CORRESPONDENCE/MEMORANDUM

State of Wisconsin

DATE: March 8, 2022 FILE REF: 07-16-585325

TO: Joe Graham, Remediation and Redevelopment

FROM: Erin Endsley, Remediation and Redevelopment

SUBJECT: Background Threshold Values for Sediment Contaminants in the St. Louis River Area of Concern

Purpose

Recent sediment characterization work in the industrial slips on the north end of Superior in the working harbor of the St. Louis River indicated detections of numerous contaminants in sediments. To determine if the concentrations of these contaminants exceeded background conditions for the St. Louis River, I derived background threshold values (BTVs) for sediment contaminants using data from numerous sediment contaminant studies from the St. Louis River. Others will compare site sediment chemistry data to background values and Consensus-Based Sediment Quality Guidelines, and use other available lines of evidence, to evaluate if remedial action is necessary. BTVs will also be helpful in future determinations of appropriate cleanup levels. For this evaluation, "background" is intended to include both naturally occurring sources and anthropogenic input but not intended to include localized discharges of contaminants released to the environment.

St. Louis River Area of Concern

The St. Louis River Area of Concern (SLRAOC) includes the lower 39 miles of the St. Louis River, upstream of Cloquet, Minnesota, to its mouth at the Duluth/Superior Harbor (Figure 1). Historical actions resulted in legacy sediment contamination and other negative environmental impacts. In 1987, the Great Lakes Water Quality Agreement between the U.S. and Canada listed the St. Louis River as one of 43 Great Lakes Areas of Concern because of numerous beneficial use impairments (BUIs). Contaminated sediments are linked directly or indirectly to many of the BUIs. DNR has worked with US EPA to identify locations with contaminated sediments and implement remedial actions in those areas to address and remove BUIs.

Abundant sediment chemistry data exists for the SLRAOC, dating back to studies beginning in 1995. The purpose of many studies was to characterize sediment quality for portions of the SLRAOC. Other studies focused on the characterization of areas with known impacts on sediment quality. The SLRAOC has been categorized into sediment assessment areas (SAAs; see Figure 2) based on these various sediment chemistry studies. These SAAs were also assigned a color based on known sediment chemistry:

- Purple: Remedial action complete, monitoring of effectiveness underway or complete.
- Red: Remedial action needed.
- Red-Gray: Additional characterization and assessment needed to determine if remedial action is necessary.
- Yellow: Remediation generally not warranted but management actions must consider the presence of contaminants, especially bioaccumulative contaminants.
- Green: No known contamination. No remedial actions planned.
- Gray: Limited or no samples, but additional characterization and assessment are not needed.

The SAAs are summarized in further detail in the *St. Louis River Area of Concern Sediment Characterization Final Report* (LimnoTech, 2013).

In 2020, DNR investigated sediments in the north end of the City of Superior's waterfront district and a sheltered bay at Clough Island below Spirit Lake. The 2020 characterization included six areas within the North End District and Clough Island area: the Hallet Dock 8 Slip, the Oil Barge Dock Slip, the General Mills Slip, the Tower Avenue Slip, the Estuary Flats, and Clough Island. Previous sediment sampling indicated the possibility of sediment contamination from historical discharges. The purpose of the 2020 investigation was to acquire additional sediment chemistry information to determine if remedial action is warranted. The BTVs derived in this evaluation will be used to assist a separate determination as to whether sediment contamination exists at levels that exceed background conditions for the SLRAOC.

Prior Studies

Previous background studies in the SLRAOC include:

- Minnesota Pollution Control Agency (MPCA), 2015, SLRIDT NRDA Baseline Analysis – background levels of total polycyclic aromatic hydrocarbons (PAH13) were derived from sediment chemistry data from thirteen industrial slips in both MN and WI in the SLRAOC as part of a Natural Resource Damage Assessment for the St. Louis River/Interlake/Duluth Tar Superfund site. Background levels of total PAH13 ranged from 8.3-9.3 mg/kg.
- Bay West, 2016, Ambient Concentrations of Chemicals of Concern in Sediment for the U.S. Steel Duluth Works Site – derived background levels for three compounds present in site sediments at concentrations that exceeded human health sediment screening levels but that were expected to be less than ambient chemical concentrations. The study was contracted by MPCA as part of the feasibility study for the contaminated sediments at the U.S. Steel Superfund site. It used data from green and yellow SAAs in the MN portion of the SLRAOC downstream of the Fond du Lac dam from studies from 2008-2011. The background levels derived included mercury – 0.397 mg/kg, benzo(a)pyrene equivalence – 796 µg/kg, 2,3,7,8-TCDD toxic equivalents (TCDD-TEQs) using human health toxic equivalency factors (TEFs) – 31.07 ng TEQ/kg, and TCDD-TEQ using wildlife TEFs – 24.93 ng TEQ/kg.
- LimnoTech, 2016, Upper Tolerance Limits and Upper Confidence Limits of Least Impacted Sediment Assessment Areas in the St. Louis River Area of Concern – Revised – derived background levels for eight metals, six individual PAHs, and total PAH13 using data from green SAAs and TCDD-TEQ using data from green and yellow SAAs from studies from 2007-2015. Datasets were primarily from the MN portion of the SLRAOC downstream of the Fond du Lac dam, and also included data from the 2007 Wisconsin St. Louis River sediment sampling study. Some of the background levels derived included lead – 47 mg/kg, mercury – 0.438 mg/kg, total PAH13 – 611 µg/kg, and TCDD-TEQ (wildlife TEFs) – 23.4 ng TEQ/kg.

The methodology utilized by these studies is similar to the methodology of this study, and the results of these studies are not inconsistent with the findings of this background evaluation. Variations in results are likely the result of dataset selection, data processing, and outlier identification and removal.

