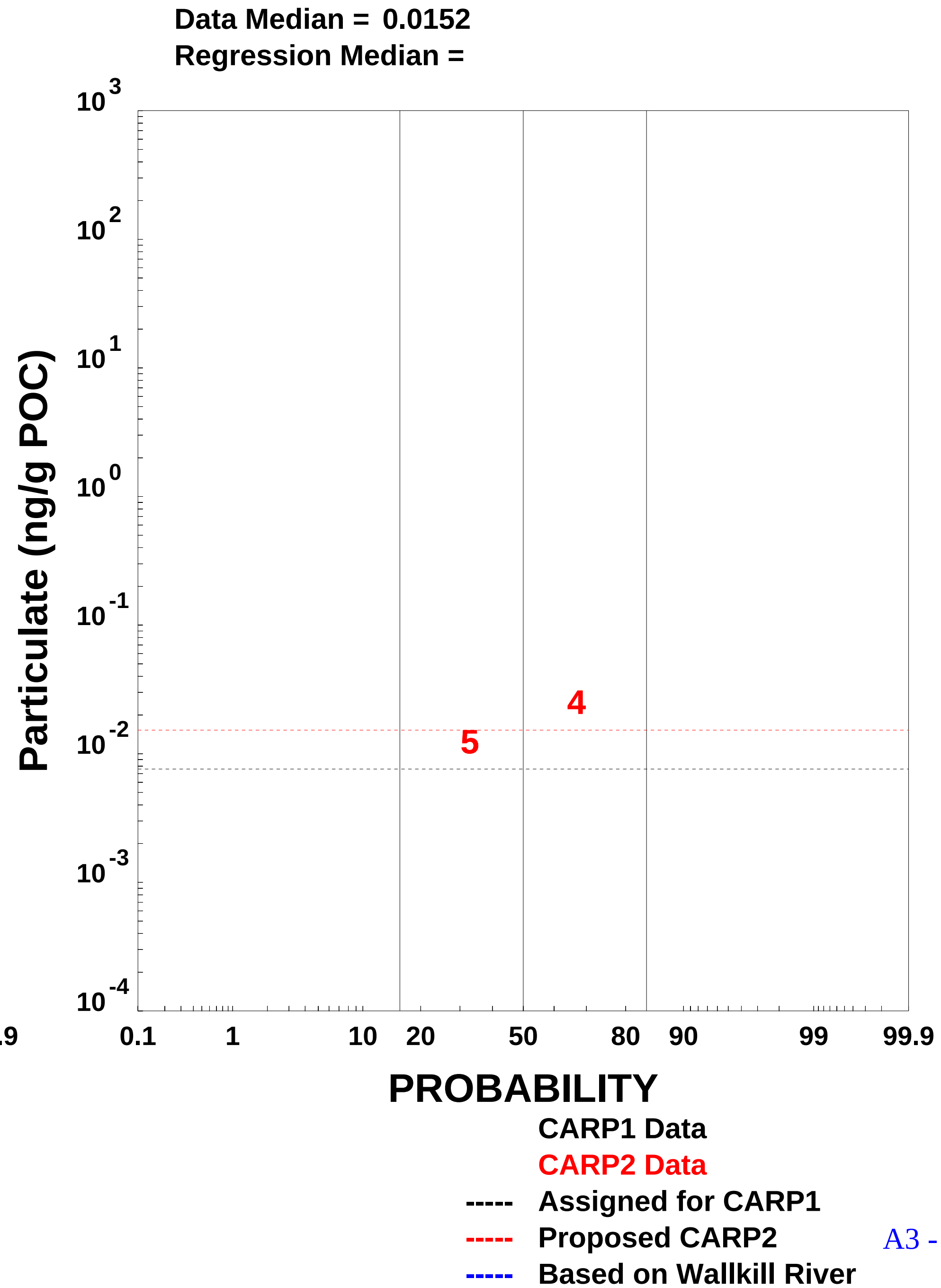


RARITAN RIVER NEAR SOUTH BOUND BROOK -- OCDF



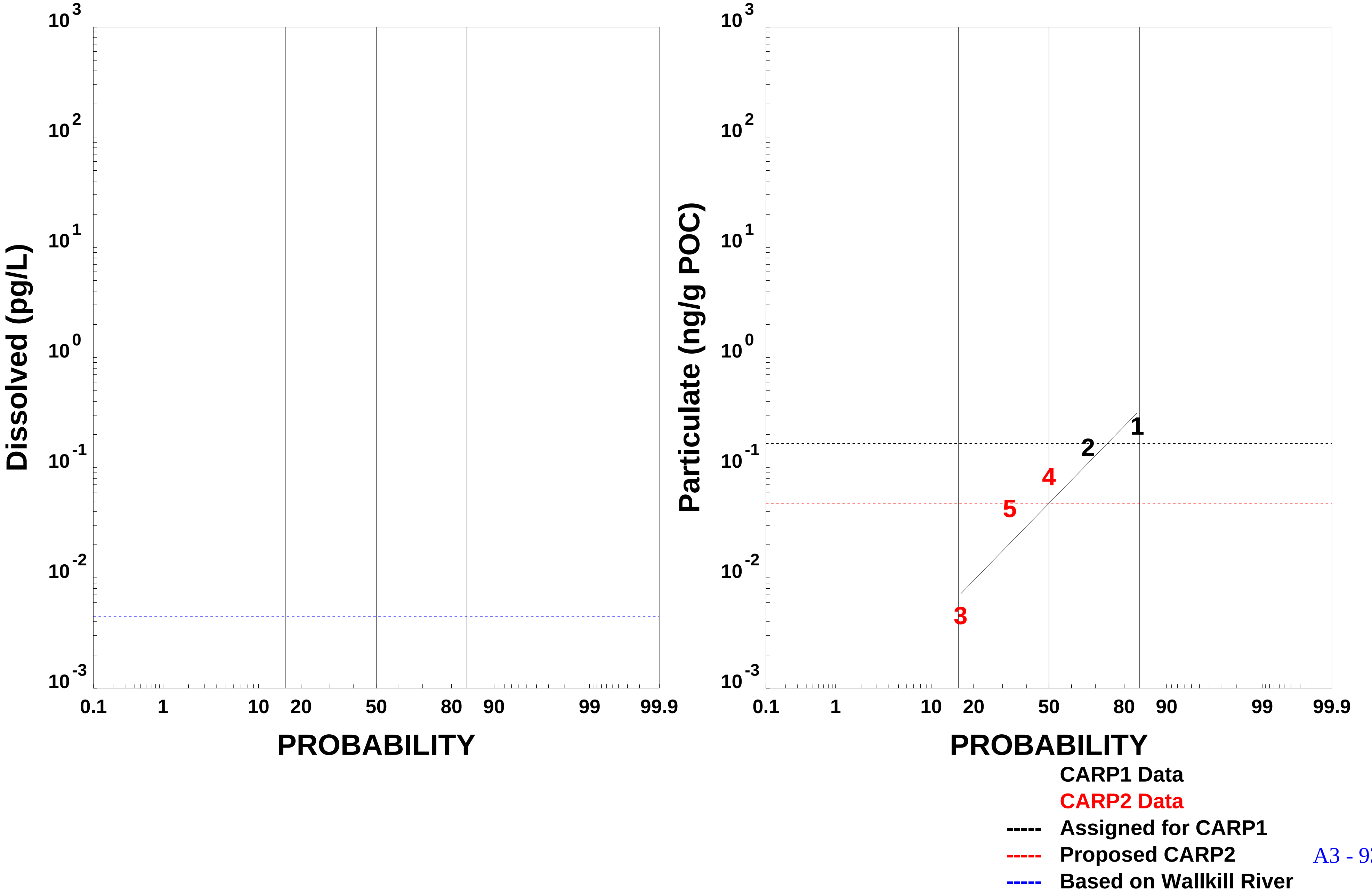
ELIZABETH RIVER AT HILLSIDE -- 2,3,7,8-TCDD





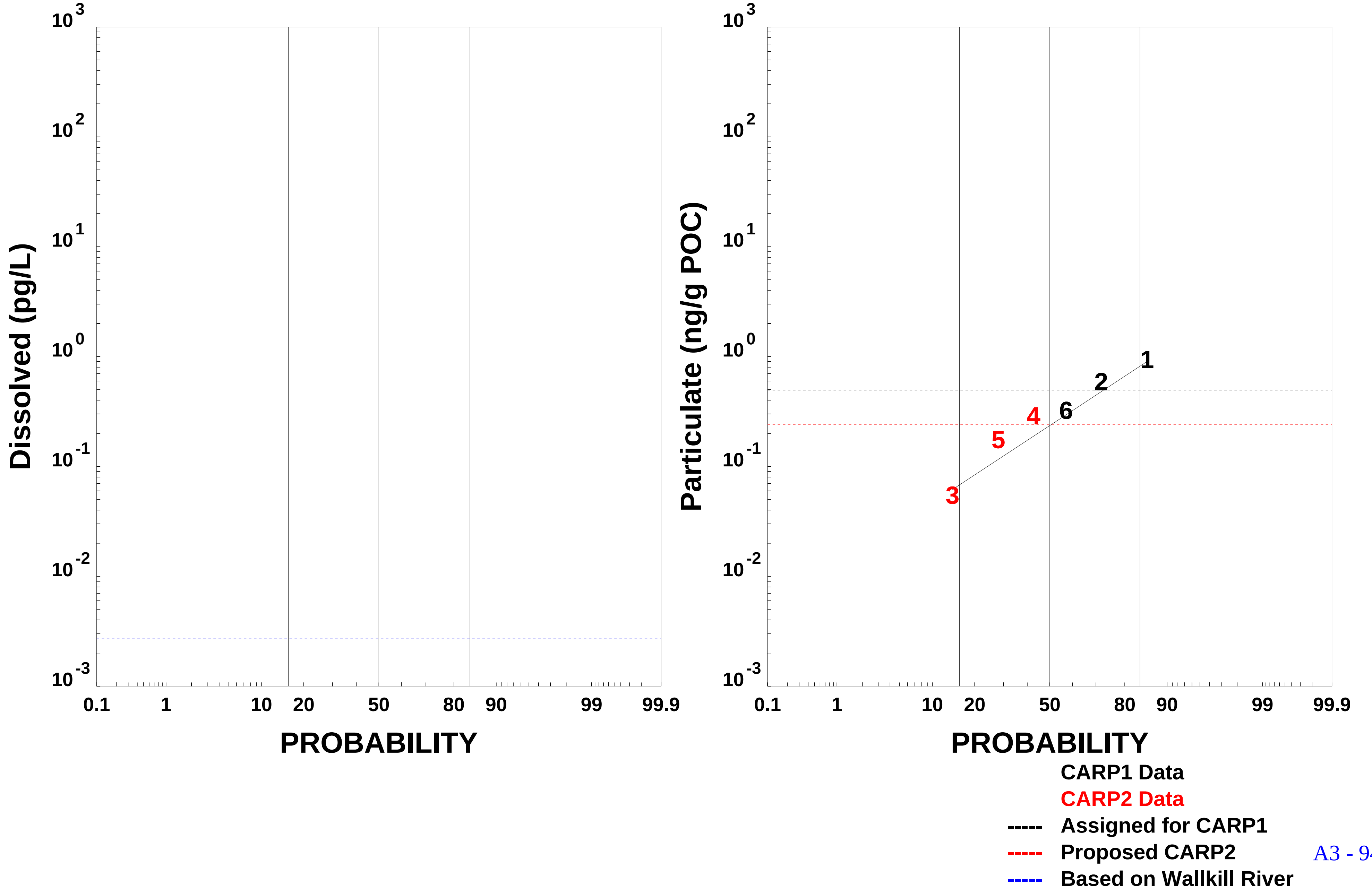
ELIZABETH RIVER AT HILLSIDE -- 1,2,3,7,8-PeCDD

Data Median = 0.0695
Regression Median = 0.0475

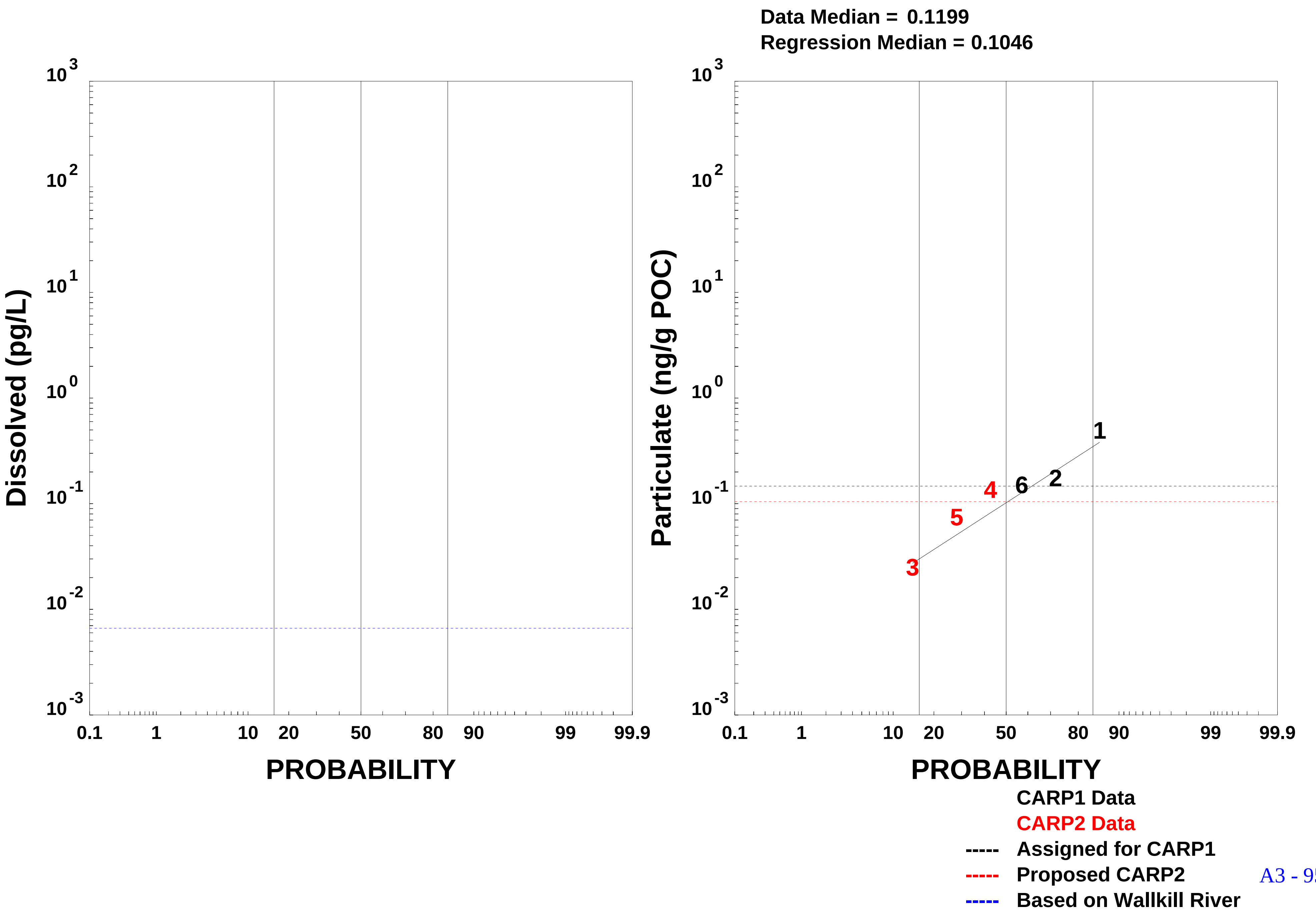


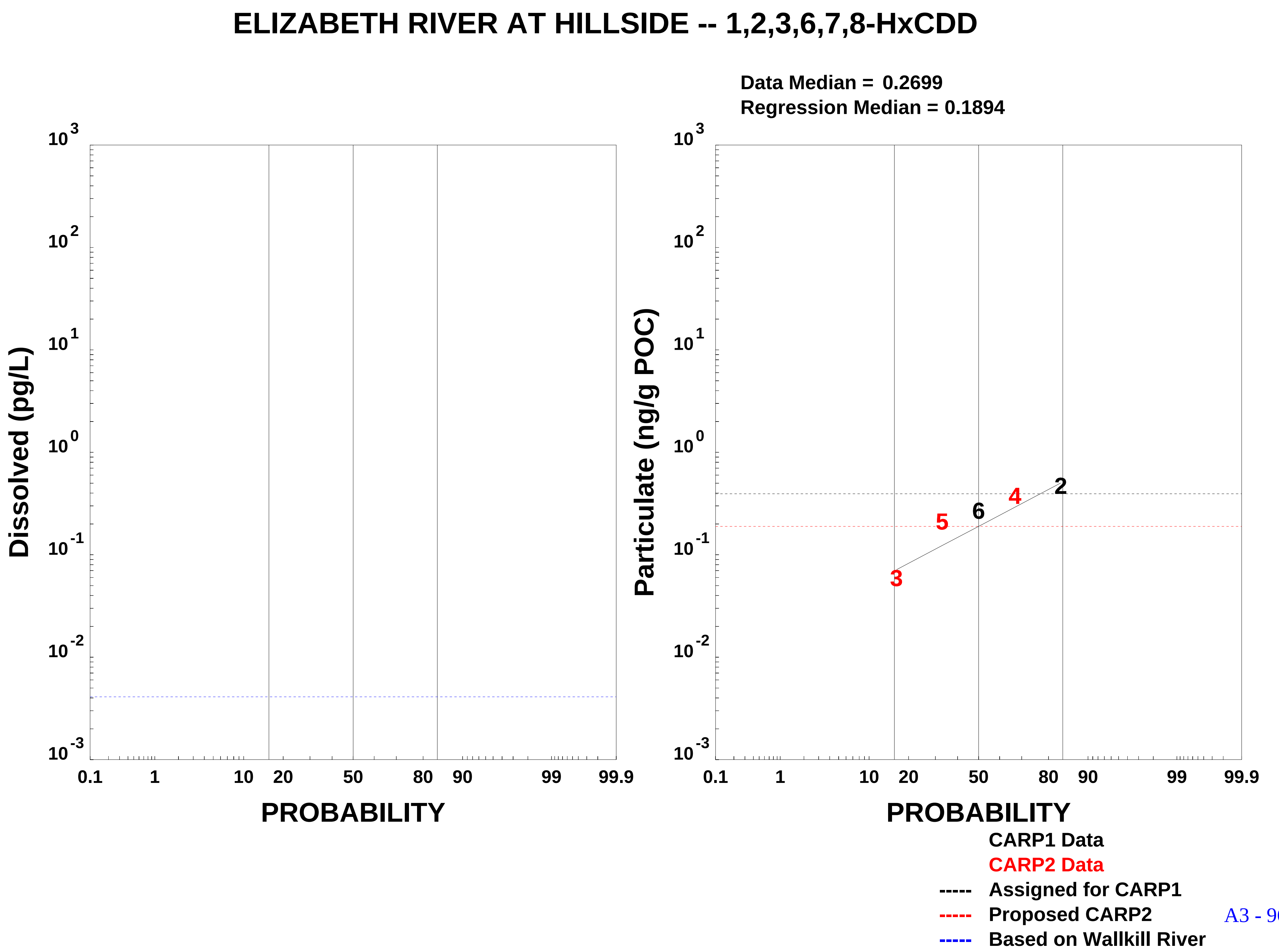
ELIZABETH RIVER AT HILLSIDE -- 1,2,3,7,8,9-HxCDD

Data Median = 0.2560
Regression Median = 0.2414



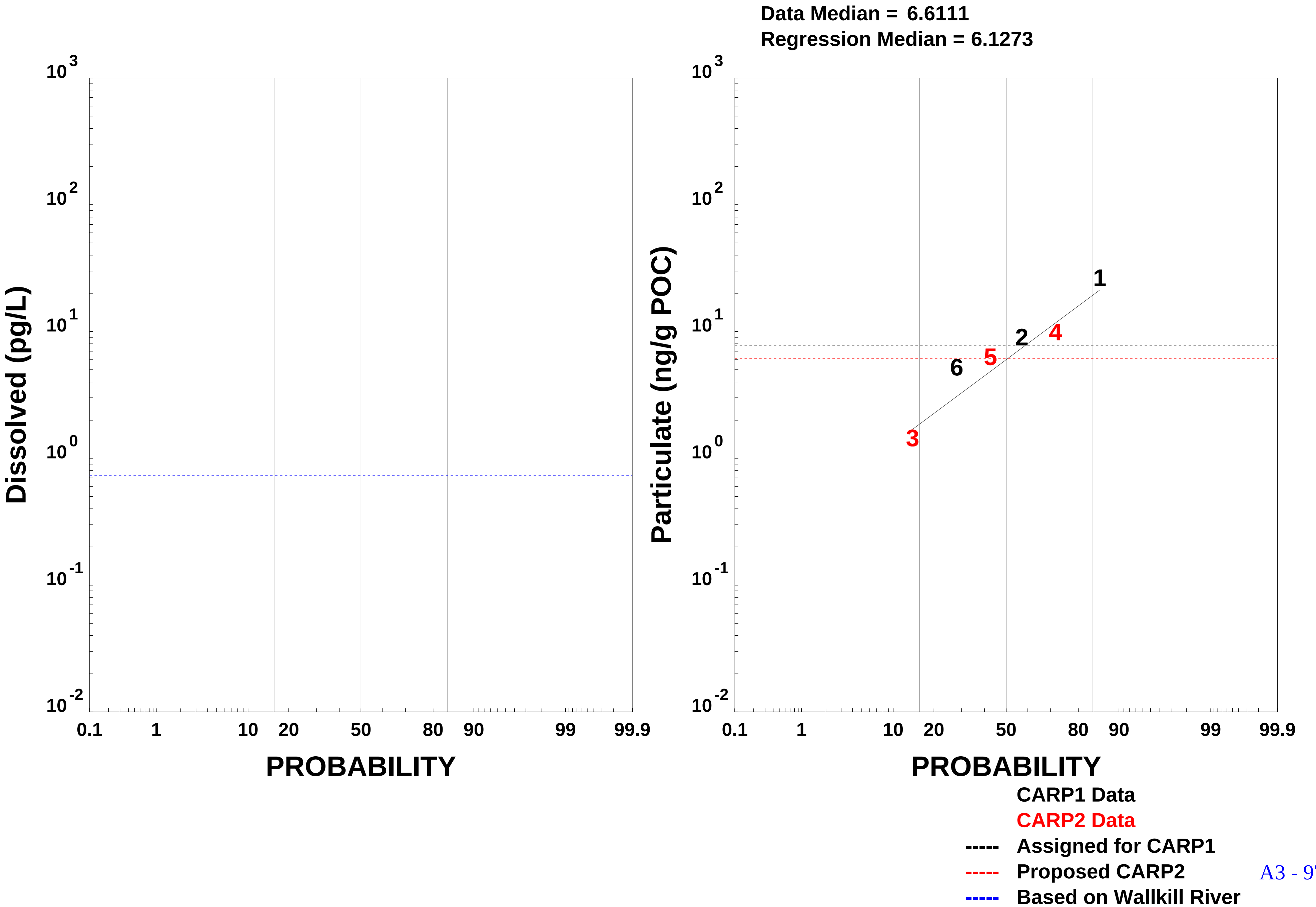
ELIZABETH RIVER AT HILLSIDE -- 1,2,3,4,7,8-HxCDD



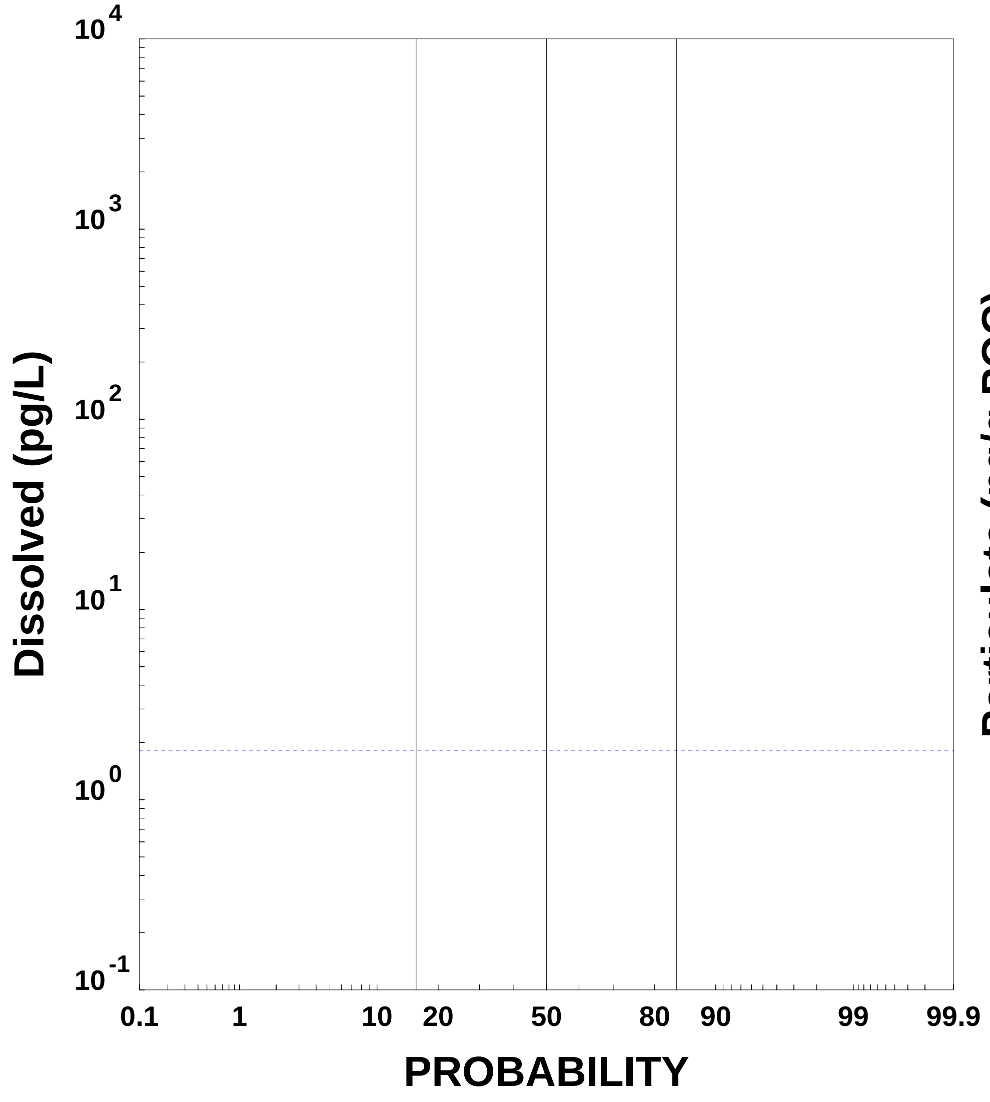


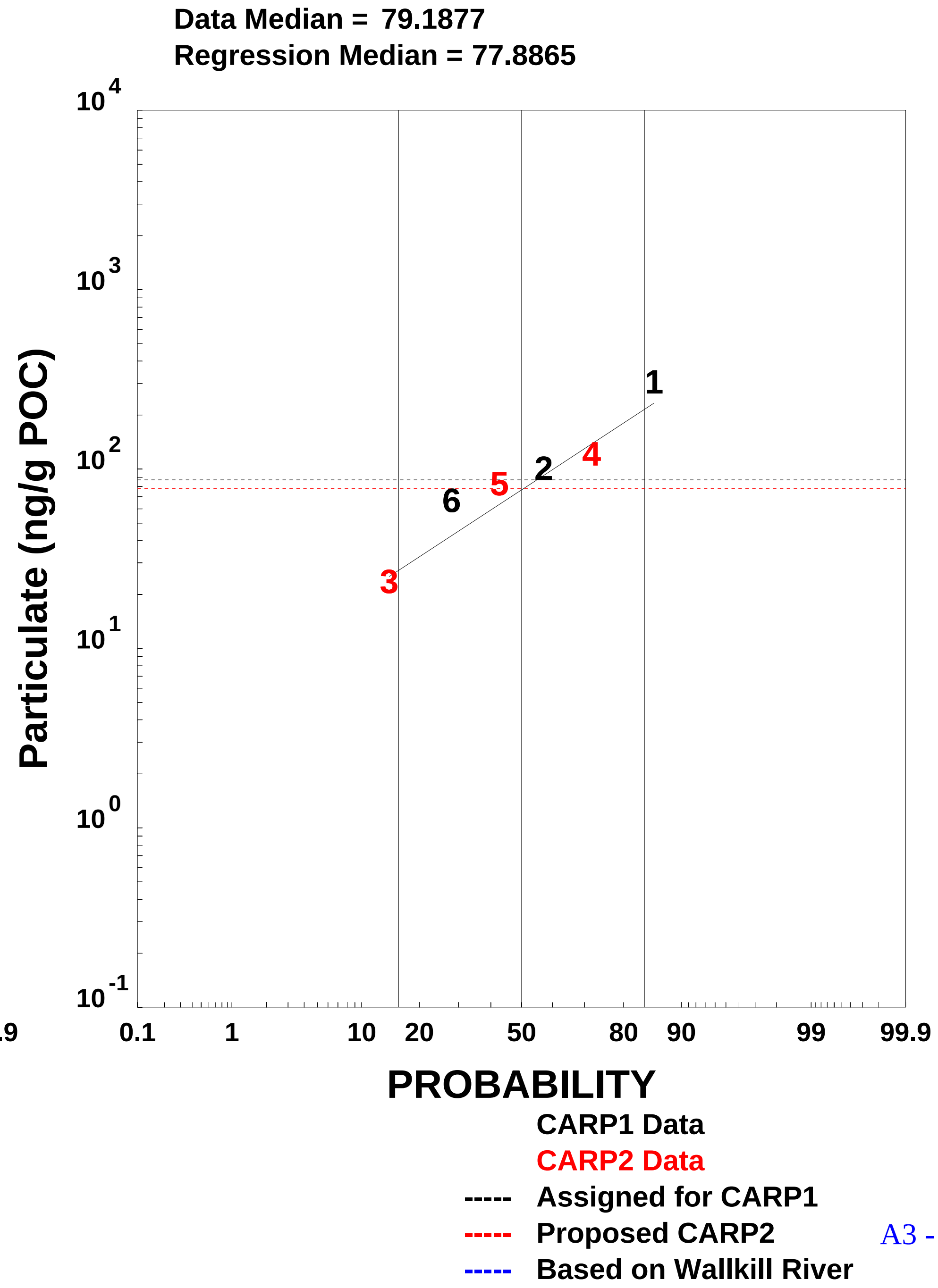
ELIZABETH RIVER AT HILLSIDE -- 1,2,3,6,7,8-HxCDD
Data Median = 0.2699
Regression Median = 0.1894
Dissolved (pg/L)
Particulate (ng/g POC)
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
0.1
1
10
20
50
80
90
99
99.9
PROBABILITY
2
3
4
5
6
CARP1 Data
CARP2 Data
----- Assigned for CARP1
----- Proposed CARP2
----- Based on Wallkill River

ELIZABETH RIVER AT HILLSIDE -- 1,2,3,4,6,7,8-HpCDD

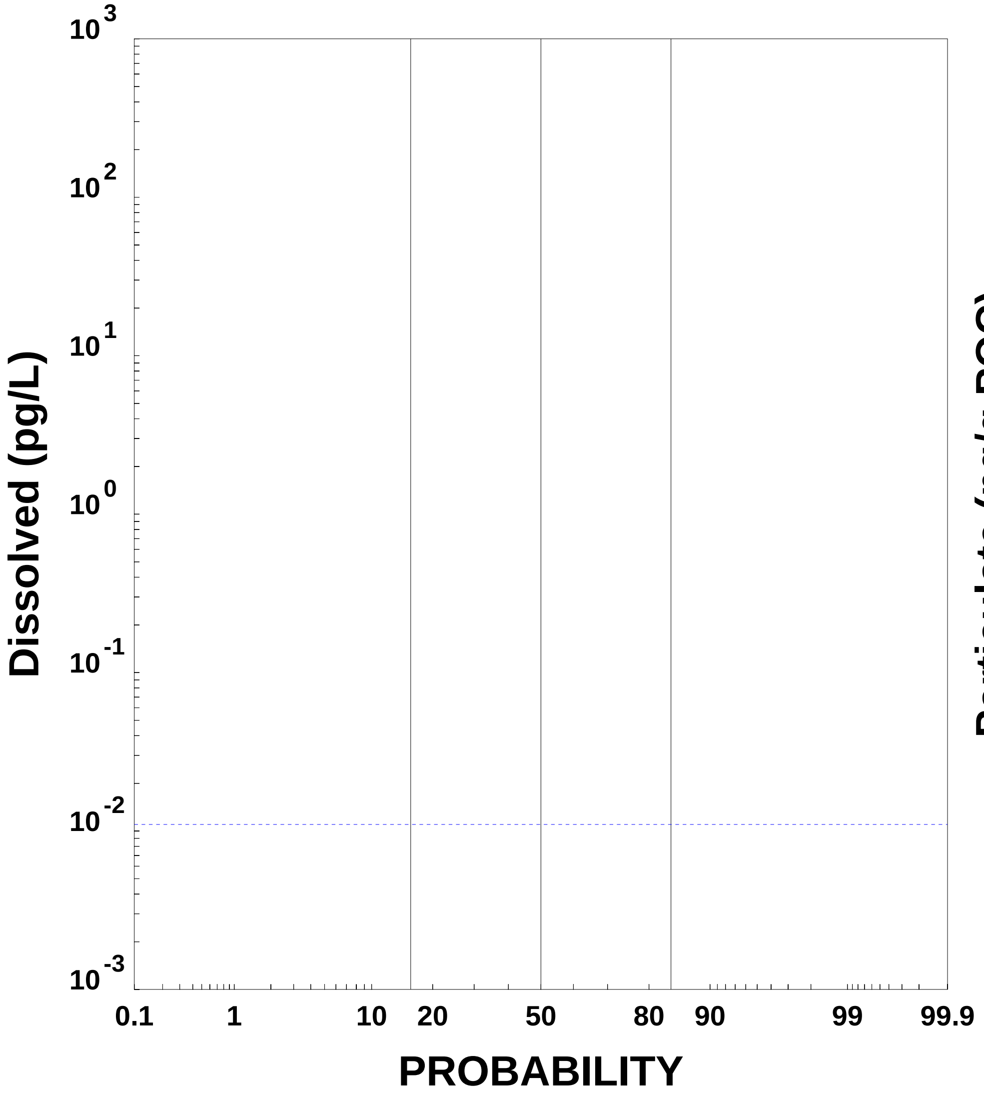


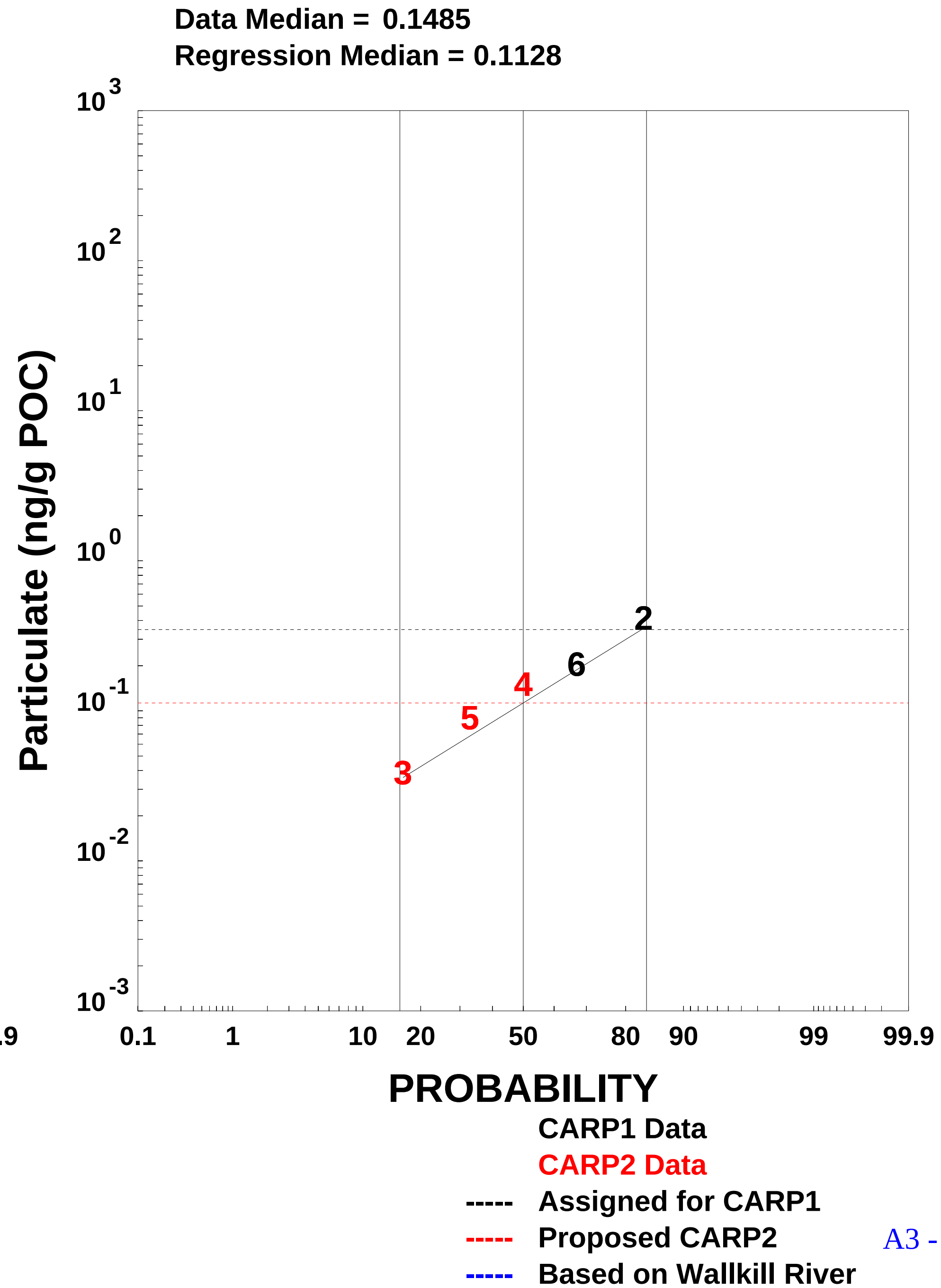
ELIZABETH RIVER AT HILLSIDE -- OCDD



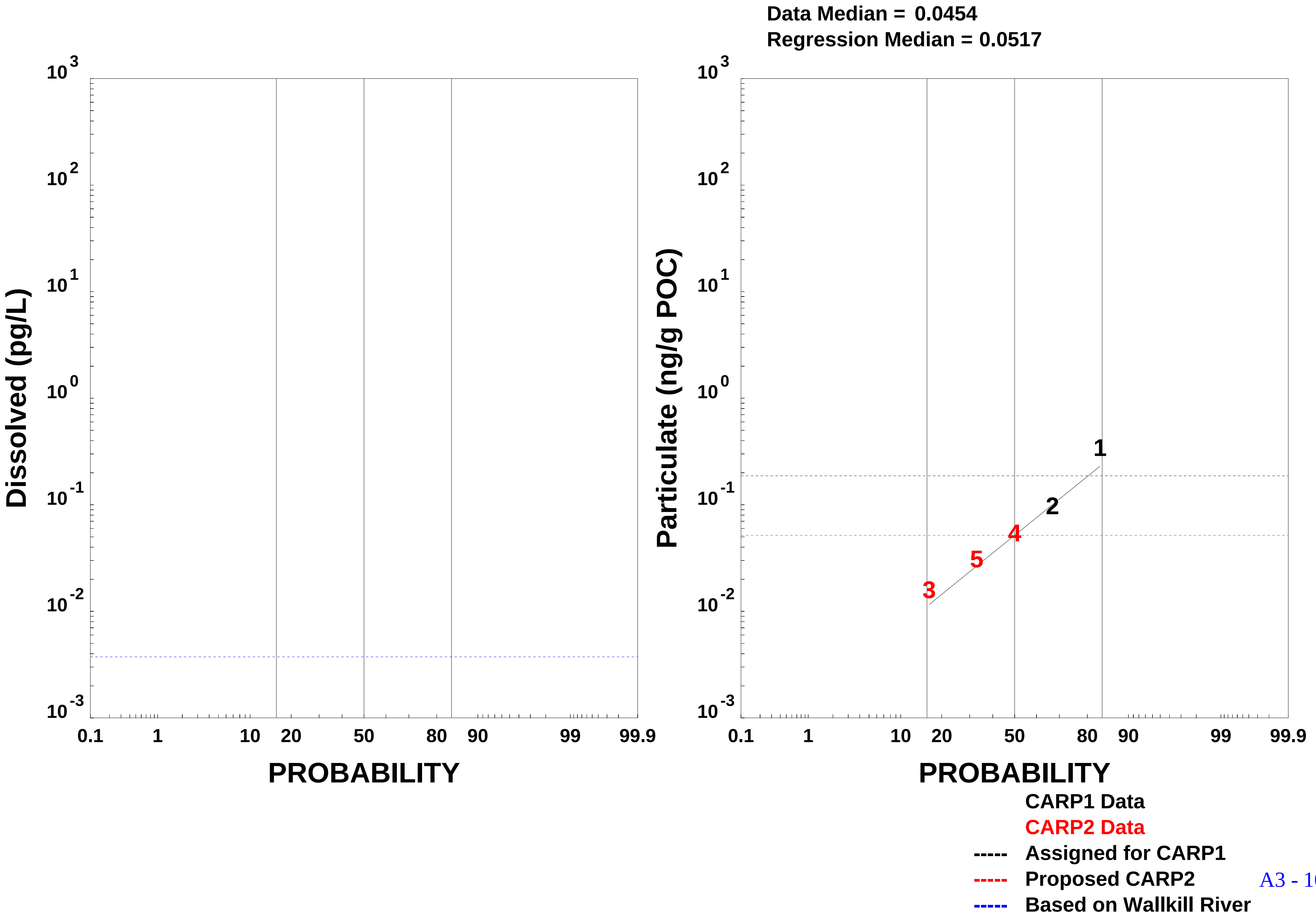


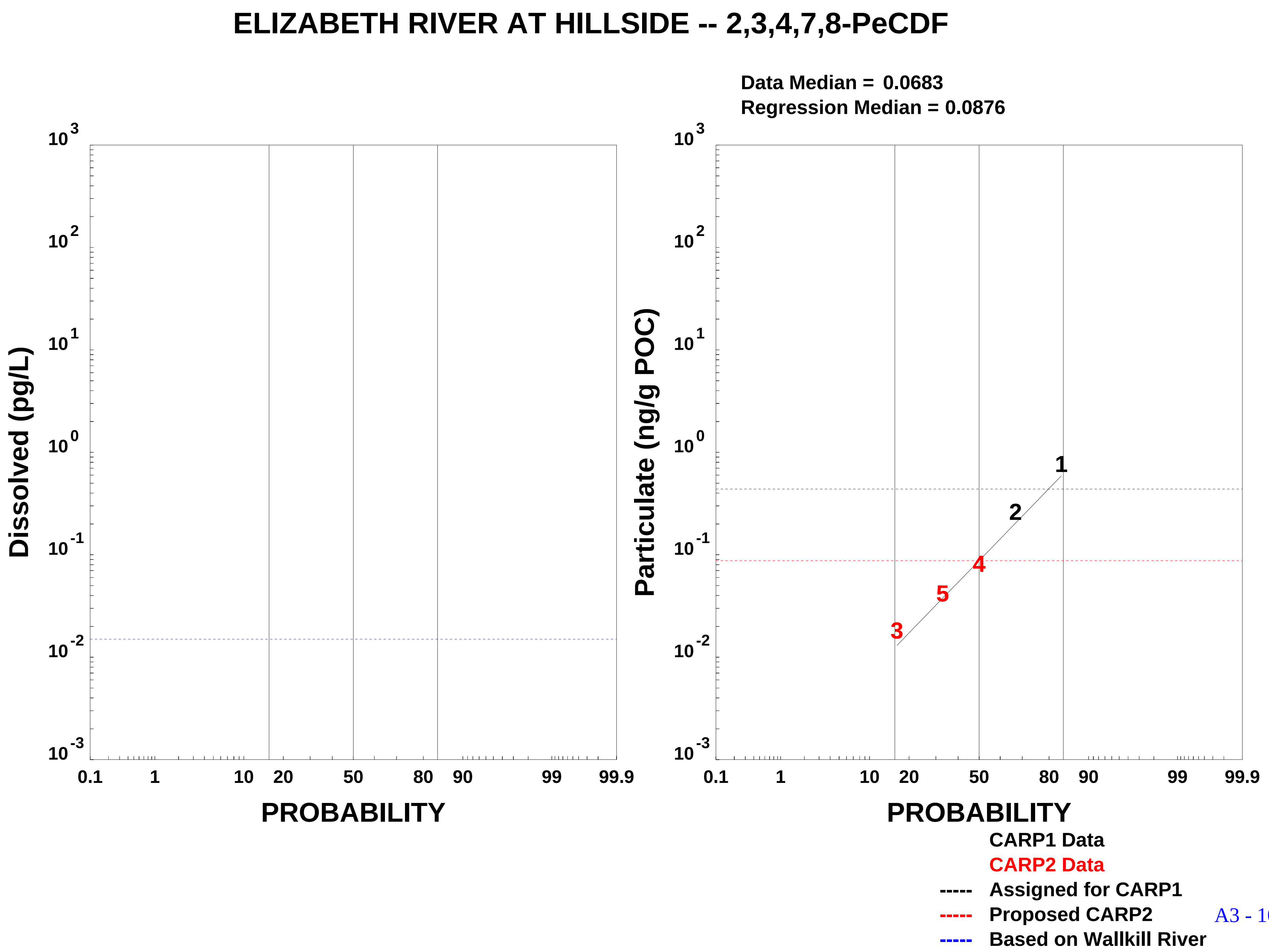
ELIZABETH RIVER AT HILLSIDE -- 2,3,7,8-TCDF



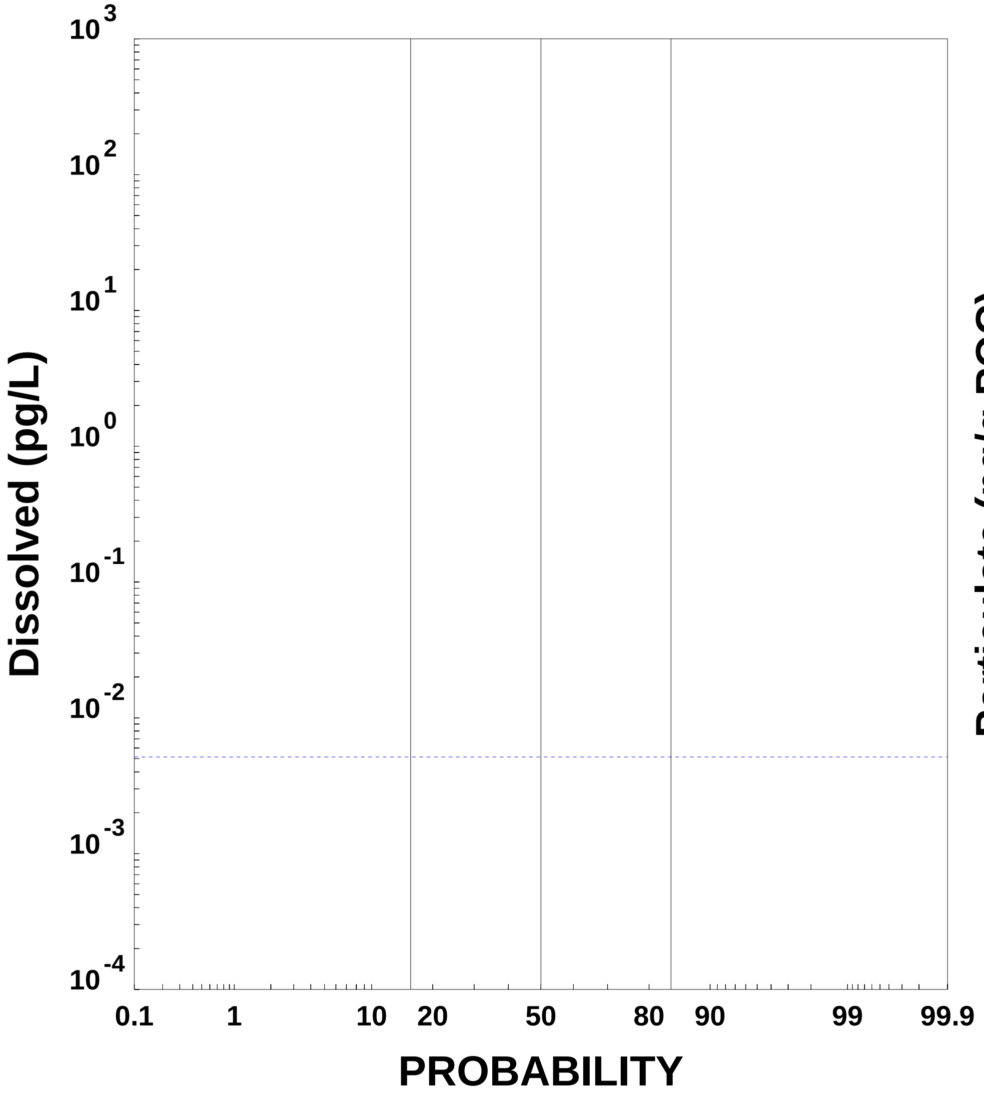


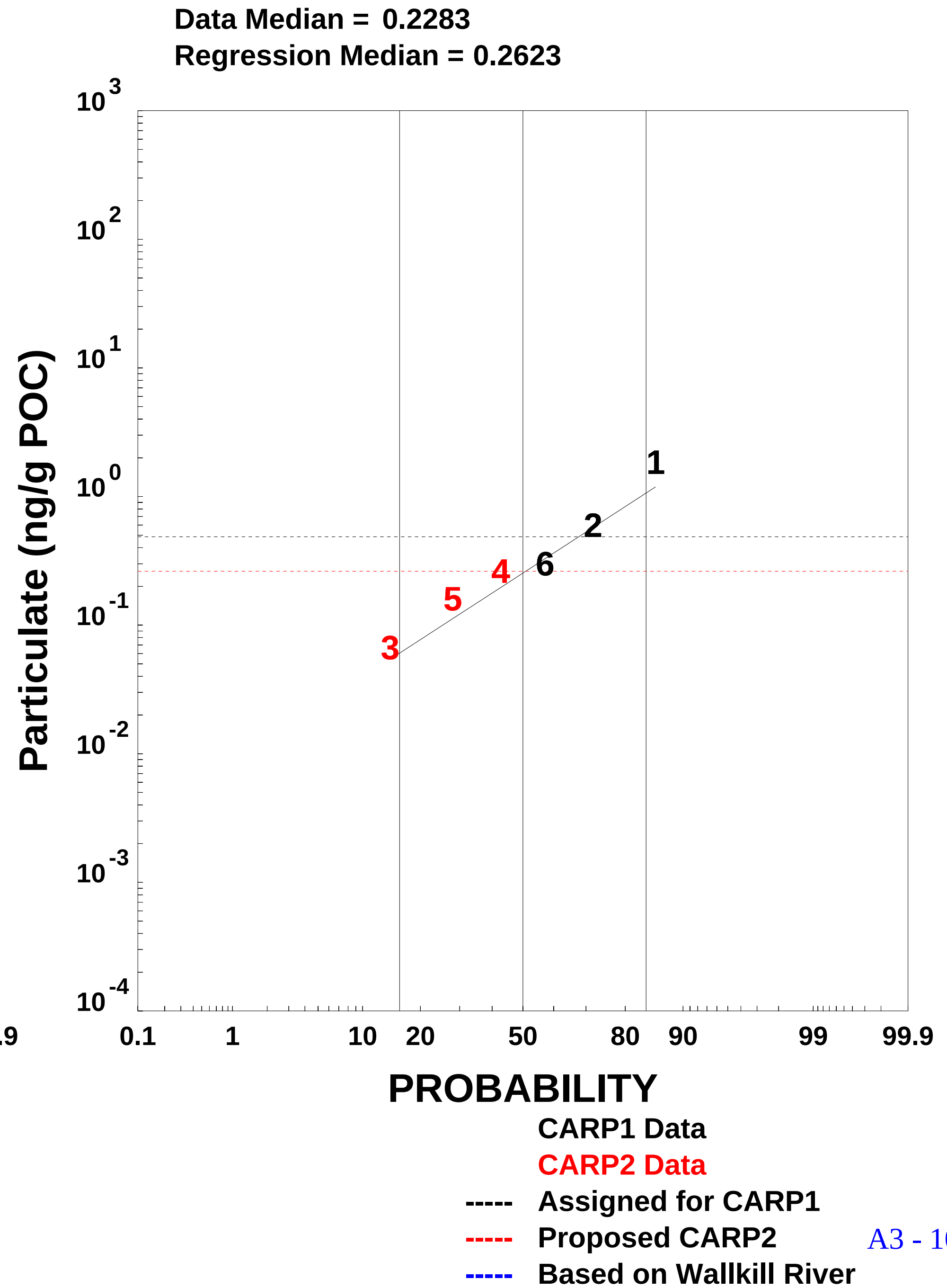
ELIZABETH RIVER AT HILLSIDE -- 1,2,3,7,8-PeCDF




ELIZABETH RIVER AT HILLSIDE -- 2,3,4,7,8-PeCDF
Data Median = 0.0683
Regression Median = 0.0876
Dissolved (pg/L)
Particulate (ng/g POC)
PROBABILITY
PROBABILITY
CARP1 Data
CARP2 Data
----- Assigned for CARP1
----- Proposed CARP2
----- Based on Wallkill River