Methodology

This evaluation utilizes sediment chemistry data from numerous studies conducted in the SLRAOC from 2007 to 2016 (see Table 1) and includes data from Minnesota and Wisconsin locations downstream of the Fond du Lac dam. The statistical methodology followed US EPA guidance and utilized US EPA's ProUCL software. The following sections describe the steps followed and the methods utilized for selecting data and deriving BTVs.

<u>Contaminants of Concern</u>

Based on the results of previous sediment investigations, the contaminants detected in the Superior slips included metals, dioxins/furans, PAHs, and polychlorinated biphenyls (PCBs). To determine if sediment

in the slips exceeded background levels, this evaluation derived BTVs for the following list of contaminants:

- Metals: Arsenic, Copper, Chromium, Iron, Lead, Manganese, Mercury, Nickel, and Zinc
- PAHs: Total PAHs and benzo(a)pyrene
- PCBs: Total PCBs
- Dioxin/furans: DF TEQ using 1998 fish toxicity equivalent factors

Data Sources and Data Selection

Data used for this evaluation were selected based on the age of the data, the study locations, and known information about potential sediment contamination at those locations. Based on decisions made in consultation with DNR SLRAOC staff on the scope of the background study, data from both MN and WI sediment characterization studies from 2007-2016 were included, from areas downstream of the Fond du Lac dam to Lake Superior, including the portions of the upper, middle, and lower reaches of the St. Louis River, St. Louis Bay, Superior Bay, and Allouez Bay.

All SAAs characterized as purple, red, or red-gray were excluded from this evaluation based on known or suspected sediment contamination. SAAs characterized as green or yellow were included in this evaluation. However, some SAAs were selectively excluded if the data indicated the potential for impacts for certain contaminants, even though the overall level of impacts might not have warranted remedial action. Table 1 lists the SAAs included in this evaluation and lists which sediment characterization studies contained data for those SAAs incorporated into this evaluation. Any data prior to 2007 were not utilized for this evaluation. This resulted in data from the following studies being used:

- SL Duluth Harbor 2008 & 2010 USACE
- SL St. Louis Bay 2010 USEPA
- SL AOC-wide 2011 USACE/MPCA Lower SL River
- SL Wisconsin 2007 WDNR Sampling
- SL St. Louis Bay USACE Metals and PAHs
- Superior Waterfront 2015 Sed Assessment
- Upper St. Louis River Contaminated Sediment Assessment 2016

The data for the first five studies were obtained from the Microsoft Access Sediment Quality Database for the St. Louis River AOC (the database), Phase VII of the database (Version 07.06.00). Database queries were used to compile data based on SAA, study, and sediment chemical analyses. Data on sample location coordinates and sample depths were also obtained from database queries. The sediment chemistry data from the remaining studies listed above were compiled from the study reports, which can be found on the Department's publicly accessible database for remediation sites, Wisconsin Remediation and Redevelopment Database (WRRD).

Data Processing

After the selected data from the database and various reports were compiled, additional data processing was done. All replicate/duplicate samples were removed. Data were sorted by depth interval (0-15 cm, 15-60 cm, and >60 cm). Depth intervals were assigned by calculating the midpoint between the sample start depth and end depth, then using the midpoint to determine the appropriate depth interval. These depth intervals were chosen because they best correlated with the depth intervals selected for sampling during the DNR's North End Sediment Characterization study. Some of the original data were recorded initially in U.S. Customary Units (feet) and later converted to SI units (cm) for this evaluation.

After assigning depth intervals to each data point, the data were formatted into individual spreadsheets for each contaminant of concern. A column was added to indicate each sample as either 'detect' or 'non-detect'. Non-detect values were replaced by the method detection limit (MDL), or by the quantitation

limit if the MDL was not available. For contaminants that were represented by either a summed total (PAHs and PCBs) or by a toxicity equivalency calculation (DF TEQ), the following steps were included:

- Total PAHs – Derived using the sum of 17 EPA target PAH compounds (see Table 2). Total PAH from the database were calculated using the 'Sed_Char_PAH_Step07a_Total_PAH17' query, and non-detect values were estimated based on log-log regressions with other PAH compounds. The predictors and R-squared values for each of the PAH compounds are described in the database. The Total PAH for the 2015 and 2016 data were calculated by substituting ½ the reporting limit for non-detect values.
- Total PCBs – The sum of PCBs for samples with Aroclor results. Total PCB sums were calculated assuming non-detects are equal to zero.
- DF TEQ – For samples from the database, DF TEQ was derived using 17 PCDD/F congeners and WHO 98 toxic equivalent factors (TEFs) for wildlife (see Table 3). The DF TEQ values were calculated using a Kaplan-Meier estimator for non-detect values. DF TEQ from 2015 and 2016 data were calculated by substituting zero for non-detects.

Background Threshold Value Calculations

EPA's ProUCL Version 5.1 was used to calculate summary statistics and background threshold values (BTVs) for the contaminants of interest. Outliers were identified and removed based on ProUCL's outlier tests, visual representation using Q-Q plots, and after review of the geolocation of the data point. Data points identified by a statistical outlier test or because the sample location was near a known or suspected contaminant source were removed from the dataset prior to calculating BTVs. Summary statistics, information on removed outliers, and Q-Q plots are included in Appendix A. The Upper Tolerance Limit (UTL) with 95% Coverage (95/95 UTL) was the parameter selected to be the most representative of background concentrations. The 95/95 UTL means that 95% of future sampling events would generate 95th percentiles that would be less than or equal to the 95/95 UTL.

Results

After selecting and processing data, the datasets for each contaminant were uploaded into EPA's ProUCL program to calculate summary statistics and BTVs. The results of the BTV calculations are shown below.

Contaminant	Number of samples	Number after outliers removed (# of outliers)	95% UCL[1] (mg/kg)	BTV (95/95 UTL)[2] (mg/kg)	Midpoint SQT (mg/kg)
Arsenic	1098	1098 (0)	3.9	7.2	21.4
Copper	1091	1090(1)	24	50	91
Chromium	1093	1093 (0)	26	47	76.5
Iron	794	794 (0)	21,971	44,910	30,000
Lead	1078	1077 (1)	26	75	83
Manganese	605	605 (0)	456	1,039	780
Mercury	869	869 (0)	0.18	0.59	0.64
Nickel	1090	1090 (0)	21	38	36
Zinc	1092	1092 (0)	81	210	290
Benzo(a)pyrene	870	869 (1)	0.20	0.71	0.8
Total PAH (17)	865	854 (11)	2.0	7.8	12.2
Total PCBs	849	848 (1)	0.033	0.11	0.368
DF TEQ Fish (WHO 1998)	290	285 (5)	7.4×10^{-6}	2.4×10^{-5}	1.12×10^{-5}

1. 95% UCL – 95% upper confidence level of the arithmetic mean
2. 95/95 UTL – upper tolerance limit with 95% upper confidence interval around the 95th percentile value

Summary and Conclusions

The purpose of this evaluation was to derive BTVs for common sediment contaminants found in the SLRAOC to determine if sites undergoing sediment characterization have sediment contamination that exceed background. This comparison will serve as one line of evidence as to whether additional investigation or remedial action is warranted. Individual site data can be compared to BTVs for the purpose of delineating the extent of contamination. Additional statistical tests can be done for a more comprehensive comparison of the site dataset to the background dataset.

The BTVs can also be compared to the SQTs to better understand typical sediment chemistry conditions in the AOC. Iron, manganese, nickel, and DF TEQ all exceed the Midpoint SQT, whereas other contaminants are at or below the Midpoint SQT. Iron, manganese, and nickel are likely attributable to naturally occurring background, whereas the elevated DF TEQ likely represents anthropogenic input.

The BTVs in this memo were derived for a specific purpose, and they are not intended to be broadly applied for other regulatory decision-making in the St. Louis River AOC without prior consultation with Department staff. When a background evaluation is needed as part of a site evaluation, it may be more appropriate to determine a specific location within the estuary to serve as a background dataset for evaluation and comparison to site data. Likewise, a different environmental statistical measure might be more appropriate, depending on the type of data comparison being conducted, and the regulatory decision being made. Any party interested in deriving background values or applying the values from this study for a site or for a regulatory application in the SLRAOC should consult with Department staff prior to workplan development to make sure the methodology and conclusions are appropriate for the site or proposed action.

References

Bay West, 2016, Ambient Concentrations of Chemicals of Concern in Sediment for the U.S. Steel Duluth Works Site.

EA Engineering, Science, and Technology, Inc., PBC (EA), 2021, Site Investigation Report, Characterization of Sediments in the North End District and Clough Island, St. Louis River and Bay Area of Concern, Superior, Wisconsin.

EA, 2017, Site Characterization Report Assessment of Contaminated Sediment Upper St. Louis River and Superior Bay, Upper St. Louis and Superior Bay Site Characterization, St. Louis River and Bay Area of Concern, Duluth, Minnesota.

EA, 2016 Site Characterization Report Assessment of Contaminated Sediment Superior Waterfront Characterization, St. Louis River and Bay Area of Concern, Duluth, Minnesota.

LimnoTech, 2013. St. Louis River Area of Concern Implementation Framework: Roadmap to Delisting.

LimnoTech, 2013. St. Louis River Area of Concern Sediment Characterization Final Report Microsoft Access Sediment Quality Database for the St. Louis River AOC, Phase VII, Version 07.06.00.

LimnoTech, 2016, Upper Tolerance Limits and Upper Confidence Limits of Least Impacted Sediment Assessment Areas in the St. Louis River Area of Concern – Revised.

NOAA, 2021, St. Louis River Area of Concern, Great Lakes Diver, Natural Resource Damage Assessment and Restoration, Data and Visualization, https://www.diver.orr.noaa.gov/web/guest/st-louis-river-aoc.

Somat Engineering, Incorporated, 2012, Sediment Investigation Report – Lower St. Louis River, Fond du Lac Dam to Kingsbury Bay, USACE/MPCA.

Somat Engineering, Incorporated, 2012, Sediment Investigation Report – St. Louis River, Duluth Harbor, USACE/MPCA.

USEPA, 2015, ProUCL 5.1 User Guide. Washington, DC: EPA. EPA/600/R-07/041. 2261 https://www.epa.gov/sites/production/files/2016-05/documents/proucl_5.1_user-guide.pdf.

USEPA, 2007, Data from St. Louis River, Wisconsin 2007 Sediment Characterization, Great Lakes National Program Office, unpublished report.

WDNR, 2003, Consensus-Based Sediment Quality Guidelines: Recommendations for Use & Application - Interim Guidance, RR-088. Contaminated Sediment Standing Team.

Weston Solutions, Inc., 2012, Sediment Assessment Report – Revision 1, St. Louis Bay-St. Louis River Area of Concern, Duluth, St. Louis County, Minnesota.

Weston Solutions, Inc., 2012, Sediment Assessment Report Upper St. Louis River, St. Louis River AOC, Cloquet, Carlton and St. Louis County, Minnesota.