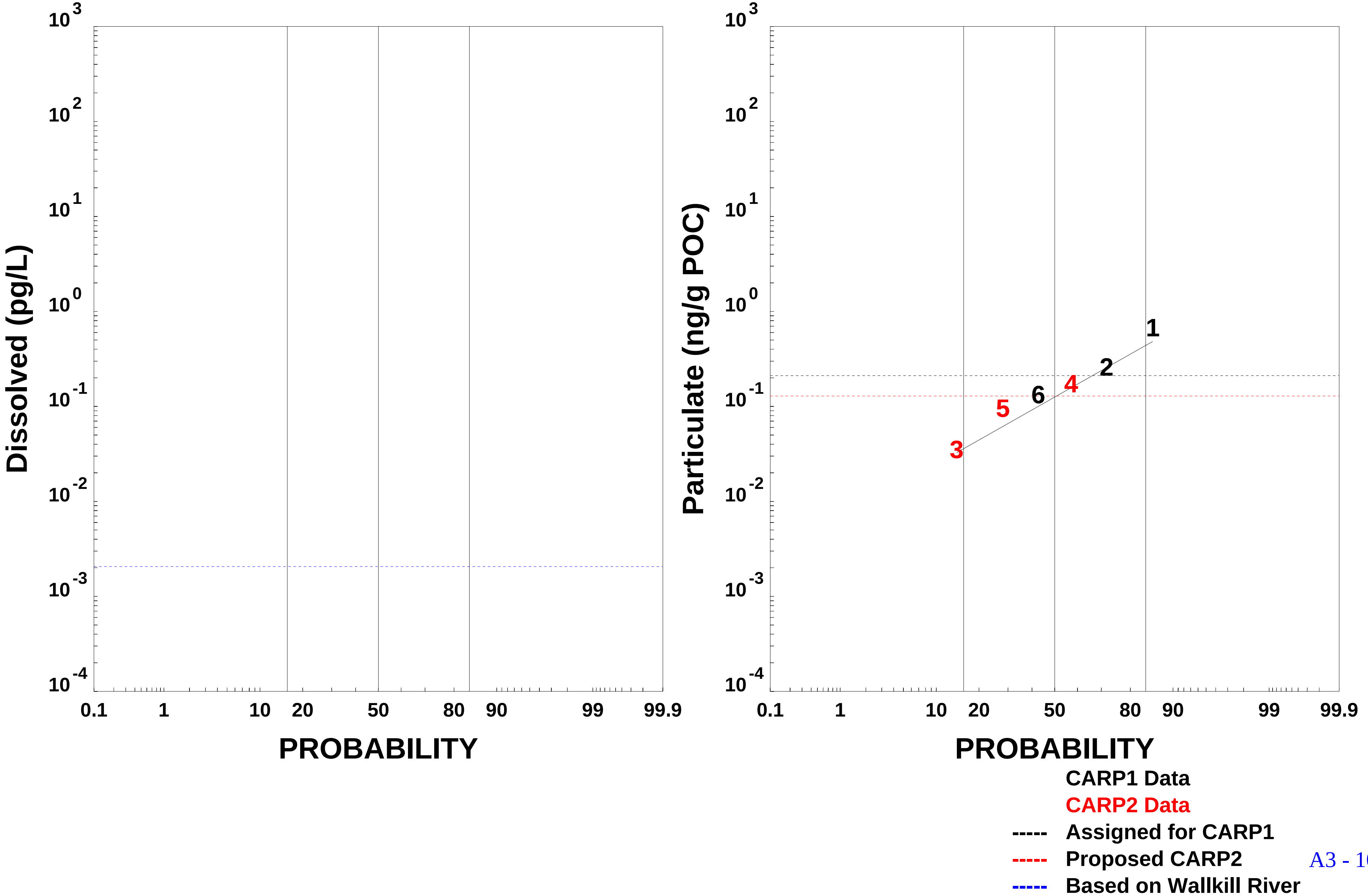
ELIZABETH RIVER AT HILLSIDE -- 1,2,3,4,7,8-HxCDF



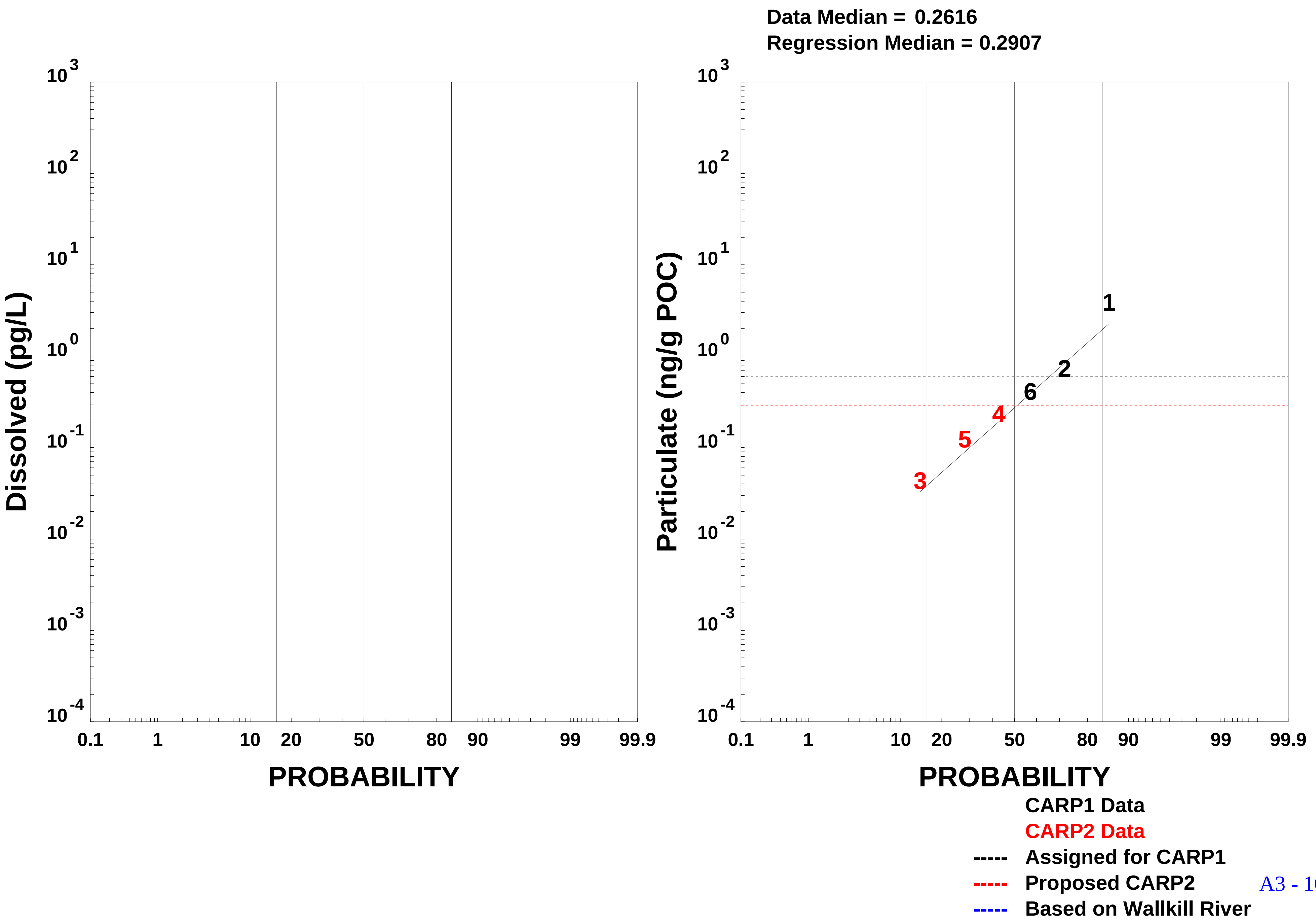


ELIZABETH RIVER AT HILLSIDE -- 2,3,4,6,7,8-HxCDF

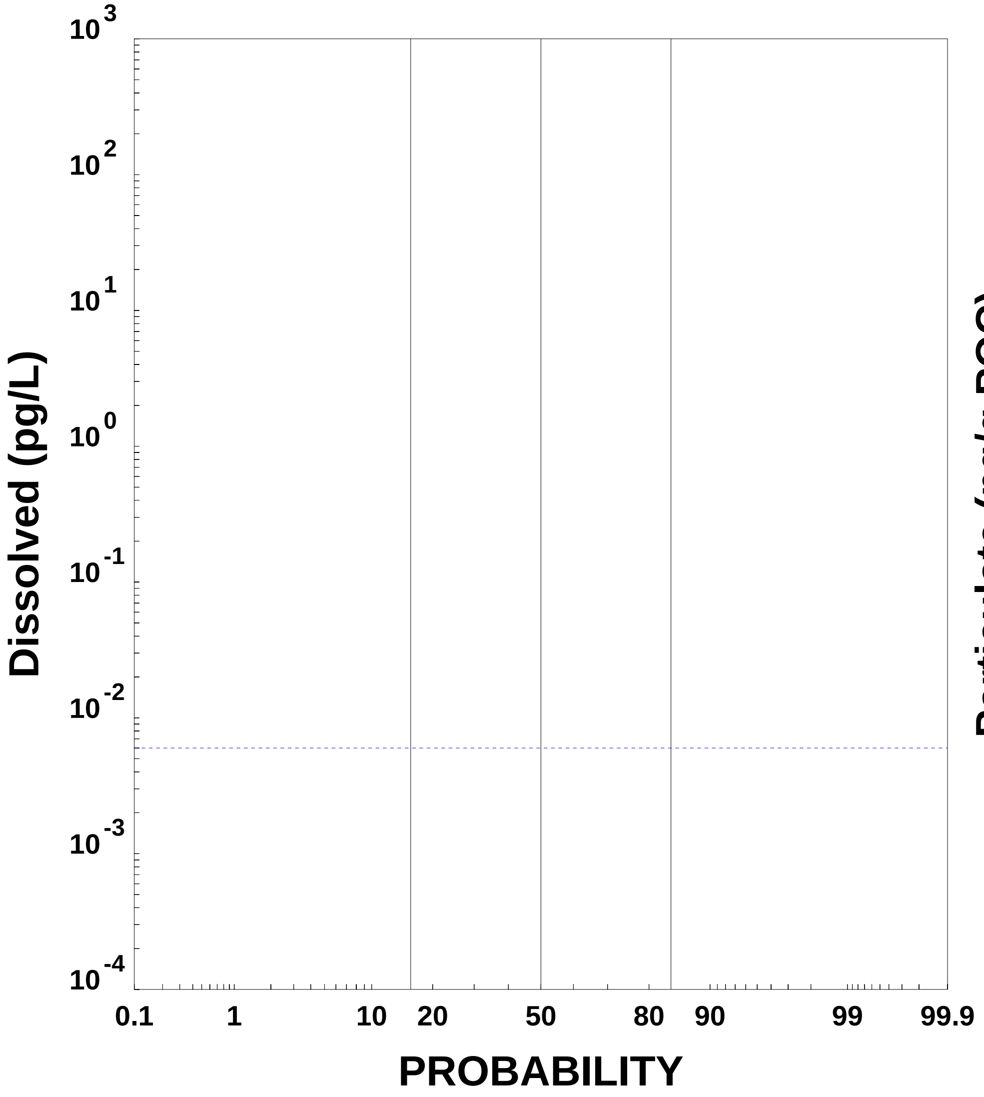
Data Median = 0.1245
Regression Median = 0.1287



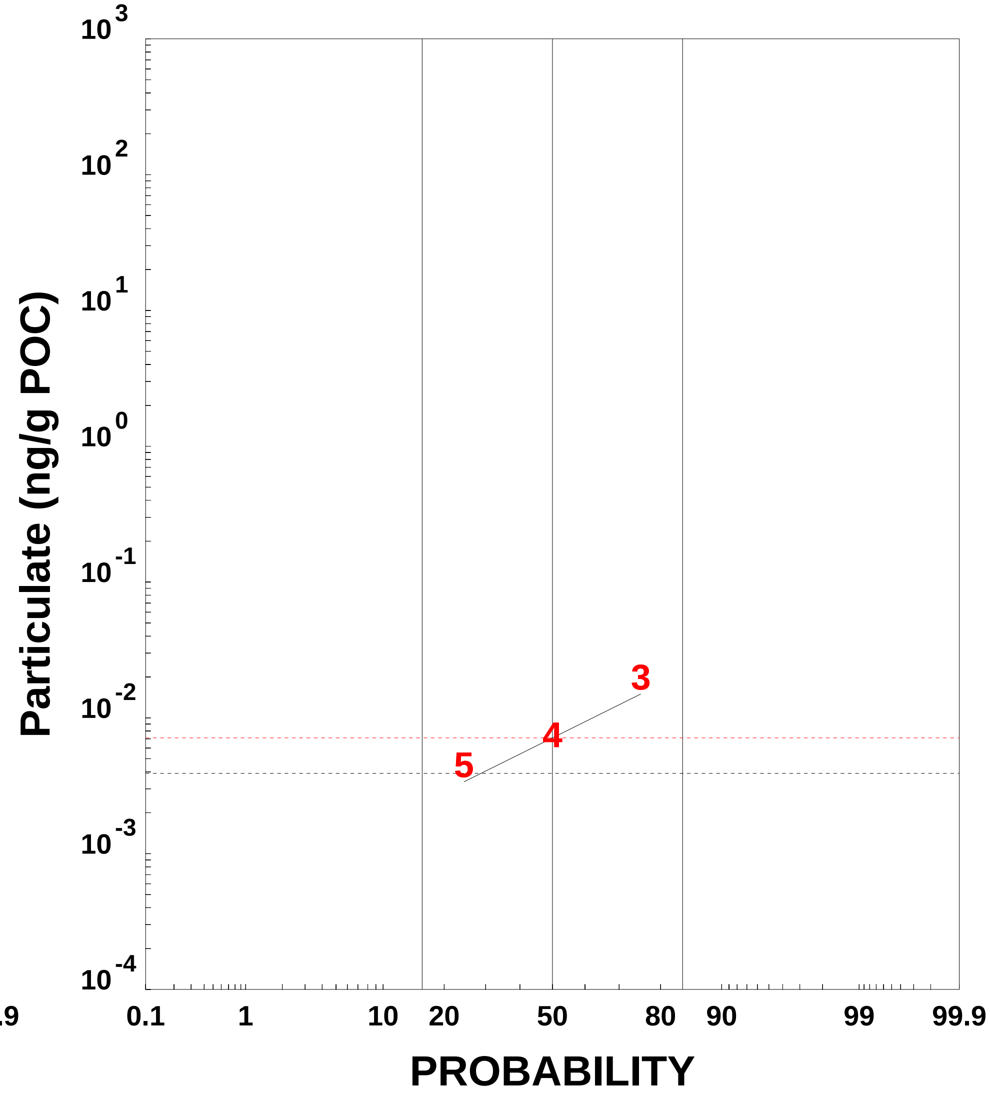
ELIZABETH RIVER AT HILLSIDE -- 1,2,3,6,7,8-HxCDF



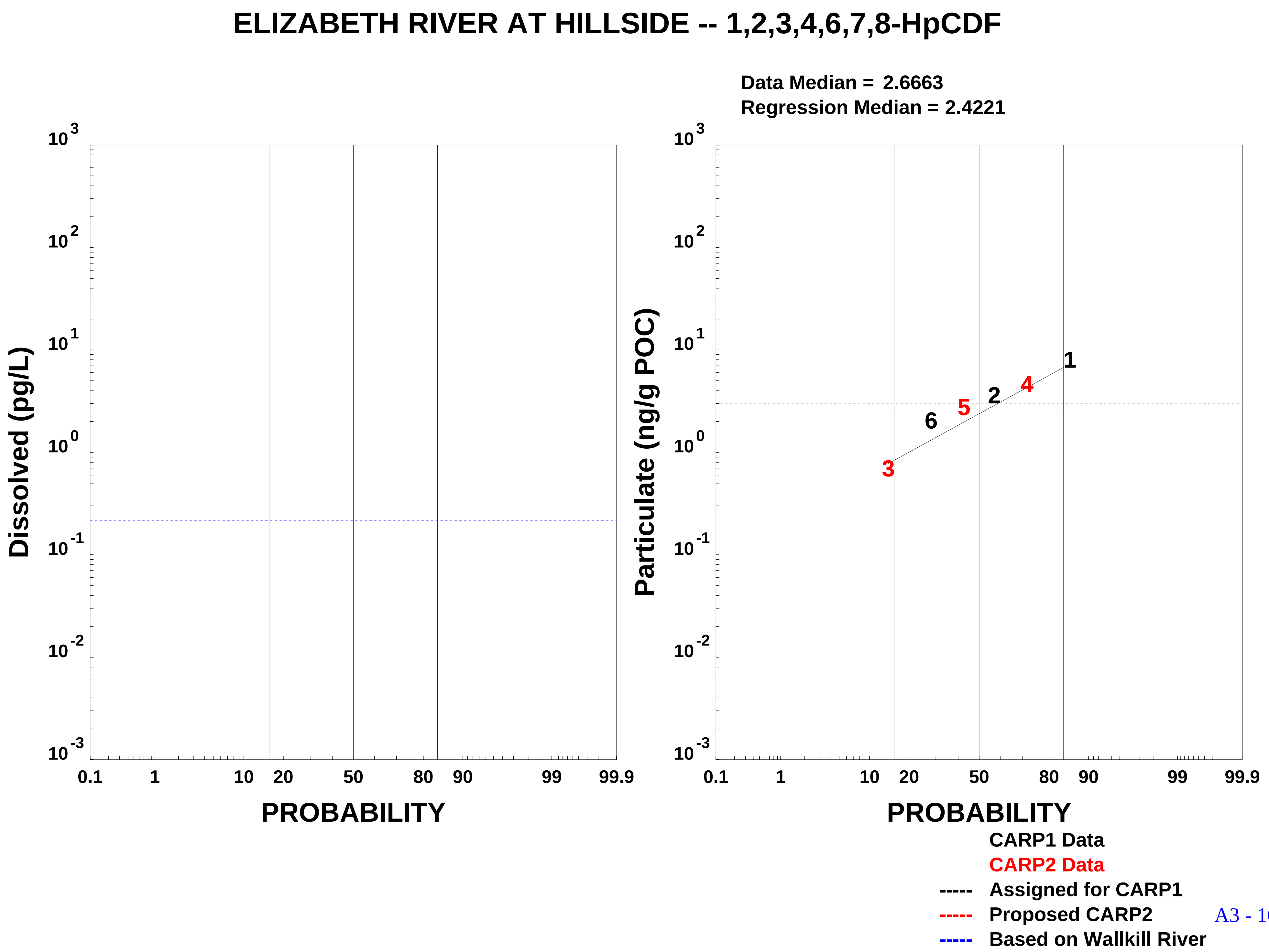
ELIZABETH RIVER AT HILLSIDE -- 1,2,3,7,8,9-HxCDF



Data Median = 0.0061
Regression Median = 0.0071

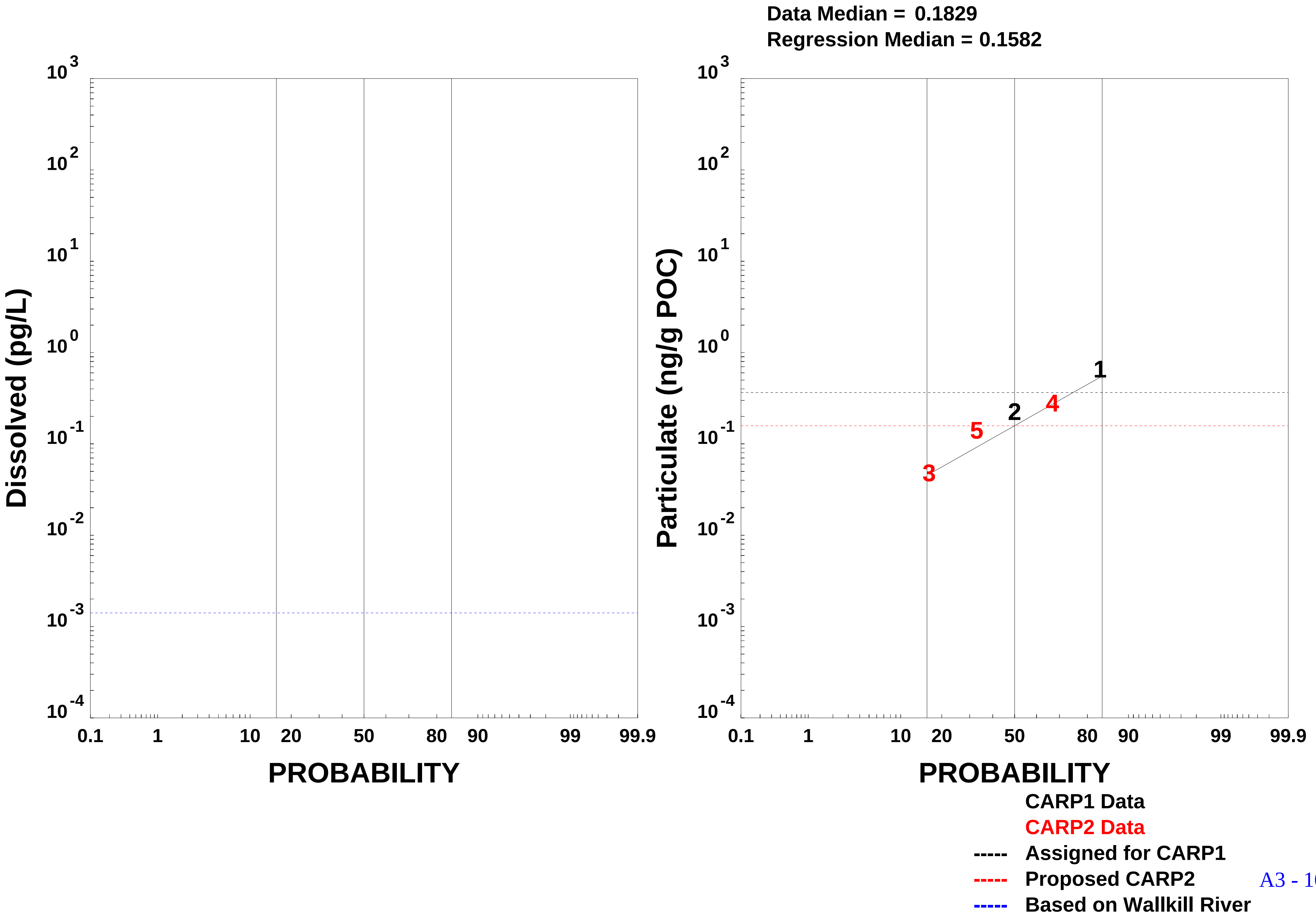


CARP1 Data
CARP2 Data
----- Assigned for CARP1
----- Proposed CARP2
----- Based on Wallkill River

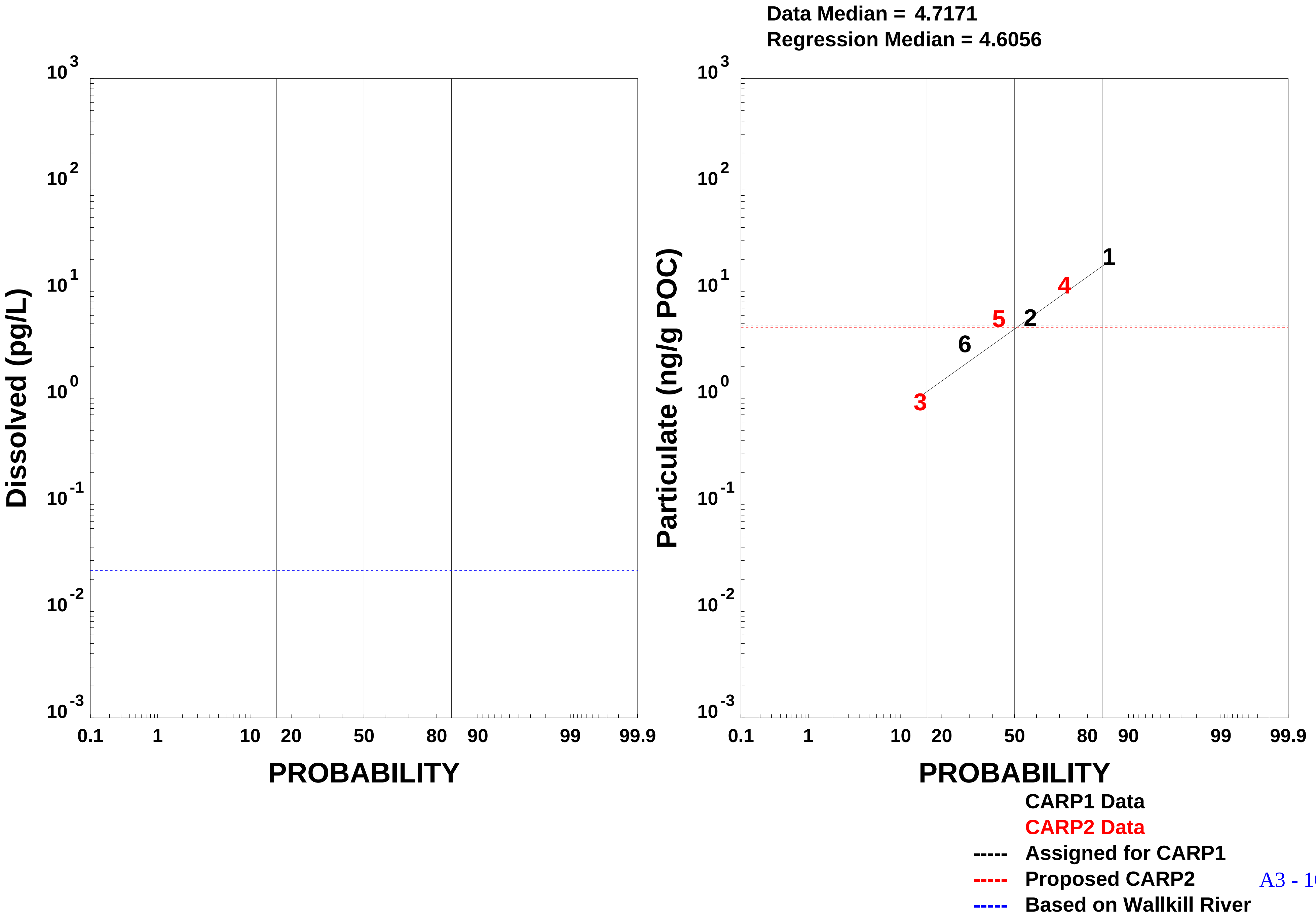


ELIZABETH RIVER AT HILLSIDE -- 1,2,3,4,6,7,8-HpCDF
Data Median = 2.6663
Regression Median = 2.4221
Dissolved (pg/L)
Particulate (ng/g POC)
PROBABILITY
PROBABILITY
CARP1 Data
CARP2 Data
----- Assigned for CARP1
----- Proposed CARP2
----- Based on Wallkill River

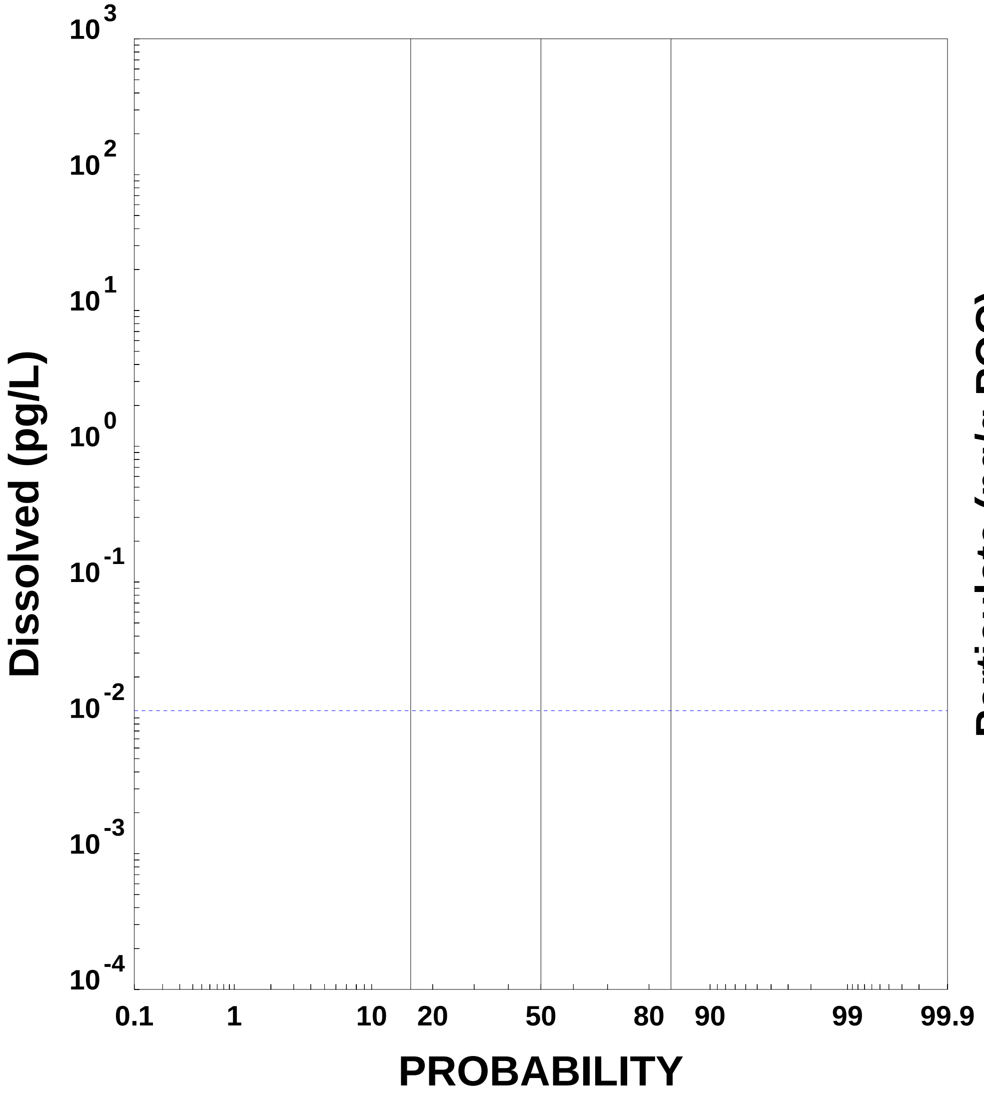
ELIZABETH RIVER AT HILLSIDE -- 1,2,3,4,7,8,9-HpCDF

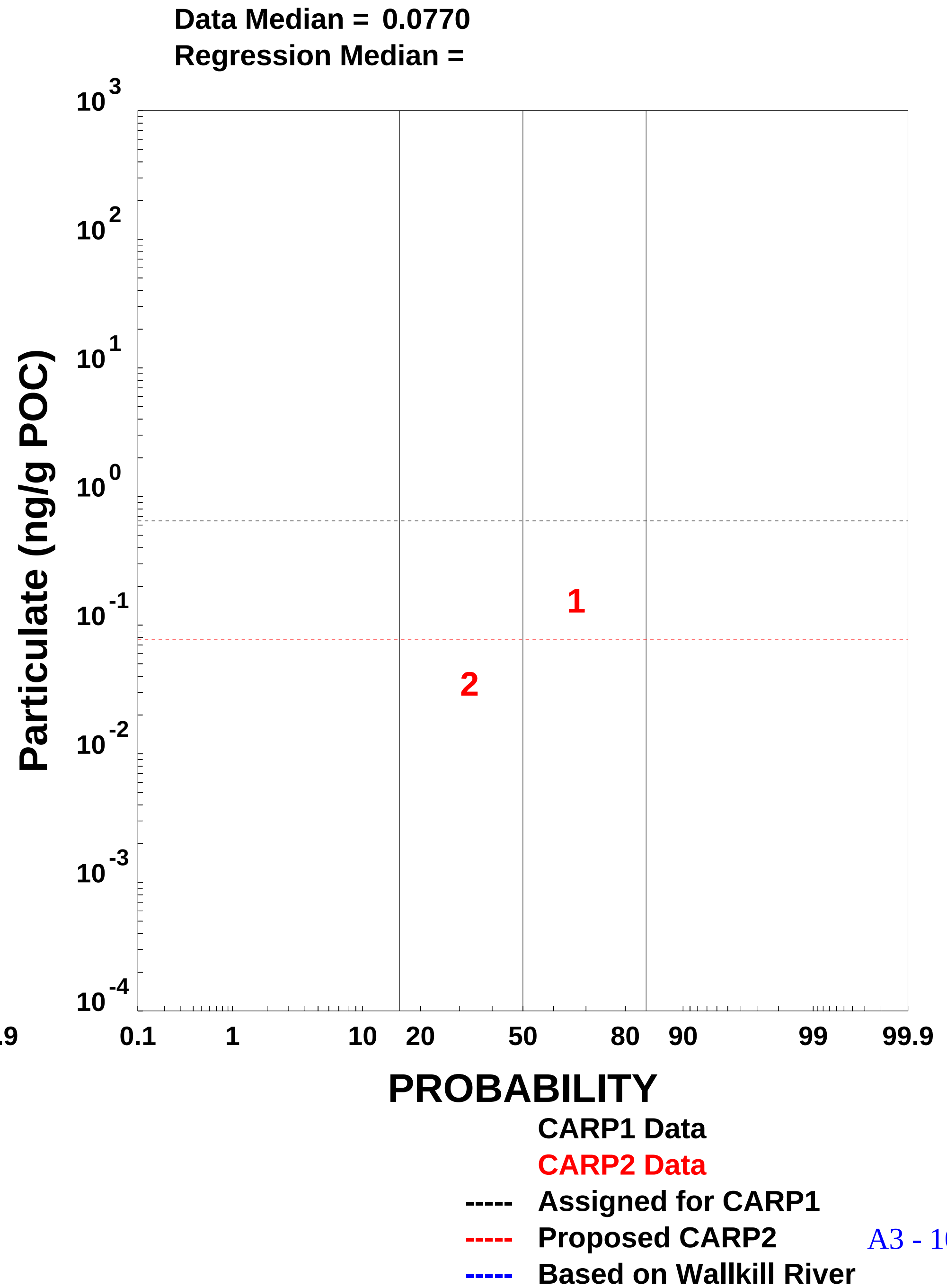


ELIZABETH RIVER AT HILLSIDE -- OCDF

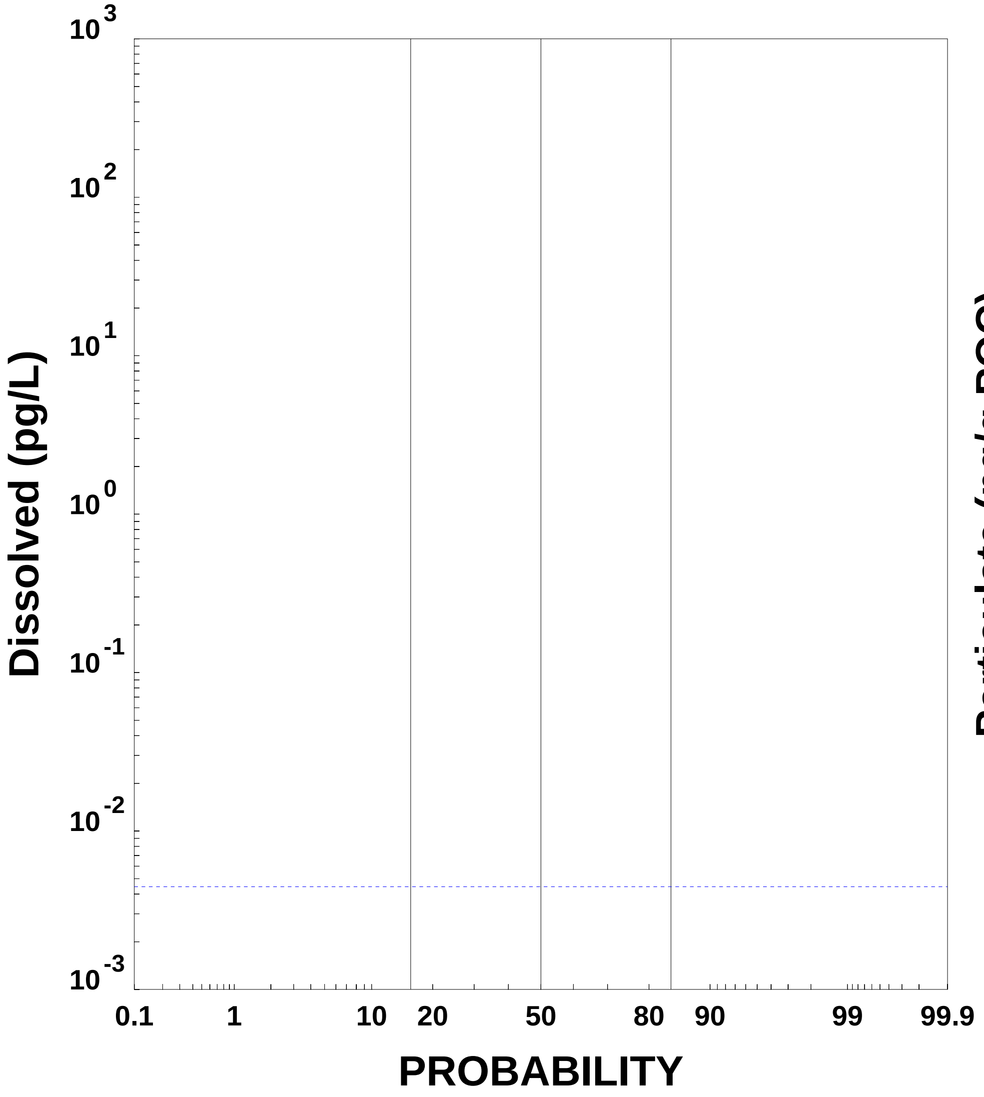


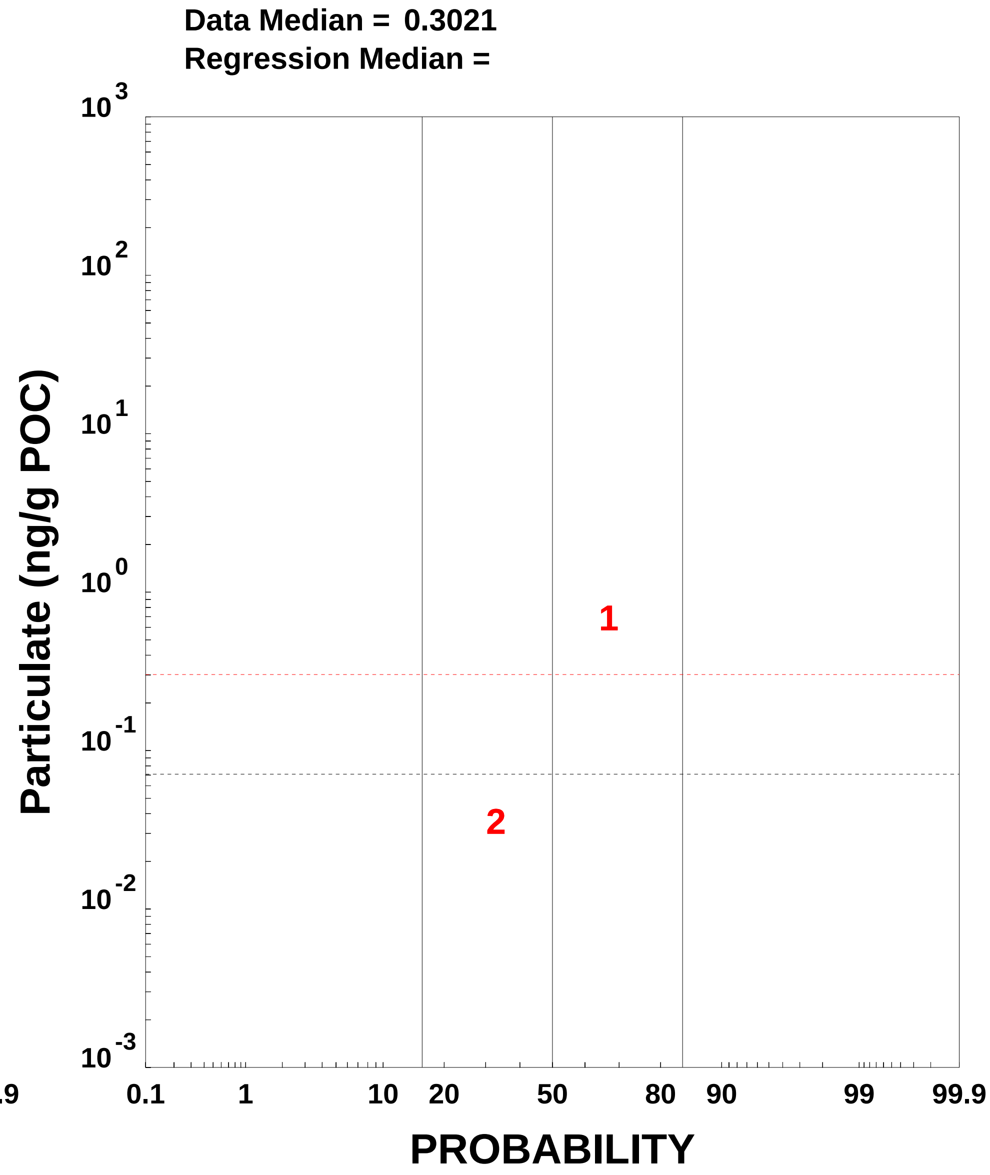
SADDLE RIVER -- 2,3,7,8-TCDD



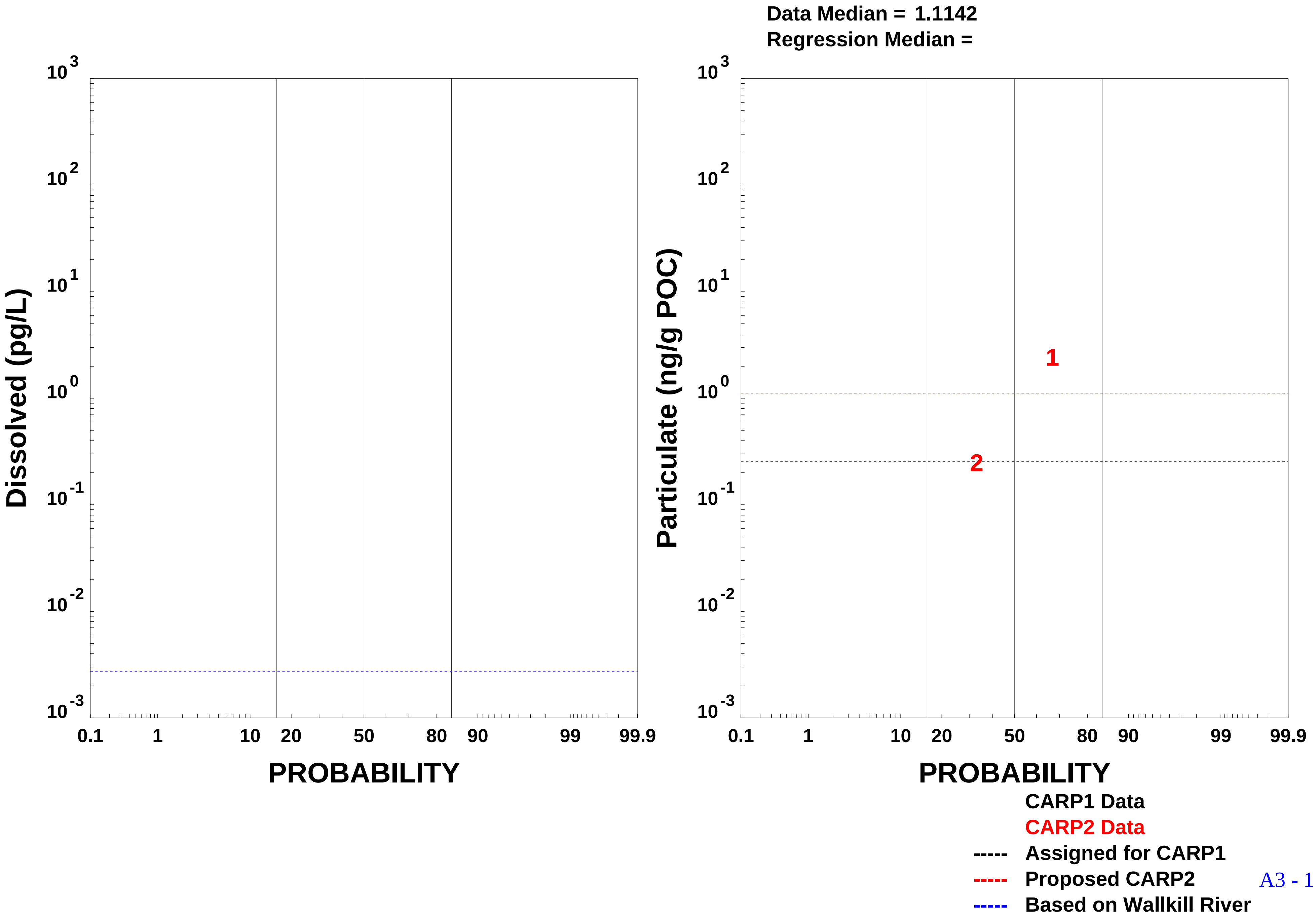


SADDLE RIVER -- 1,2,3,7,8-PeCDD



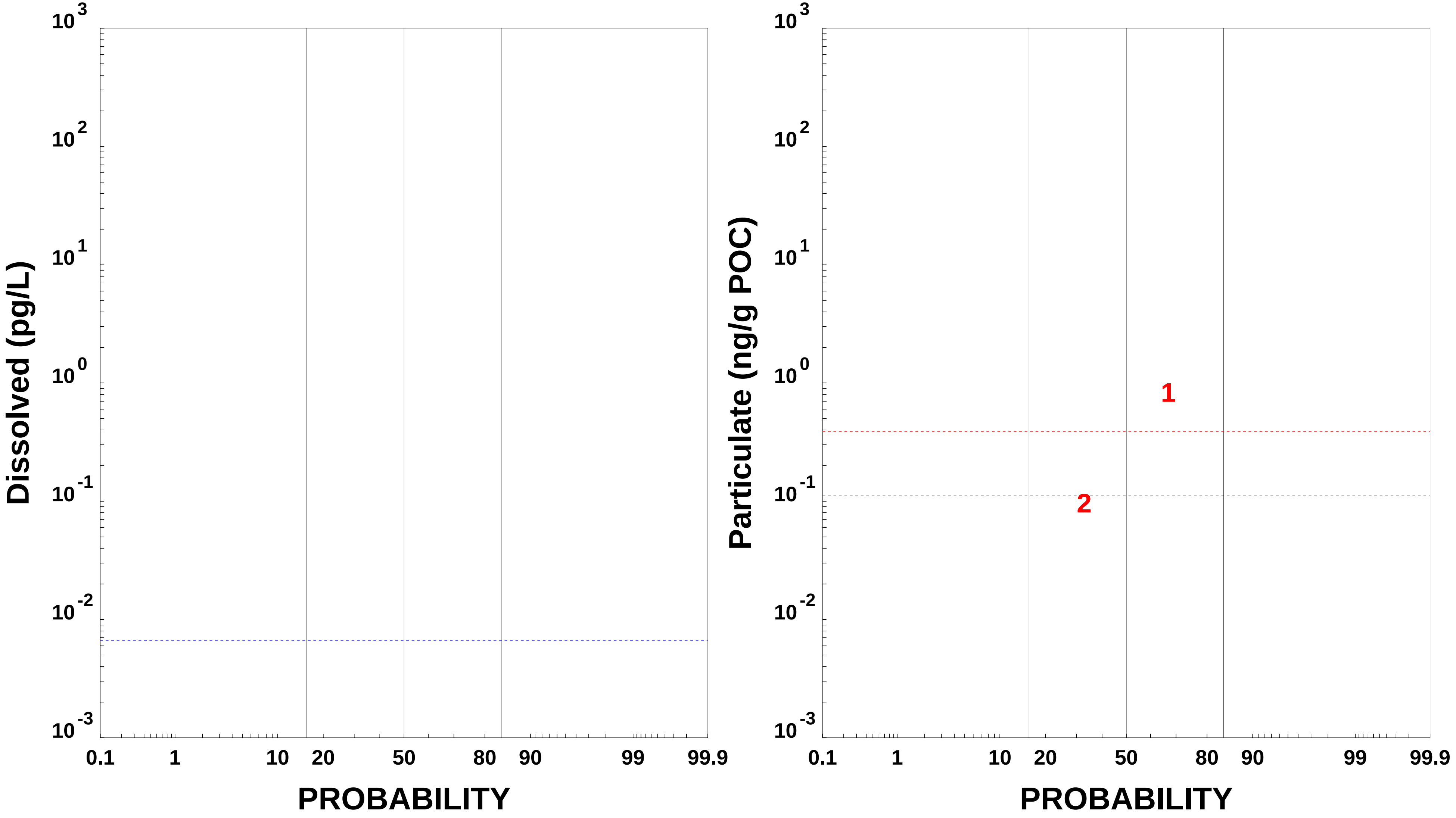


SADDLE RIVER -- 1,2,3,7,8,9-HxCDD



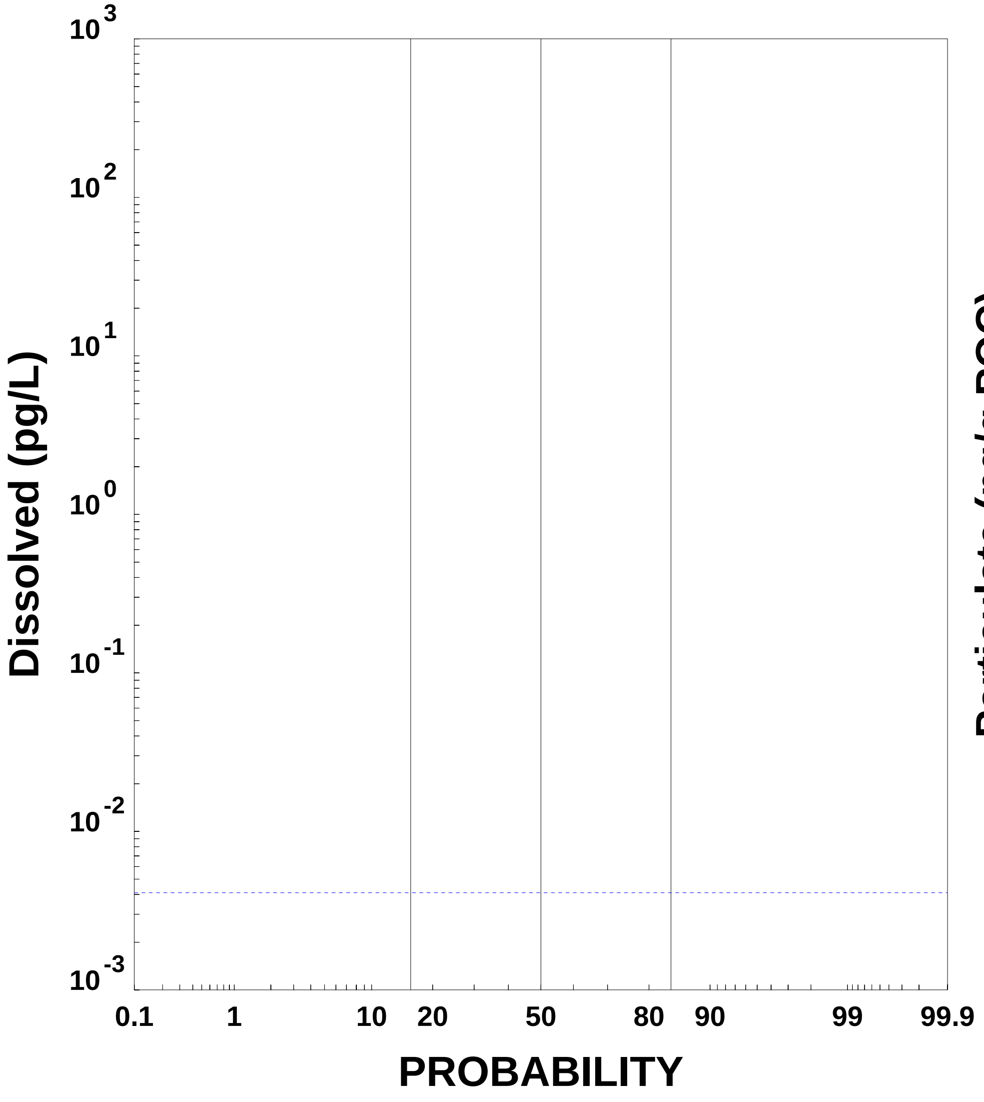
SADDLE RIVER -- 1,2,3,4,7,8-HxCDD

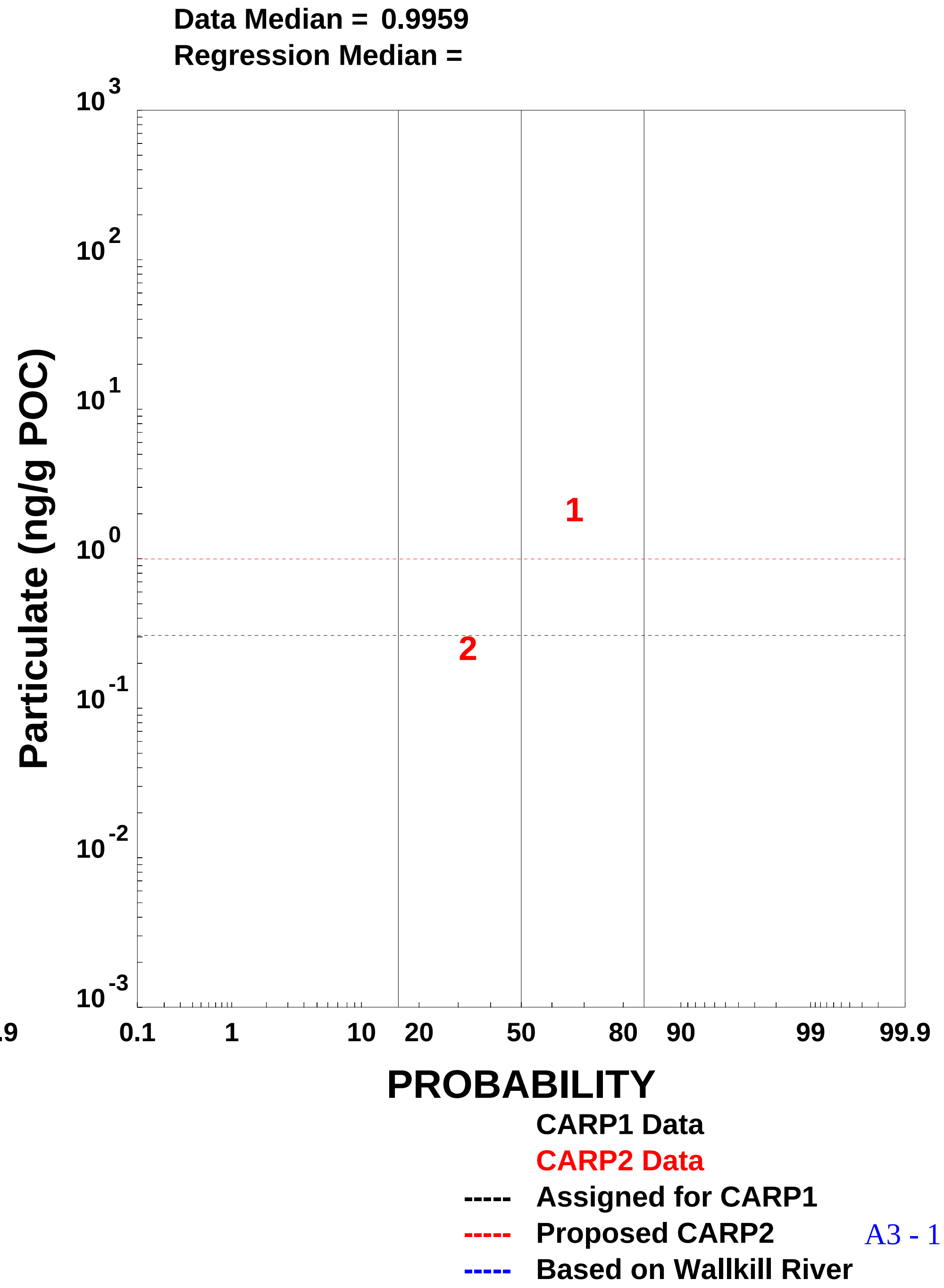
Data Median = 0.3880
Regression Median =