Figures

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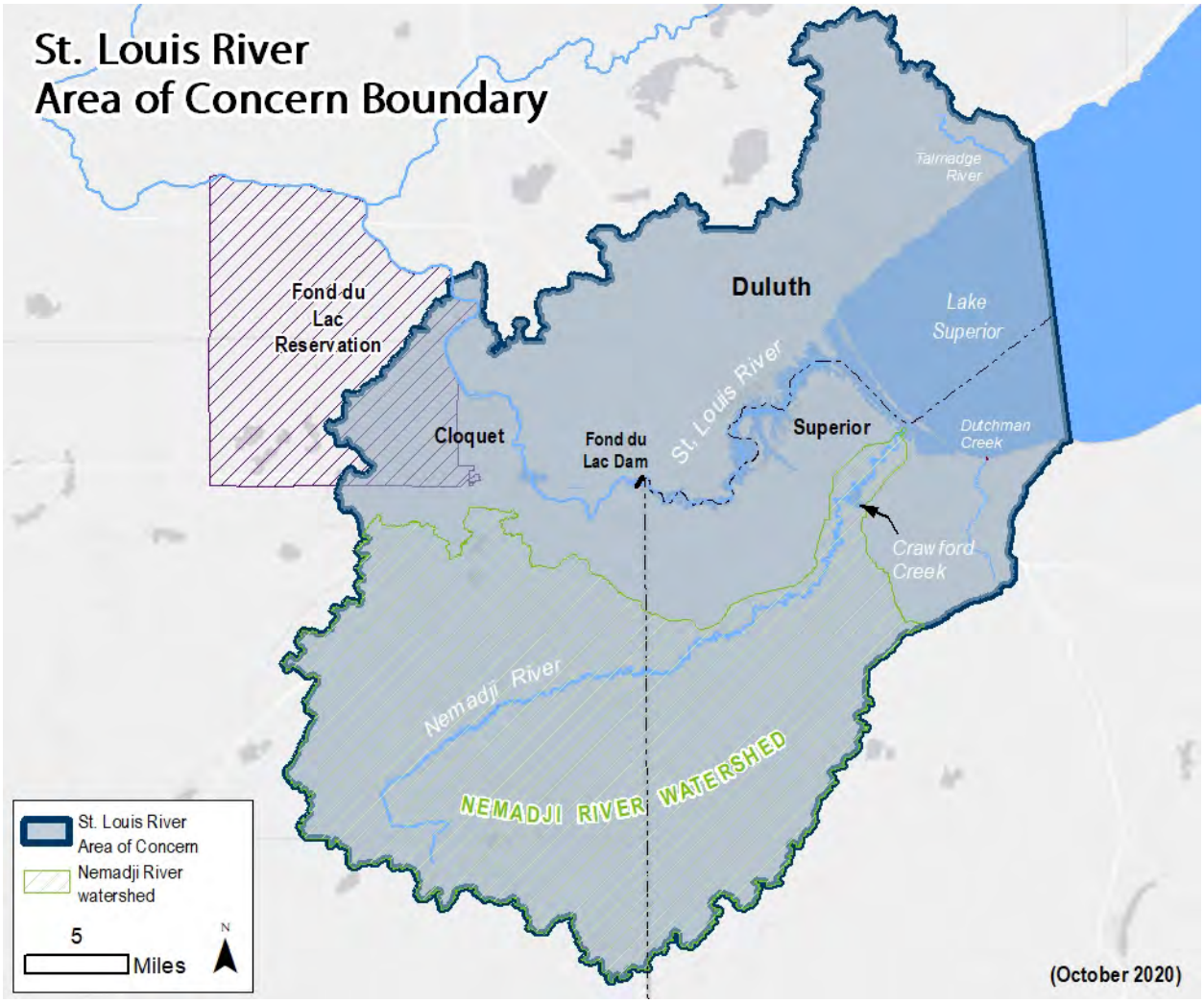
Appendices

A. Summary Statistics, Outlier Removal, and Q-Q Plots

Figure 1. St. Louis River Area of Concern Boundary



Figures 2a-2f. Sediment Assessment Areas. From St. Louis River Area of Concern Implementation Framework: Roadmap to Delisting (2013)

Figure 2a. Sediment Assessment Area – Allouez Bay

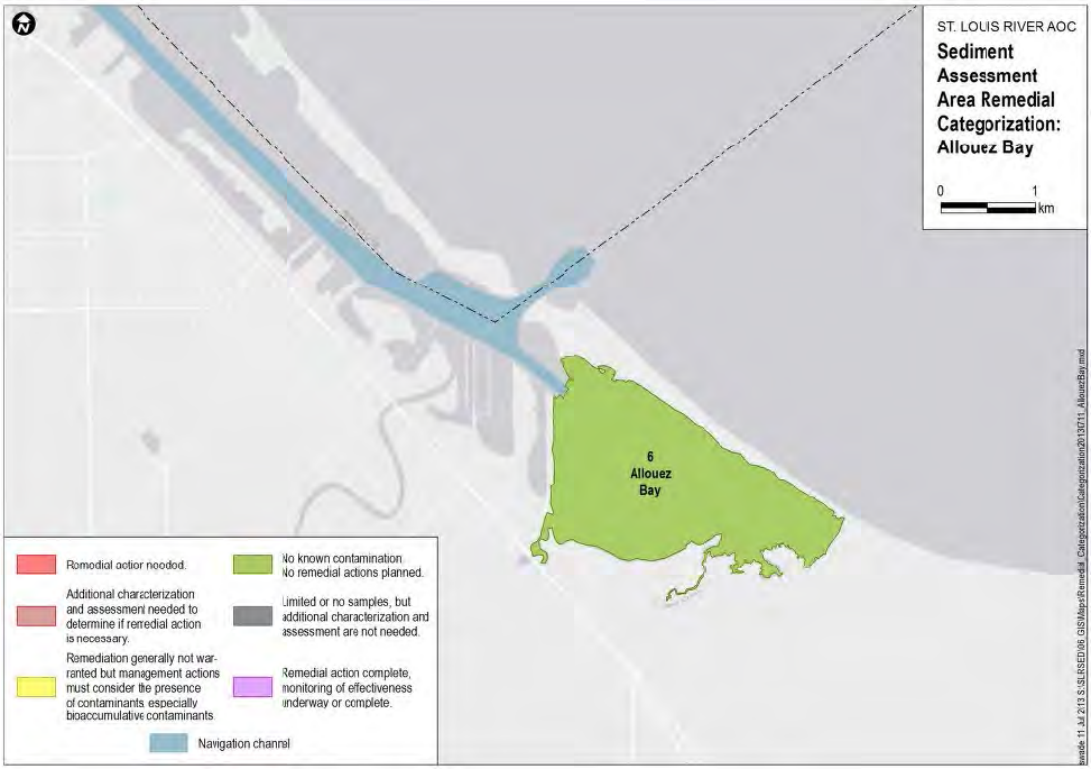


Figure 2b. Sediment Assessment Areas – Superior Bay

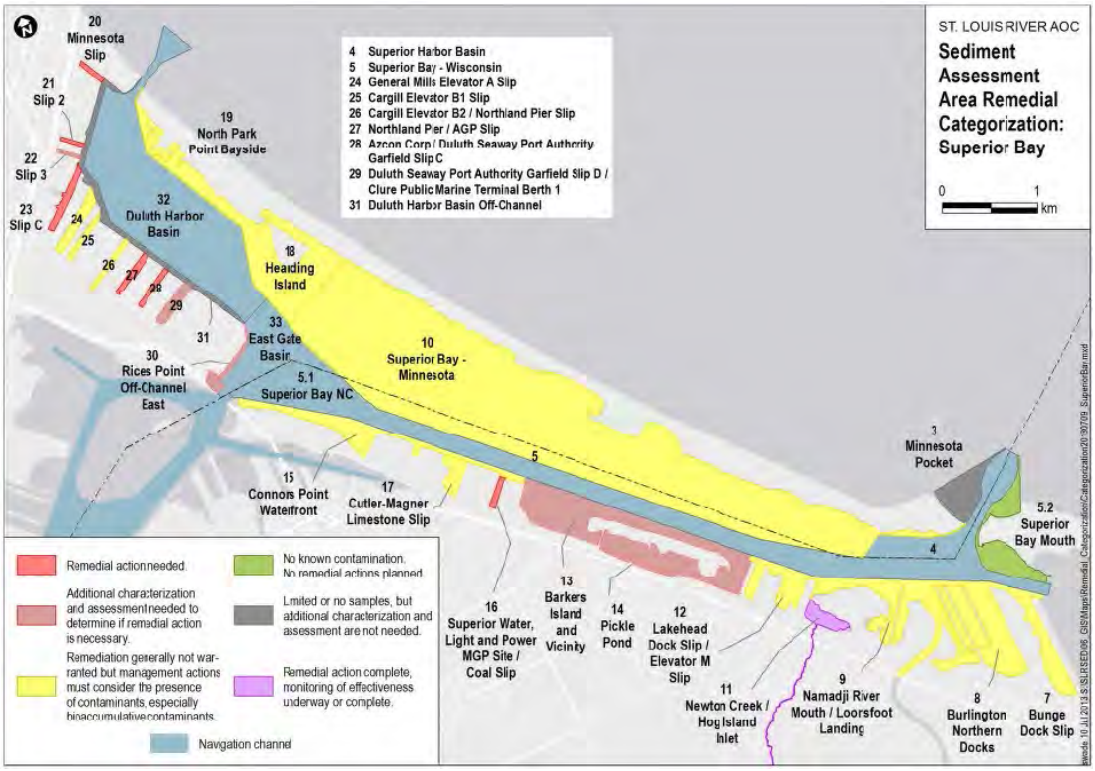


Figure 2c. Sediment Assessment Areas – St. Louis Bay

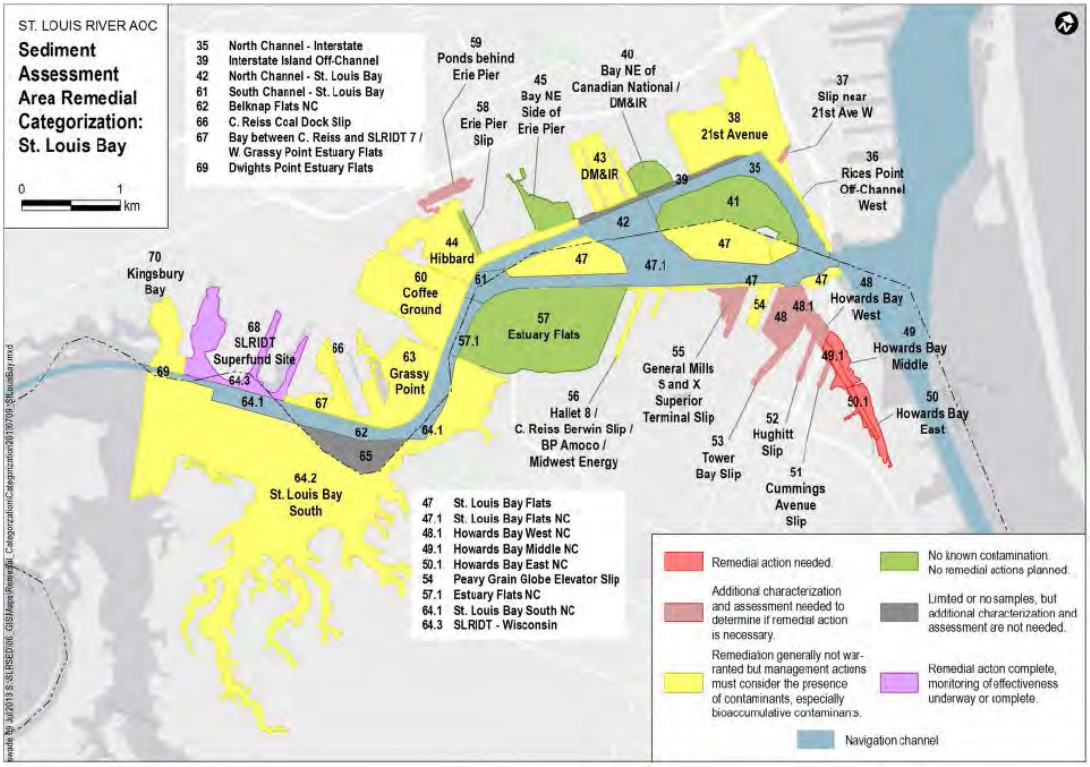


Figure 2d. Sediment Assessment Areas – Lower St. Louis River

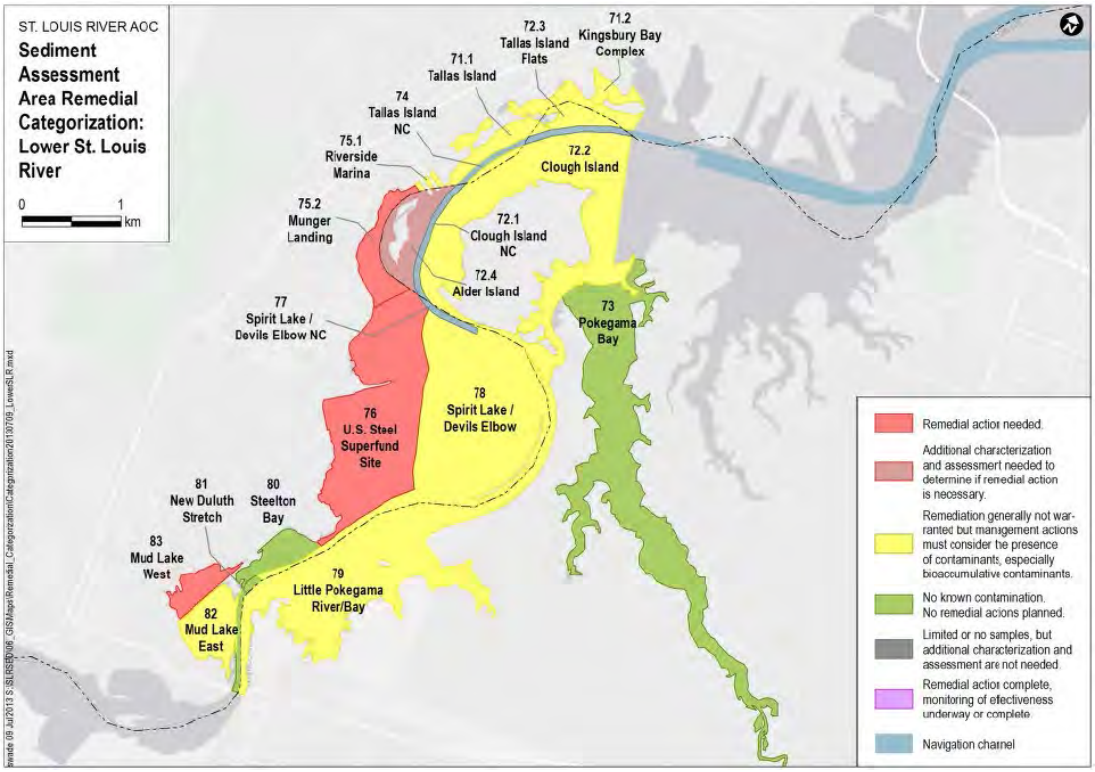


Figure 2e. Sediment Assessment Areas – Middle St. Louis River

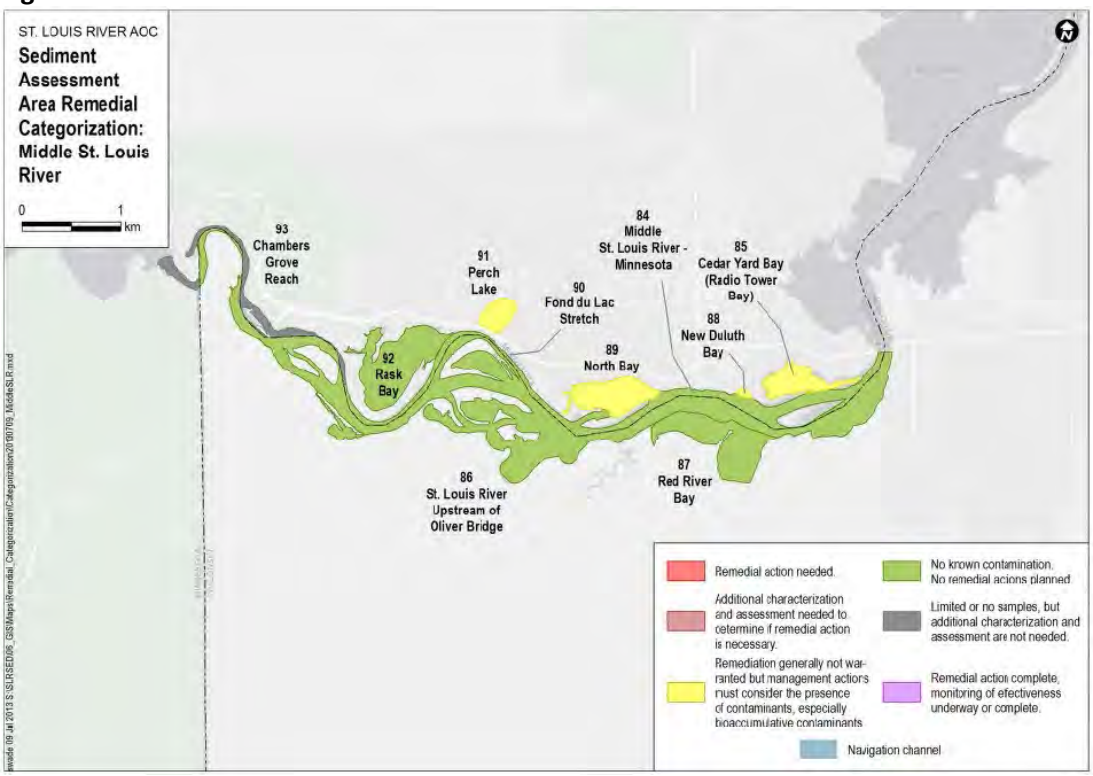


Figure 2f. Sediment Assessment Areas – Upper St. Louis River

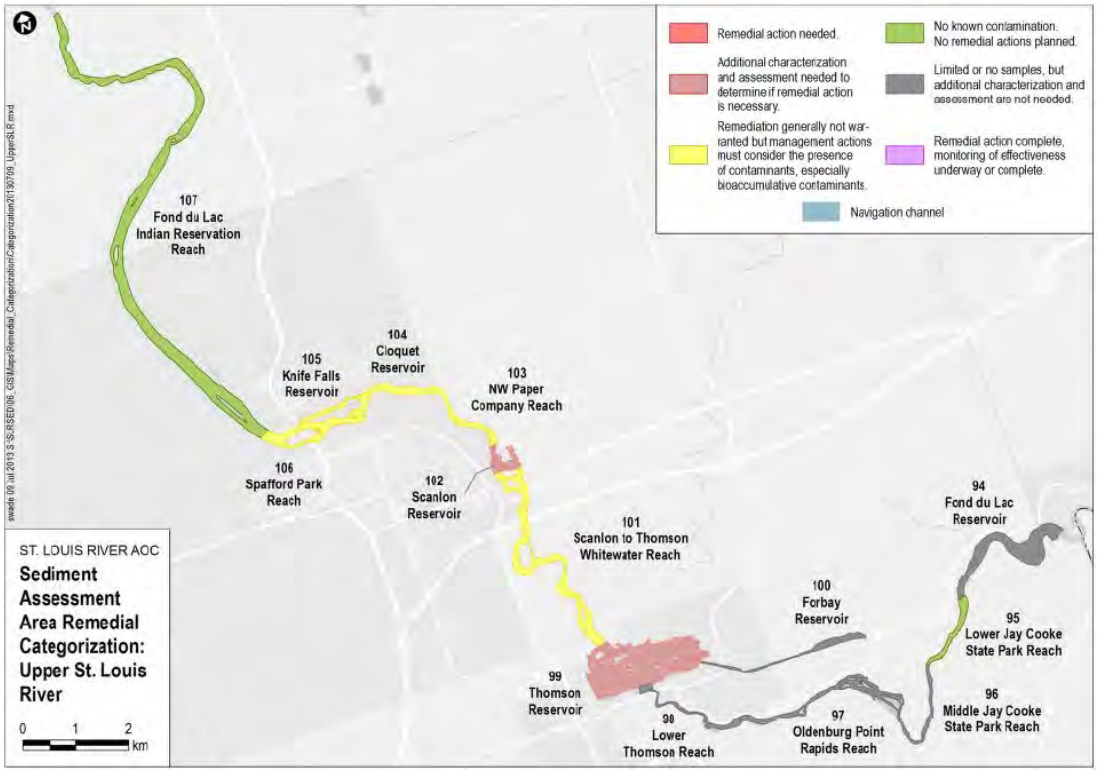


Table 1. Sediment Assessment Areas

SAA ID	Zone	SAA Name	Nav Channel	State	Categorization	Comments	SL Duluth Harbor 2008 & 2010 USACE Study 67 (MN)	SL St. Louis Bay 2010 USEPA Study 69 (MN)	SL AOC-wide 2011 USACE/MPCA Lower SL River Study 72 (MN)	SL Wisconsin 2007 WDNR Sampling Study 75 (WI)	SL St. Louis Bay USACE Metals and PAHs Study 87 (MN)	Superior Waterfront 2015 Sed Assessment 2015 (WI)	Upper St. Louis River Cont. Sed. Assess. 2016 2016 (WI)
5	SB	Superior Bay - Wisconsin	Out	WI	Yellow							X	
5.1	SB	Superior Bay NC	In	WI	Yellow					X		X	
5.4	SB	Allouez Bay Mouth	Out	WI	Green								X