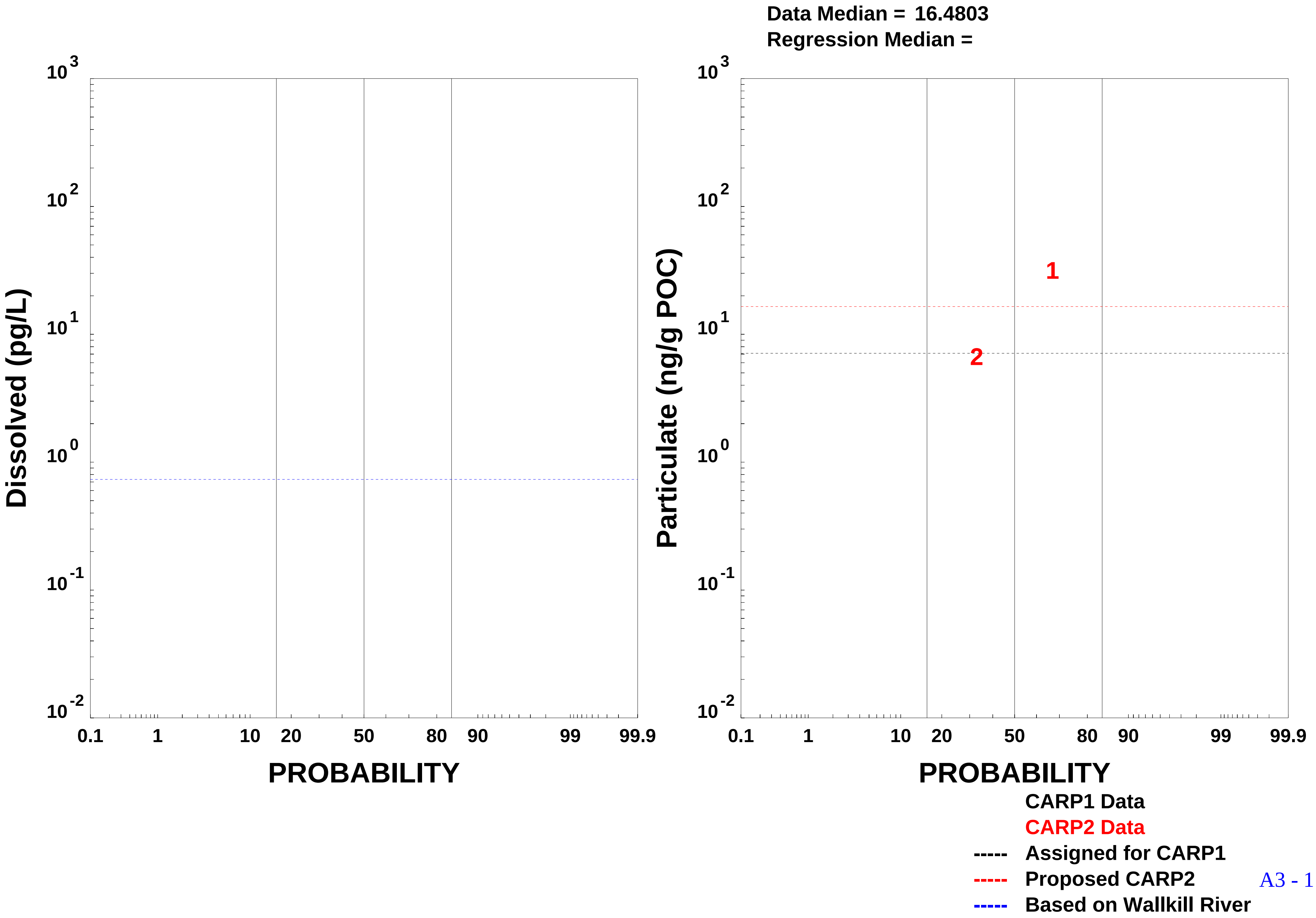
CARP1 Data
CARP2 Data
----- Assigned for CARP1
----- Proposed CARP2
----- Based on Wallkill River

SADDLE RIVER -- 1,2,3,6,7,8-HxCDD

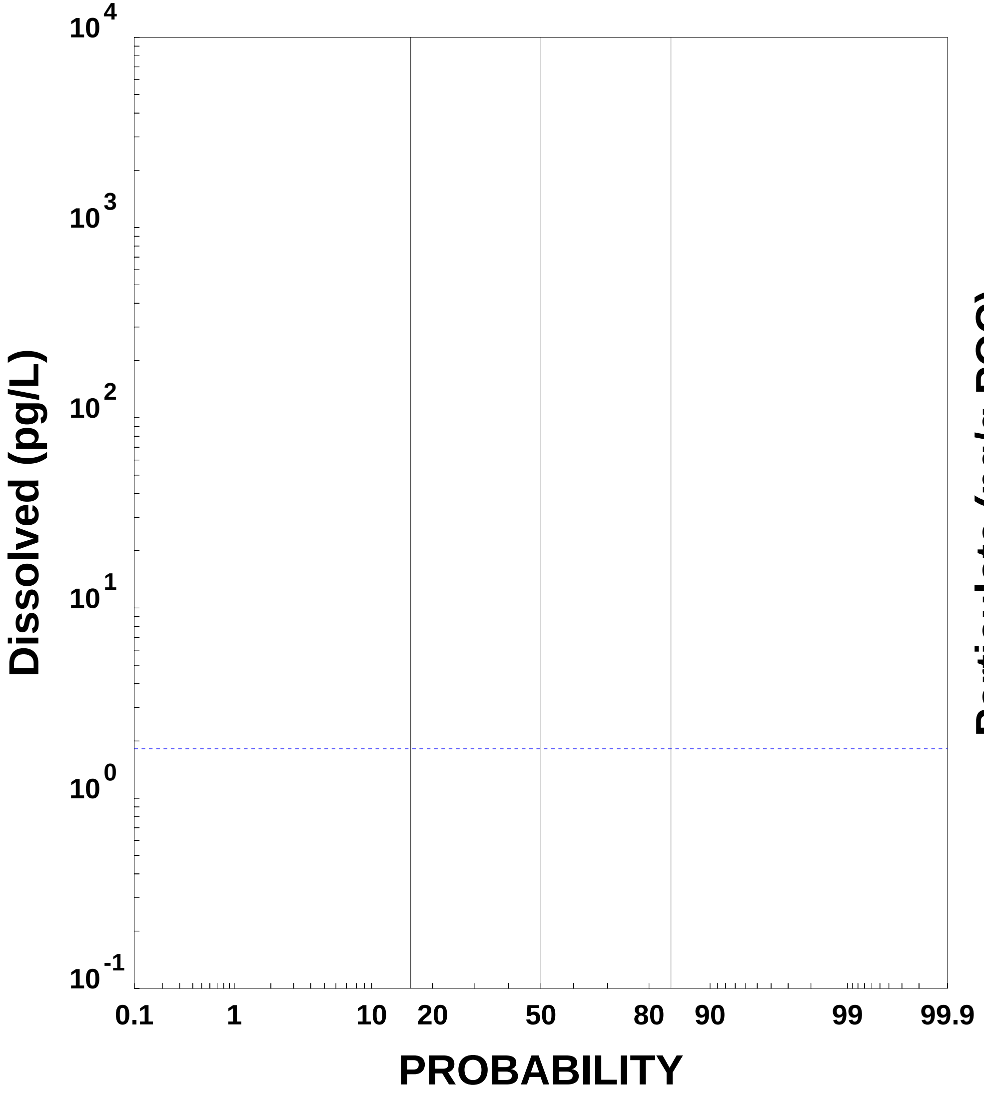


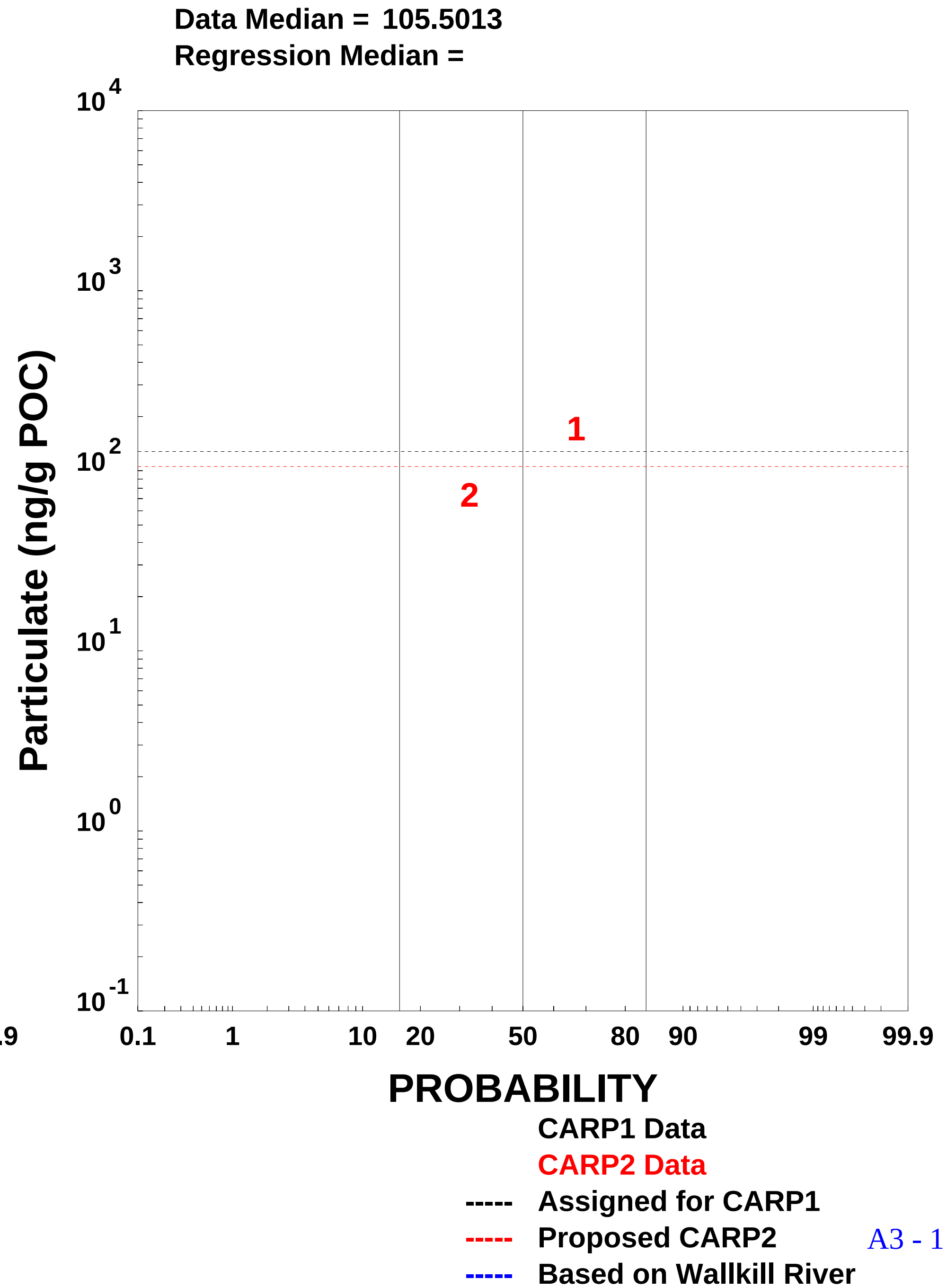


SADDLE RIVER -- 1,2,3,4,6,7,8-HpCDD

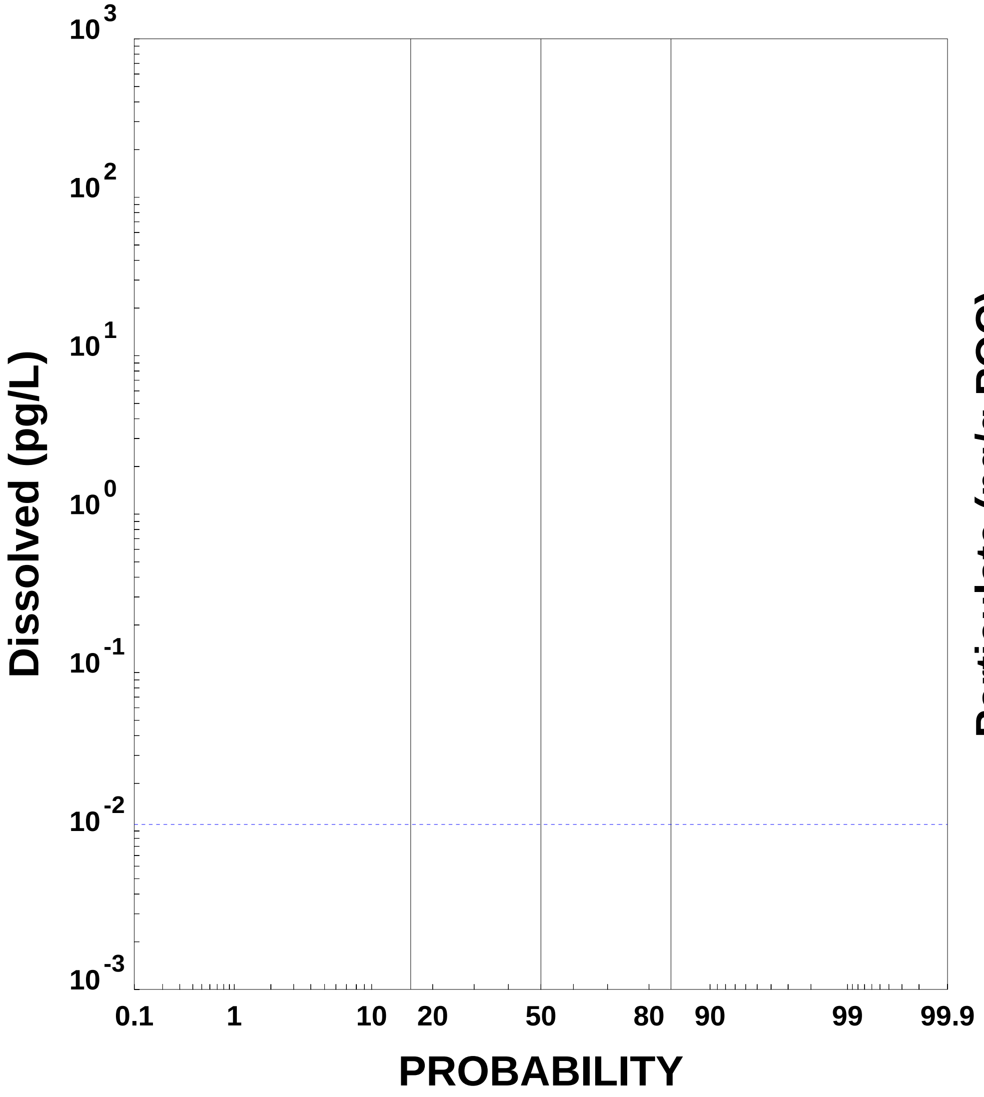


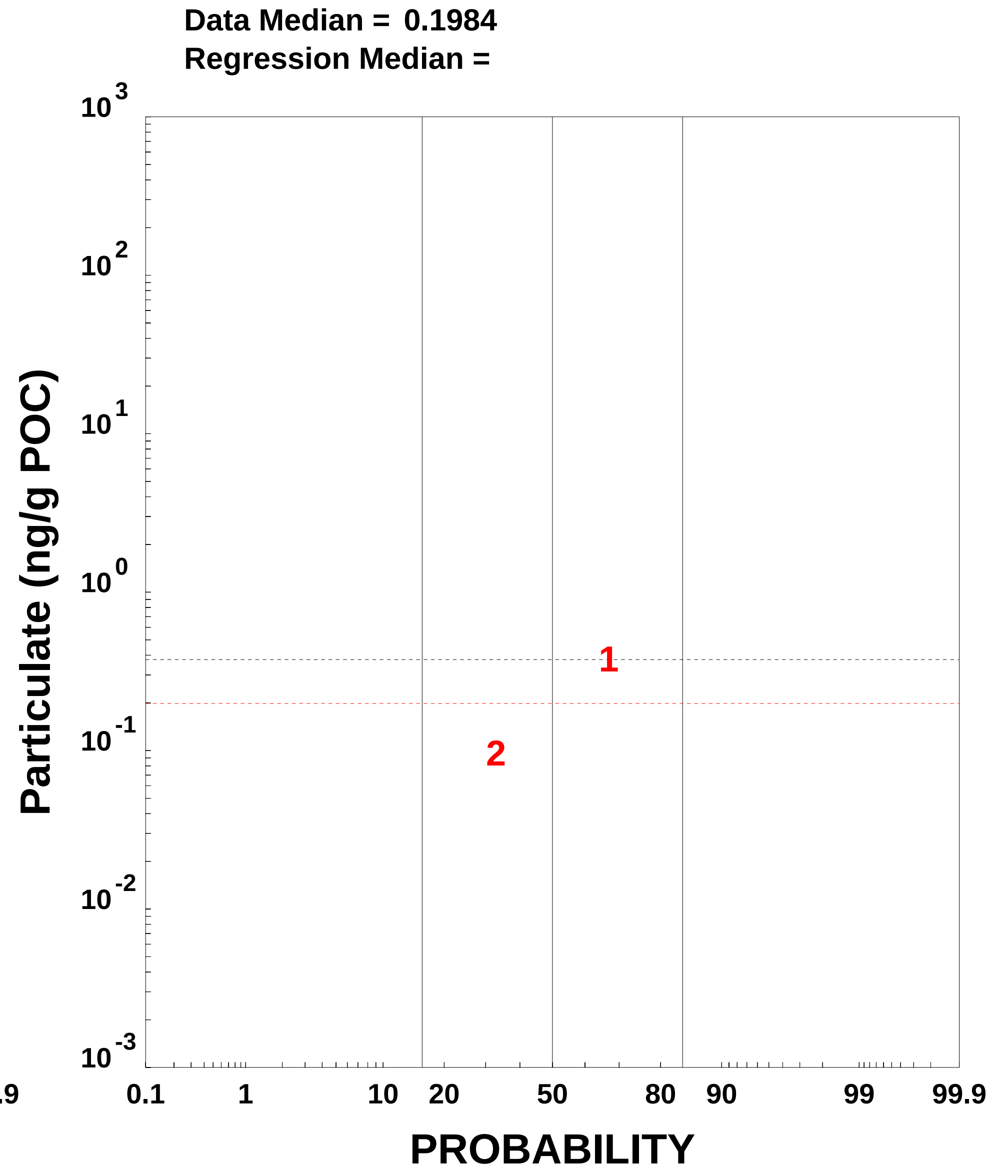
SADDLE RIVER -- OCDD



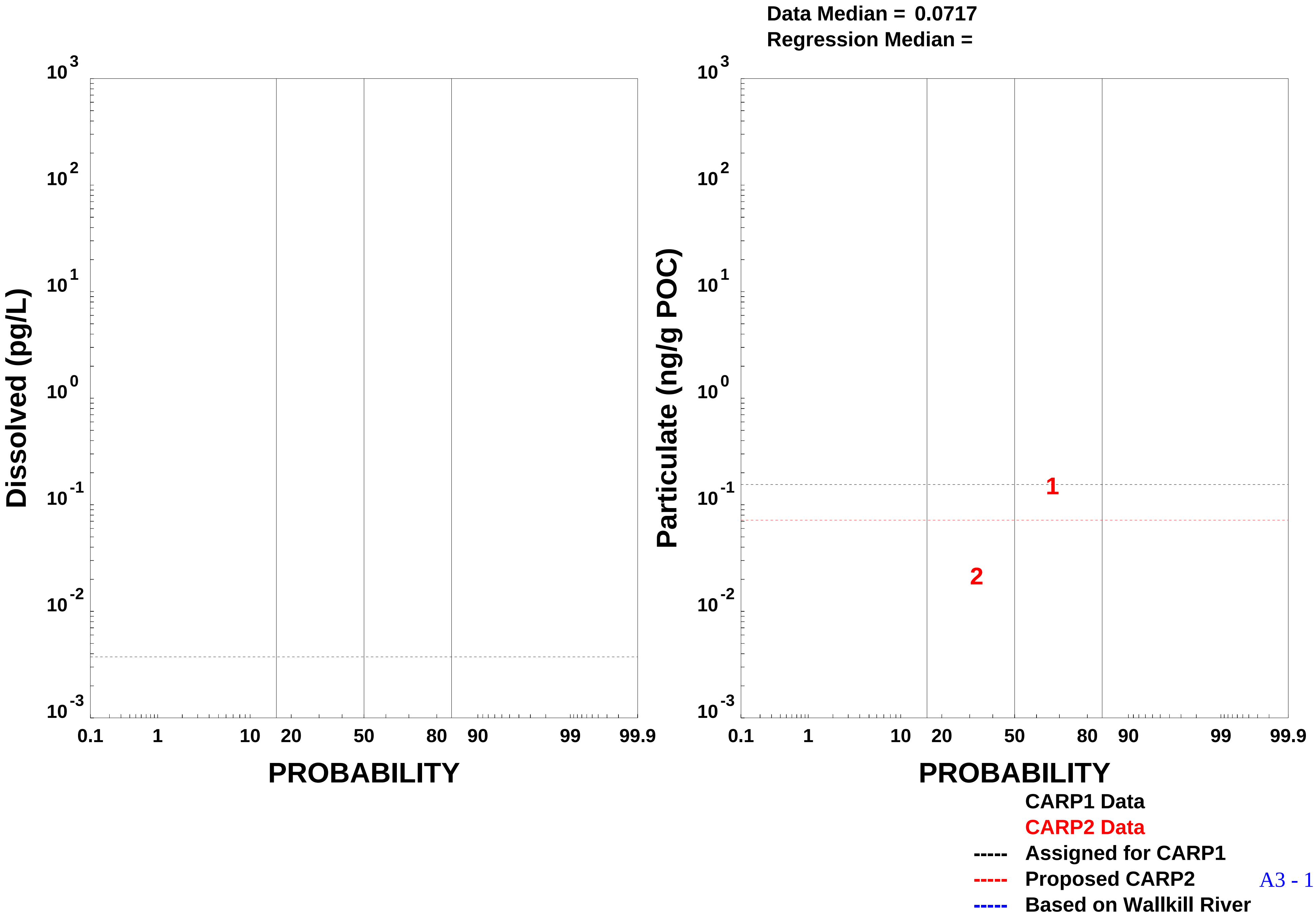


SADDLE RIVER -- 2,3,7,8-TCDF

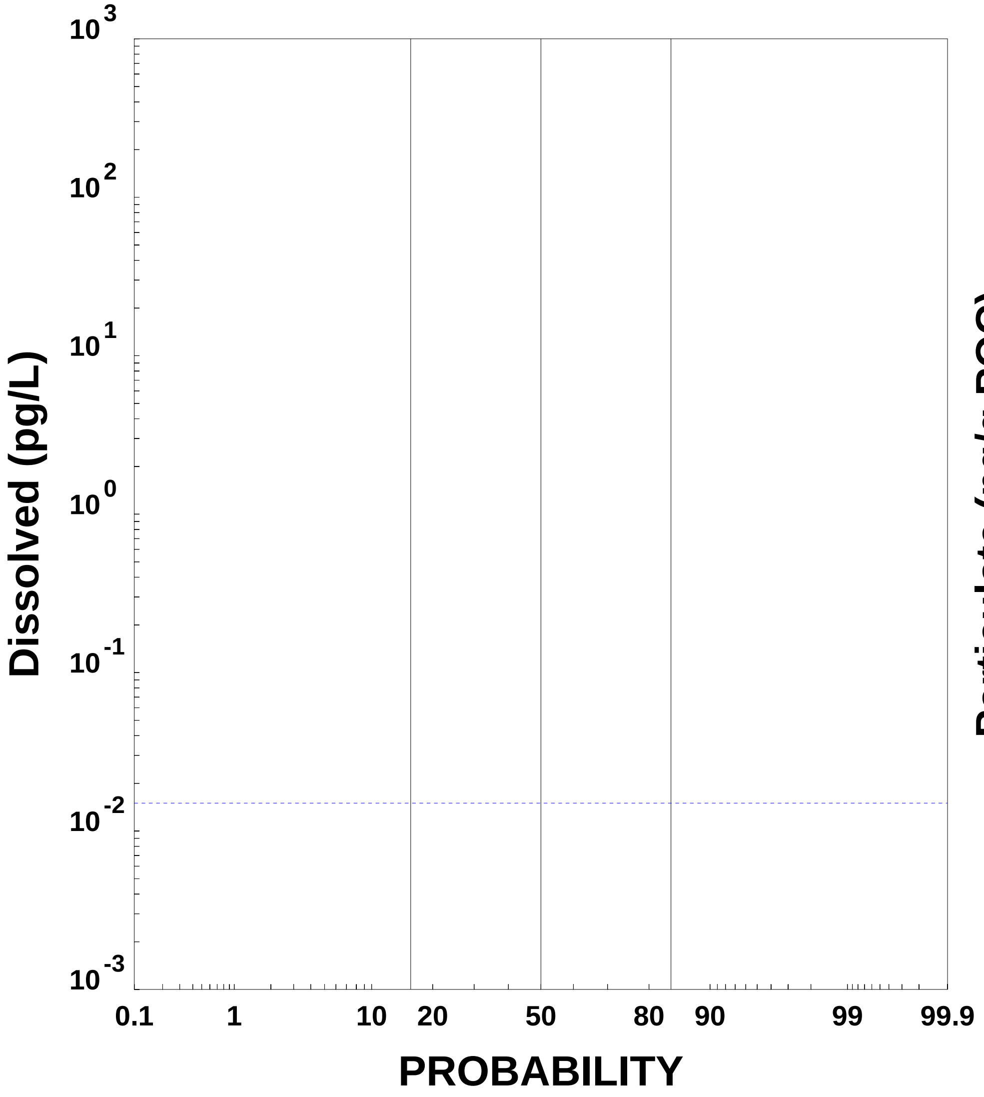


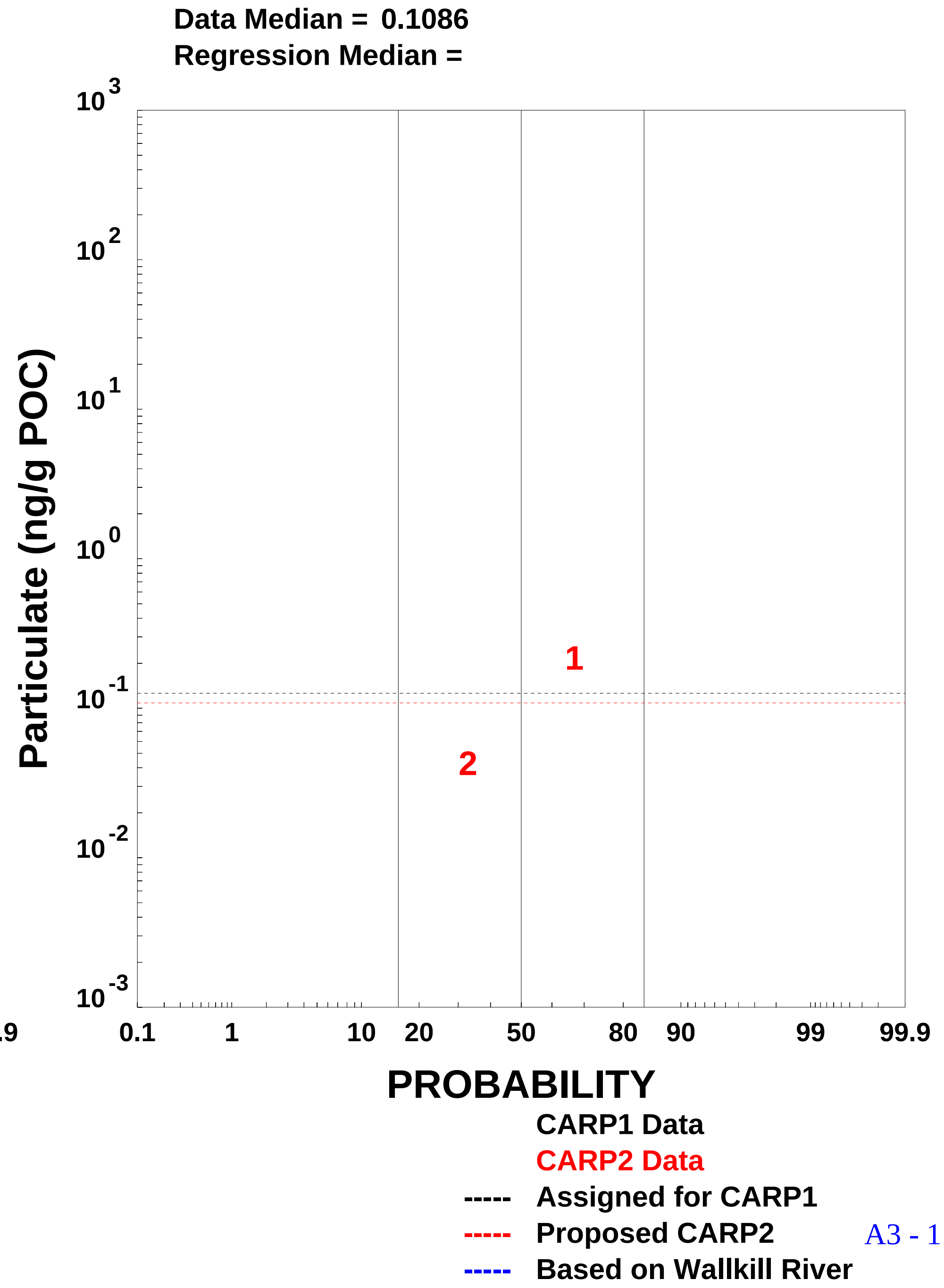


SADDLE RIVER -- 1,2,3,7,8-PeCDF

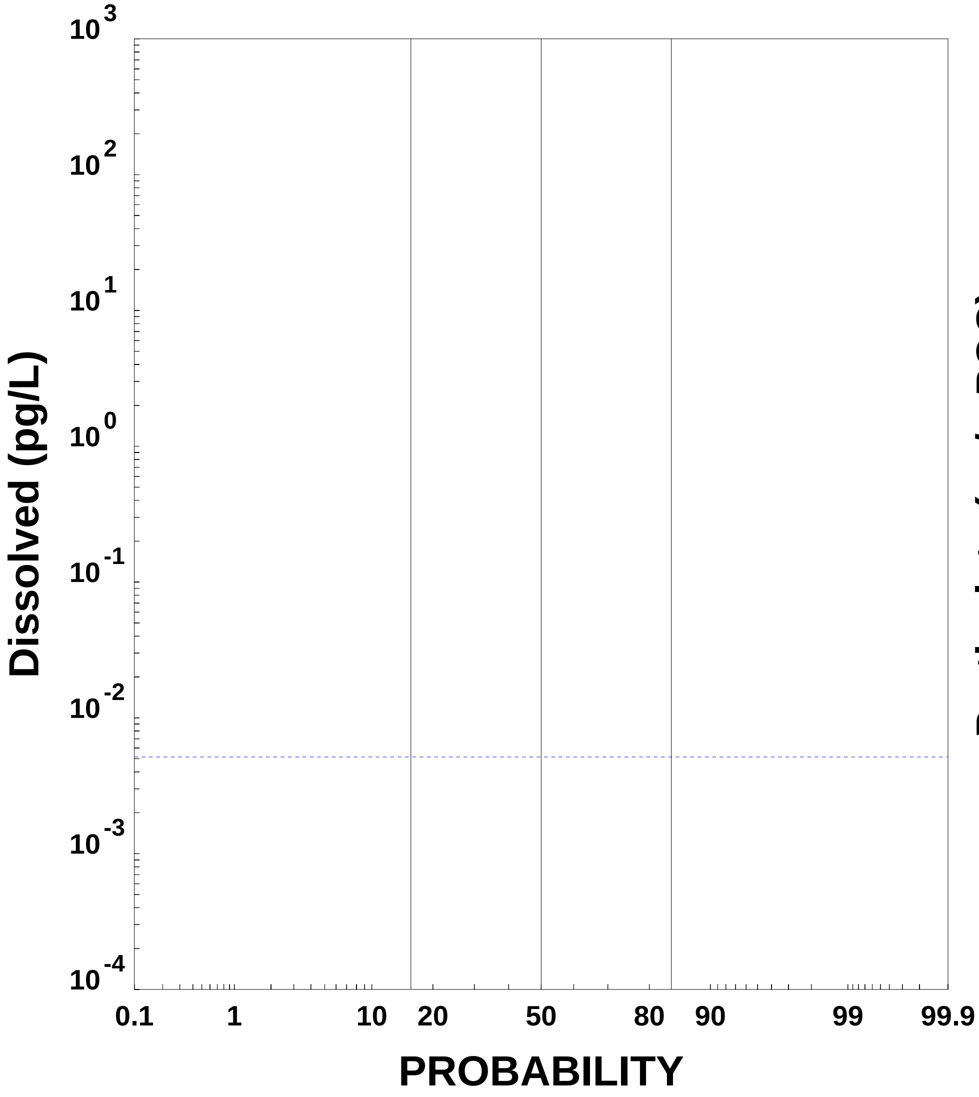


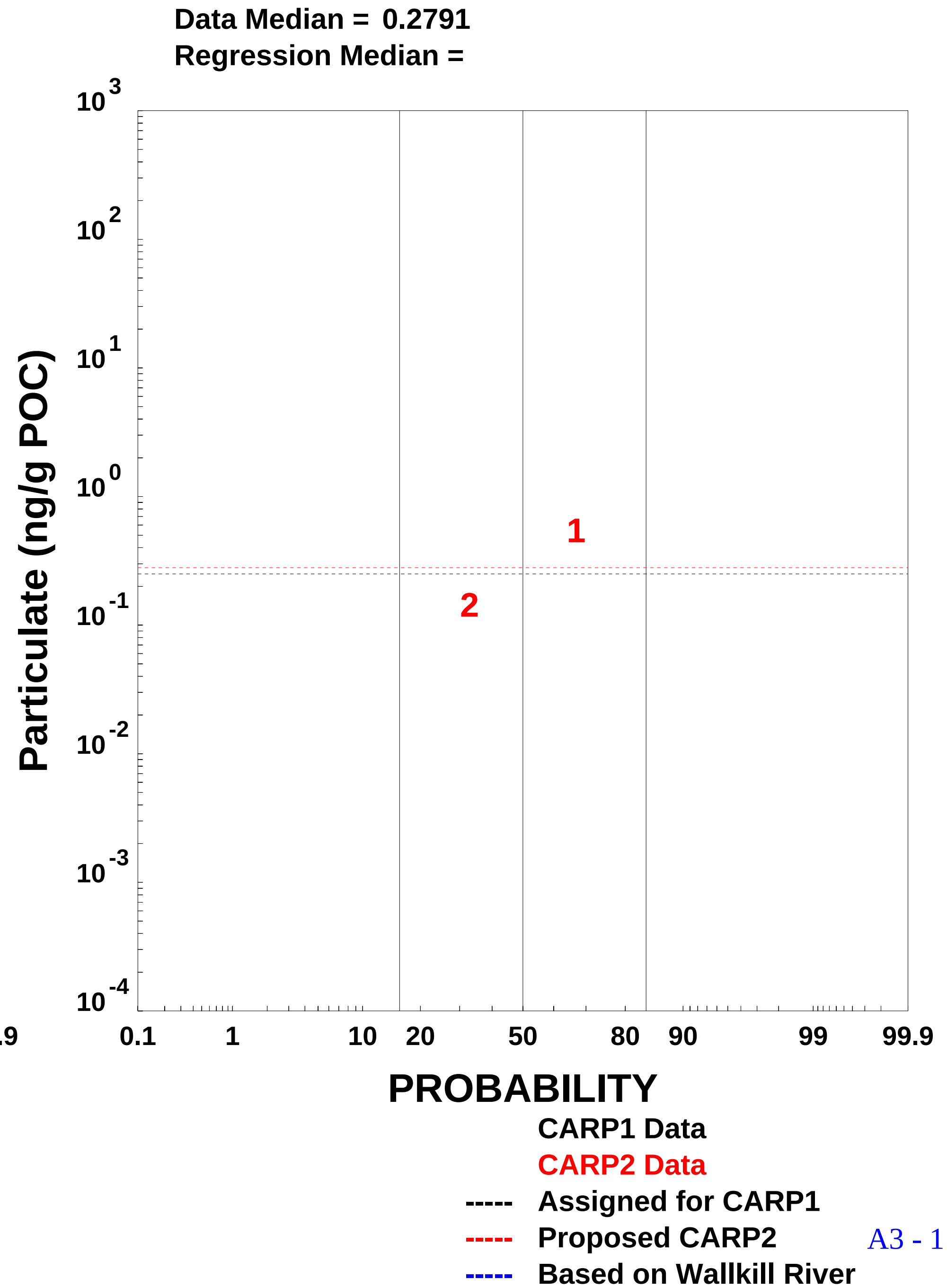
SADDLE RIVER -- 2,3,4,7,8-PeCDF



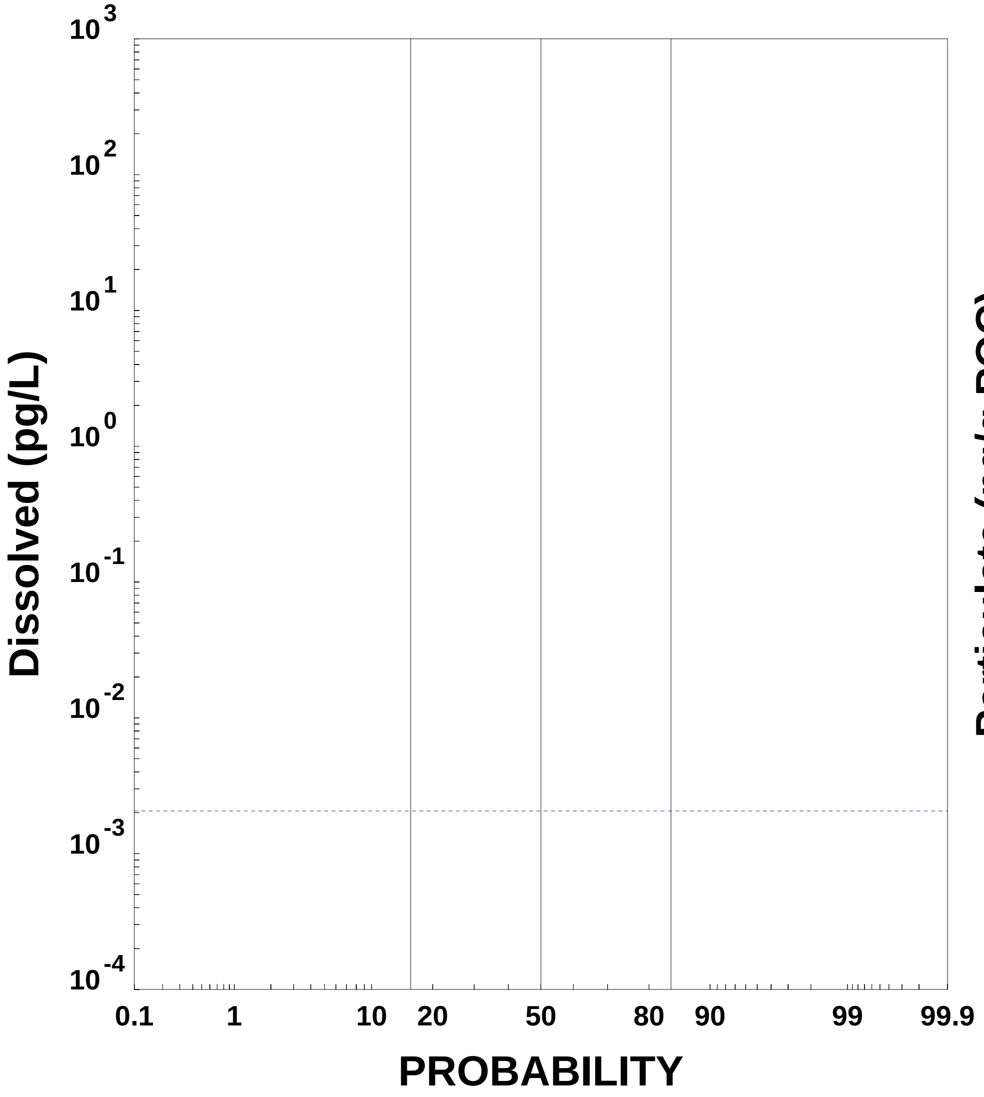


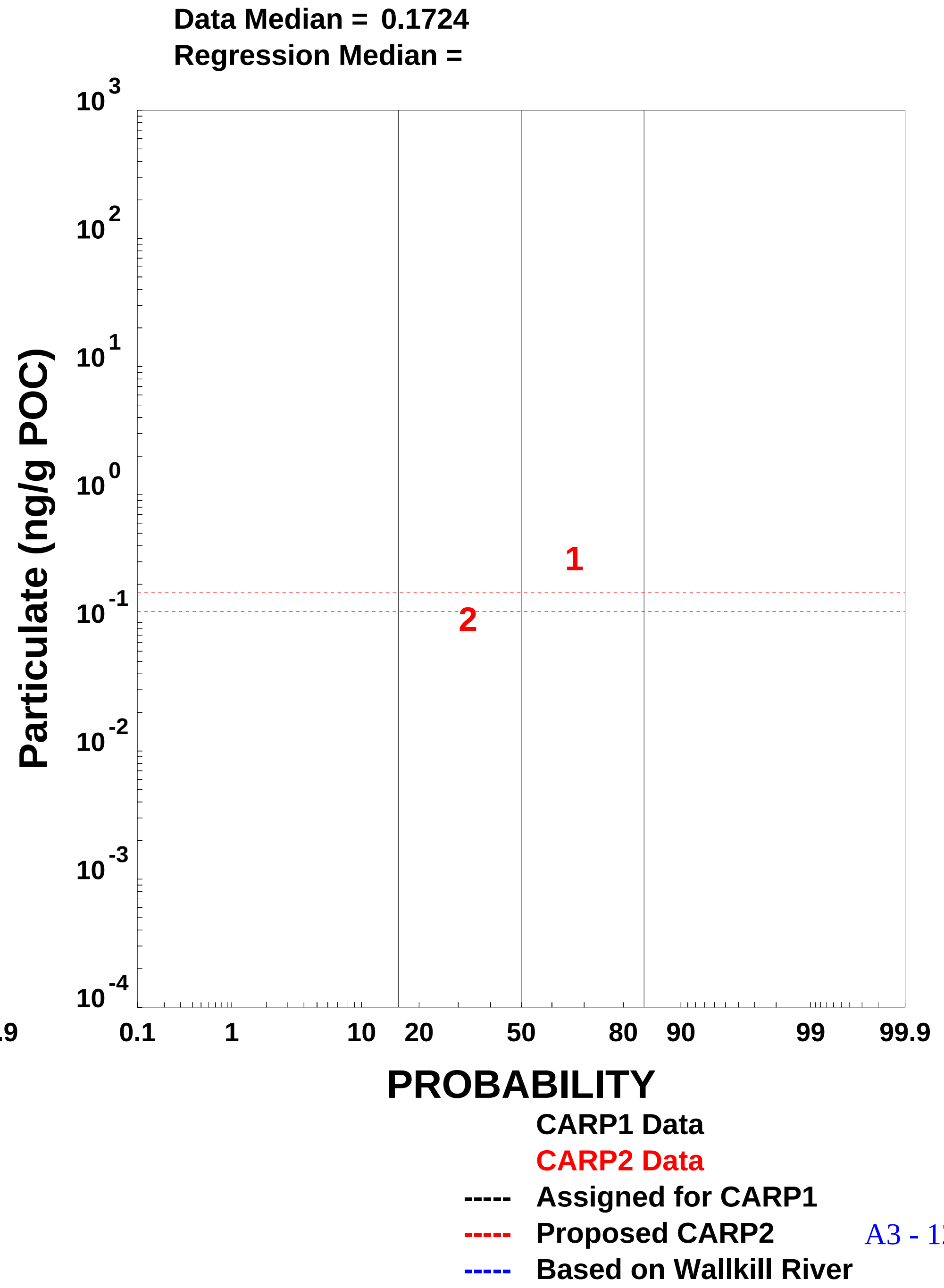
SADDLE RIVER -- 1,2,3,4,7,8-HxCDF



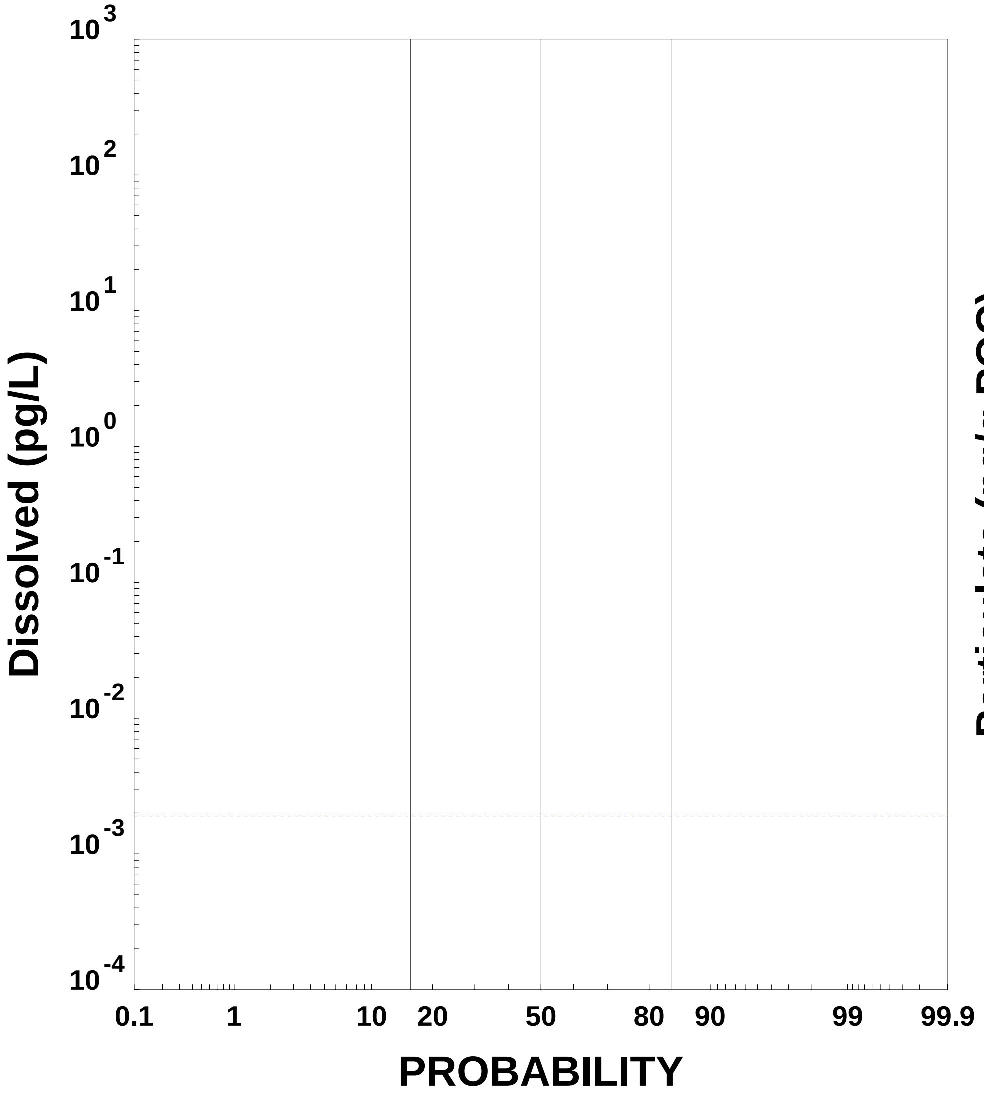


SADDLE RIVER -- 2,3,4,6,7,8-HxCDF

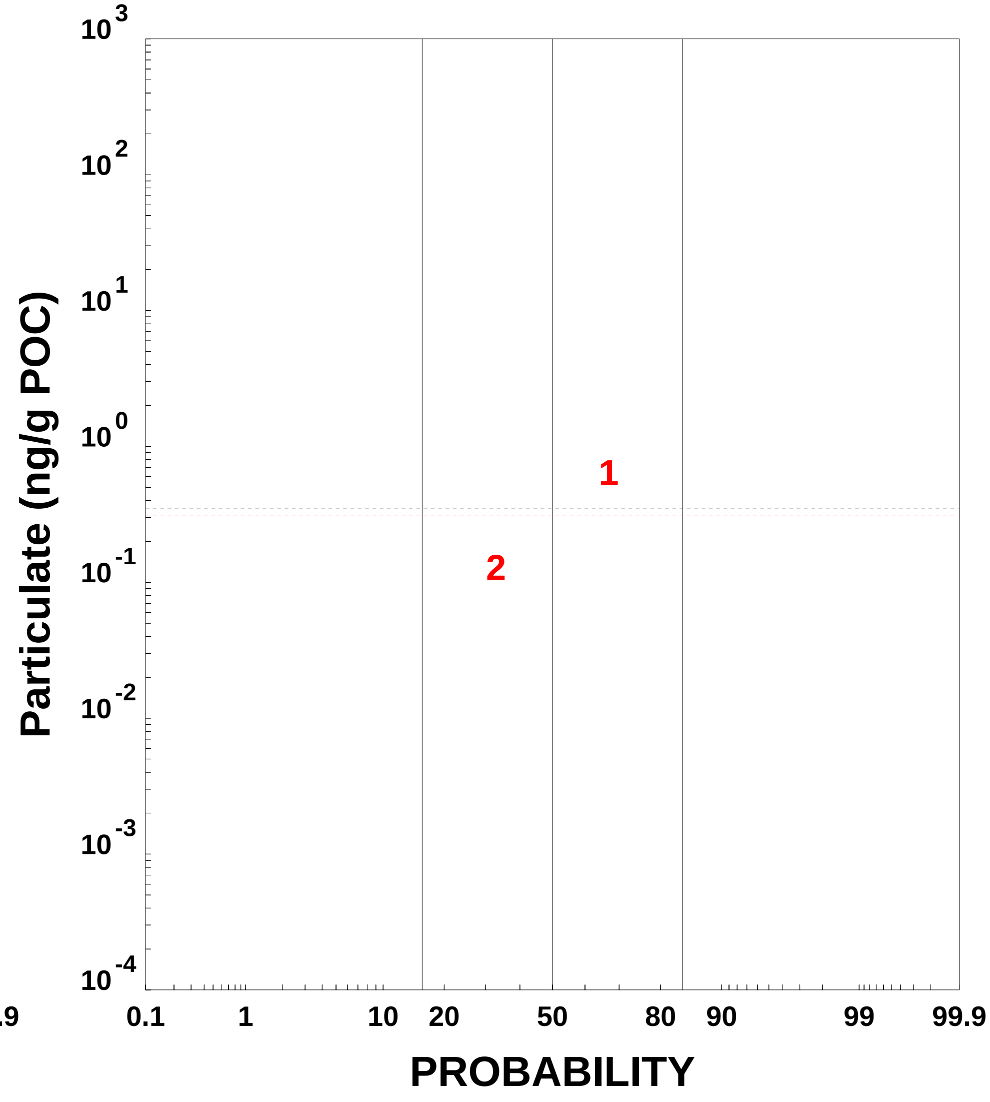




SADDLE RIVER -- 1,2,3,6,7,8-HxCDF

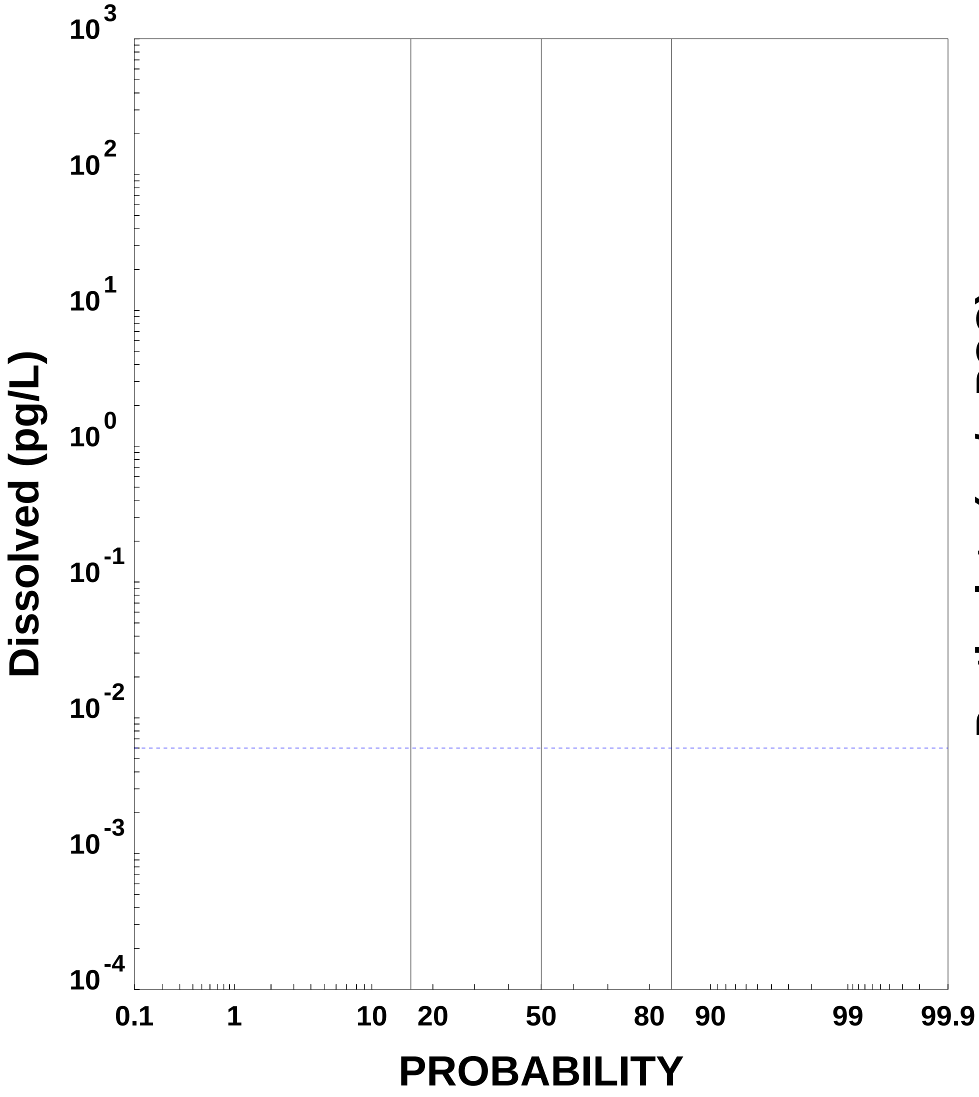


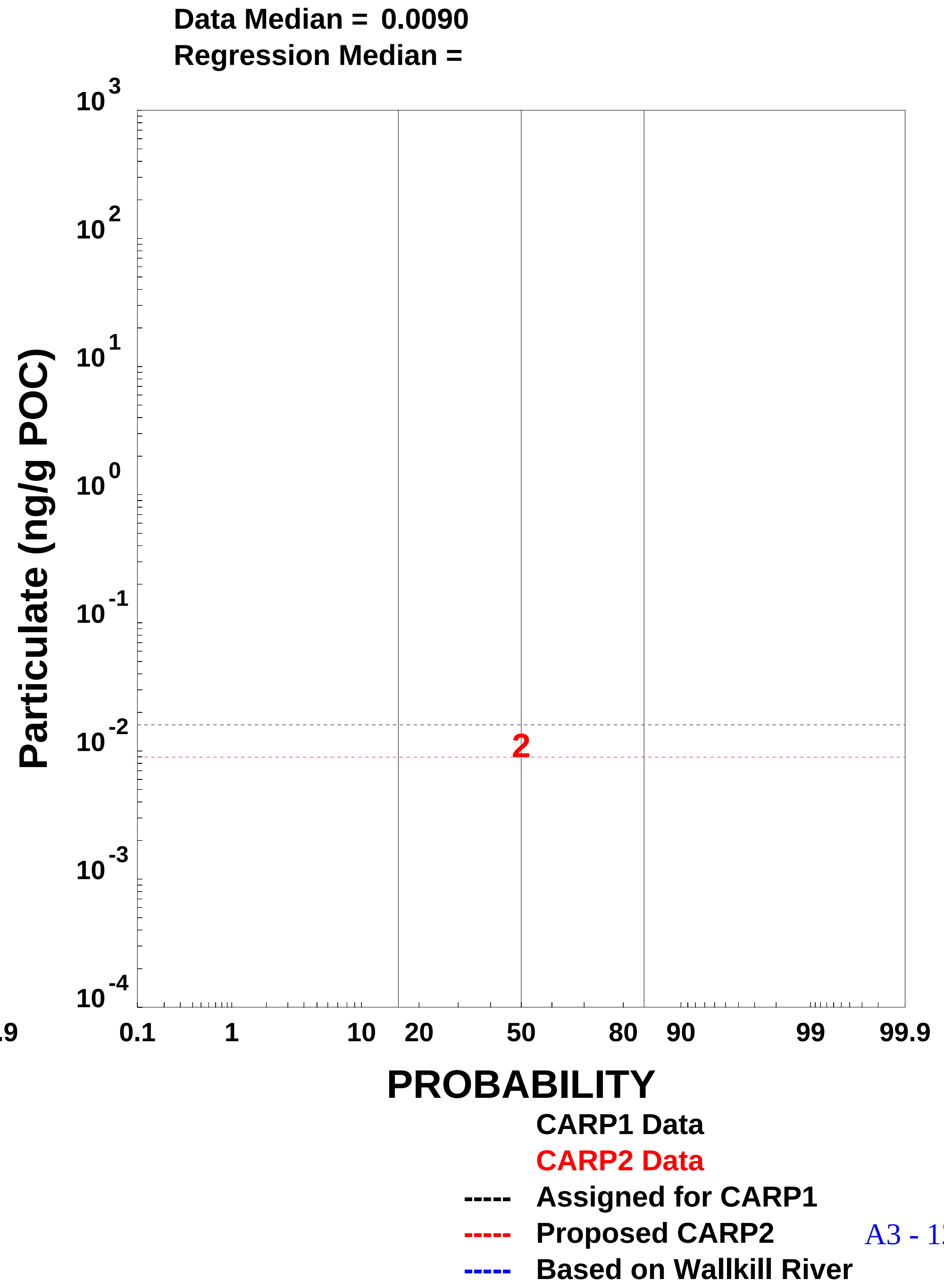
Data Median = 0.3127
Regression Median =