6	AB	Allouez Bay	Out	WI	Green								X
7	SB	Bunge Dock Slip	Out	WI	Yellow	exclude PAHs				X		X	
8	SB	Burlington Northern Docks	Out	WI	Not Classified								X
9	SB	Nemadji R. Mouth/Loonsfoot Landing	Out	WI	Not Classified								X
10	SB	Superior Bay – Minnesota	Out	MN	Yellow		X						
12	SB	Lakehead Dock Slip / Elevator M Slip	Out	WI	Yellow					X		X	
13	SB	Barkers Island and Vicinity	Out	WI	Yellow	exclude pre-2015 data				X		X	
15	SB	Connors Point Waterfront	Out	WI	Yellow					X		X	
17	SB	Cutler-Magner Limestone Slip	Out	WI	Yellow					X		X	
18	SB	Hearding Island	Out	MN	Yellow		X						
19	SB	North Park Point Bayside	Out	MN	Yellow		X						
24	SB	General Mills Elevator A Slip	Out	MN	Yellow		X						
25	SB	Cargill Elevator B1 Slip	Out	MN	Yellow		X						
26	SB	Cargill Elevator B2 / Northland Pier Slip	Out	MN	Yellow		X						
32	SB	Duluth Harbor Basin	In	MN	Not Classified		X						
35	SLB	North Channel – Interstate	In	MN	Not Classified		X						
36	SLB	Rices Point Off-Channel West	Out	MN	Yellow		X						
37	SLB	Slip near 21st Ave W	Out	MN	Yellow		X						
38	SLB	21st Avenue West	Out	MN	Yellow		X						
40	SLB	Bay NE of Canadian National / DM&IR	Out	MN	Green			X			X		
41	SLB	Interstate Island Flats	Out	MN	Green			X			X		
43	SLB	DM&IR	Out	MN	Yellow			X			X		
45	SLB	Bay NE Side of Erie Pier	Out	MN	Green			X			X		
47	SLB	St. Louis Bay Flats	Out	WI	Yellow			X		X	X		
48	SLB	Howards Bay West	Out	WI	Not Classified							X	
54	SLB	Peavey Grain Globe Elevator Slip	Out	WI	Yellow					X			
57	SLB	Estuary Flats	Out	WI	Yellow					X			
58	SLB	Erie Pier Slip	Out	MN	Green			X			X		
60	SLB	Coffee Ground	Out	MN	Yellow			X			X		
64.1	SLB	St. Louis Bay South NC	In	WI	Not Classified								X
66	SLB	C. Reiss Coal Dock Slip	Out	MN	Yellow			X			X		
69	SLB	Dwights Point Estuary Flats	In	MN	Not Classified				X				
70	SLB	Kingsbury Bay	Out	MN	Yellow				X				
71.1	LSLR	Tallas Island	Out	MN	Yellow				X				
71.2	LSLR	Kingsbury Bay Complex	Out	MN	Yellow				X				
72.2	LSLR	Clough Island	Out	WI	Yellow/Red-gray	Exclude DF							X
72.4	LSLR	Alder Island	Out	WI	Not Classified								X
73	LSLR	Pokegama Bay	Out	WI	Green								X
74	LSLR	Tallas Island NC	In	MN	Not Classified				X				
79	LSLR	Little Pokegama River/Bay	Out	WI	Yellow								X
81	LSLR	New Duluth Stretch	Out	MN	Green				X				
82	LSLR	Mud Lake East	Out	MN	Yellow				X				
84	MSLR	Middle St. Louis River – Minnesota	Out	MN	Green				X				