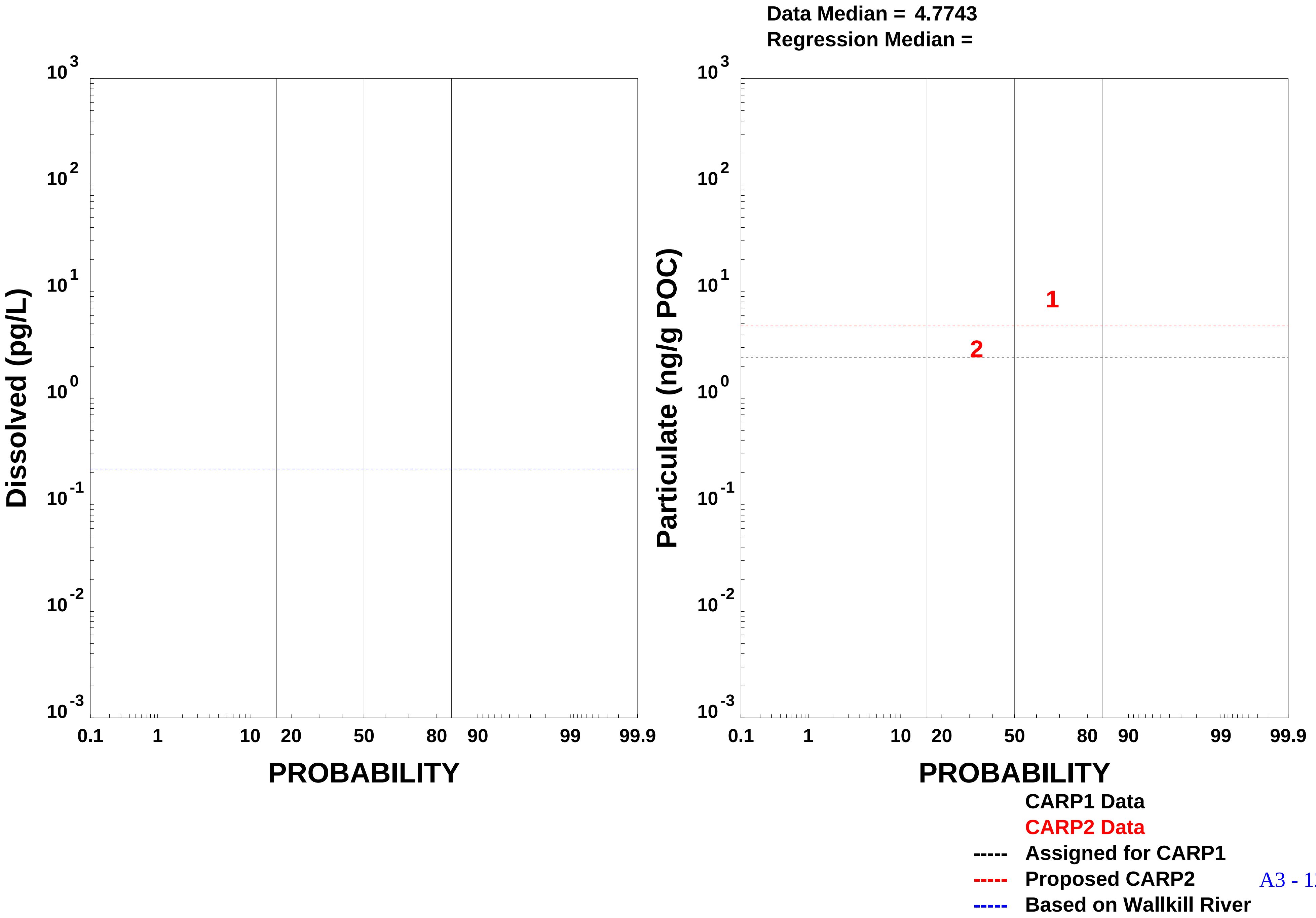
CARP1 Data
CARP2 Data
----- Assigned for CARP1
----- Proposed CARP2
----- Based on Wallkill River

SADDLE RIVER -- 1,2,3,7,8,9-HxCDF

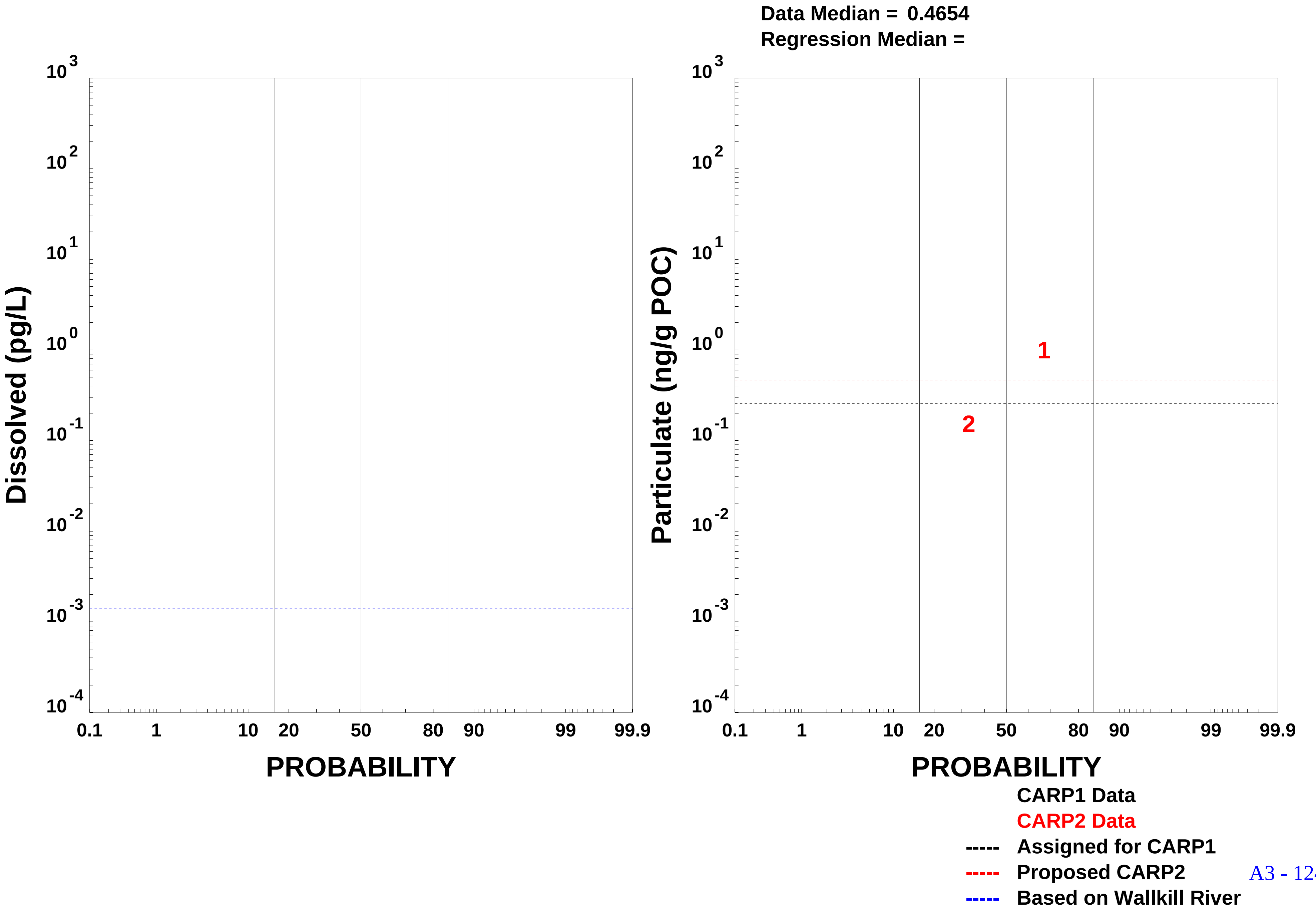




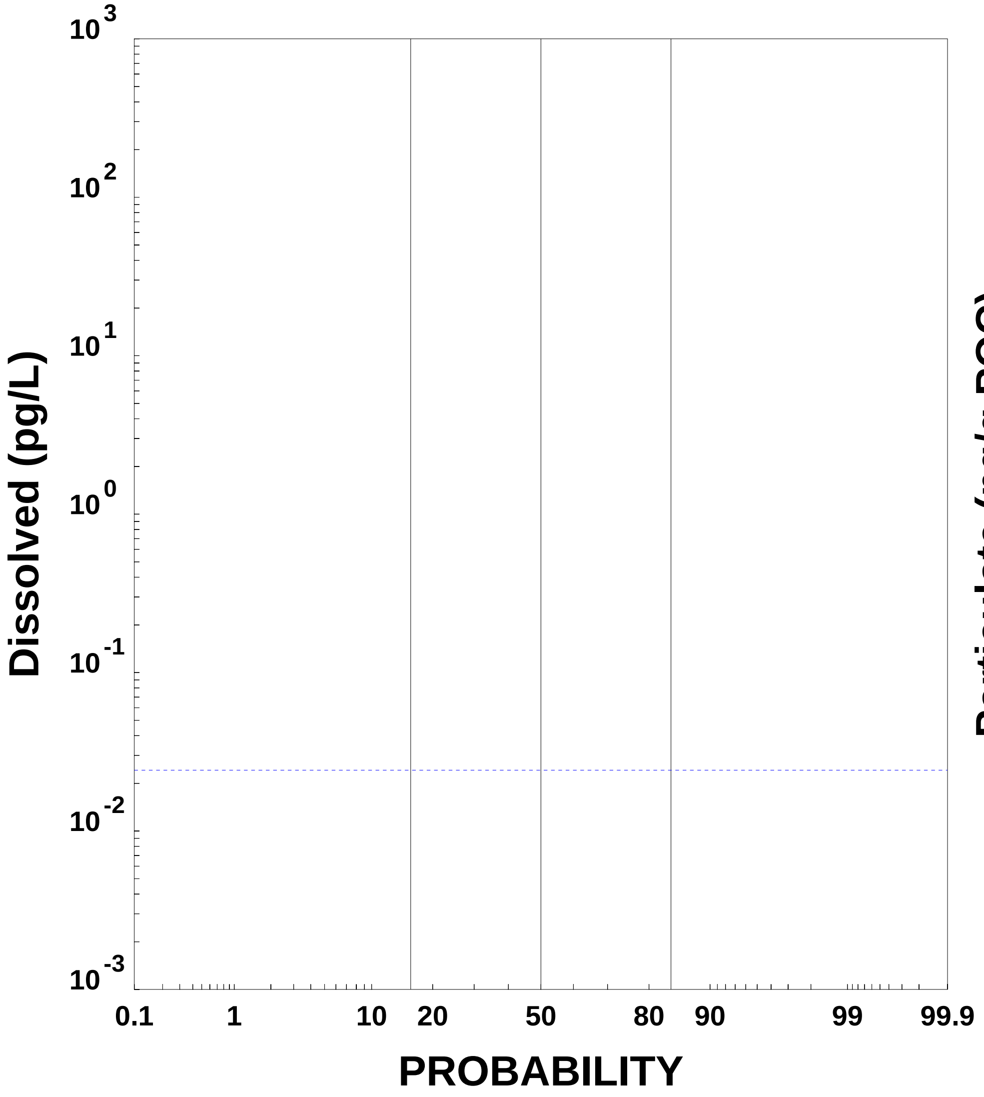
SADDLE RIVER -- 1,2,3,4,6,7,8-HpCDF

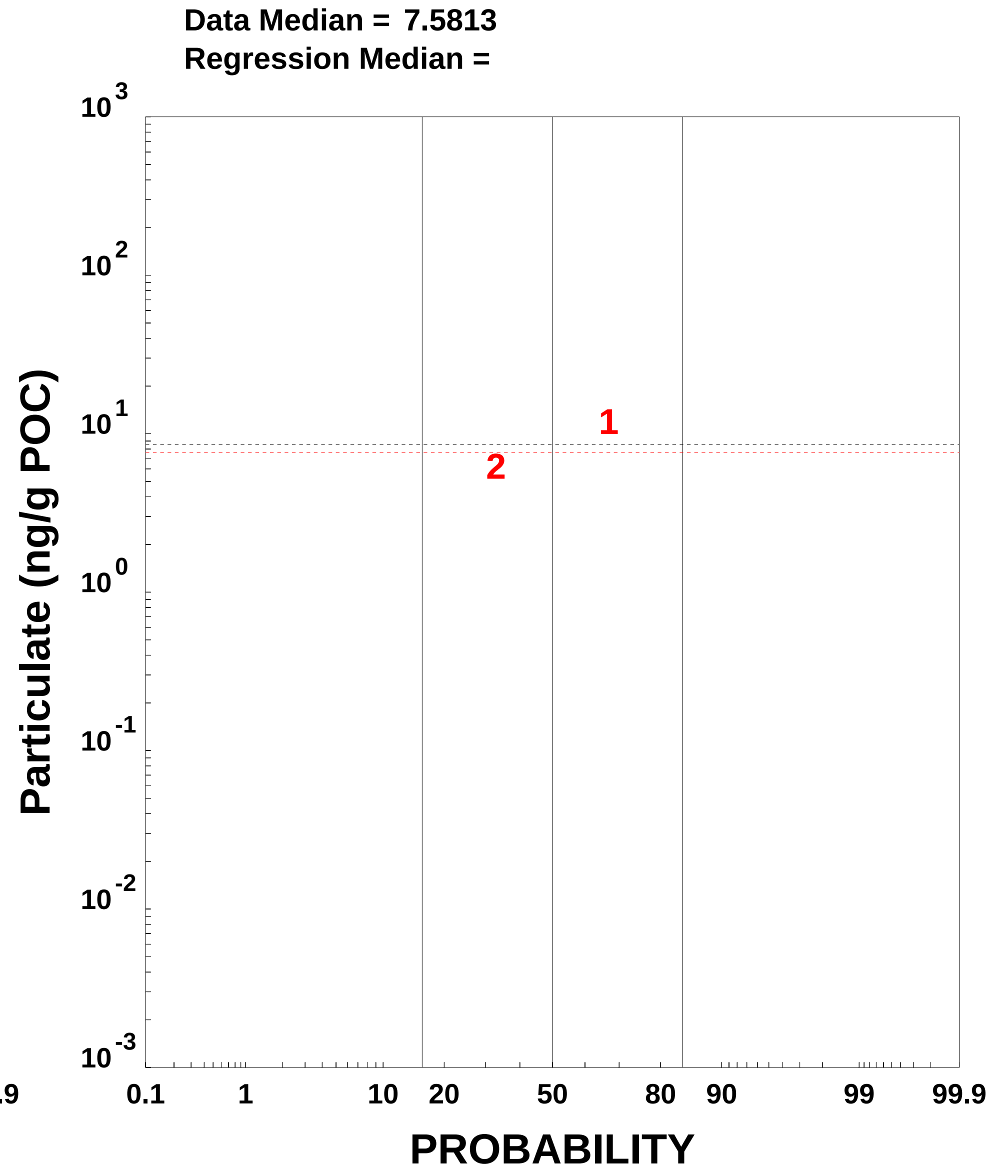


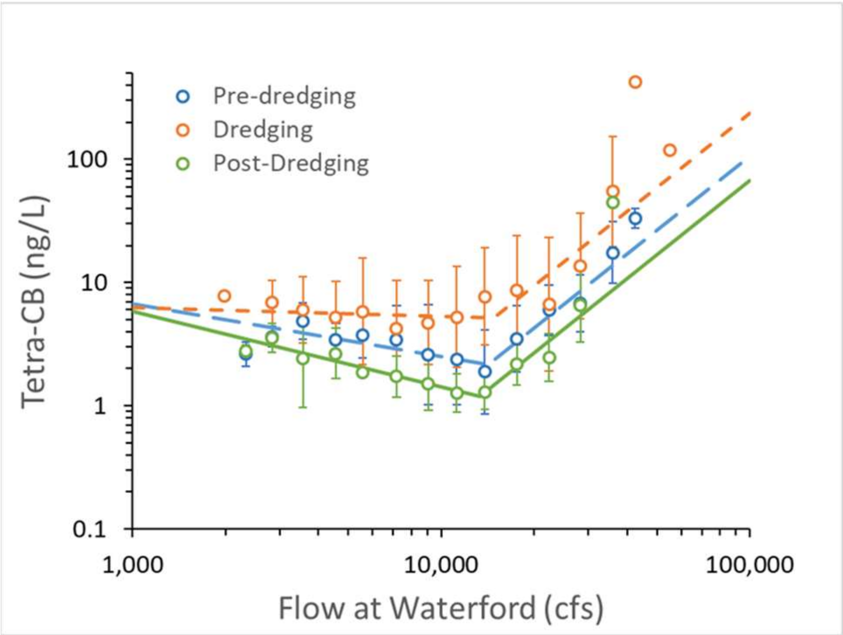
SADDLE RIVER -- 1,2,3,4,7,8,9-HpCDF

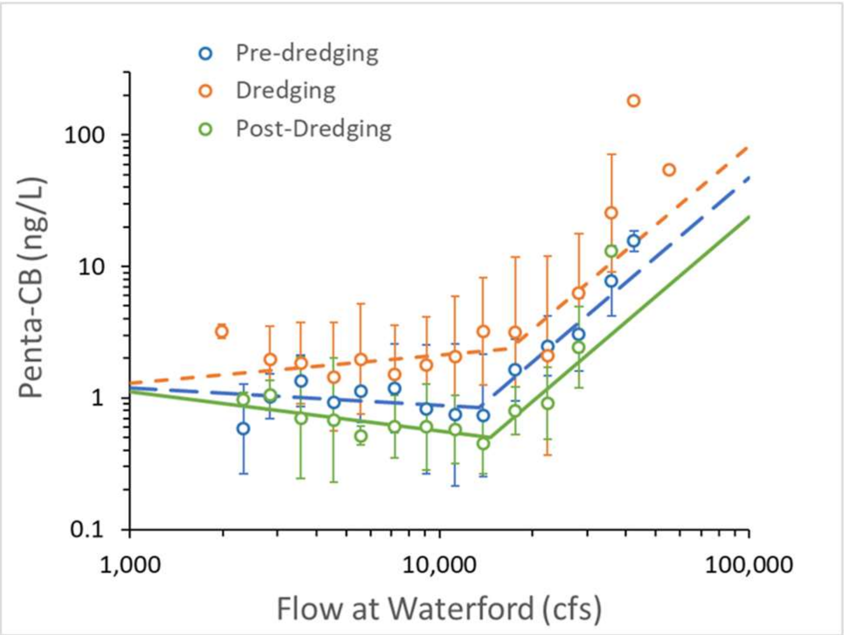


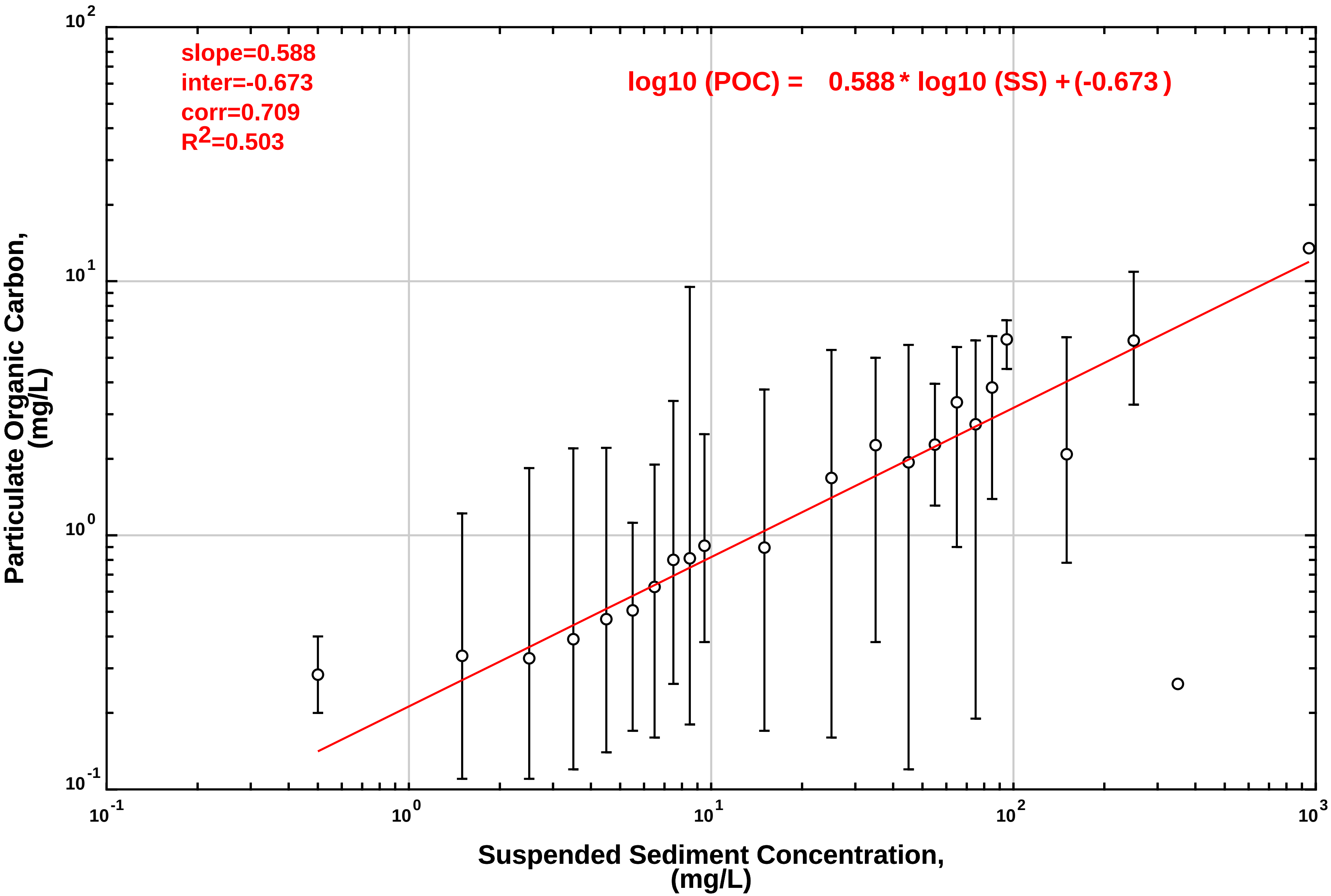
SADDLE RIVER -- OCDF






Pre-dredging
Dredging
Post-Dredging
Tetra-CB (ng/L)
100
10
1
0.1
1,000
10,000
100,000
Flow at Waterford (cfs)


Pre-dredging
Dredging
Post-Dredging
Penta-CB (ng/L)
100
10
1
0.1
1,000
10,000
100,000
Flow at Waterford (cfs)



All USGS Locations

APPENDIX 4

Stormwater Contaminant Loadings Development Method Diagrams

Log probability diagrams with combined CARP 1, CARP 2, and Superfund stormwater measurements and regressions used for PCB Monte Carlo selections, ten PCB homologs and seventeen dioxin and furan congeners (final diagrams for PCB homologs, initial combined urban and rural diagrams for dioxin and furan congers)

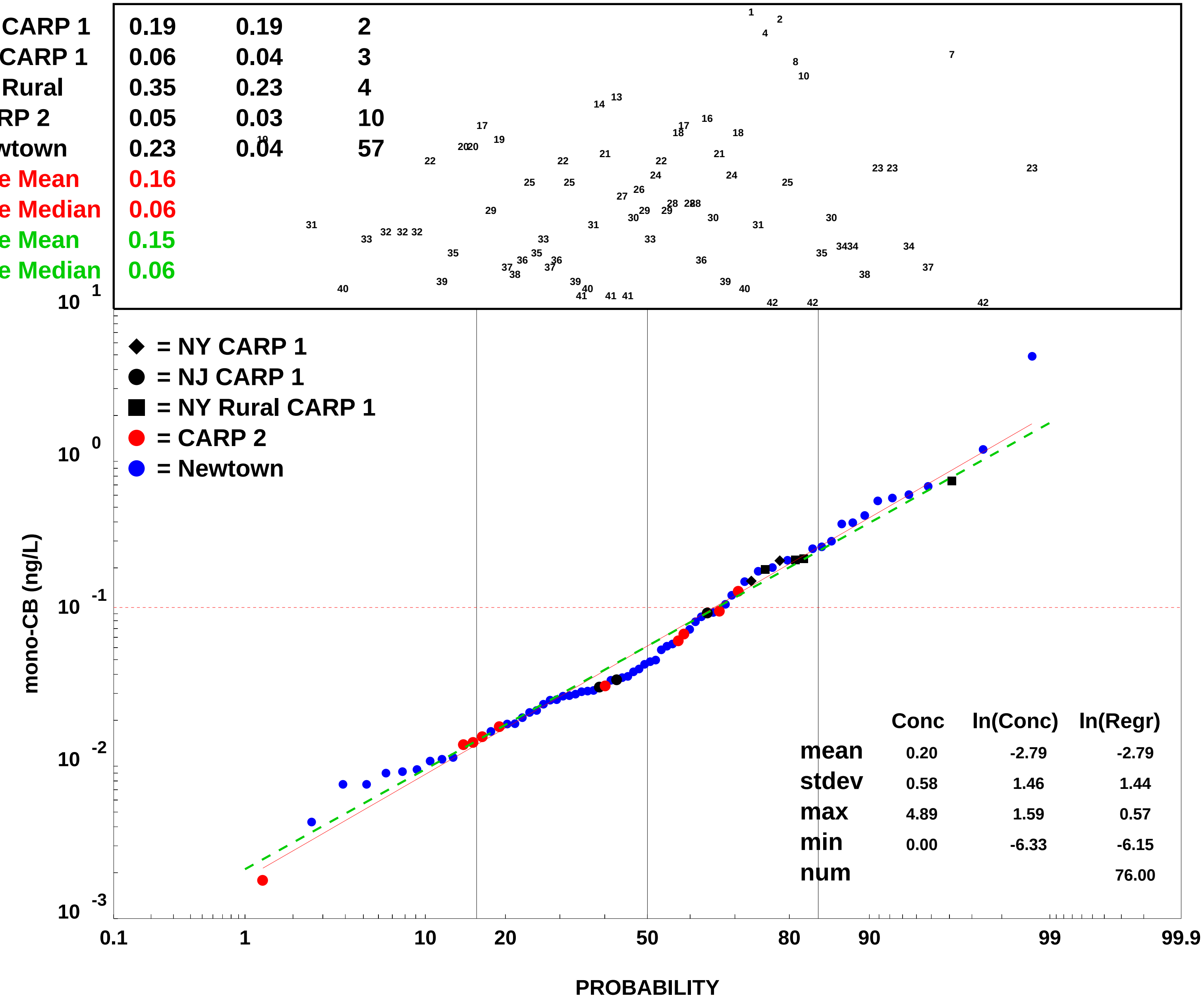
Log probability diagrams with combined CARP 1 urban, CARP 2, and Superfund stormwater measurements and regressions used for Monte Carlo selections, seventeen dioxin and furan congeners (final urban diagrams for dioxin and furan congeners)

Log probability diagrams with CARP 1 rural stormwater measurements and CARP 2 loading concentration assignments for modeling seventeen dioxin and furan congeners (final rural diagrams for dioxin and furan congeners)

PCB Loading Concentration Distributions (this page and 9 following pages)

New York and New Jersey SWOs (Combined)

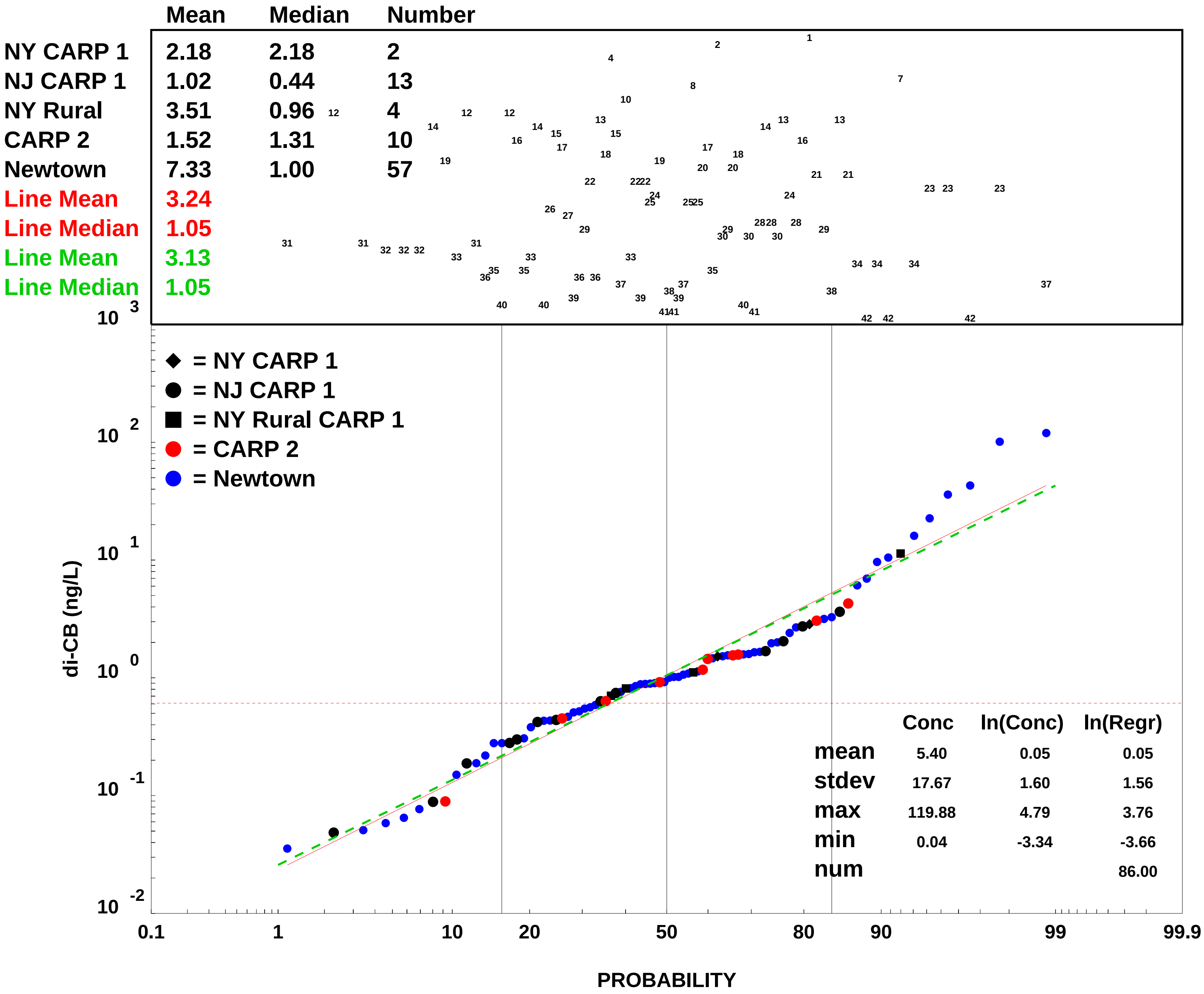
	Mean	Median	Number
NY CARP 1	0.19	0.19	2
NJ CARP 1	0.06	0.04	3
NY Rural	0.35	0.23	4
CARP 2	0.05	0.03	10
Newtown	0.23	0.04	57
Line Mean	0.16		
Line Median	0.06		
Line Mean	0.15		
Line Median	0.06		



	Conc	ln(Conc)	ln(Regr)
mean	0.20	-2.79	-2.79
stdev	0.58	1.46	1.44
max	4.89	1.59	0.57
min	0.00	-6.33	-6.15
num			76.00

1 Jamaica, Industrial
2 Jamaica, Commercial
3 CatsKill Cr.
4 Kinderhook Cr.
5 Moordners Kill
6 Normans Kill
7 Papscanee Cr.
8 Patroon Cr.
9 Sickles Cr.
10 Hyland and Armstrong, SI
11 Vlomans Kill
12 Peripheral Ditch (Newark Air)
13 Blanchard Street (Passaic R)
14 CCI
15 Smith Marina
16 Henley Road (Hackensack R)
17 Bayonne
18 Belleville
19 Kearny
20 Keyport Waterfront
21 New Milford
22 Terminus of Dutch Kills
23 Hugo Neu Schnitzer
24 Runoff from Long Island Expressway
25 Maspeth Concrete Loading Corp
26 East Branch, near Grand St. Bridge
27 Newtown Creek, Queens Side
28 East Branch, near Grand St. Bridge
29 Malu Properties, Former Ditmas Oil
30 Near Terminus of English Kills
31 BP Products N America Brooklyn Terminal
32 Exxon Mobile Greenpoint Remediation Projec
33 Former Laurel Hill Site
34 Meeker Avenue - Overland Flow
35 Motive Brooklyn Terminal
36 Greenpoint Energy Center
37 Between Greenpoint Ave and Apollo Str.
38 Queens District - 5,5a Garage
39 Review Avenue Development
40 Waste Management of NY, Steel Equities
41 North Henry Str. and Whale Creek
42 Near Calvary Cemetery

New York and New Jersey SWOs (Combined)



1 Jamaica, Industrial
2 Jamaica, Commercial
3 CatsKill Cr.
4 Kinderhook Cr.
5 Moordners Kill
6 Normans Kill
7 Papscanee Cr.
8 Patroon Cr.
9 Sickles Cr.
10 Hyland and Armstrong, SI
11 Vlomans Kill
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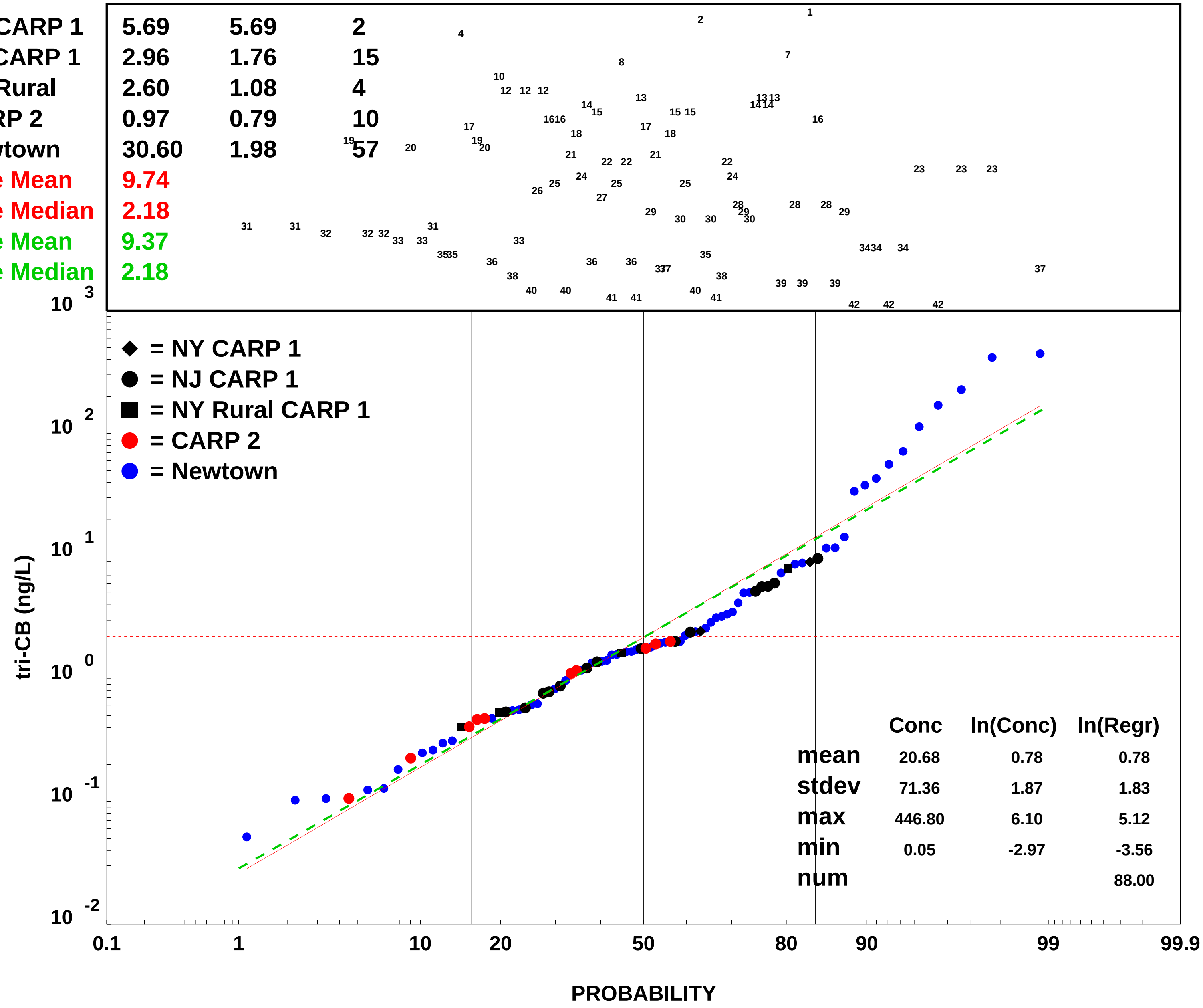
41 North Henry Str. and Whale Creek
42 Near Calvary Cemetery

New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	5.69	5.69	2
NJ CARP 1	2.96	1.76	15
NY Rural	2.60	1.08	4
CARP 2	0.97	0.79	10
Newtown	30.60	1.98	57
Line Mean	9.74		
Line Median	2.18		
Line Mean	9.37		
Line Median	2.18		



1 Jamaica, Industrial
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5 Moordners Kill
6 Normans Kill
7 Papscanee Cr.
8 Patroon Cr.
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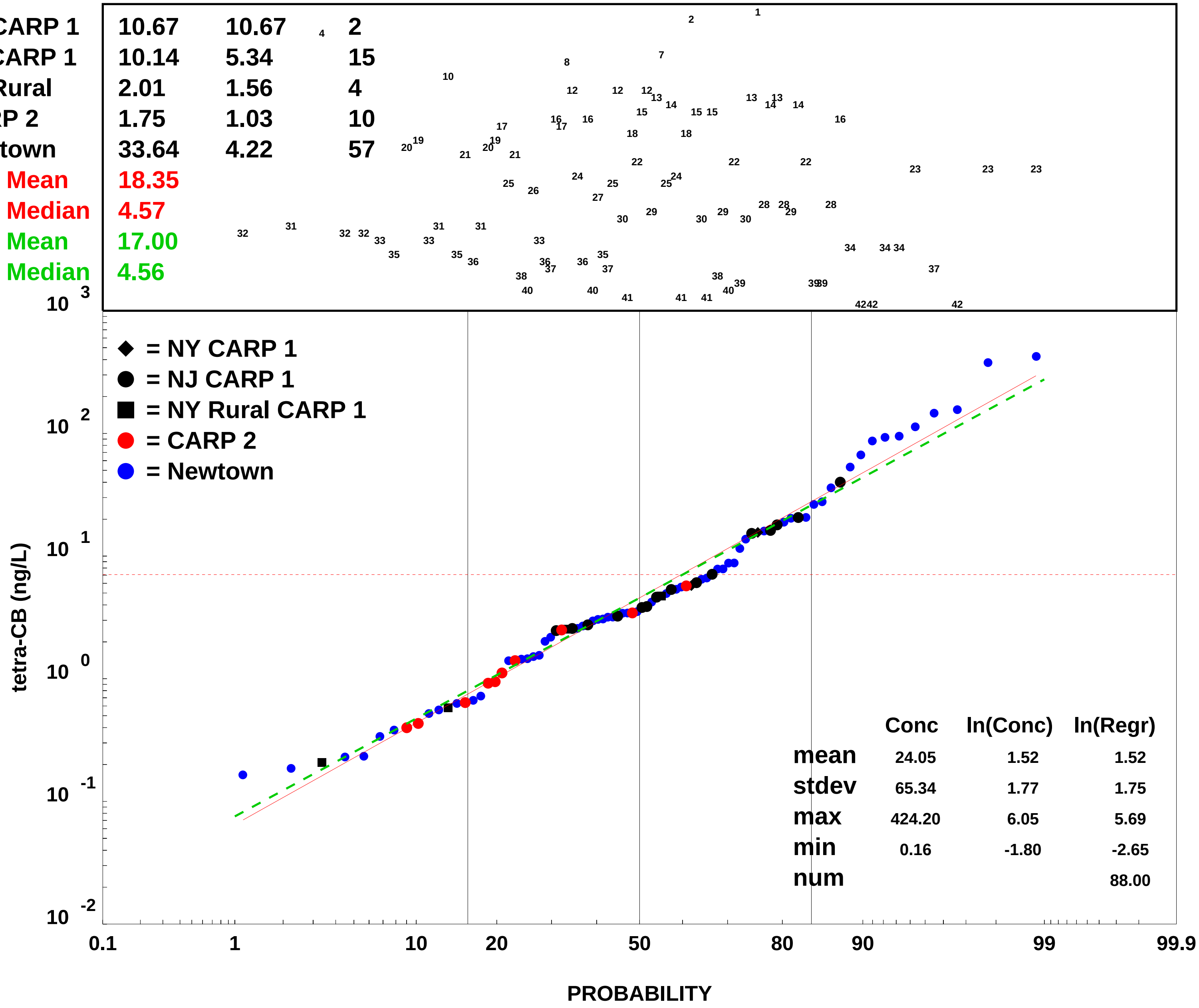
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	10.67	10.67	2
NJ CARP 1	10.14	5.34	15
NY Rural	2.01	1.56	4
CARP 2	1.75	1.03	10
Newtown	33.64	4.22	57
Line Mean	18.35		
Line Median	4.57		
Line Mean	17.00		
Line Median	4.56		



	Conc	ln(Conc)	ln(Regr)
mean	24.05	1.52	1.52
stdev	65.34	1.77	1.75
max	424.20	6.05	5.69
min	0.16	-1.80	-2.65
num			88.00

1 Jamaica, Industrial
2 Jamaica, Commercial
3 CatsKill Cr.
4 Kinderhook Cr.
5 Moordners Kill
6 Normans Kill
7 Papscanee Cr.
8 Patroon Cr.
9 Sickles Cr.
10 Hyland and Armstrong, SI
11 Vlomans Kill
12 Peripheral Ditch (Newark Air)
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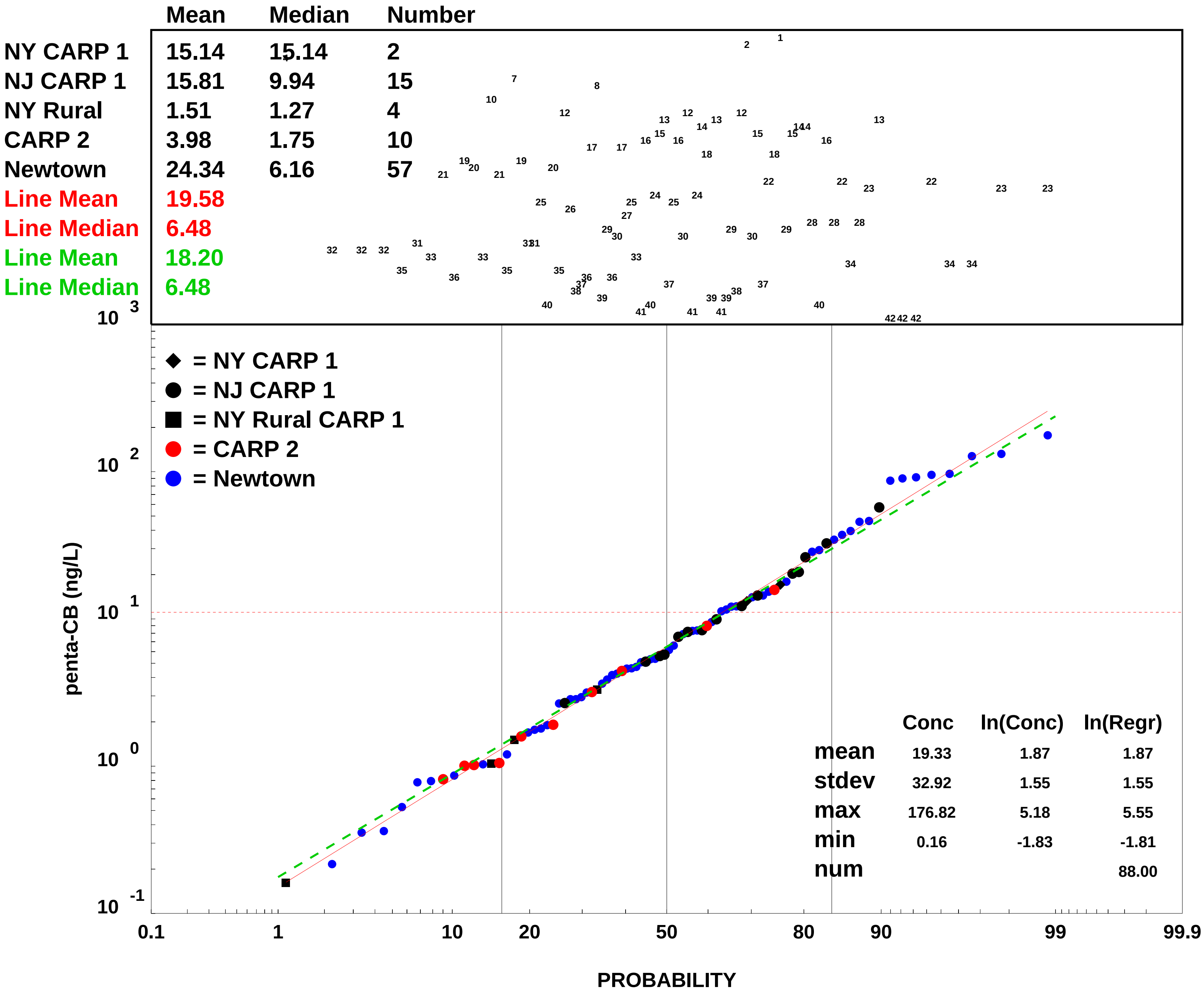
New York and New Jersey SWOs (Combined)



1 Jamaica, Industrial
2 Jamaica, Commercial
3 CatsKill Cr.
4 Kinderhook Cr.
5 Moordners Kill
6 Normans Kill
7 Papscanee Cr.
8 Patroon Cr.
9 Sickles Cr.
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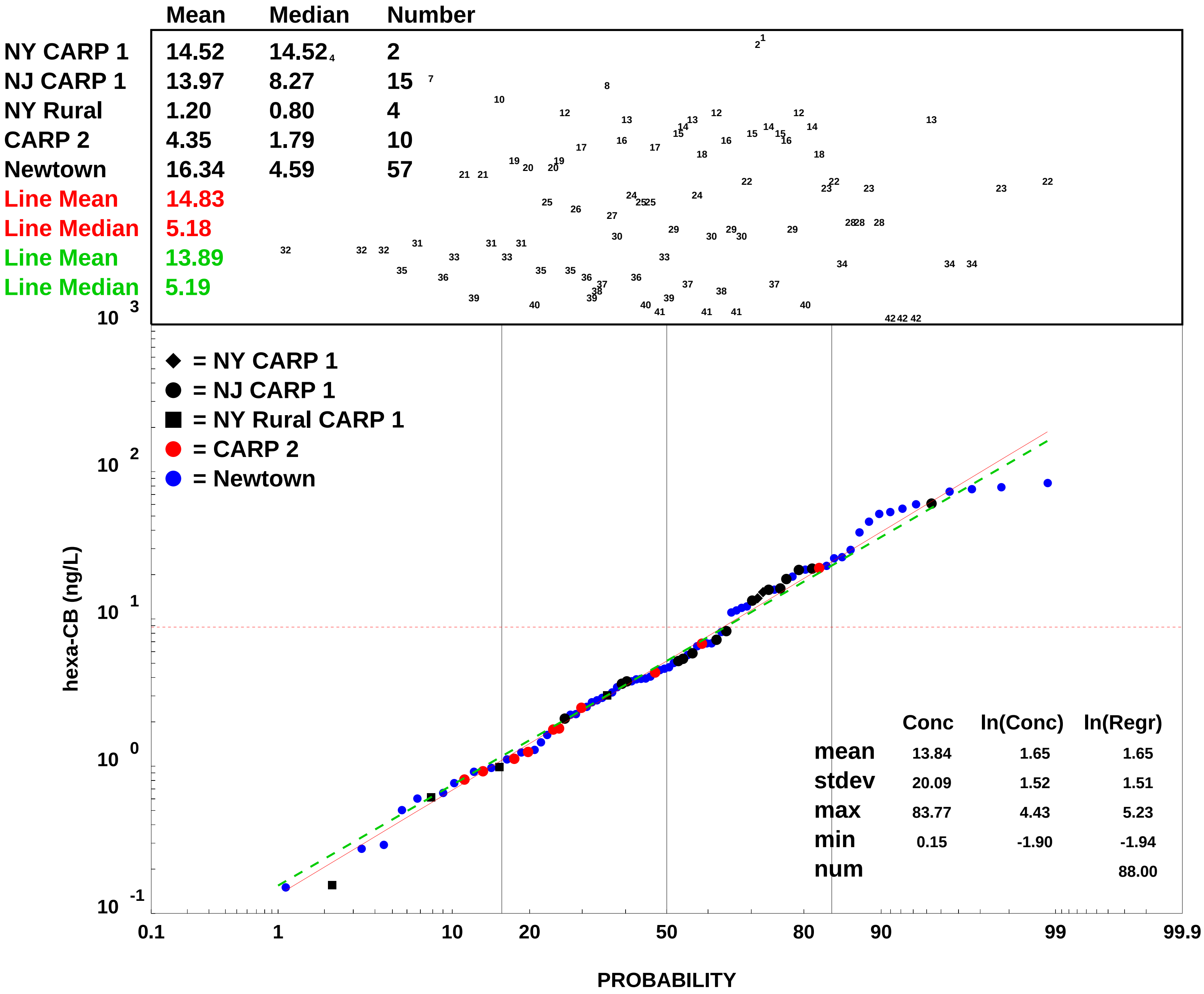
New York and New Jersey SWOs (Combined)



1 Jamaica, Industrial
2 Jamaica, Commercial
3 CatsKill Cr.
4 Kinderhook Cr.
5 Moordners Kill
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7 Papscanee Cr.
8 Patroon Cr.
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41 North Henry Str. and Whale Creek
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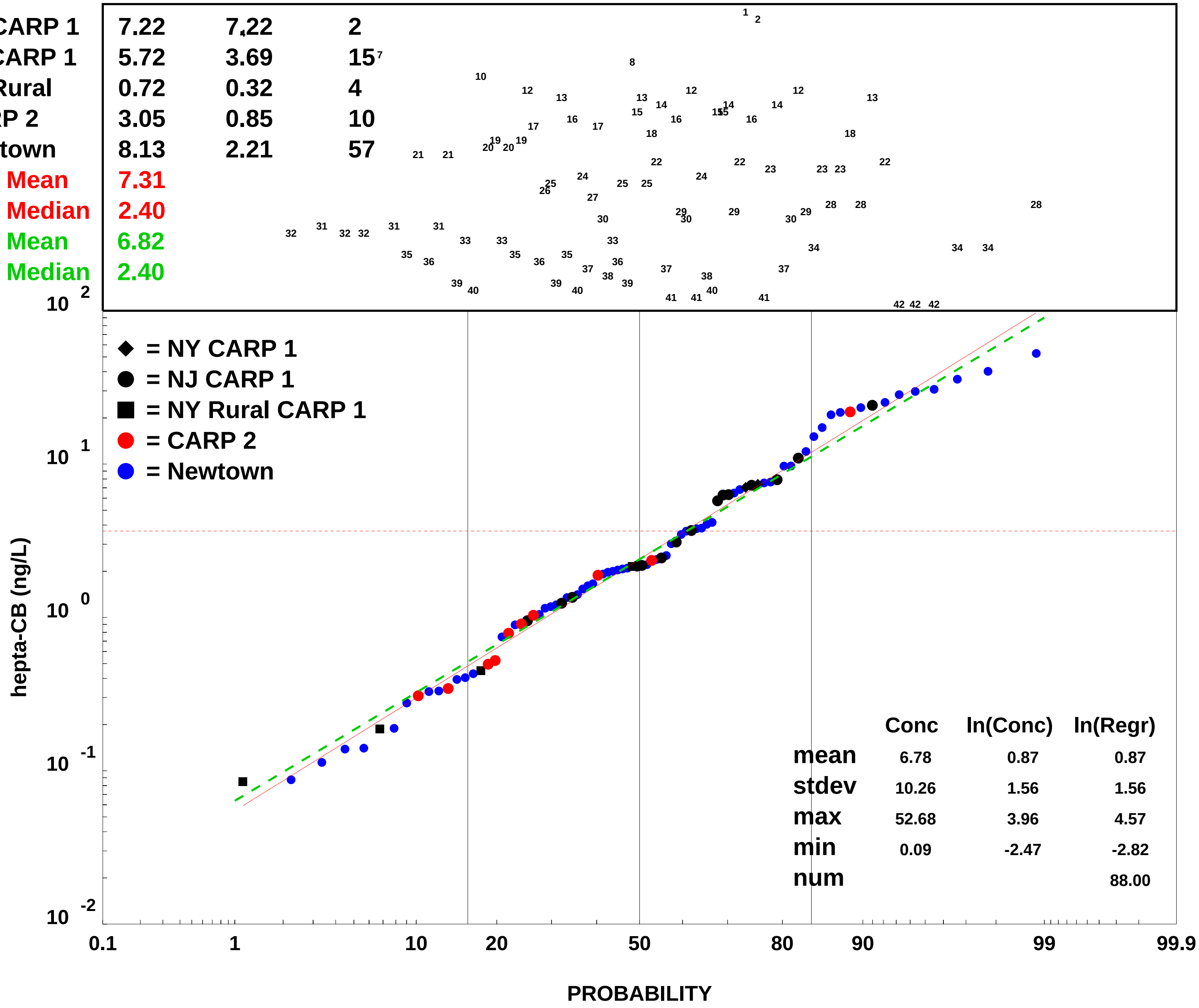
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	7.22	7.22	2
NJ CARP 1	5.72	3.69	15
NY Rural	0.72	0.32	4
CARP 2	3.05	0.85	10
Newtown	8.13	2.21	57
Line Mean	7.31		
Line Median	2.40		
Line Mean	6.82		
Line Median	2.40		



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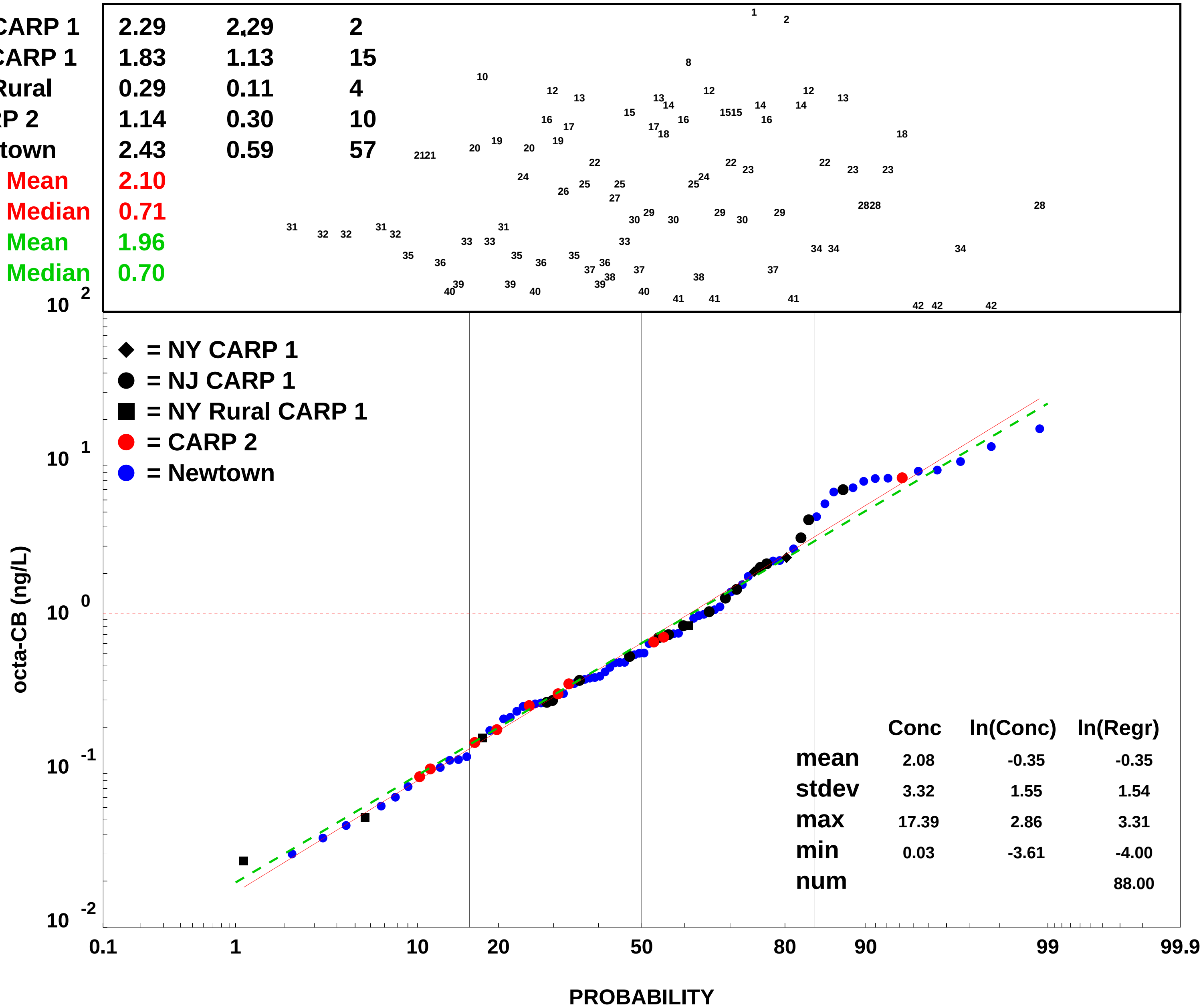
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	2.29	2.29	2
NJ CARP 1	1.83	1.13	15
NY Rural	0.29	0.11	4
CARP 2	1.14	0.30	10
Newtown	2.43	0.59	57
Line Mean	2.10		
Line Median	0.71		
Line Mean	1.96		
Line Median	0.70		



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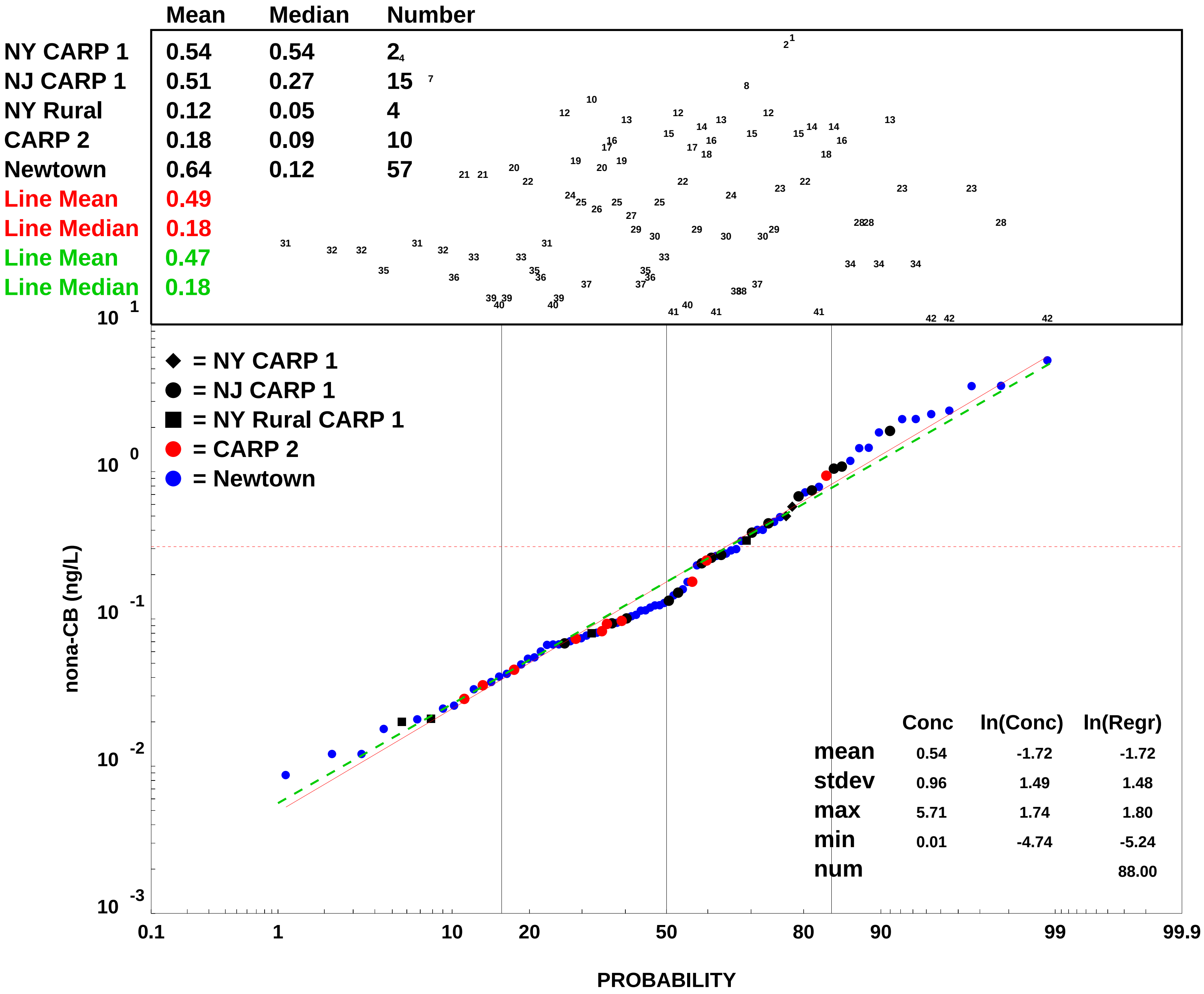

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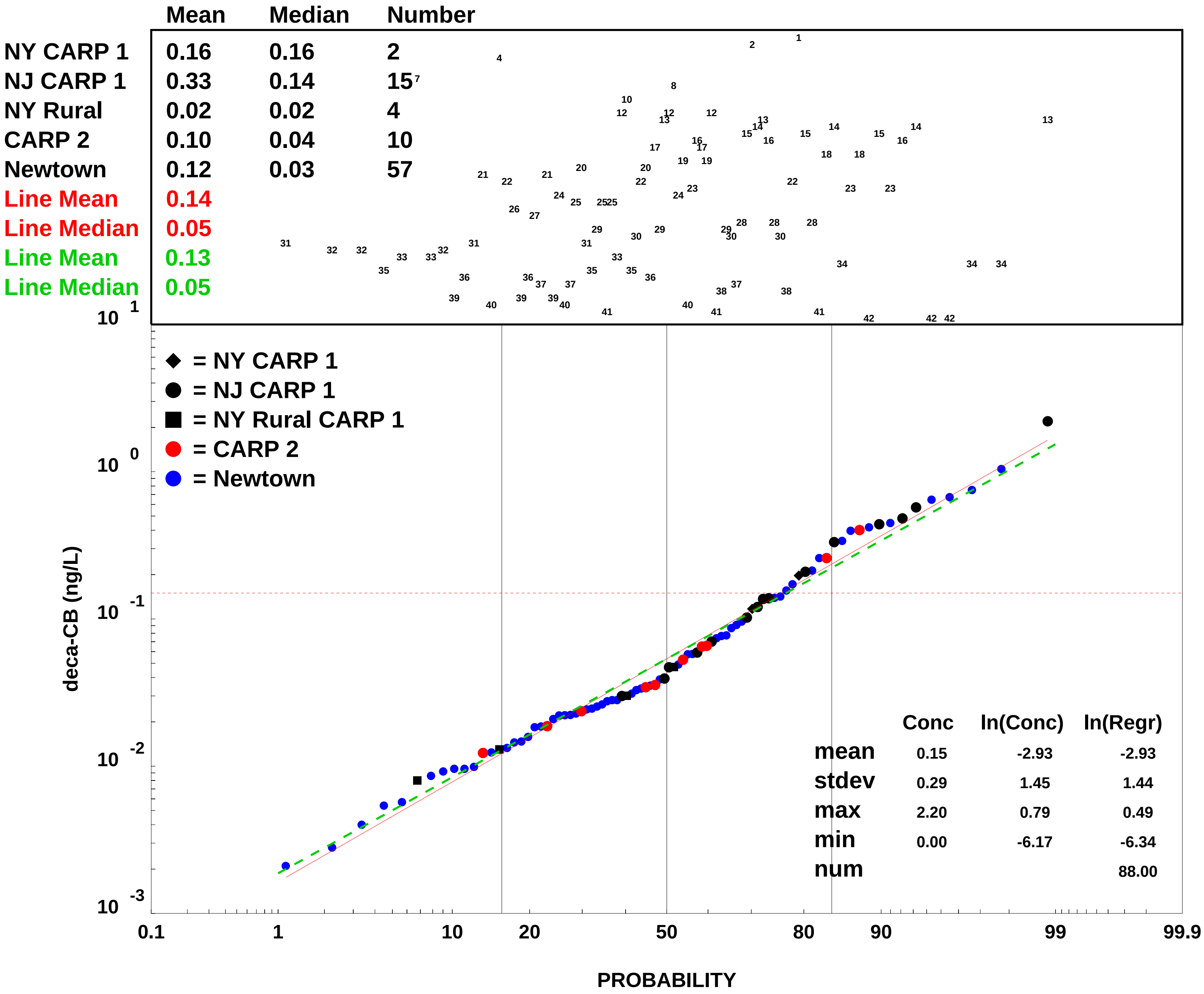

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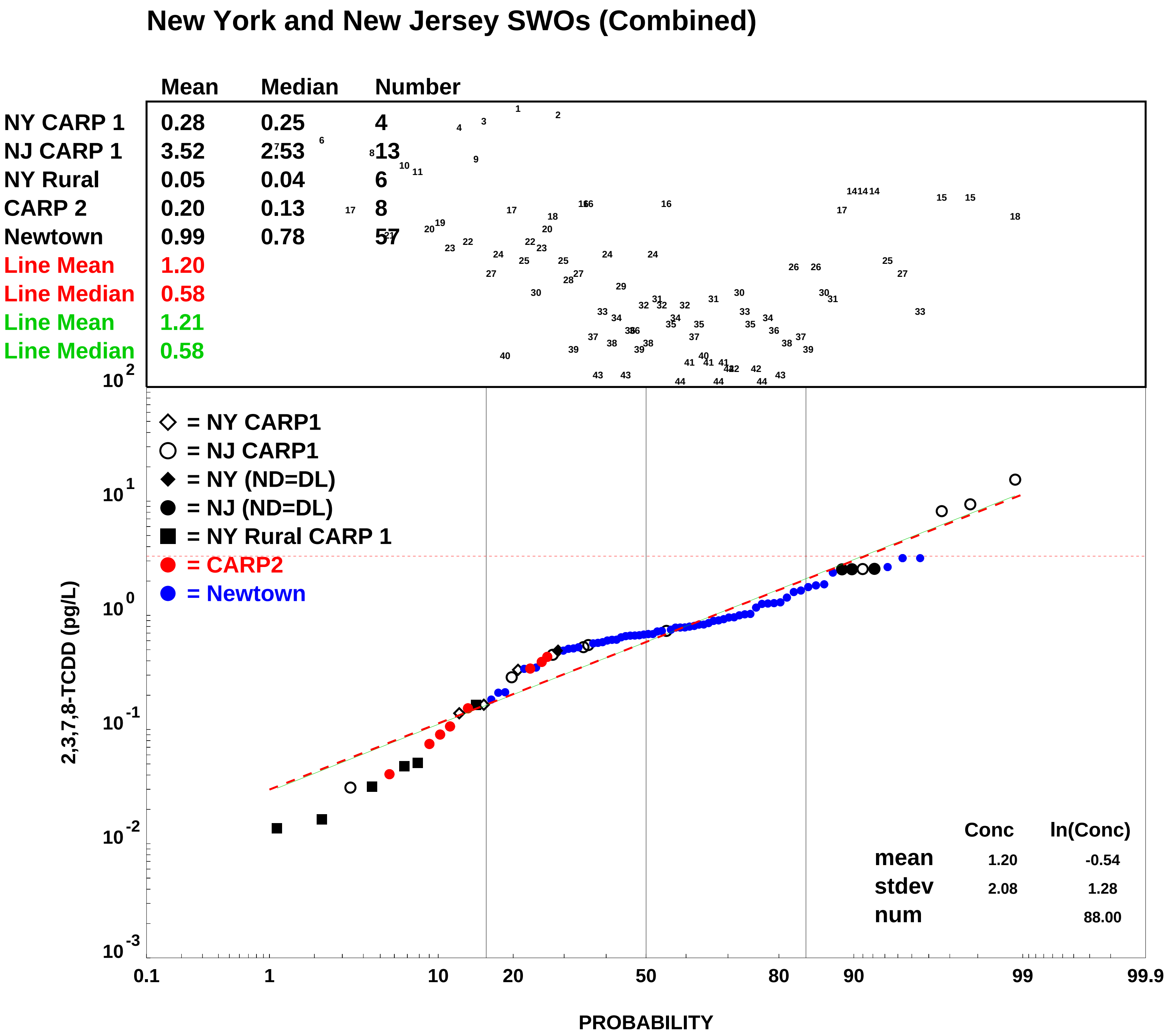
Dioxin/Furan Loading Concentrations, Not Used (this page and 16 following pages)



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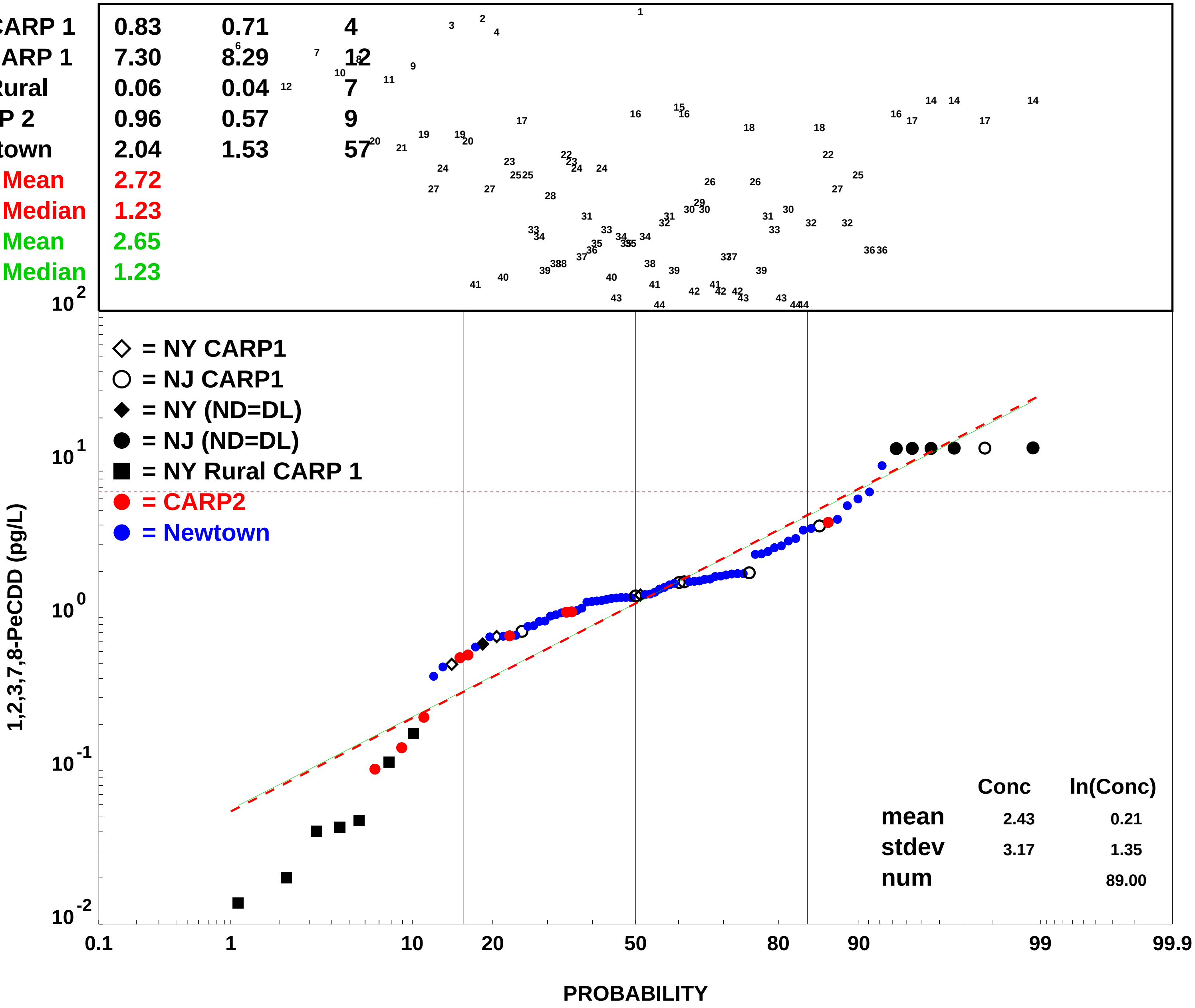
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	0.83	0.71	4
NJ CARP 1	7.30	8.29	12
NY Rural	0.06	0.04	7
CARP 2	0.96	0.57	9
Newtown	2.04	1.53	57
Line Mean	2.72		
Line Median	1.23		
Line Mean	2.65		
Line Median	1.23		



	Conc	ln(Conc)
mean	2.43	0.21
stdev	3.17	1.35
num		89.00

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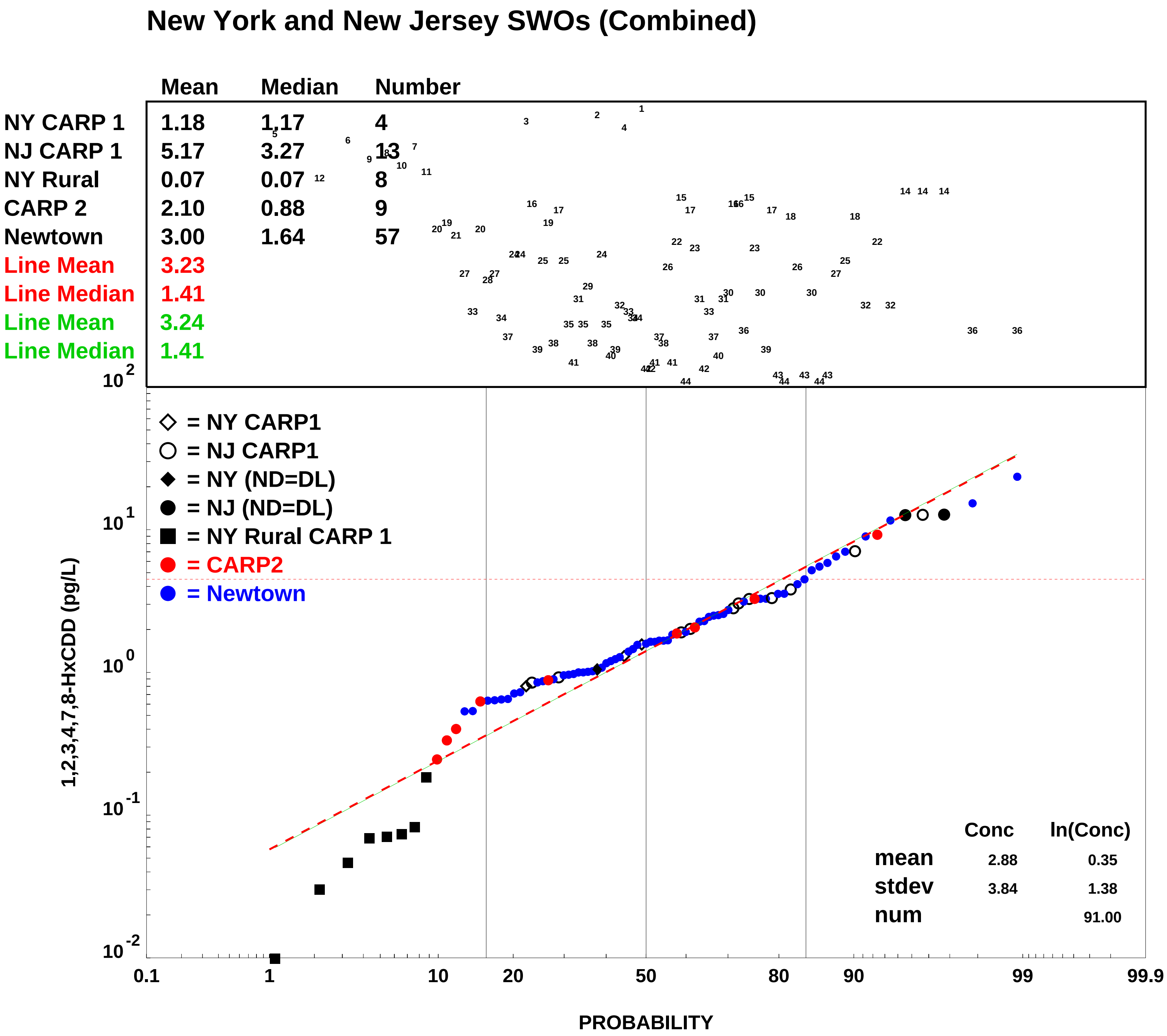

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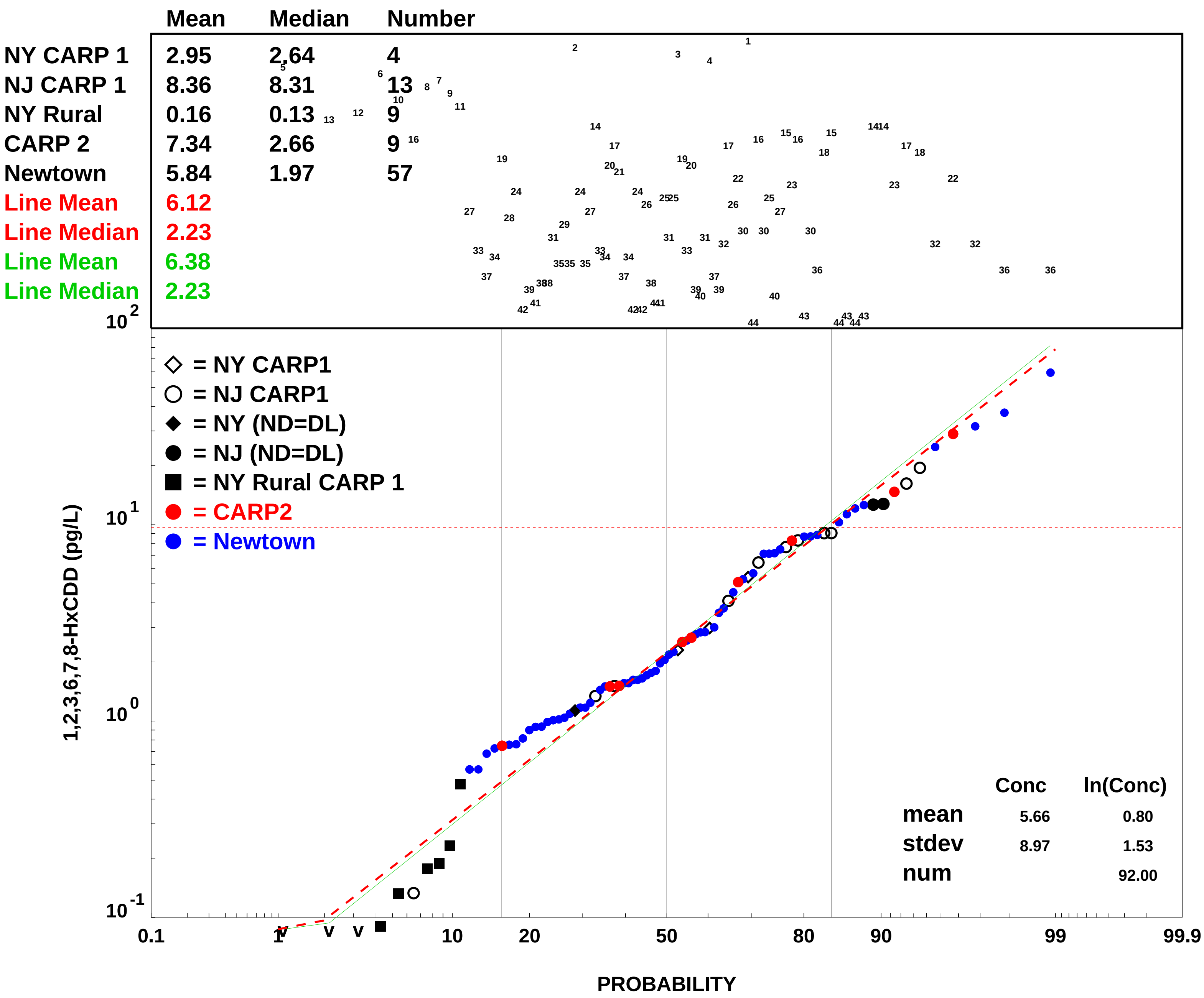
New York and New Jersey SWOs (Combined)



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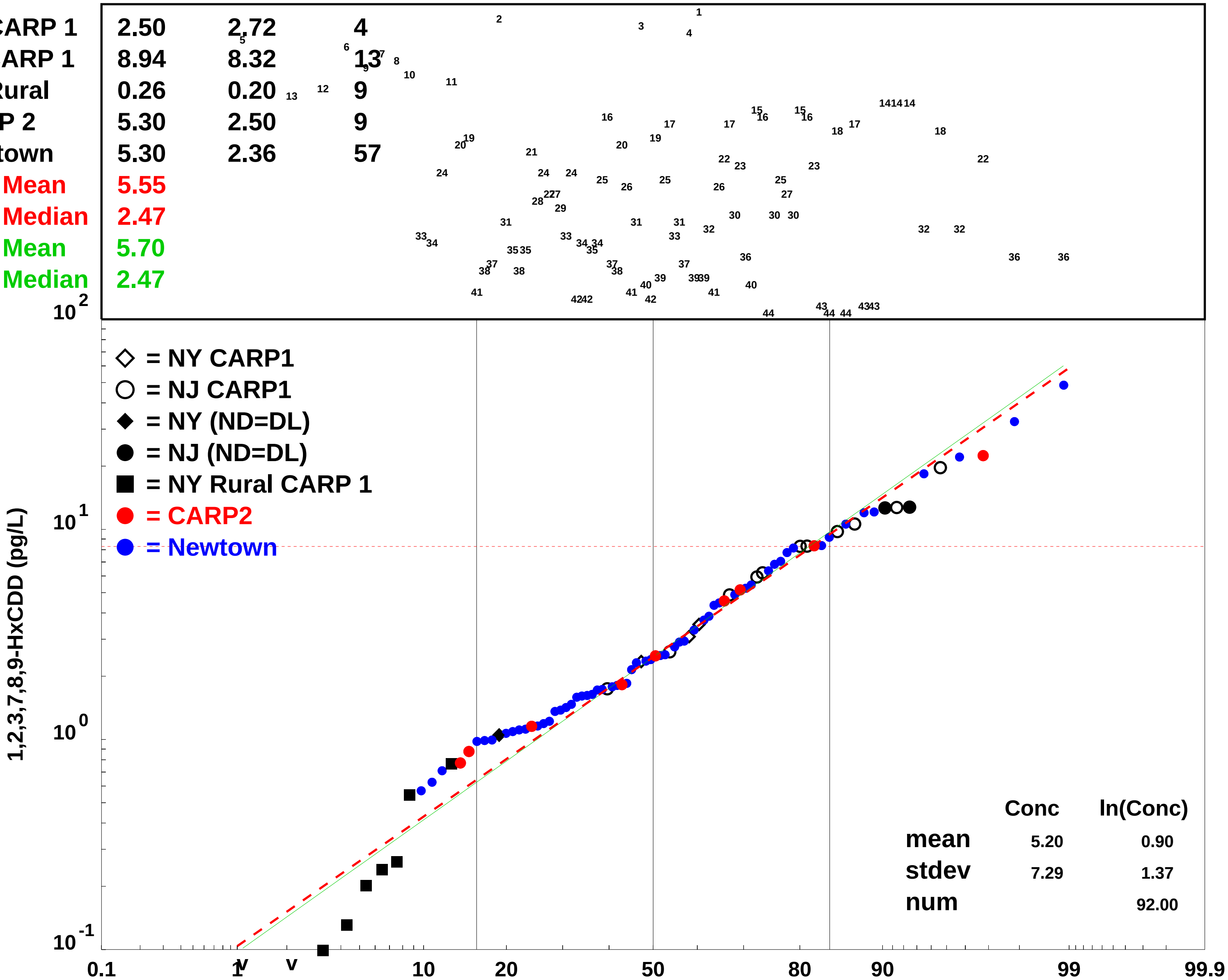
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	2.50	2.72	4
NJ CARP 1	8.94	8.32	13
NY Rural	0.26	0.20	9
CARP 2	5.30	2.50	9
Newtown	5.30	2.36	57
Line Mean	5.55		
Line Median	2.47		
Line Mean	5.70		
Line Median	2.47		



	Conc	ln(Conc)
mean	5.20	0.90
stdev	7.29	1.37
num		92.00

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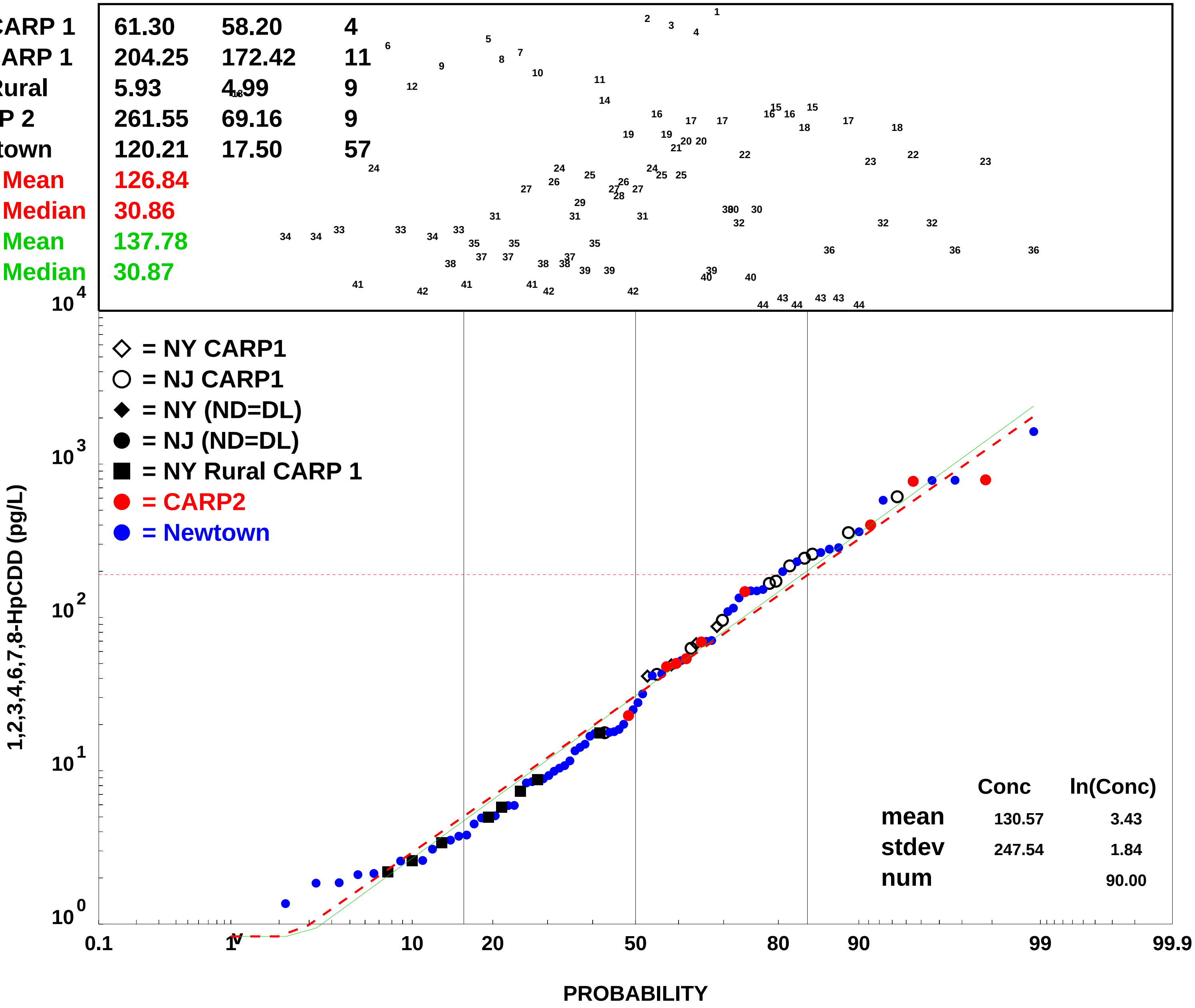
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	61.30	58.20	4
NJ CARP 1	204.25	172.42	11
NY Rural	5.93	4.99	9
CARP 2	261.55	69.16	9
Newtown	120.21	17.50	57
Line Mean	126.84		
Line Median	30.86		
Line Mean	137.78		
Line Median	30.87		



	Conc	ln(Conc)
mean	130.57	3.43
stdev	247.54	1.84
num		90.00

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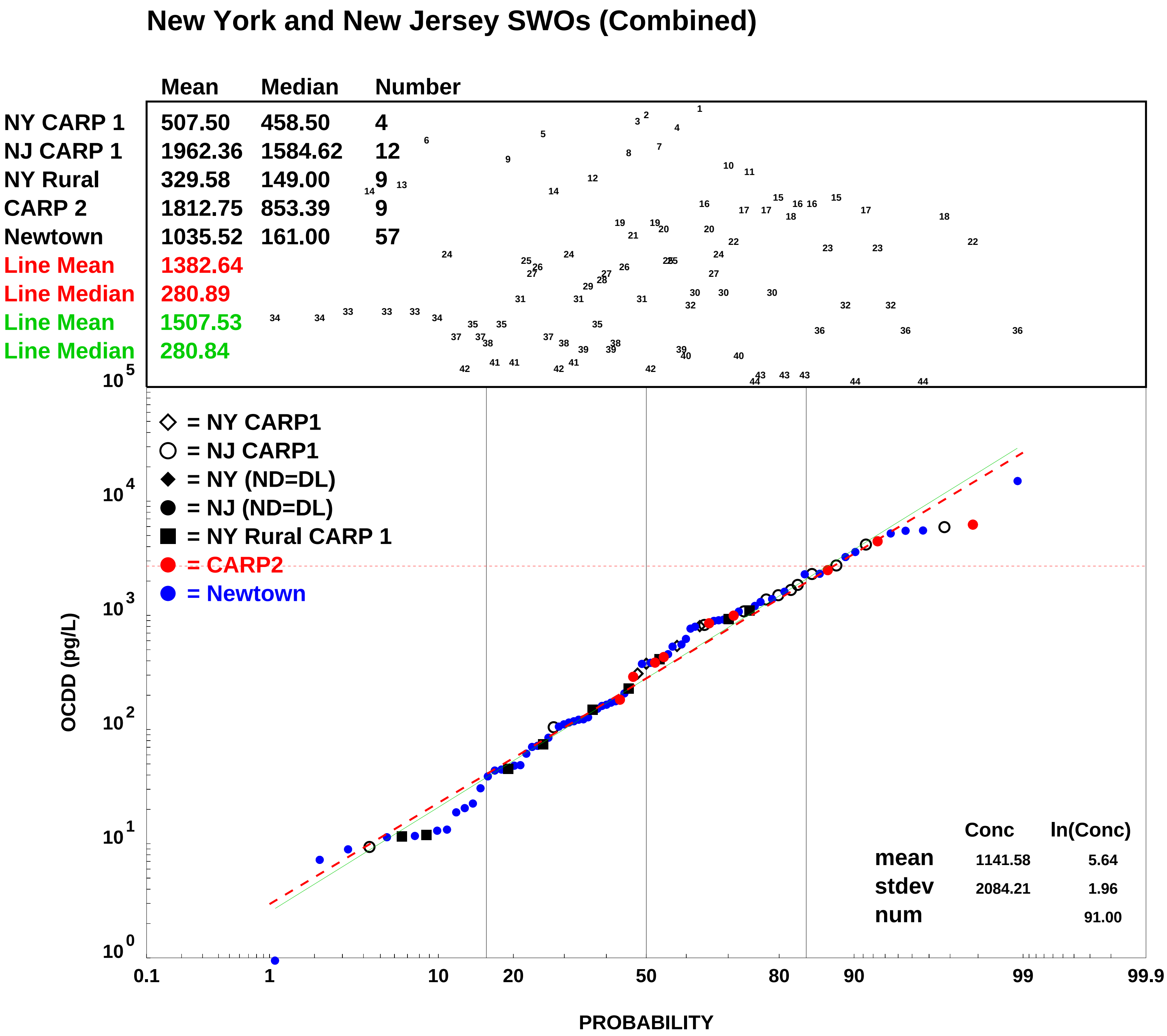

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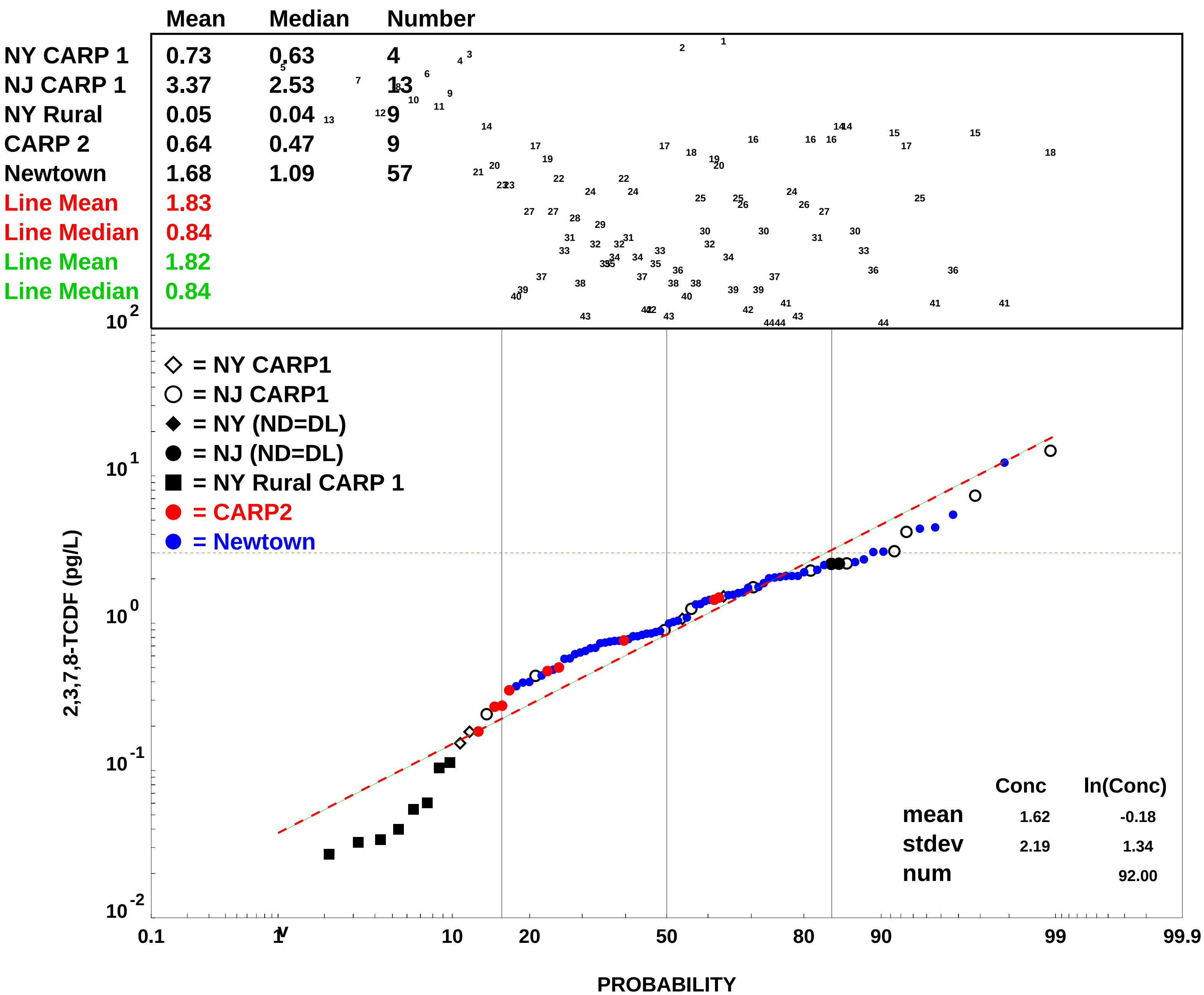

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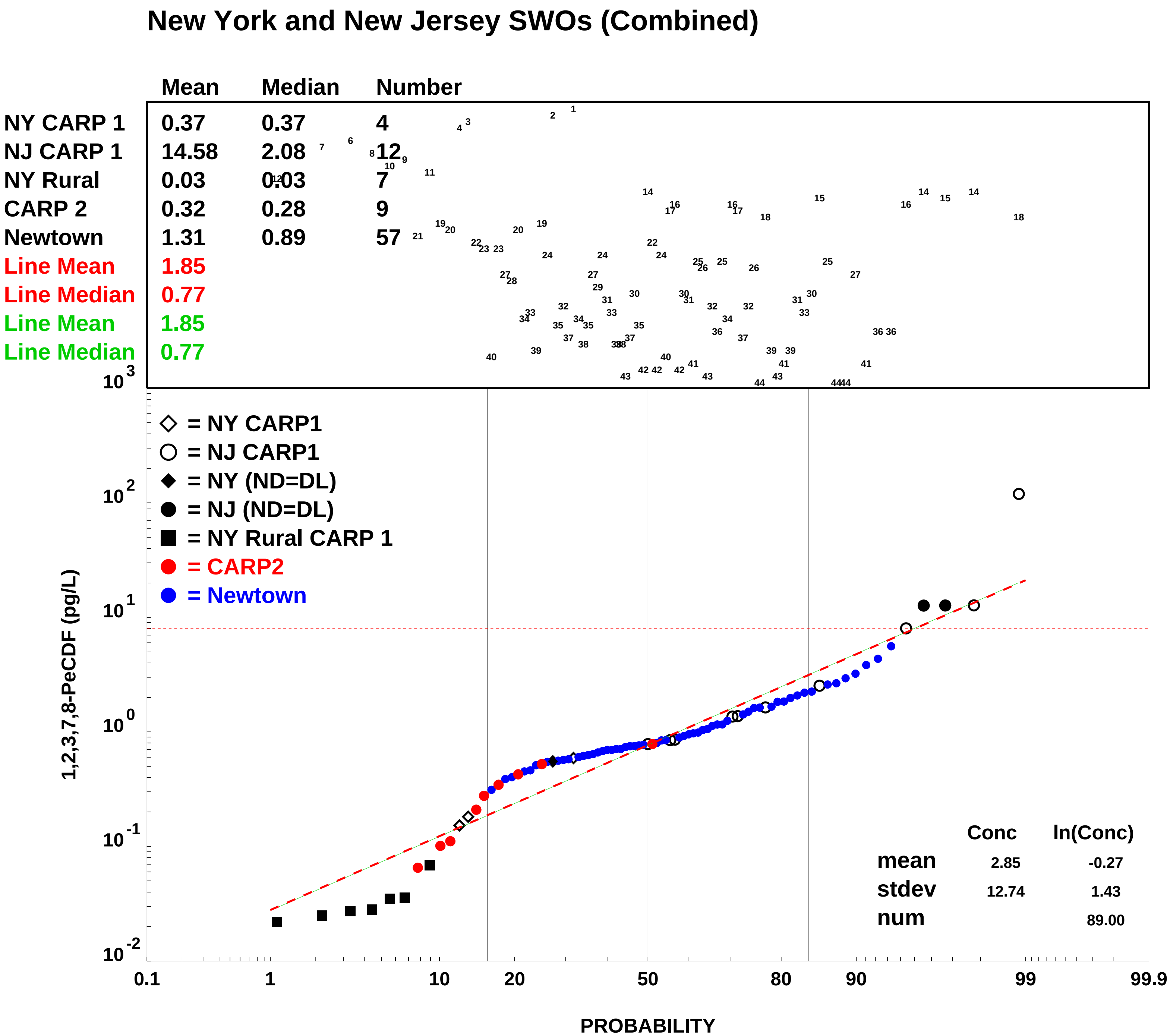

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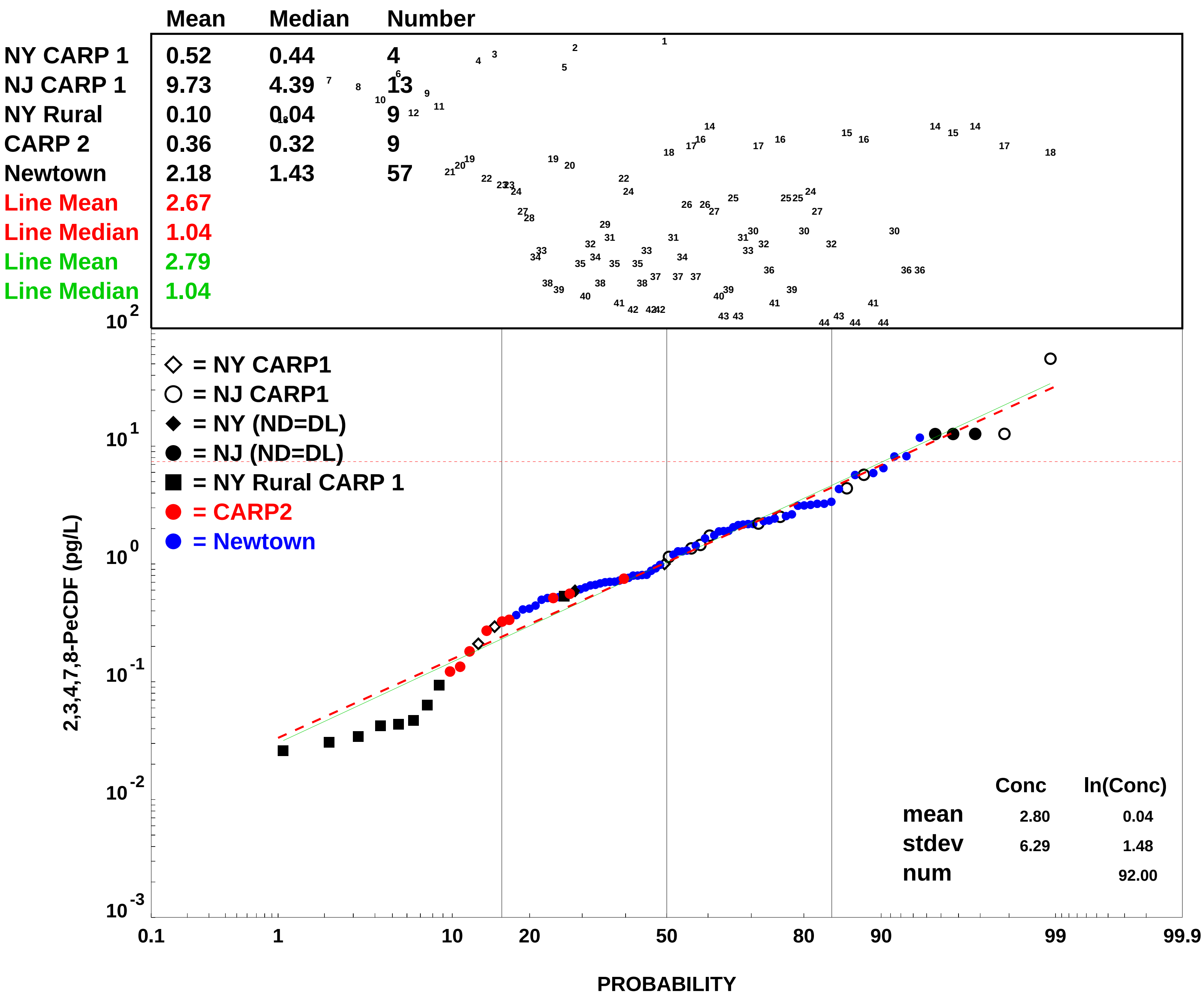

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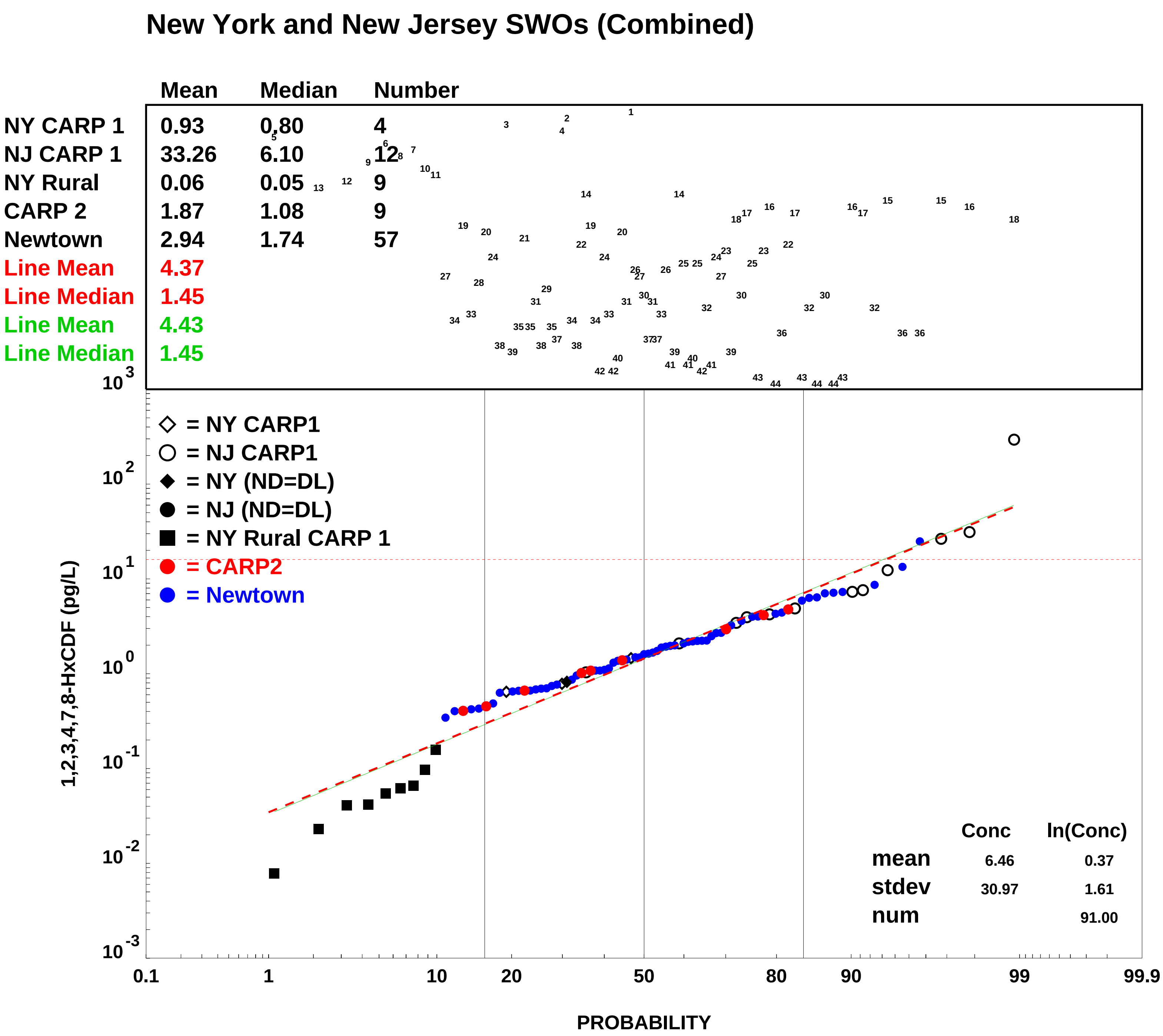

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33 BP Products N America Brooklyn Terminal
34 Exxon Mobile Greenpoint Remediation Project
35 Former Laurel Hill Site
36 Meeker Avenue - Overland Flow
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38 Greenpoint Energy Center
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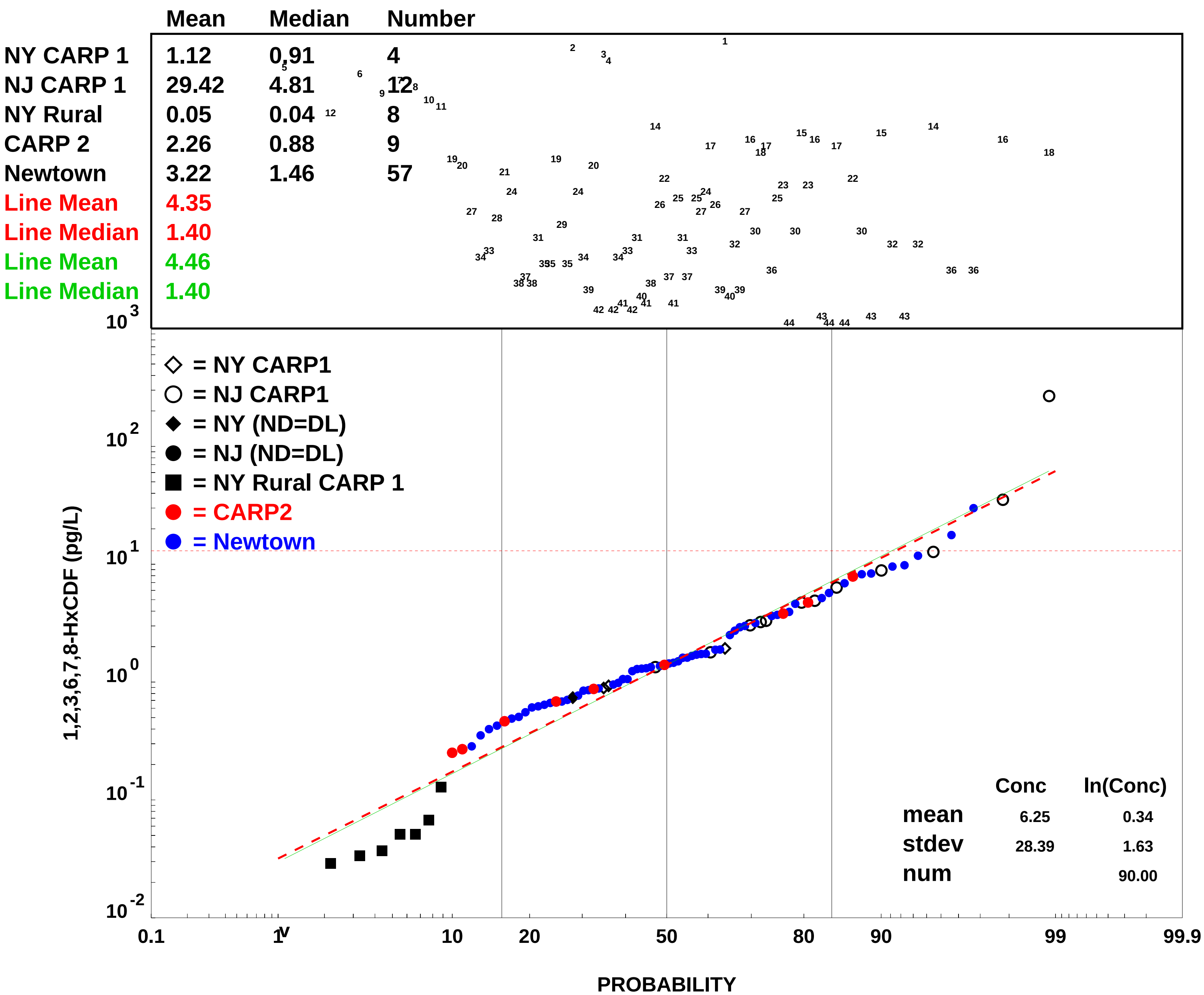
42 Waste Management of NY, Steel Equities
43 North Henry Str. and Whale Creek
44 Near Calvar Cemetery

New York and New Jersey SWOs (Combined)



1 Jamaica, Industrial
2 Jamaica, Commercial
3 Patroon Creek
4 Hyland and Armstrong, SI
5 CatsKill Cr.
6 Kinderhook Cr.
7 Moordners Kill
8 Normans Kill
9 Papscanee Cr.
10 Sickles Cr.
11 Vlomans Kill
12 Klein Kill
13 Roeliff Jansen Kill
14 Peripheral Ditch (Newark Air)
15 Blanchard Street (Passaic R)
16 CCI
17 Smith Marina
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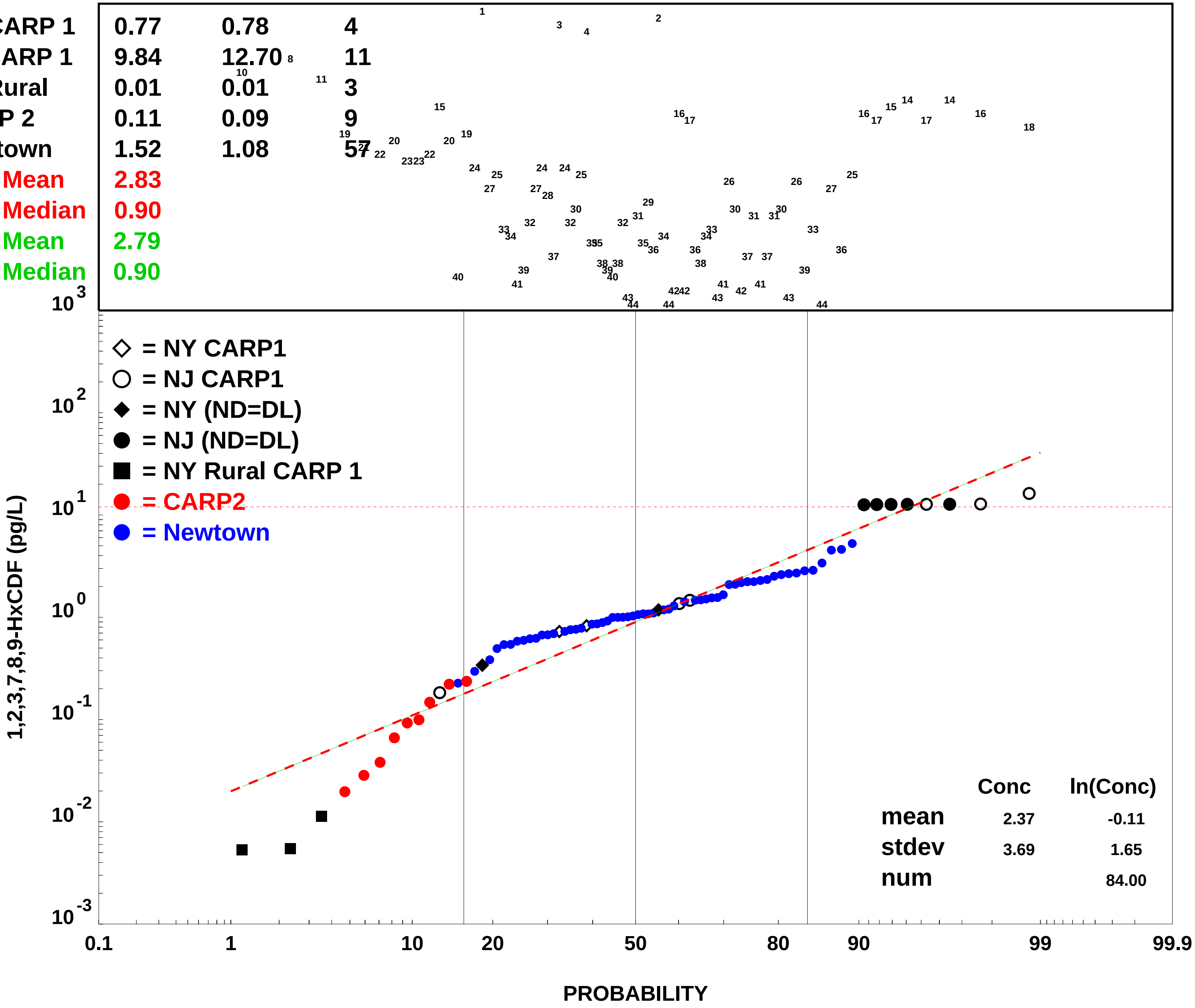
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	0.77	0.78	4
NJ CARP 1	9.84	12.70	11
NY Rural	0.01	0.01	3
CARP 2	0.11	0.09	9
Newtown	1.52	1.08	57
Line Mean	2.83		
Line Median	0.90		
Line Mean	2.79		
Line Median	0.90		



	Conc	ln(Conc)
mean	2.37	-0.11
stdev	3.69	1.65
num		84.00

1 Jamaica, Industrial
2 Jamaica, Commercial
3 Patroon Creek
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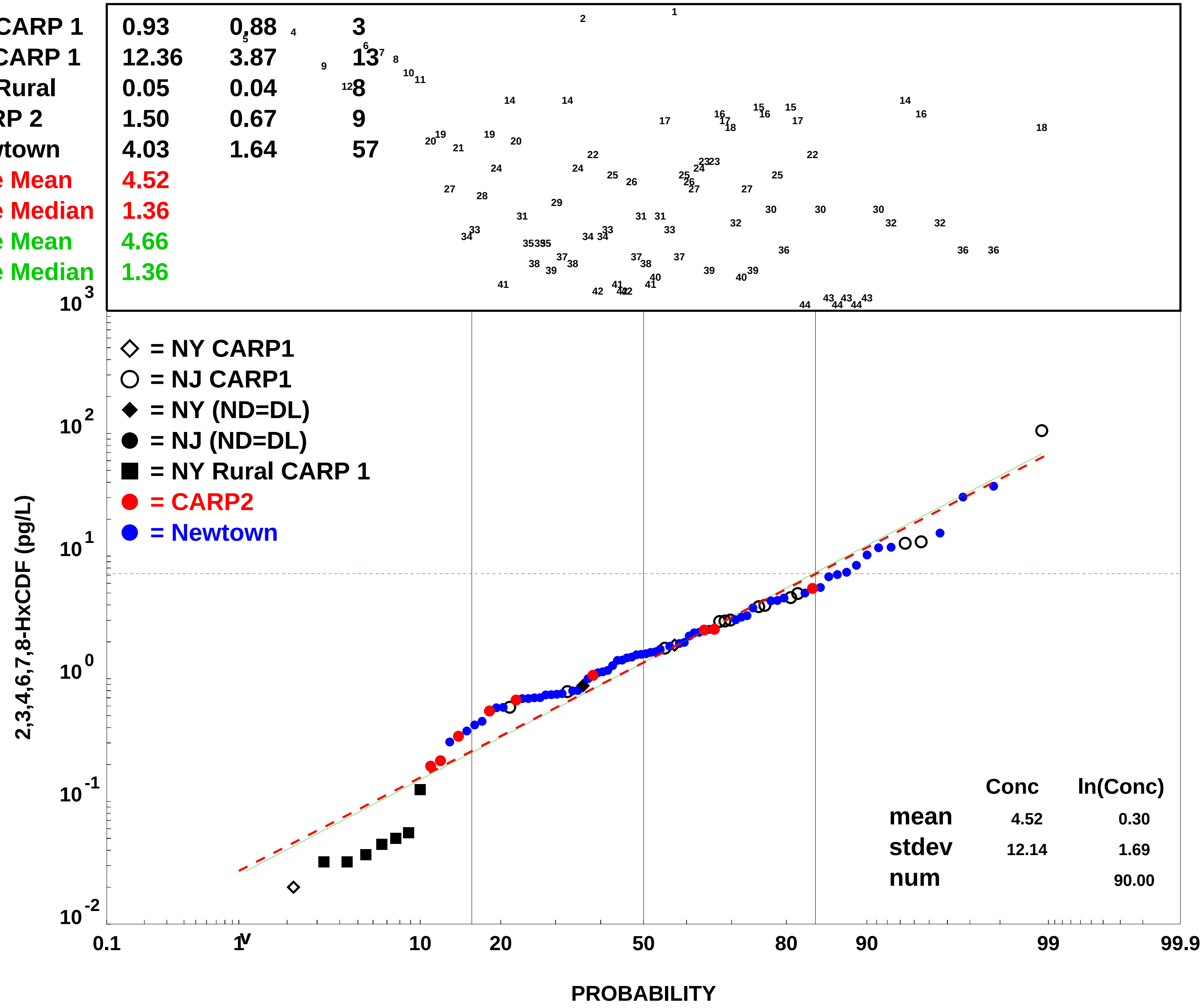
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	0.93	0.88	3
NJ CARP 1	12.36	3.87	13
NY Rural	0.05	0.04	8
CARP 2	1.50	0.67	9
Newtown	4.03	1.64	57
Line Mean	4.52		
Line Median	1.36		
Line Mean	4.66		
Line Median	1.36		



1 Jamaica, Industrial
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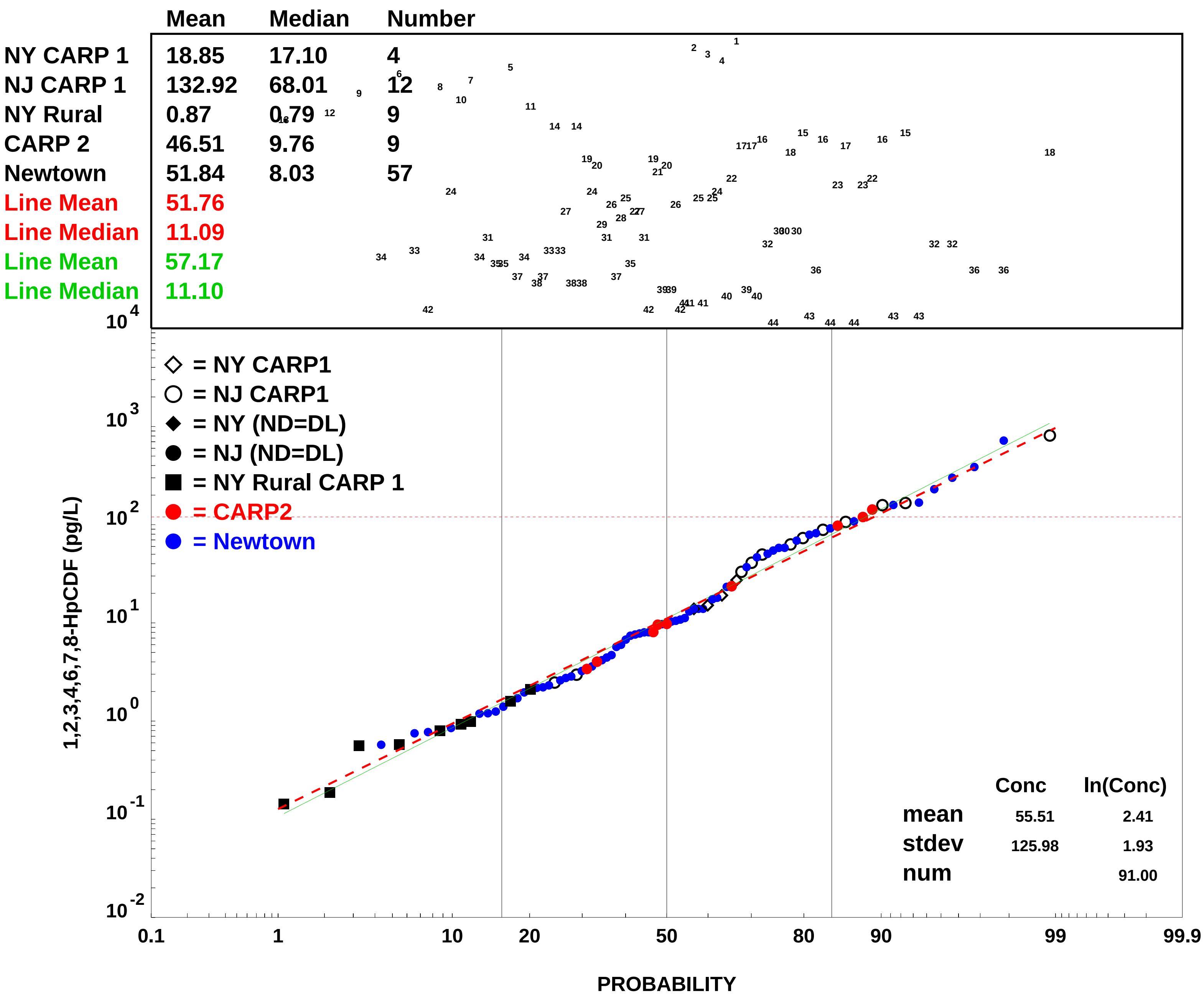

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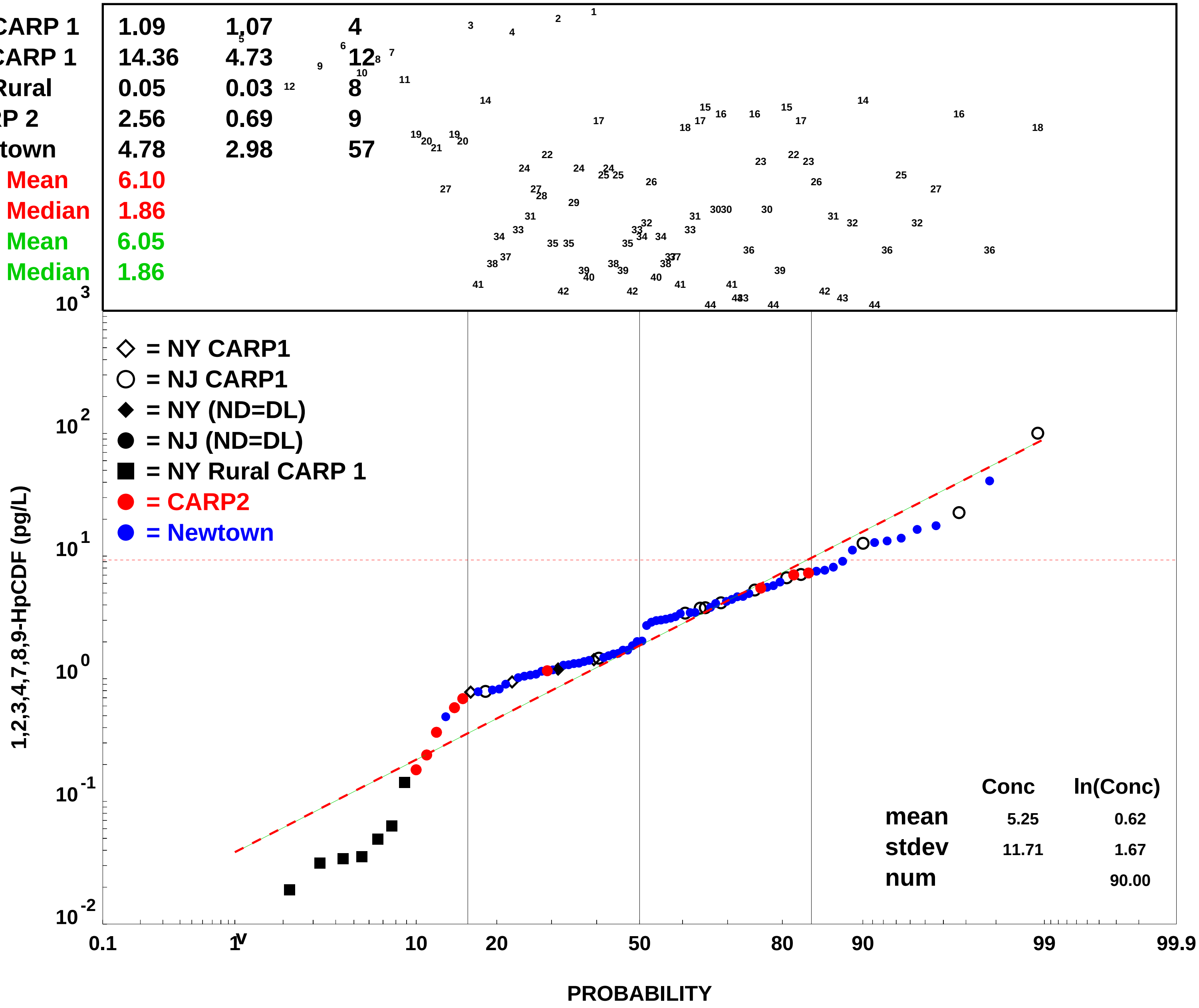
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	1.09	1.07	4
NJ CARP 1	14.36	4.73	12
NY Rural	0.05	0.03	8
CARP 2	2.56	0.69	9
Newtown	4.78	2.98	57
Line Mean	6.10		
Line Median	1.86		
Line Mean	6.05		
Line Median	1.86		



	Conc	ln(Conc)
mean	5.25	0.62
stdev	11.71	1.67
num		90.00

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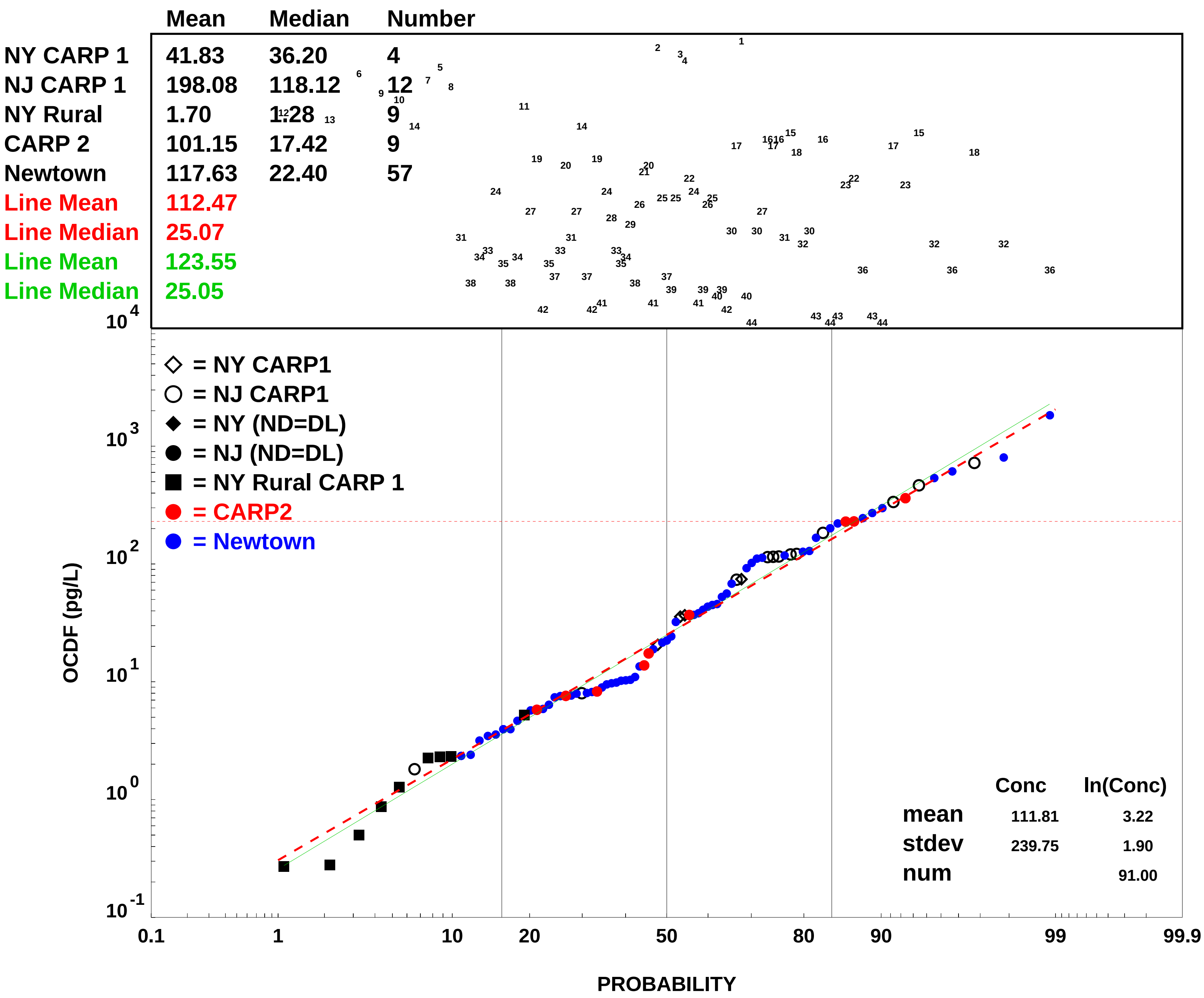

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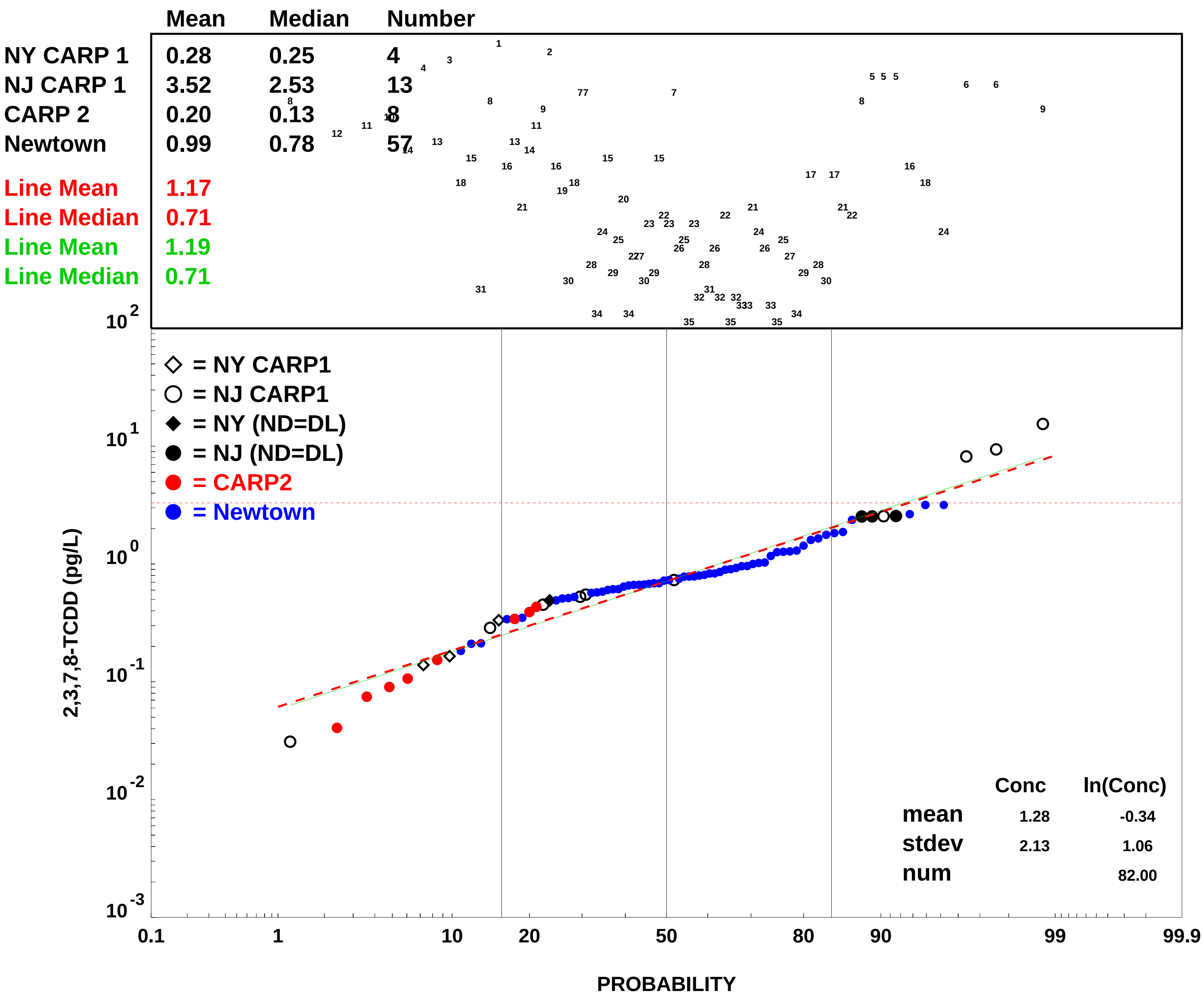
Dioxin/Furan Loading Concentration Distributions, Urban, this page, next 16 pages

New York and New Jersey SWOs (Combined)



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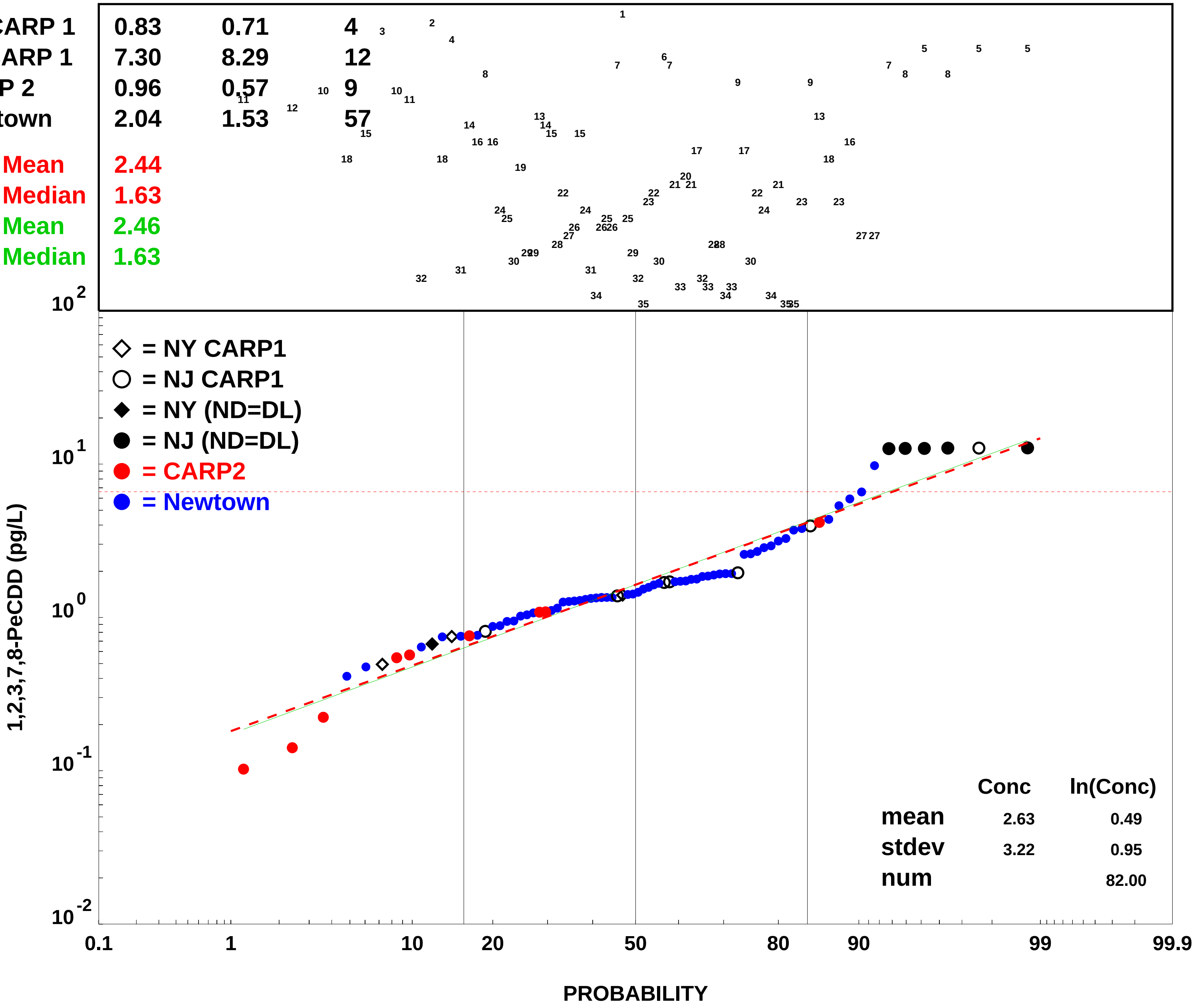
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	0.83	0.71	4
NJ CARP 1	7.30	8.29	12
CARP 2	0.96	0.57	9
Newtown	2.04	1.53	57
Line Mean	2.44		
Line Median	1.63		
Line Mean	2.46		
Line Median	1.63		



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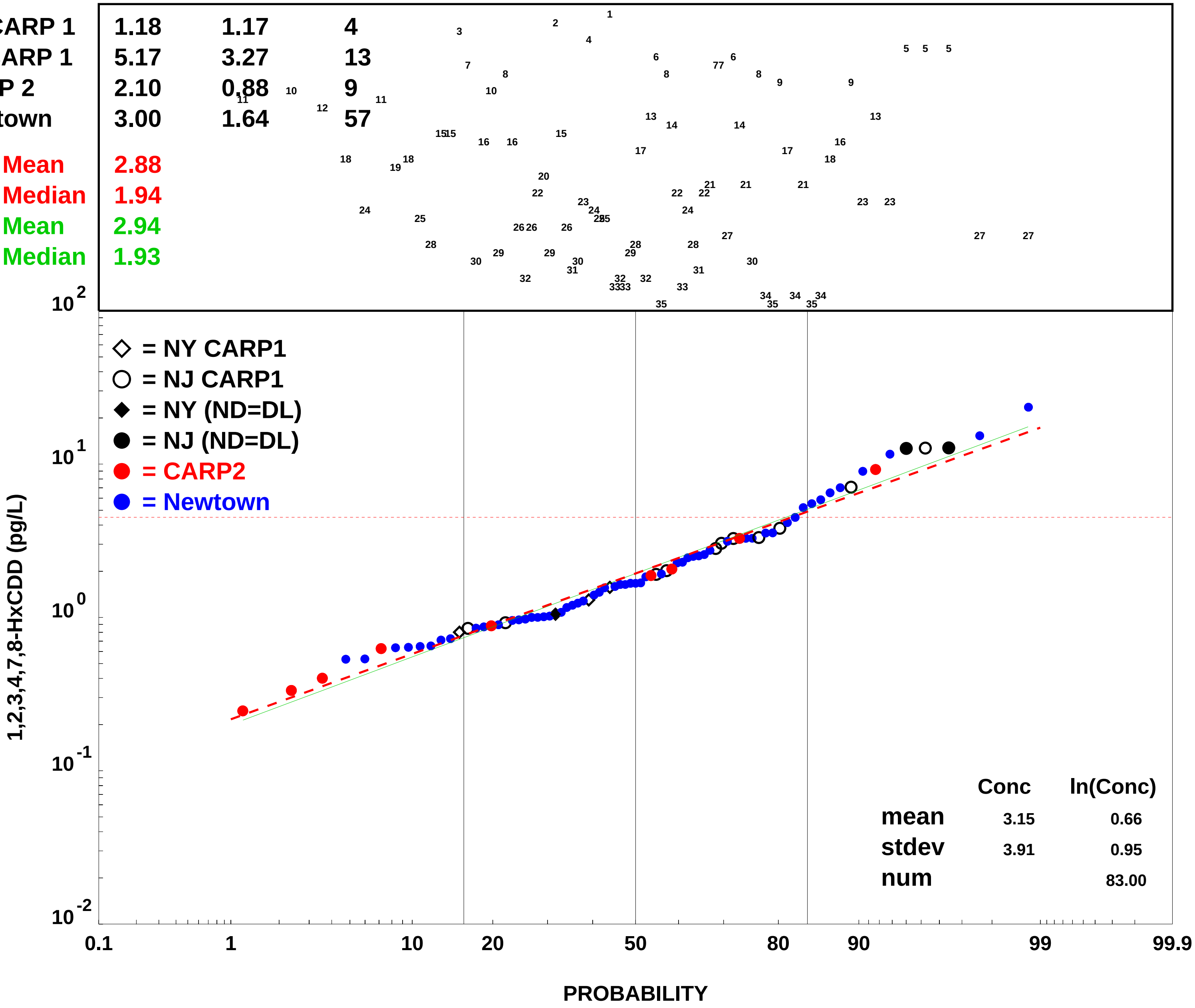
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	1.18	1.17	4
NJ CARP 1	5.17	3.27	13
CARP 2	2.10	0.88	9
Newtown	3.00	1.64	57
Line Mean	2.88		
Line Median	1.94		
Line Mean	2.94		
Line Median	1.93		



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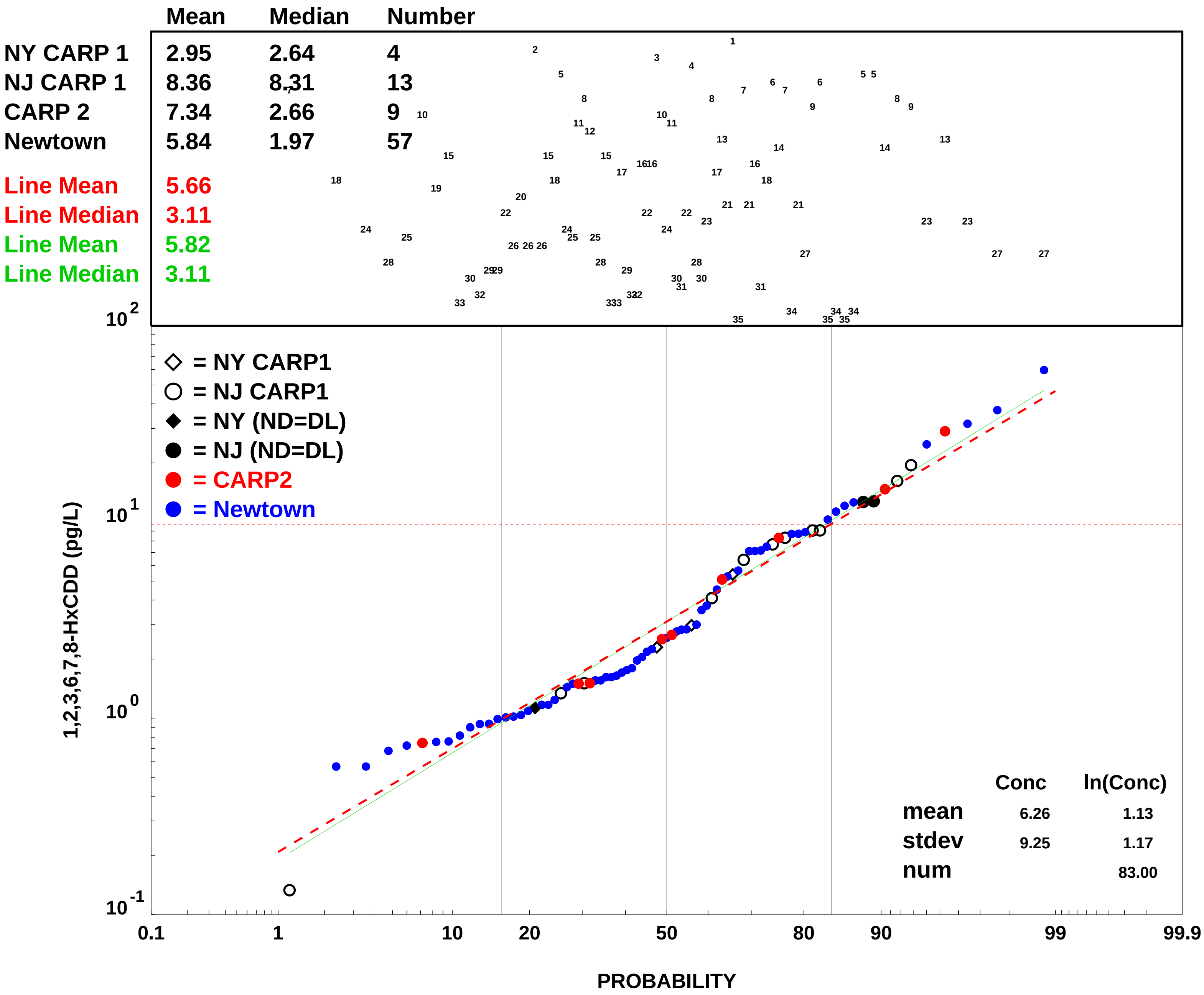

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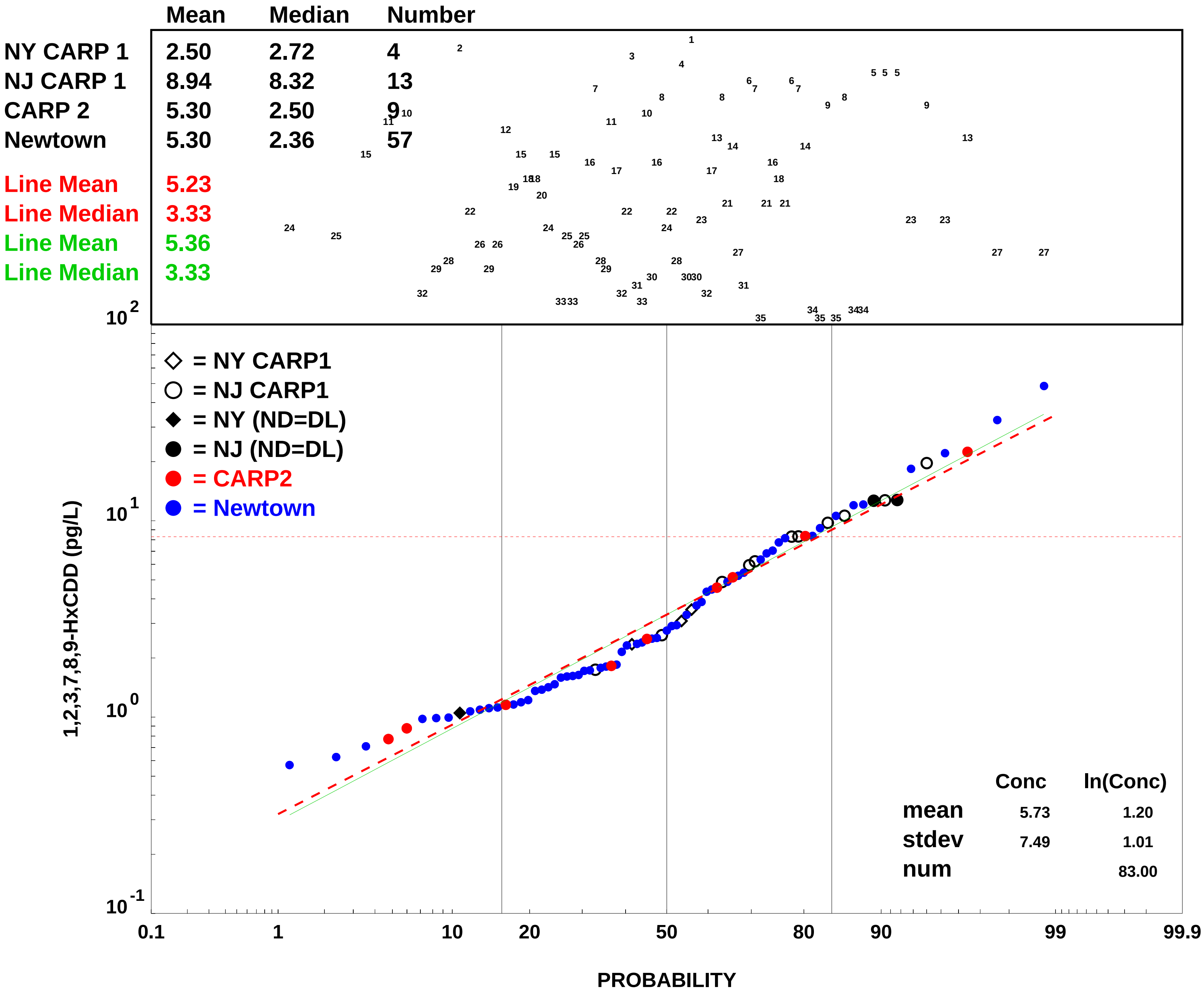

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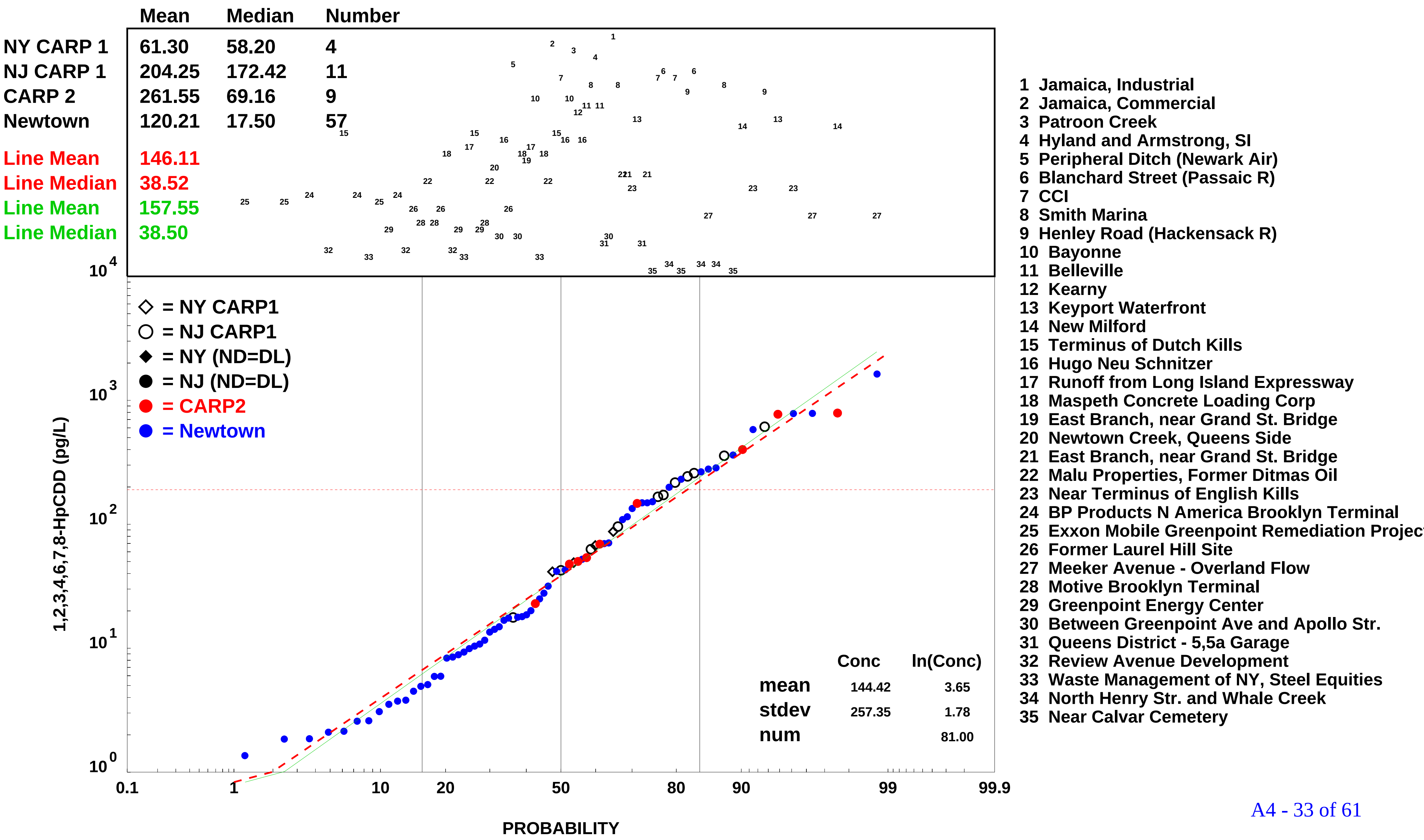
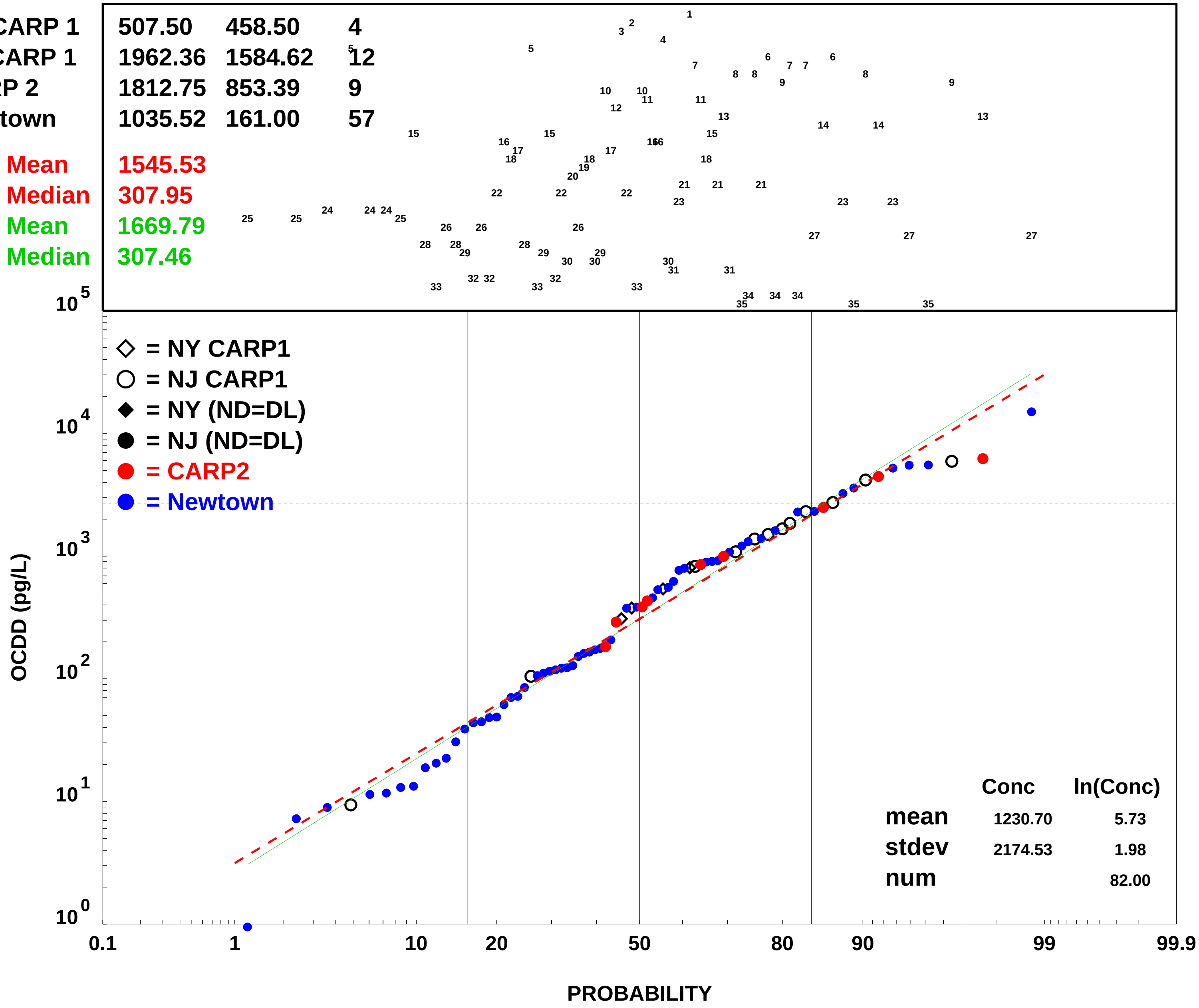


New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	507.50	458.50	4
NJ CARP 1	1962.36	1584.62	12
CARP 2	1812.75	853.39	9
Newtown	1035.52	161.00	57
Line Mean	1545.53		
Line Median	307.95		
Line Mean	1669.79		
Line Median	307.46		



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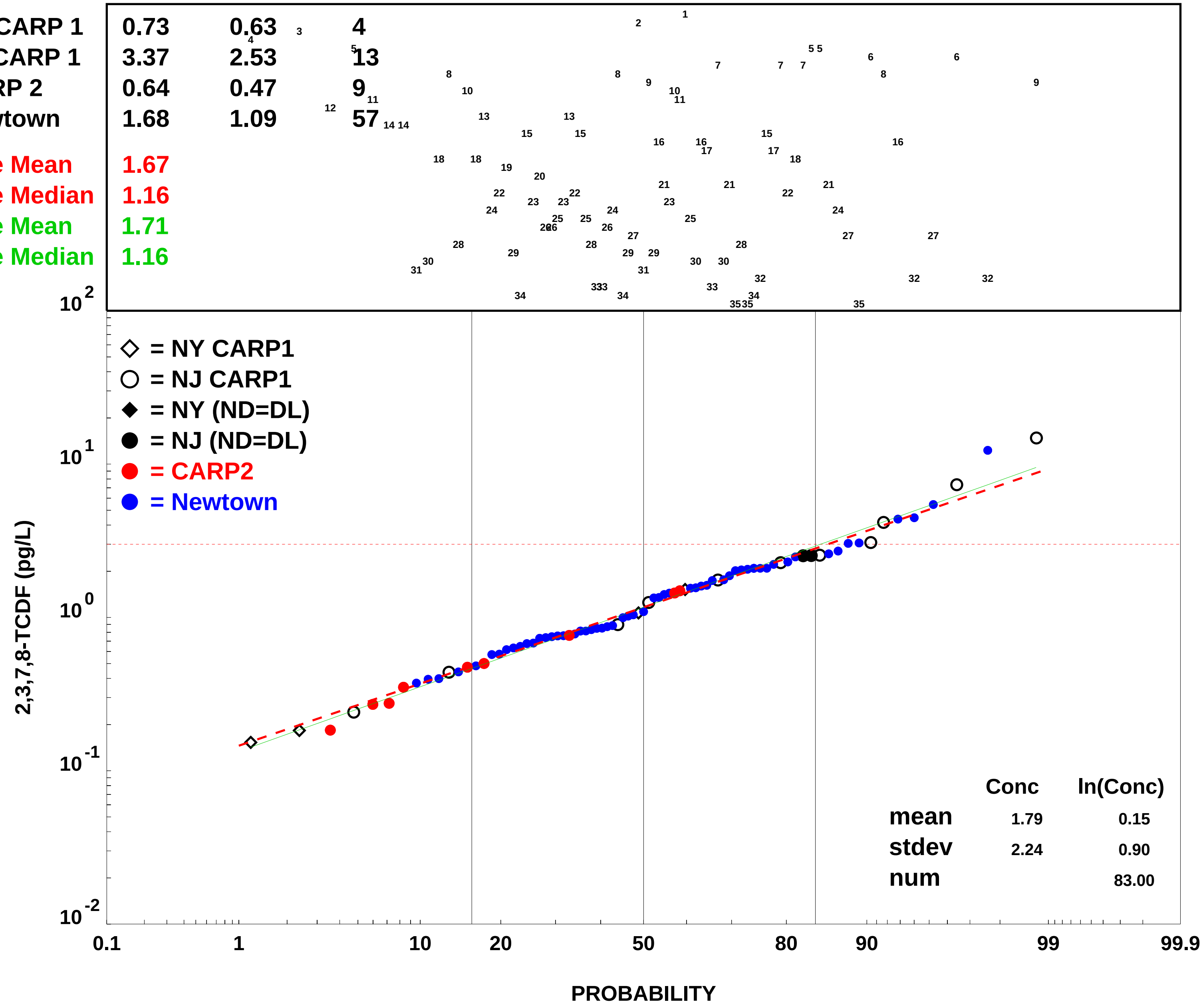
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	0.73	0.63	4
NJ CARP 1	3.37	2.53	13
CARP 2	0.64	0.47	9
Newtown	1.68	1.09	57
Line Mean	1.67		
Line Median	1.16		
Line Mean	1.71		
Line Median	1.16		



	Conc	ln(Conc)
mean	1.79	0.15
stdev	2.24	0.90
num		83.00

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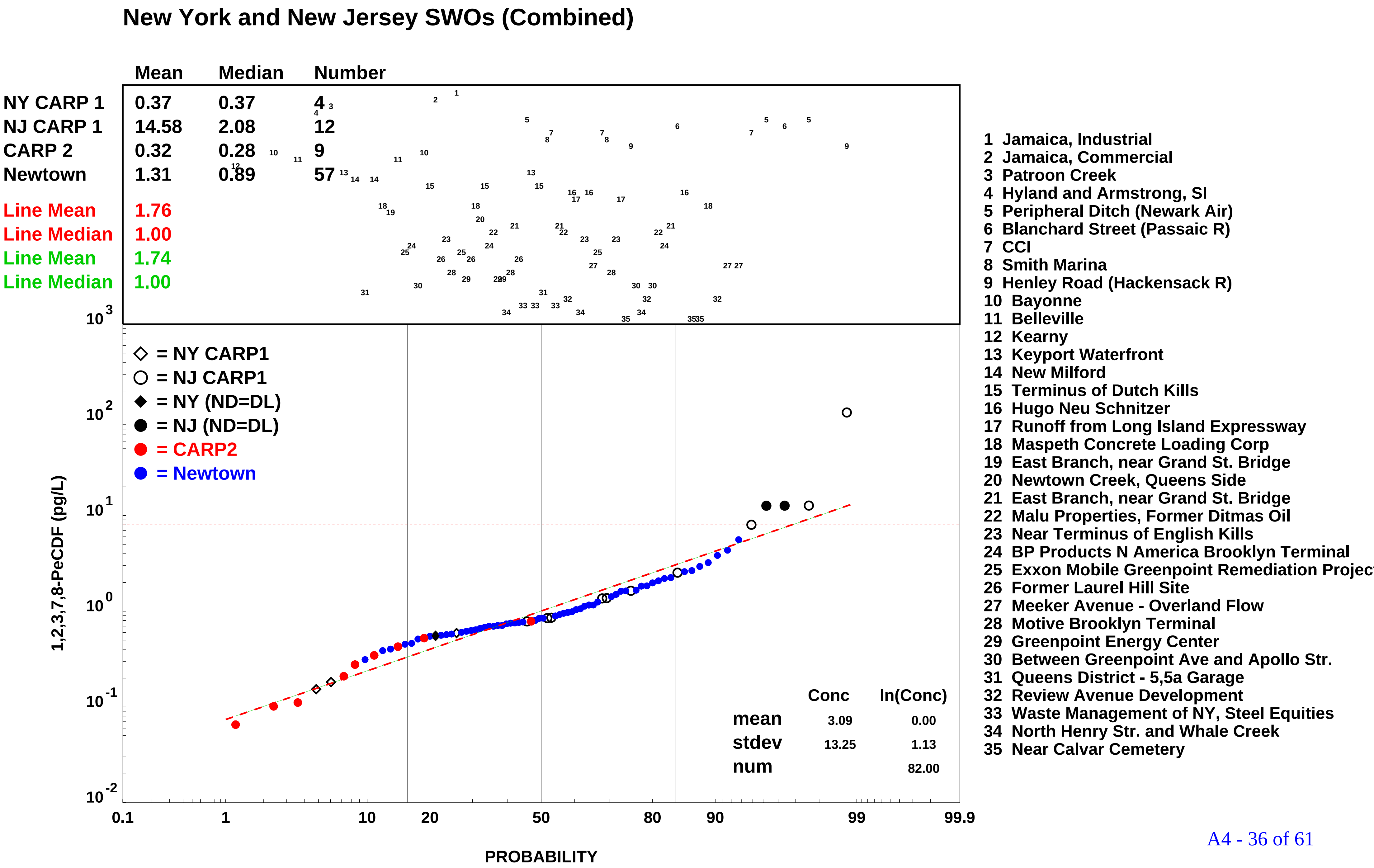
New York and New Jersey SWOs (Combined)
Mean Median Number
NY CARP 1 0.37 0.37 4
NJ CARP 1 14.58 2.08 12
CARP 2 0.32 0.28 9
Newtown 1.31 0.89 57
Line Mean 1.76
Line Median 1.00
Line Mean 1.74
Line Median 1.00
◇ = NY CARP1
○ = NJ CARP1
◆ = NY (ND=DL)
● = NJ (ND=DL)
● = CARP2
● = Newtown
Conc ln(Conc)
mean 3.09 0.00
stdev 13.25 1.13
num 82.00
1,2,3,7,8-PeCDF (pg/L)
PROBABILITY
0.1
1
10
20
50
80
90
99
99.9
1 Jamaica, Industrial
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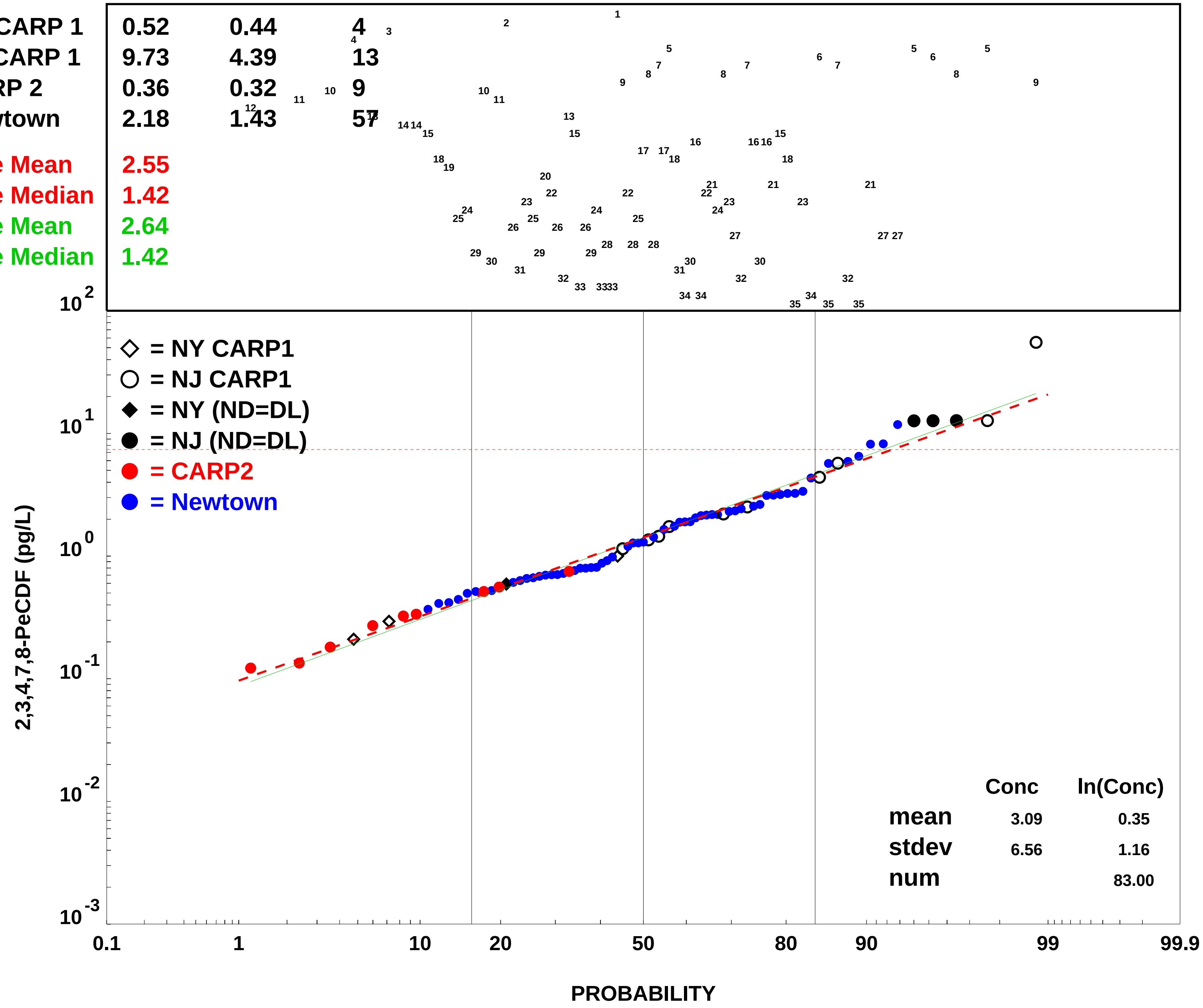
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	0.52	0.44	4
NJ CARP 1	9.73	4.39	13
CARP 2	0.36	0.32	9
Newtown	2.18	1.43	57
Line Mean	2.55		
Line Median	1.42		
Line Mean	2.64		
Line Median	1.42		



	Conc	ln(Conc)
mean	3.09	0.35
stdev	6.56	1.16
num		83.00

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23 Near Terminus of English Kills
24 BP Products N America Brooklyn Terminal
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32 Review Avenue Development
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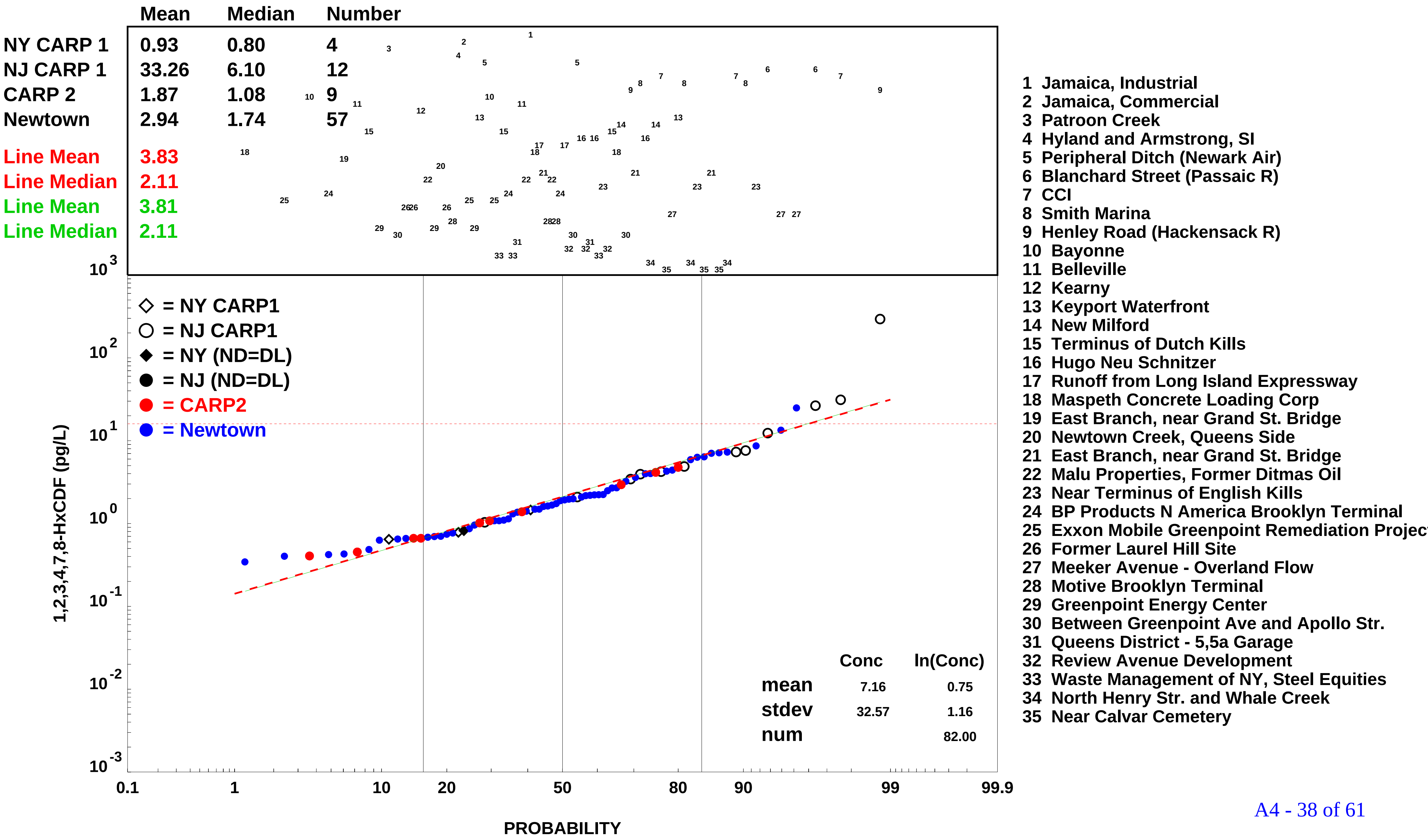
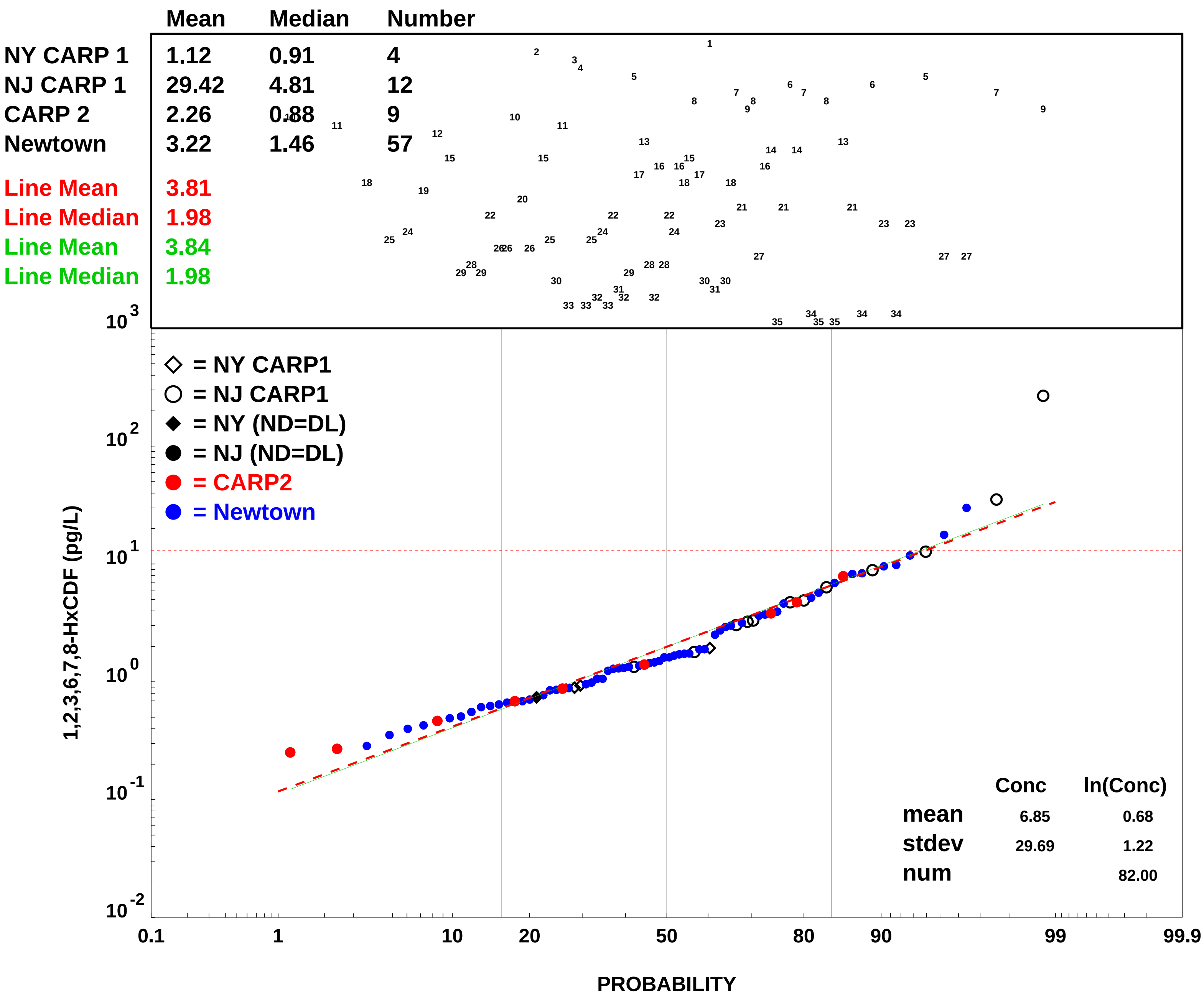
34 North Henry Str. and Whale Creek
35 Near Calvar Cemetery

New York and New Jersey SWOs (Combined)



New York and New Jersey SWOs (Combined)



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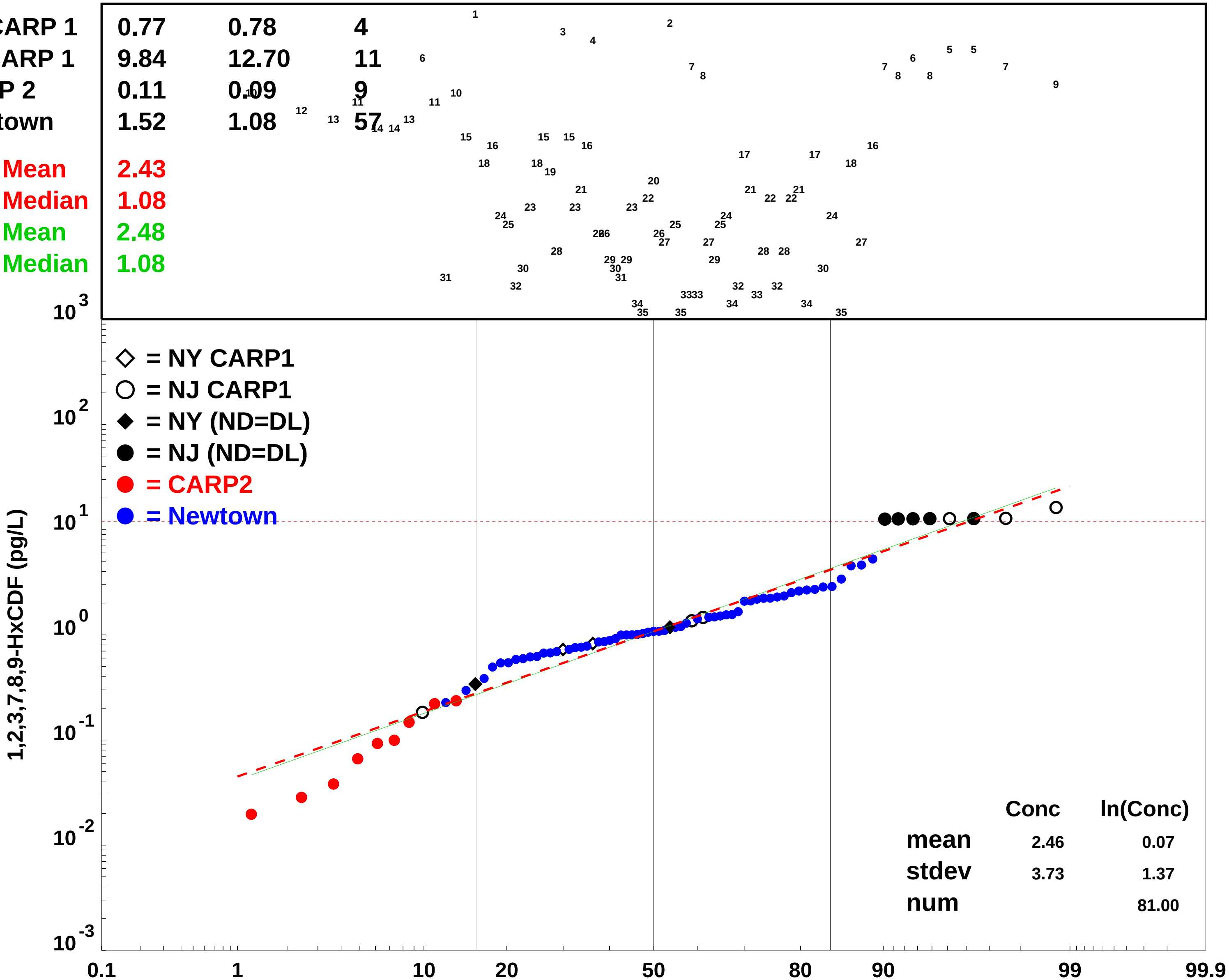
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	0.77	0.78	4
NJ CARP 1	9.84	12.70	11
CARP 2	0.11	0.09	9
Newtown	1.52	1.08	57
Line Mean	2.43		
Line Median	1.08		
Line Mean	2.48		
Line Median	1.08		



	Conc	ln(Conc)
mean	2.46	0.07
stdev	3.73	1.37
num		81.00

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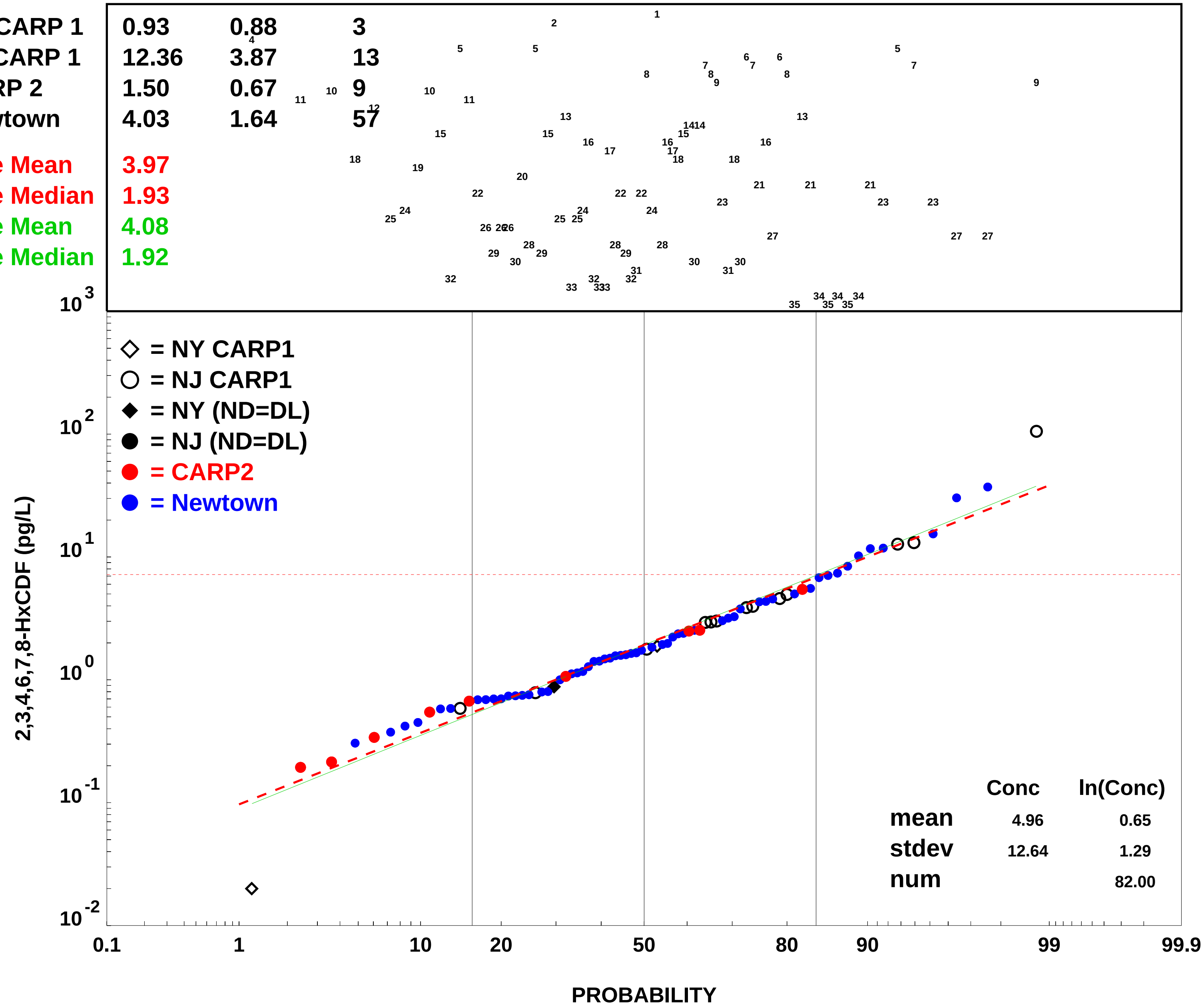
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	0.93	0.88	3
NJ CARP 1	12.36	3.87	13
CARP 2	1.50	0.67	9
Newtown	4.03	1.64	57
Line Mean	3.97		
Line Median	1.93		
Line Mean	4.08		
Line Median	1.92		



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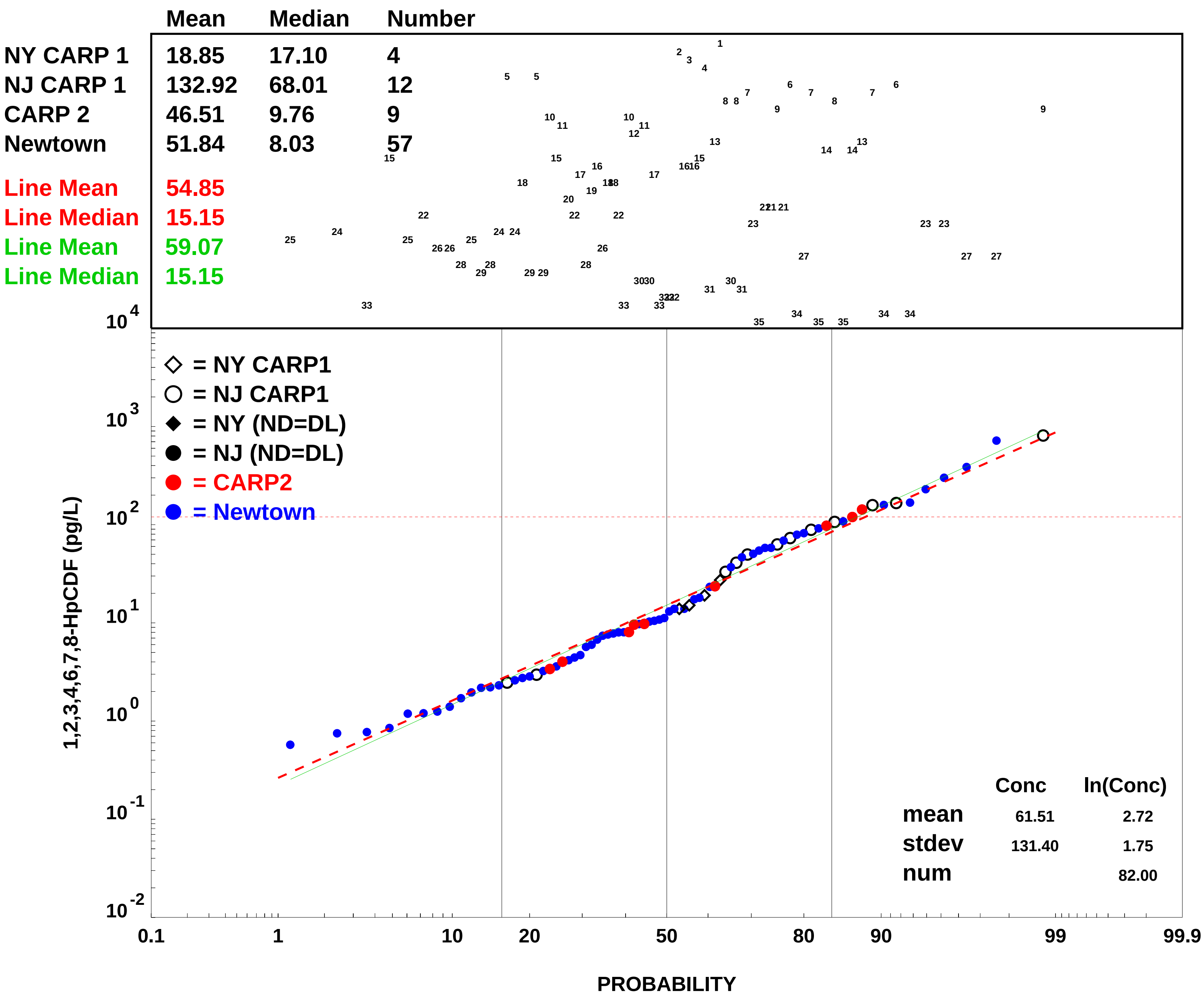

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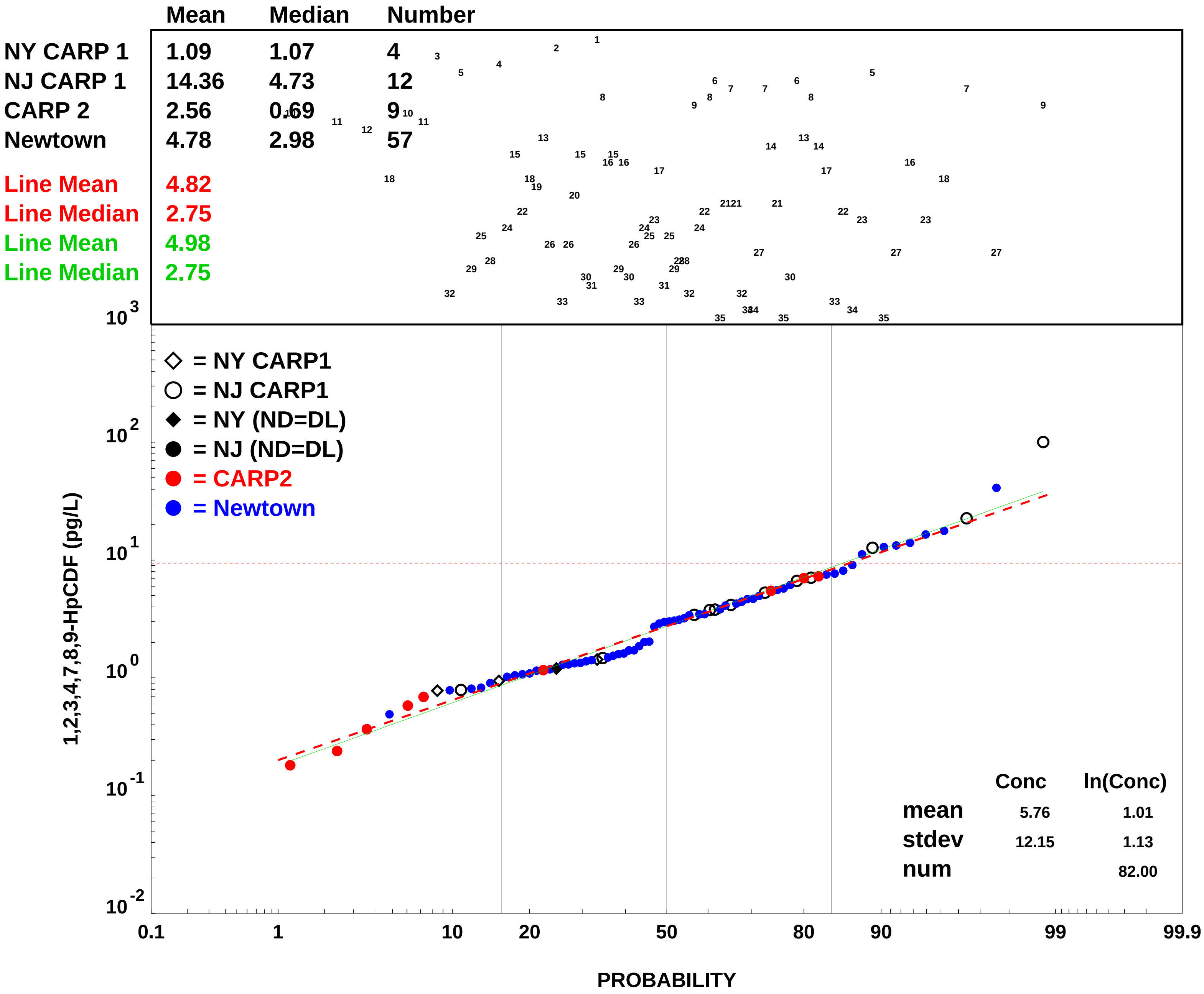

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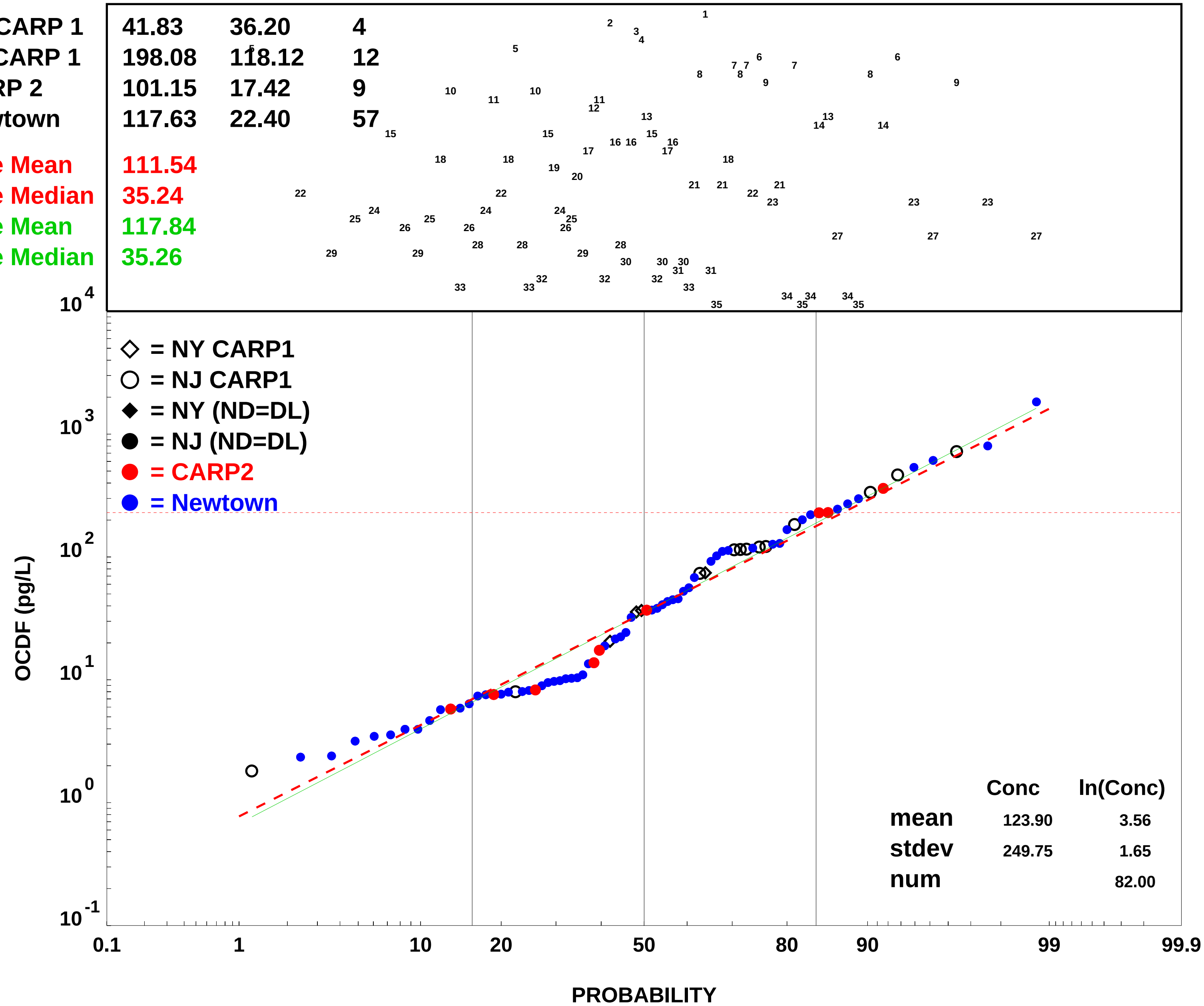
New York and New Jersey SWOs (Combined)

	Mean	Median	Number
NY CARP 1	41.83	36.20	4
NJ CARP 1	198.08	118.12	12
CARP 2	101.15	17.42	9
Newtown	117.63	22.40	57
Line Mean	111.54		
Line Median	35.24		
Line Mean	117.84		
Line Median	35.26		



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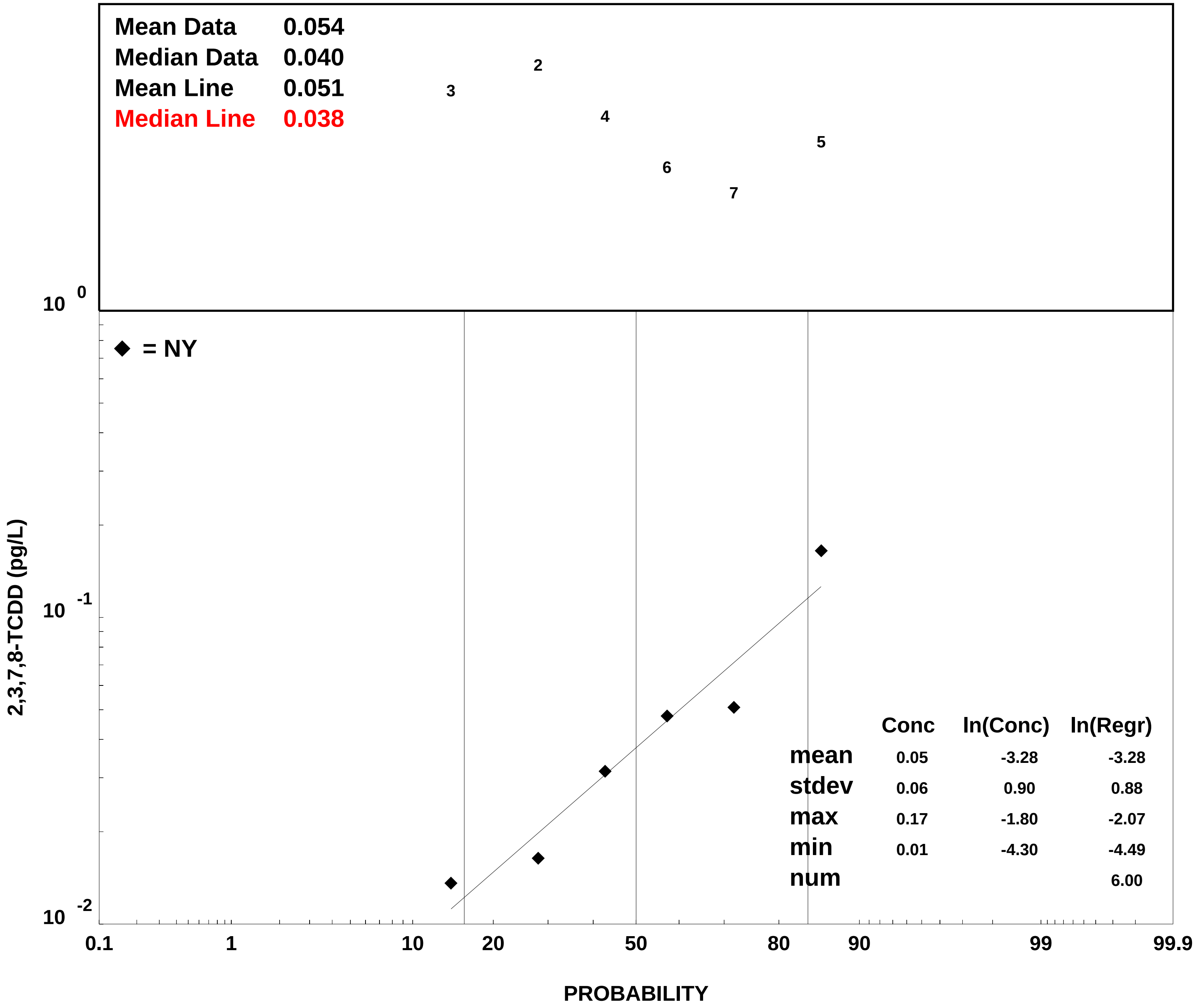
Dioxin/Furan Loading Concentration Distributions, Rural, this page, next 16 pages

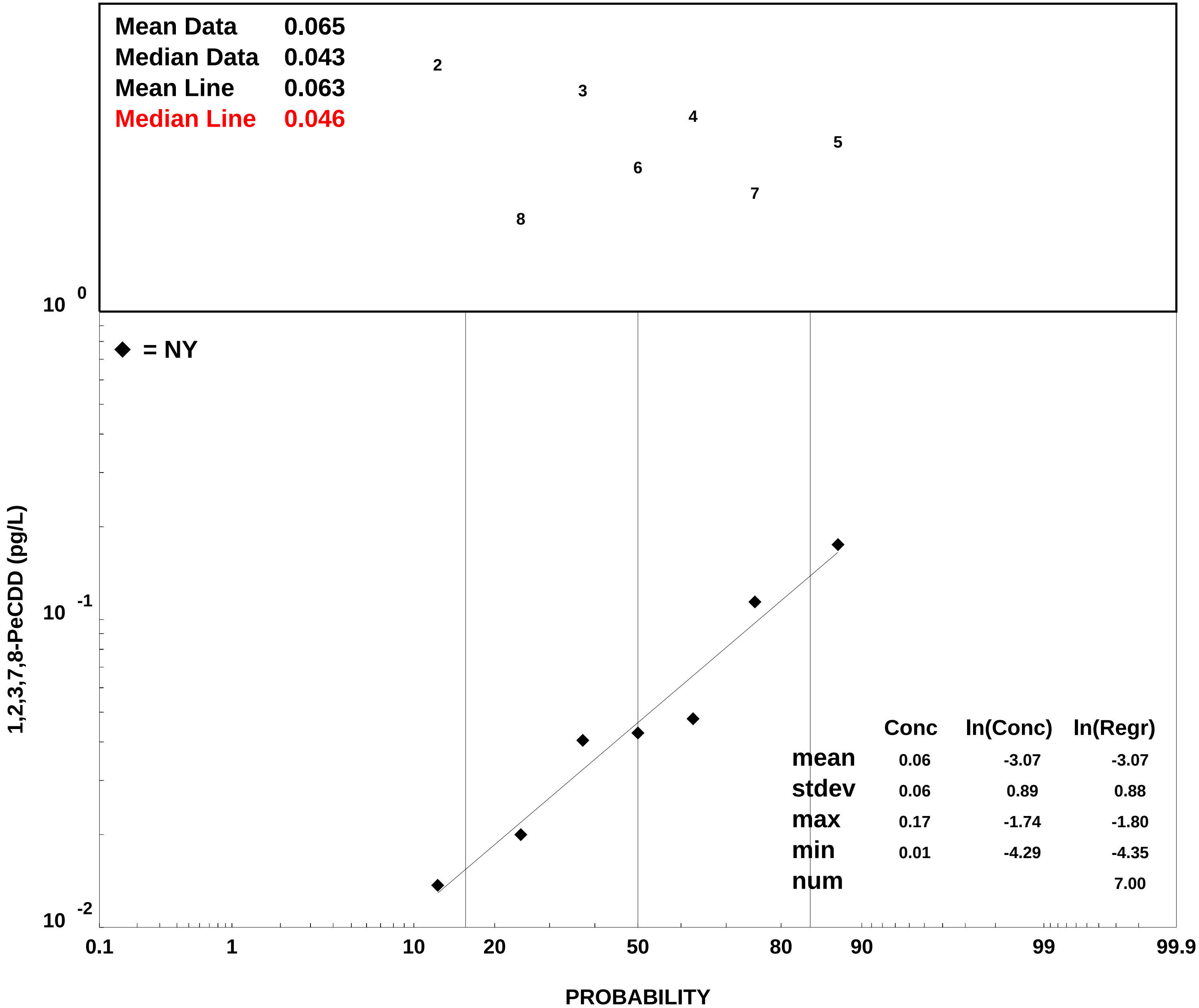
RURAL (New York) SWOs



	Conc	ln(Conc)	ln(Regr)
mean	0.05	-3.28	-3.28
stdev	0.06	0.90	0.88
max	0.17	-1.80	-2.07
min	0.01	-4.30	-4.49
num			6.00

1 CatsKill Cr.
2 Kinderhook Cr.
3 Moordners Kill
4 Normans Kill
5 Papscanee Cr.
6 Sickles Cr.
7 Vlomans Kill
8 Klein Kill
9 Roeliff Jansen Kill

RURAL (New York) SWOs



	Conc	ln(Conc)	ln(Regr)
mean	0.06	-3.07	-3.07
stdev	0.06	0.89	0.88
max	0.17	-1.74	-1.80
min	0.01	-4.29	-4.35
num			7.00

1 CatsKill Cr.

2 Kinderhook Cr.

3 Moordners Kill

4 Normans Kill

5 Papscanee Cr.

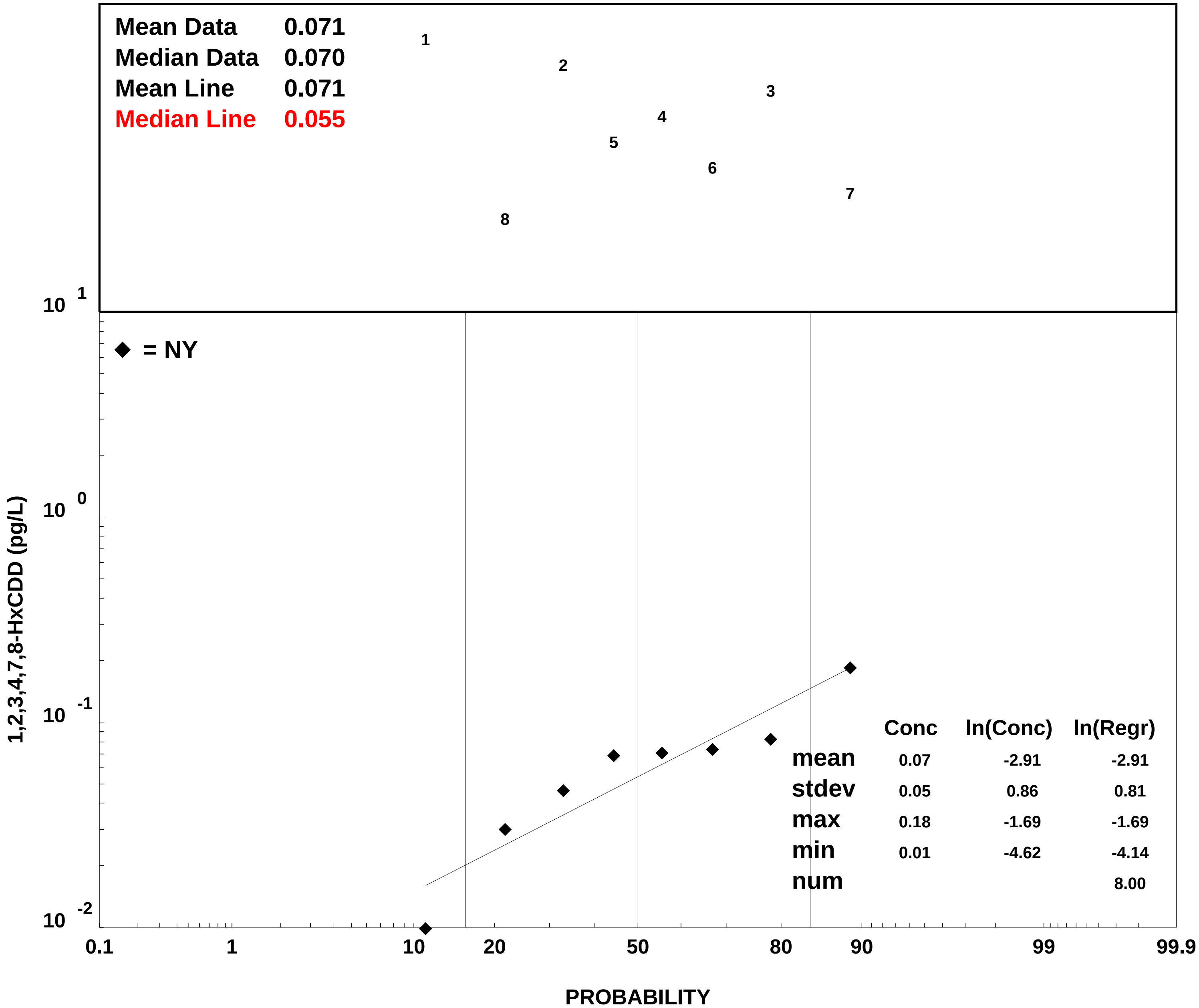
6 Sickles Cr.

7 Vlomans Kill

8 Klein Kill

9 Roeliff Jansen Kill

RURAL (New York) SWOs



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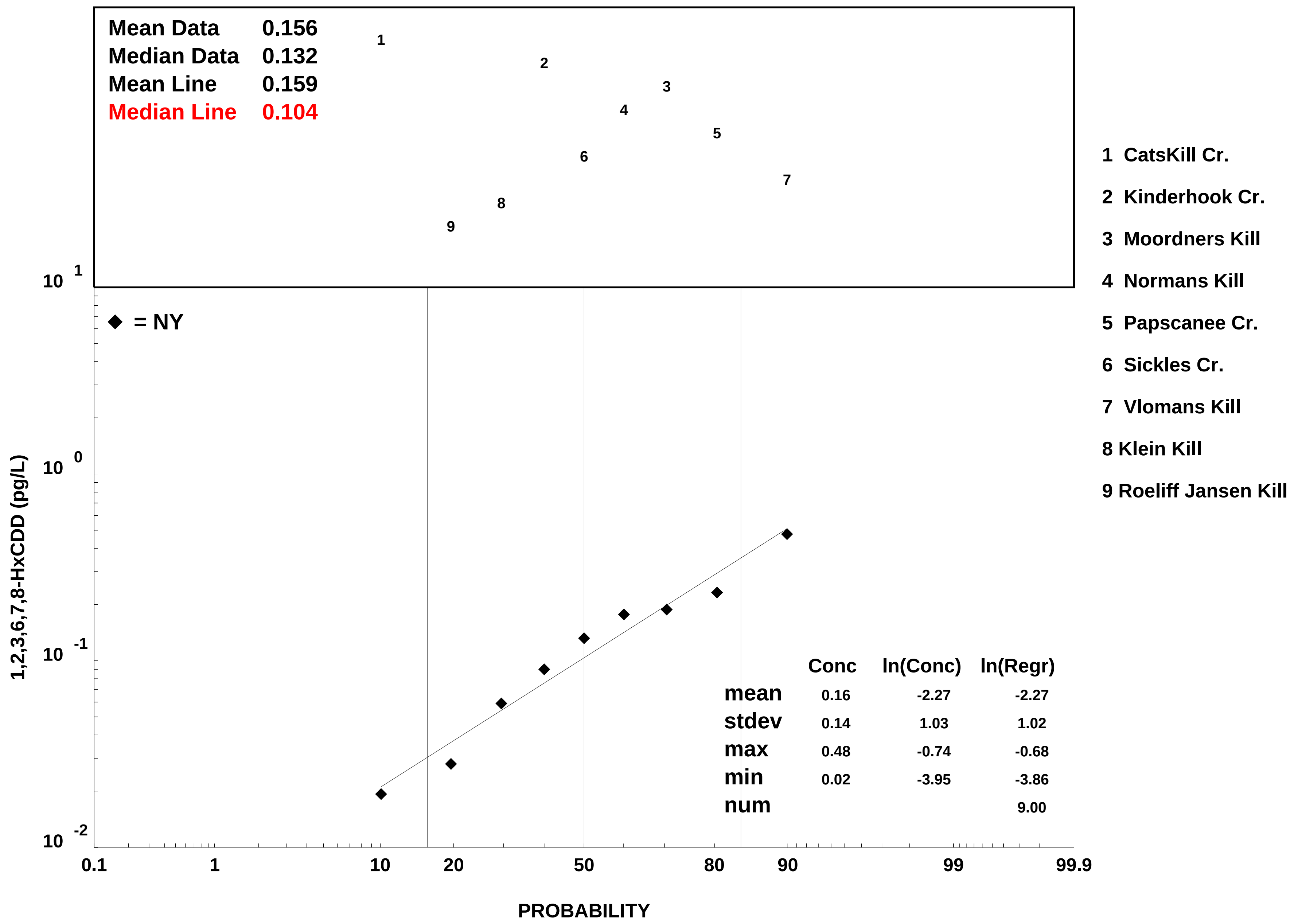
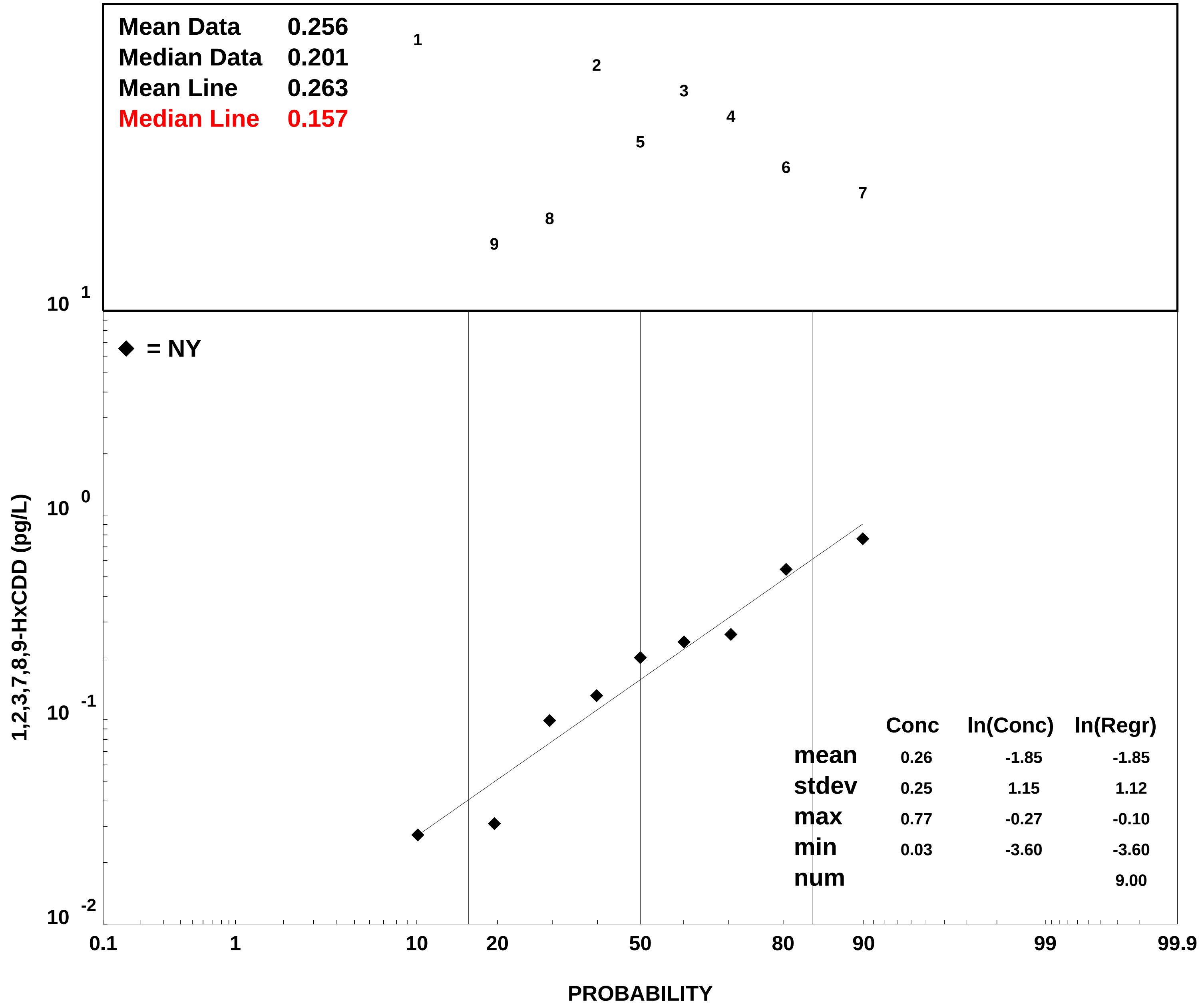
RURAL (New York) SWOs



	Conc	ln(Conc)	ln(Regr)
mean	0.16	-2.27	-2.27
stdev	0.14	1.03	1.02
max	0.48	-0.74	-0.68
min	0.02	-3.95	-3.86
num			9.00

RURAL (New York) SWOs



	Conc	ln(Conc)	ln(Regr)
mean	0.26	-1.85	-1.85
stdev	0.25	1.15	1.12
max	0.77	-0.27	-0.10
min	0.03	-3.60	-3.60
num			9.00

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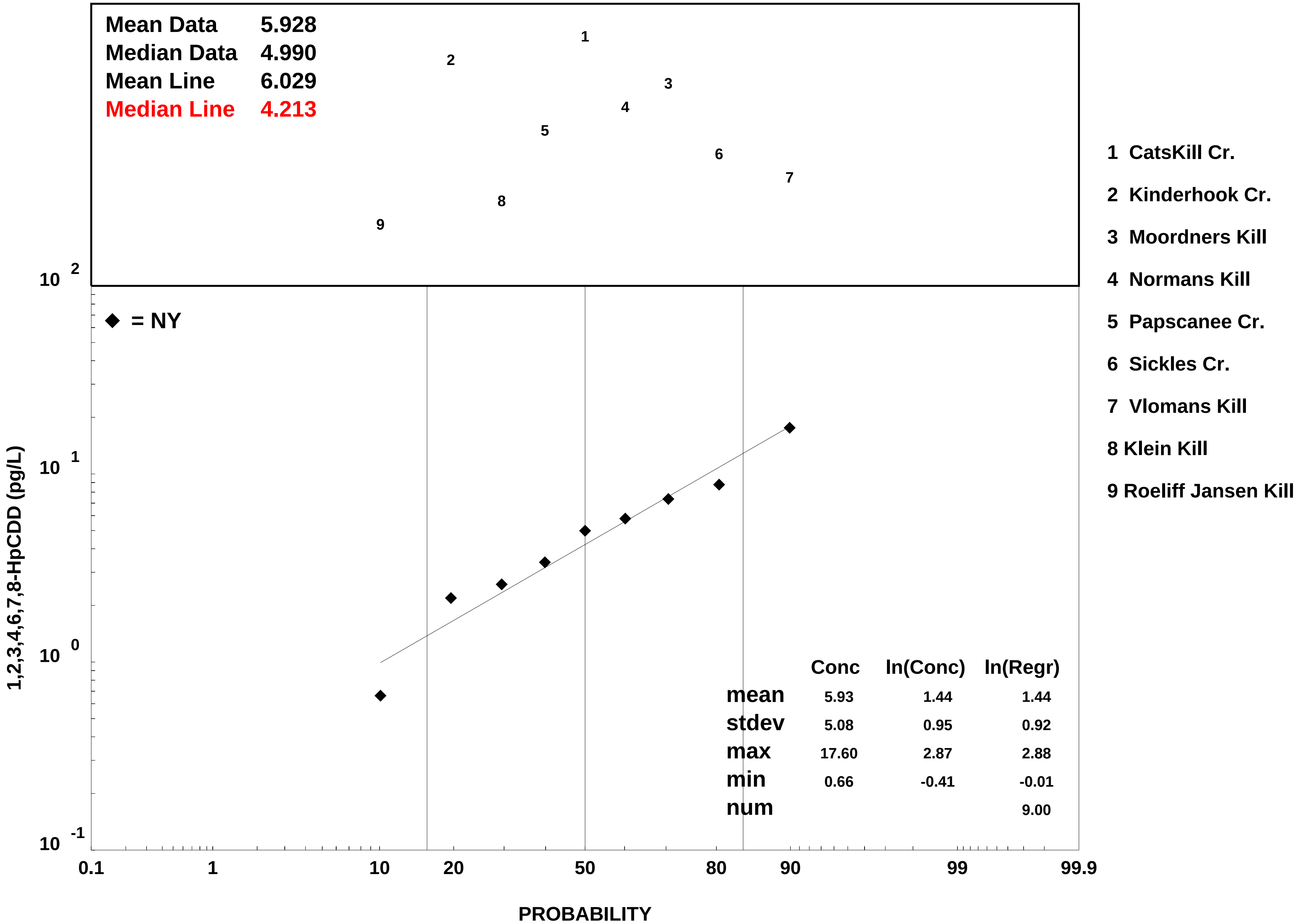
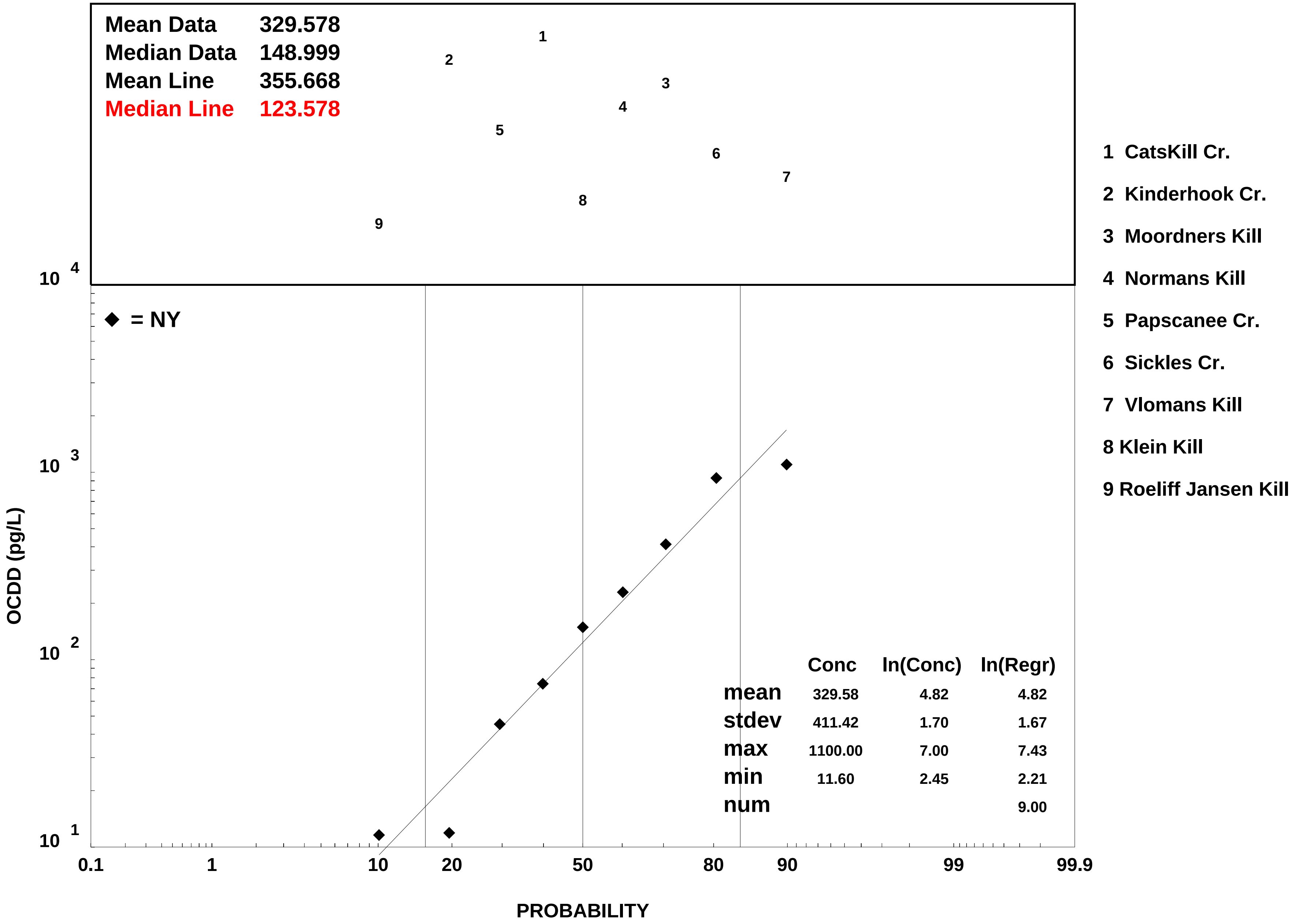
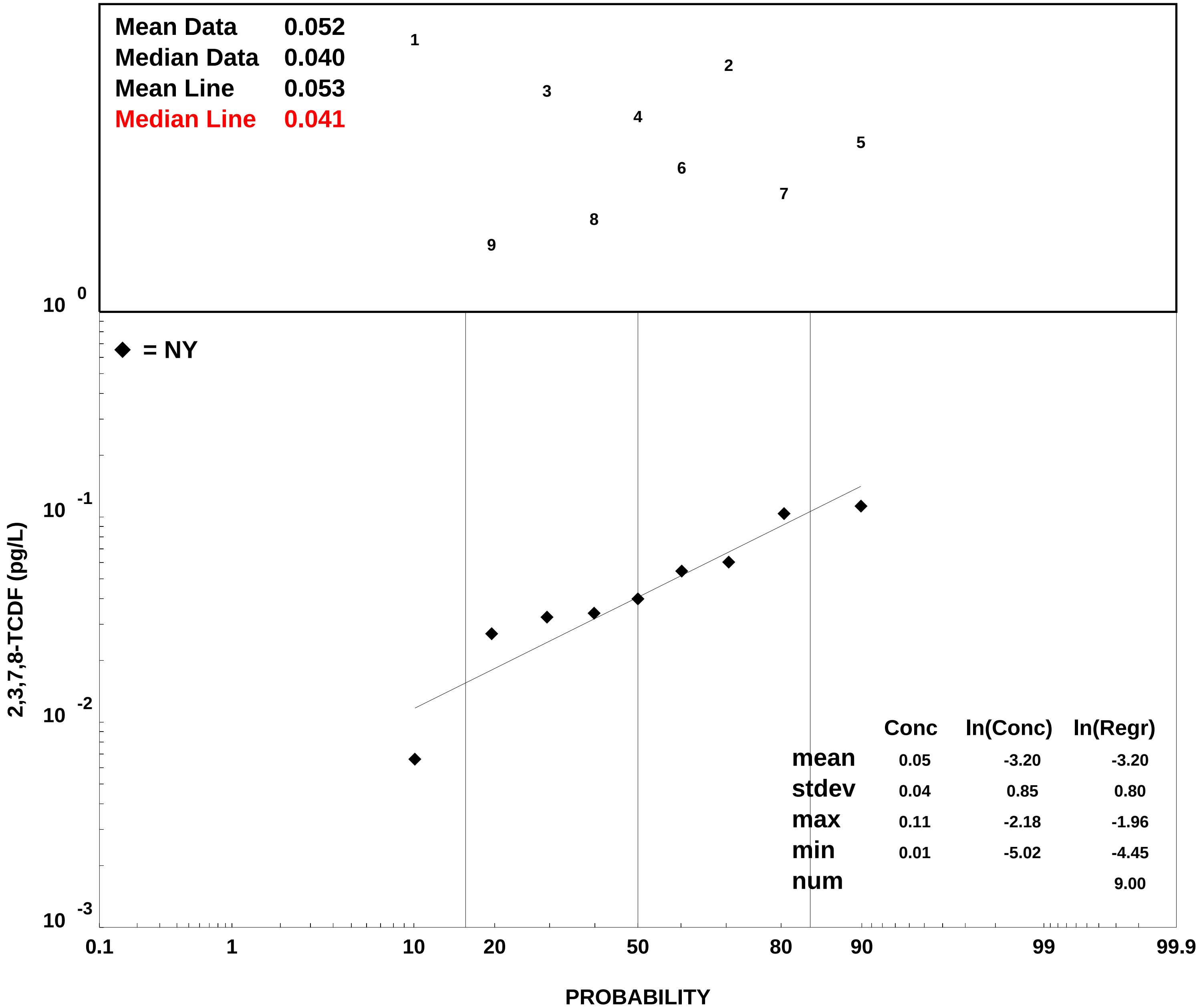
RURAL (New York) SWOs



RURAL (New York) SWOs



RURAL (New York) SWOs



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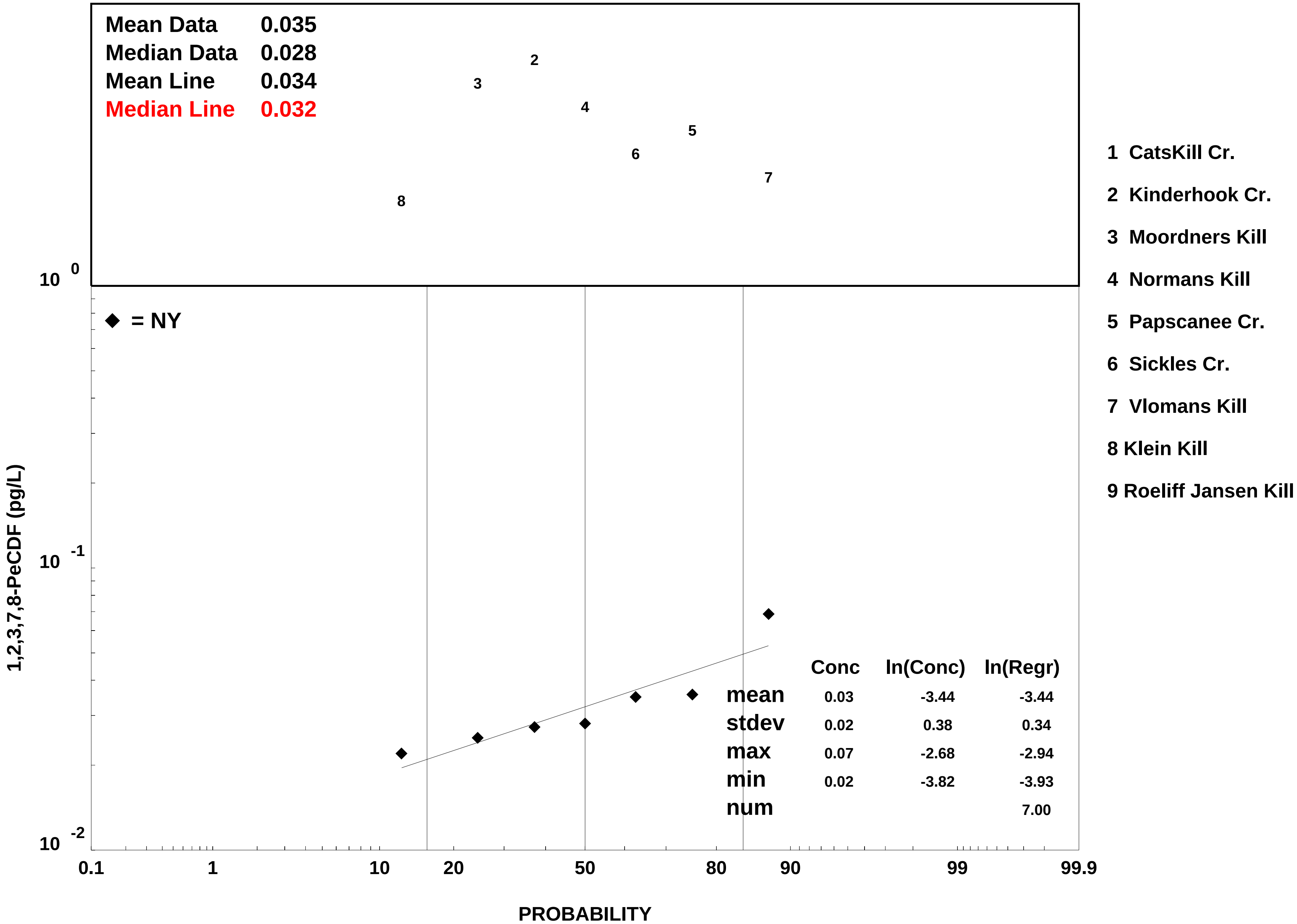
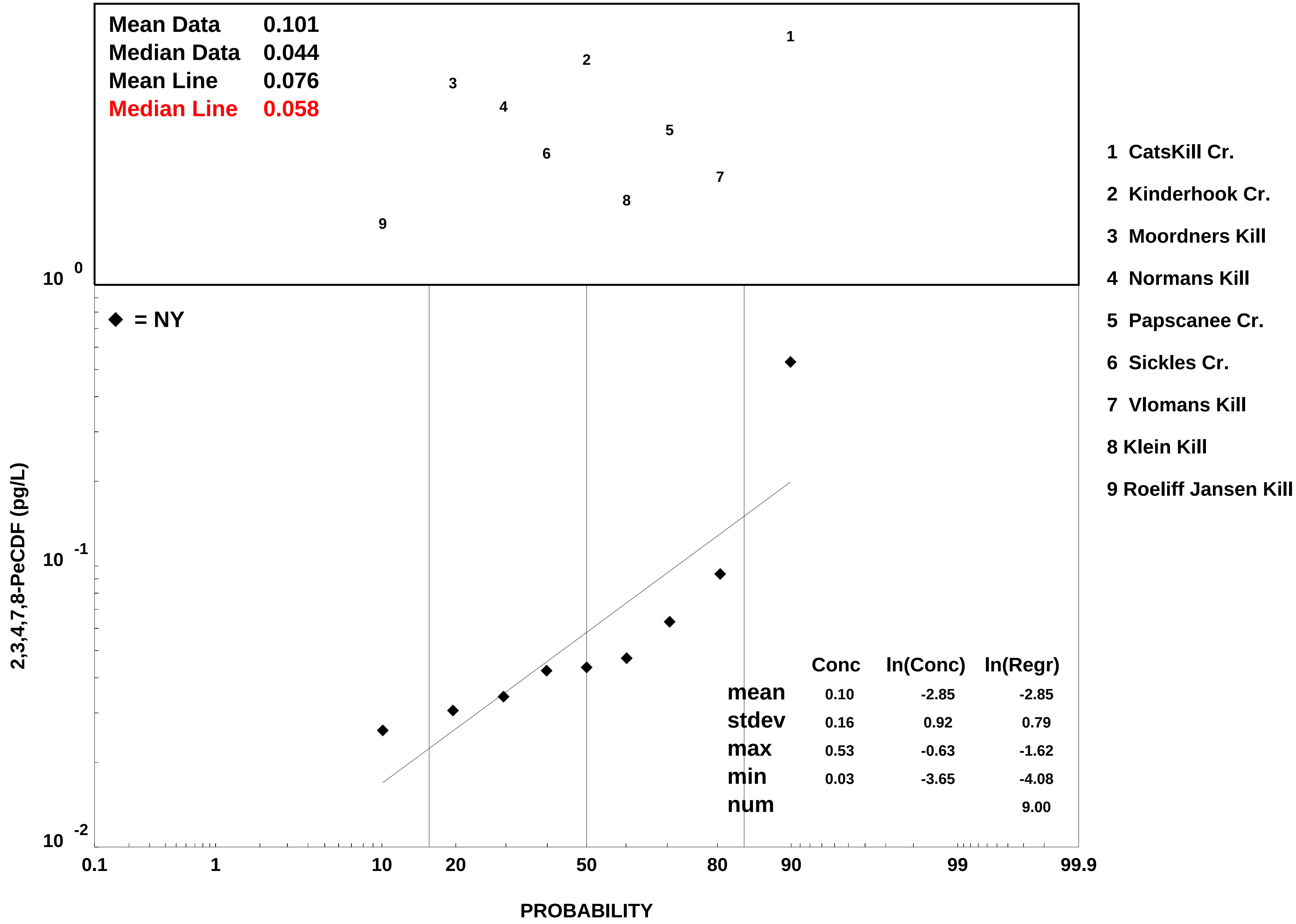
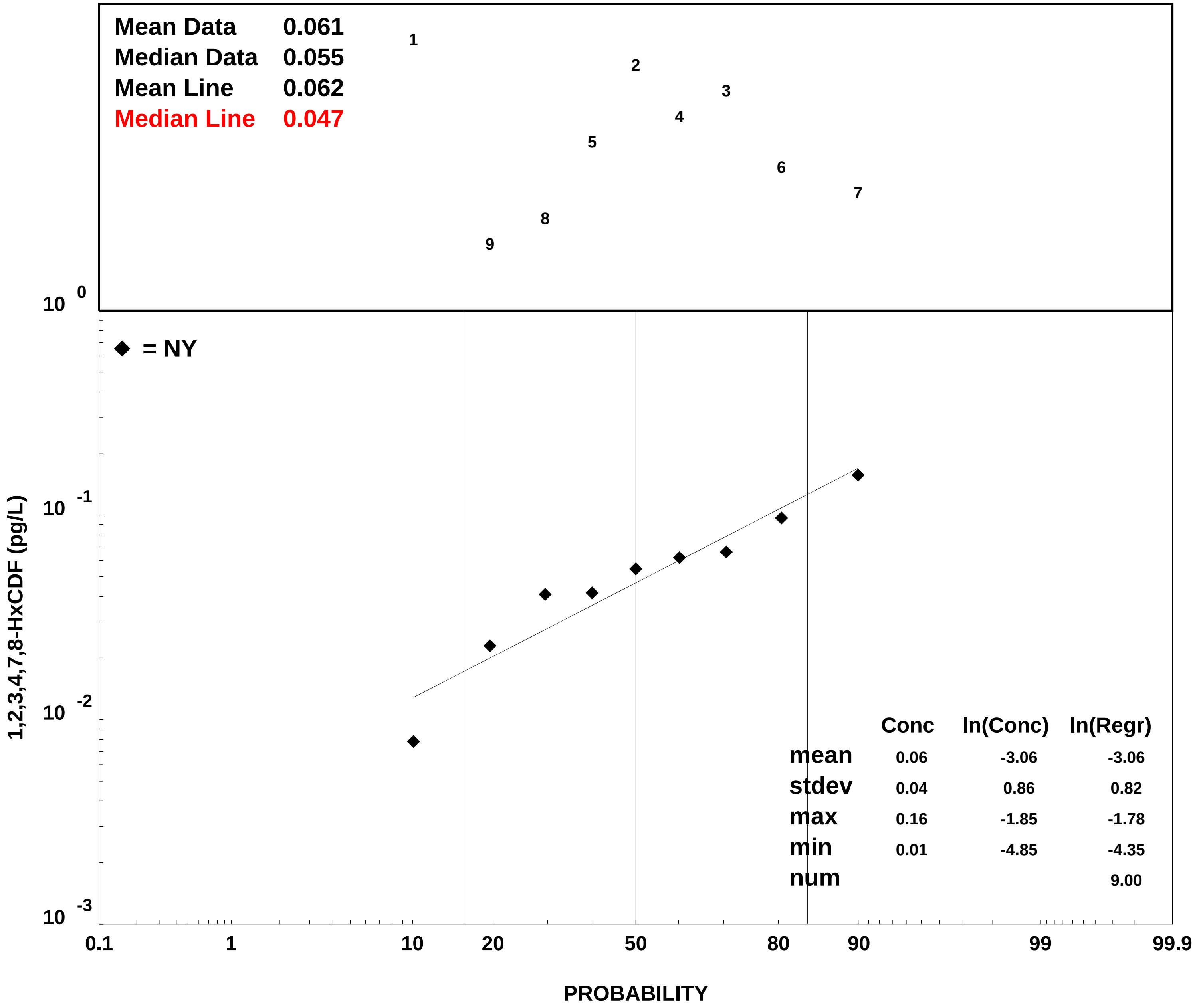
RURAL (New York) SWOs



RURAL (New York) SWOs



RURAL (New York) SWOs



	Conc	ln(Conc)	ln(Regr)
mean	0.06	-3.06	-3.06
stdev	0.04	0.86	0.82
max	0.16	-1.85	-1.78
min	0.01	-4.85	-4.35
num			9.00

1 CatsKill Cr.
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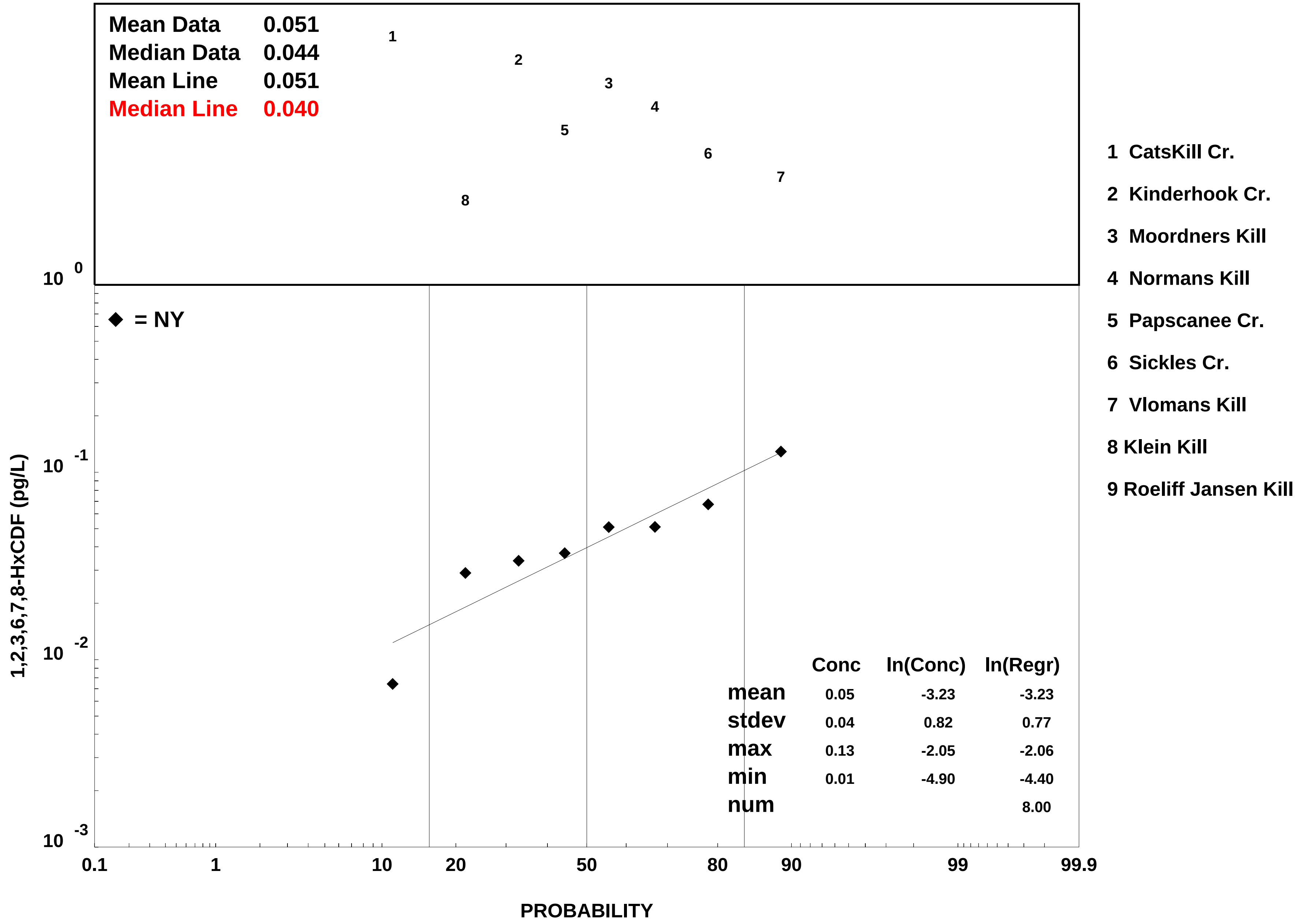
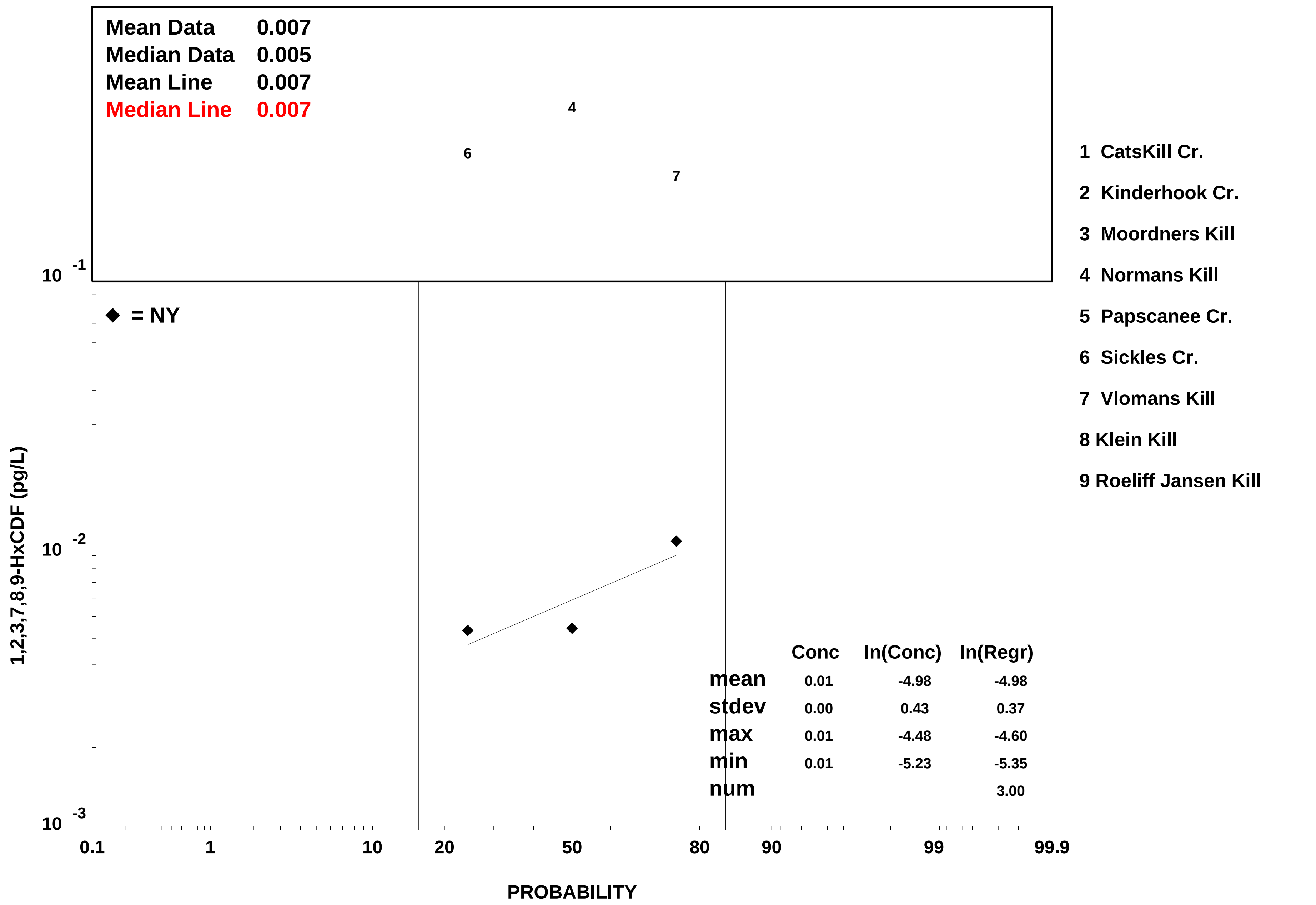
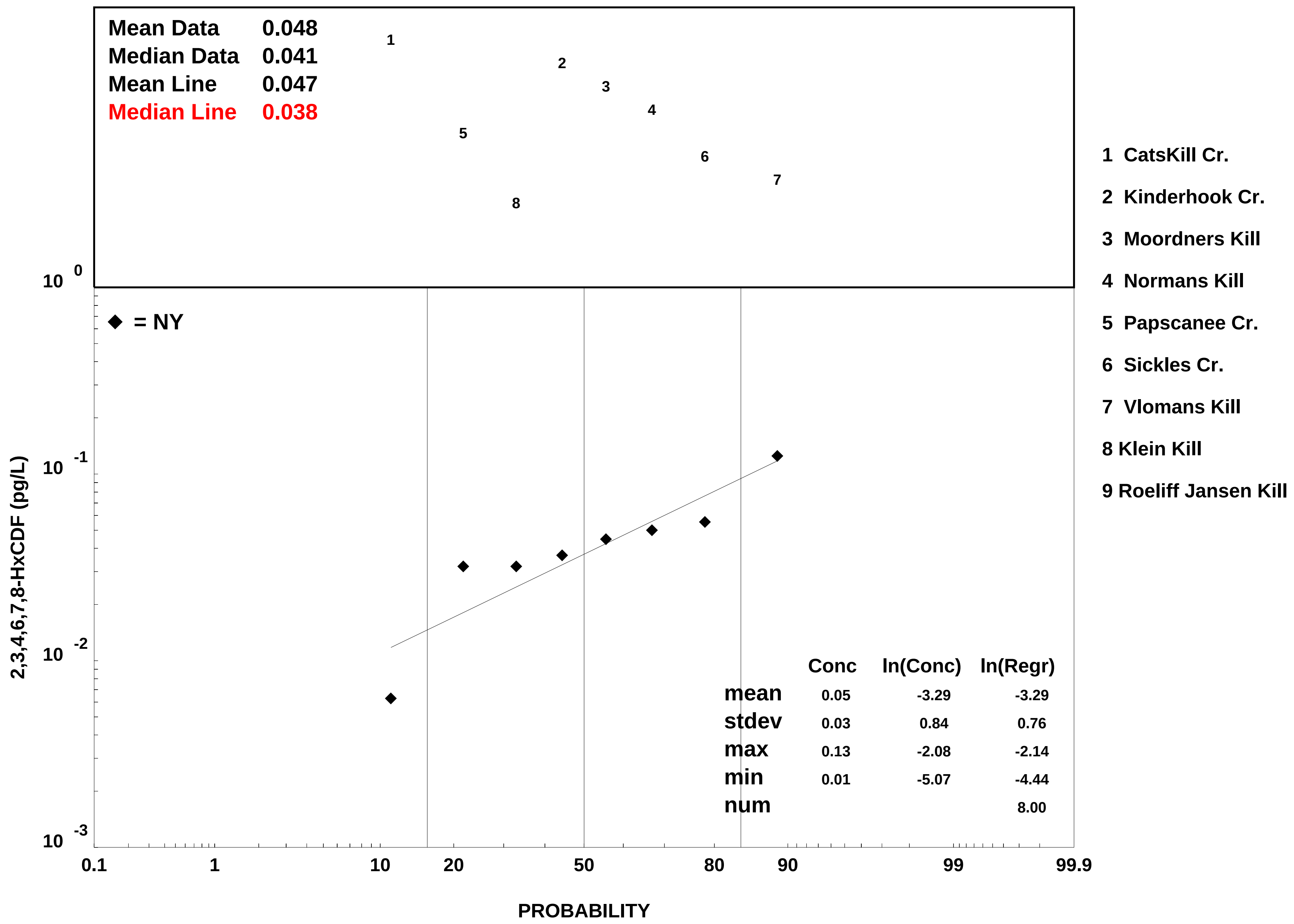
RURAL (New York) SWOs



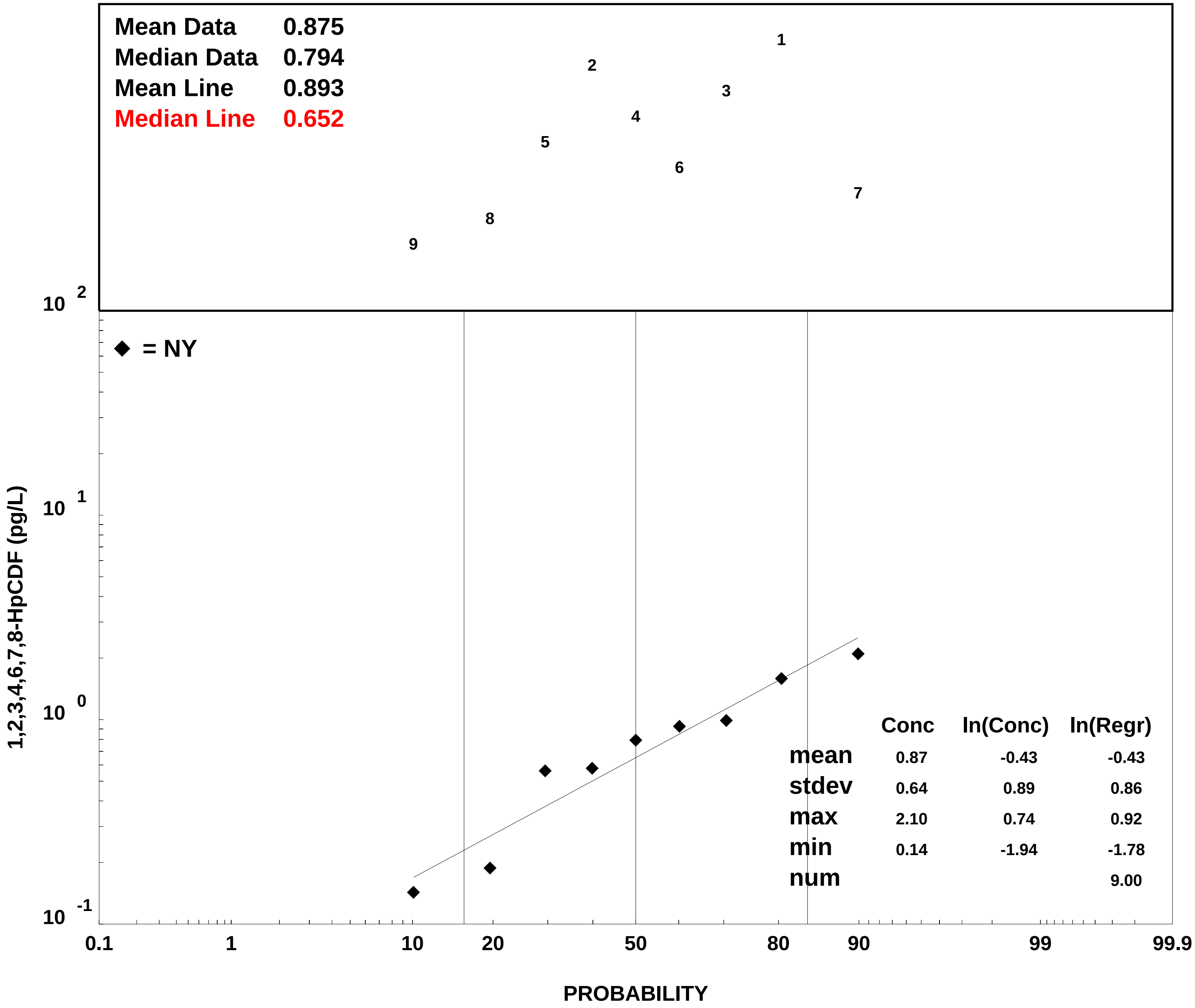
RURAL (New York) SWOs



RURAL (New York) SWOs



RURAL (New York) SWOs



	Conc	ln(Conc)	ln(Regr)
mean	0.87	-0.43	-0.43
stdev	0.64	0.89	0.86
max	2.10	0.74	0.92
min	0.14	-1.94	-1.78
num			9.00

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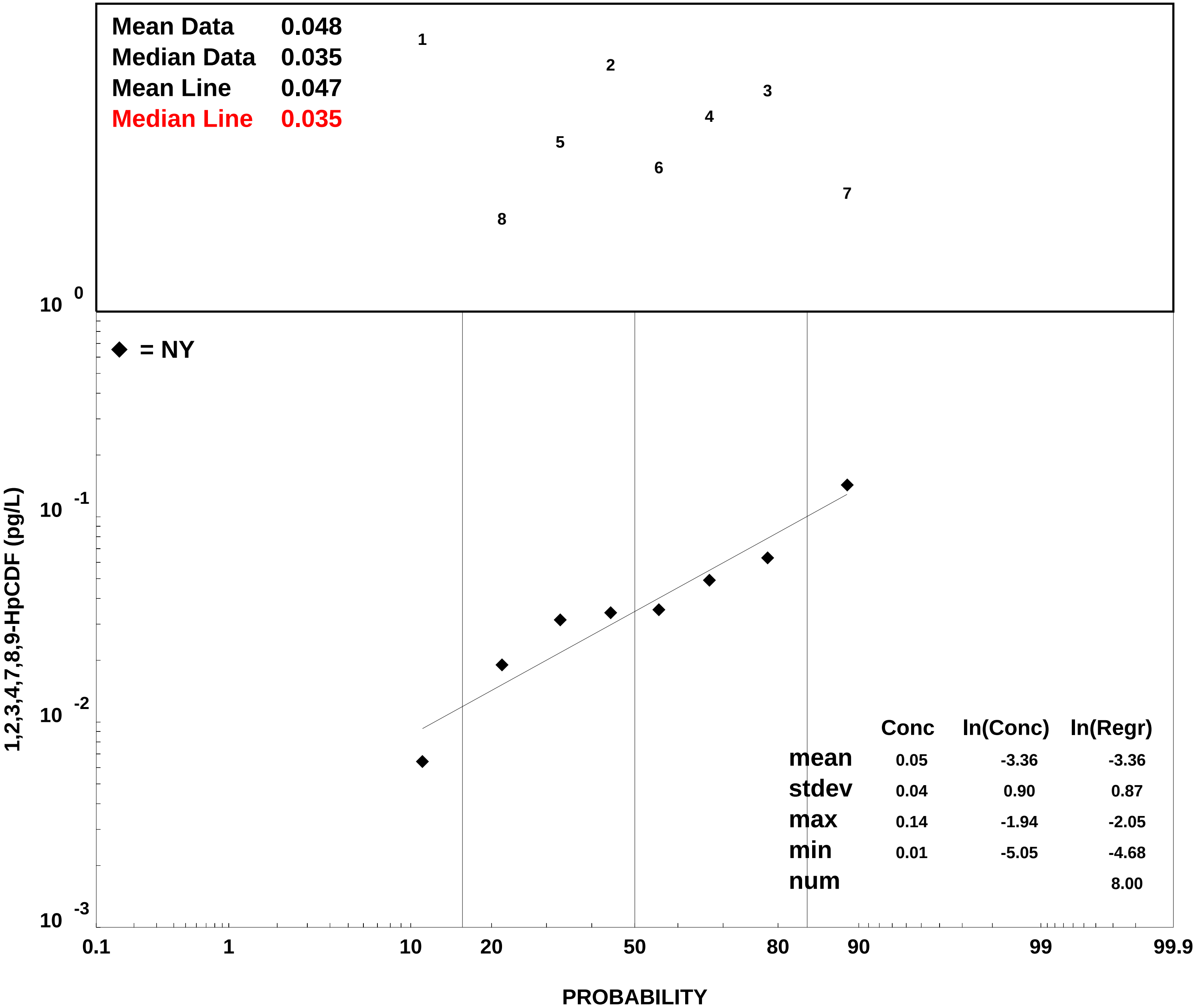

	Conc	ln(Conc)	ln(Regr)
mean	0.05	-3.36	-3.36
stdev	0.04	0.90	0.87
max	0.14	-1.94	-2.05
min	0.01	-5.05	-4.68
num			8.00

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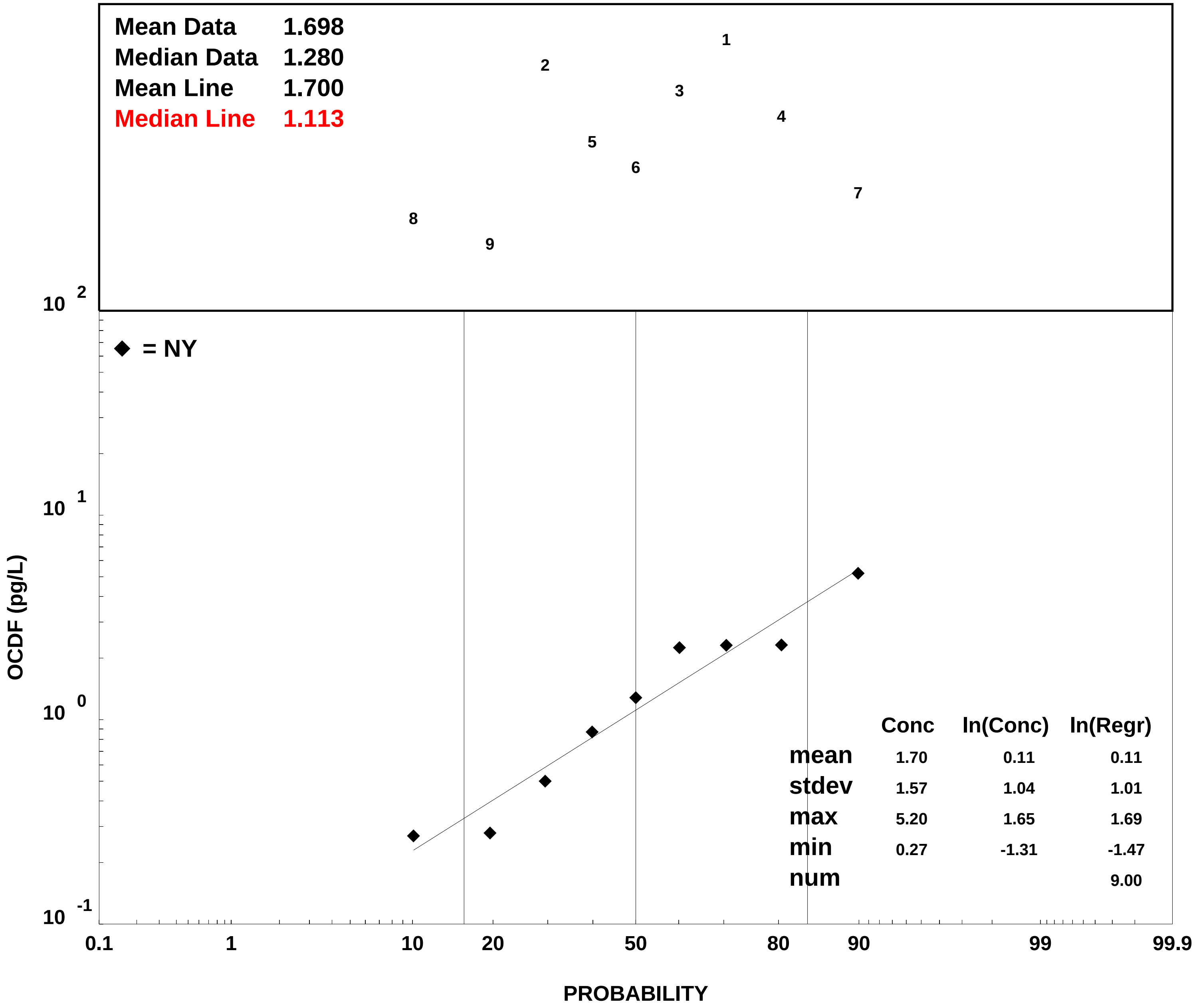

	Conc	ln(Conc)	ln(Regr)
mean	1.70	0.11	0.11
stdev	1.57	1.04	1.01
max	5.20	1.65	1.69
min	0.27	-1.31	-1.47
num			9.00

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