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SAA ID	Zone	SAA Name	Nav Channel	State	Categorization	Comments	SL Duluth Harbor 2008 & 2010 USACE Study 67 (MN)	SL St. Louis Bay 2010 USEPA Study 69 (MN)	SL AOC-wide 2011 USACE/MPCA Lower SL River Study 72 (MN)	SL Wisconsin 2007 WDNR Sampling Study 75 (WI)	SL St. Louis Bay USACE Metals and PAHs Study 87 (MN)	Superior Waterfront 2015 Sed Assessment 2015 (WI)	Upper St. Louis River Cont. Sed. Assess. 2016 2016 (WI)
85	MSLR	Cedar Yard Bay (Radio Tower Bay)	Out	MN	Yellow				X				
86	MSLR	St. Louis River Upstream of Oliver Bridge	Out	WI	Green				X				X
87	MSLR	Red River Bay	Out	WI	Green								X
88	MSLR	New Duluth Bay	Out	MN	Yellow				X				
89	MSLR	North Bay	Out	MN	Yellow				X				
90	MSLR	Fond du Lac Stretch	Out	MN	Green				X				
91	MSLR	Perch Lake	Out	MN	Yellow				X				
92	MSLR	Rask Bay	Out	MN	Green				X				
93	MSLR	Chambers Grove Reach	Out	MN	Gray				X				

Table 2. Polycyclic Aromatic Hydrocarbons (PAHs) Used in PAH17 Calculation

Contaminant
Acenaphthylene
Anthracene
Benz[a]anthracene
Benzo[a]pyrene
Benzo[b]fluoranthene
Benzo(g,h,k)perylene
Benzo[k]fluoranthene
Chrysene
Dibenz[a,h]anthracene
Fluoranthene
Fluorene
Indeno[1,2,3-cd]pyrene
Methylnaphthalene, 2-
Naphthalene
Phenanthrene
Pyrene

Table 3. Dioxins/Furans Used in Tovicity Equivalency Calculation

Contaminant	WHO TEFs (1998)[1]
Polychlorinated dibenzo-p-dioxins (PCDDs)	
2,3,7,8-Tetrachloro-dibenzo-p-dioxin (TCDD)	1
1,2,3,7,8-Pentachloro dibenzo-p-dioxin (PeCDD)	1
1,2,3,4,7,8-Hexachloro- dibenzo-p-dioxin (HxCDD)	0.1
1,2,3,6,7,8-Hexachloro- dibenzo-p-dioxin (HxCDD)	0.1
1,2,3,7,8,9-Hexachloro- dibenzo-p-dioxin (HxCDD)	0.1
1,2,3,7,8,9-Heptachloro- dibenzo-p-dioxin (HpCDD)	0.01
Octachloro-dibenzo-p-dioxin (OCDD)	0.0001
Polychlorinated dibenzofurans (PCDFs)	
2,3,7,8-Tetrachlor-dibenzofuran (TCDF)	0.1
1,2,3,7,8-Pentachloro-dibenzofuran (PeCDF)	0.05
2,3,4,7,8-Pentachloro-dibenzofuran (PeCDF)	0.5
1,2,3,4,7,8-Hexachloro-dibenzofuran (HxCDF)	0.1
1,2,3,6,7,8-Hexachloro-dibenzofuran (HxCDF)	0.1
1,2,3,7,8,9-Hexachloro-dibenzofuran (HxCDF)	0.1
2,3,4,6,7,8-Hexachloro-dibenzofuran (HxCDF)	0.1
1,2,3,4,6,7,8-Heptachloro-dibenzofuran (HpCDF)	0.01
1,2,3,4,7,8,9-Heptachloro-dibenzofuran (HpCDF)	0.01
Octachloro-dibenzofuran (OCDF)	0.0001

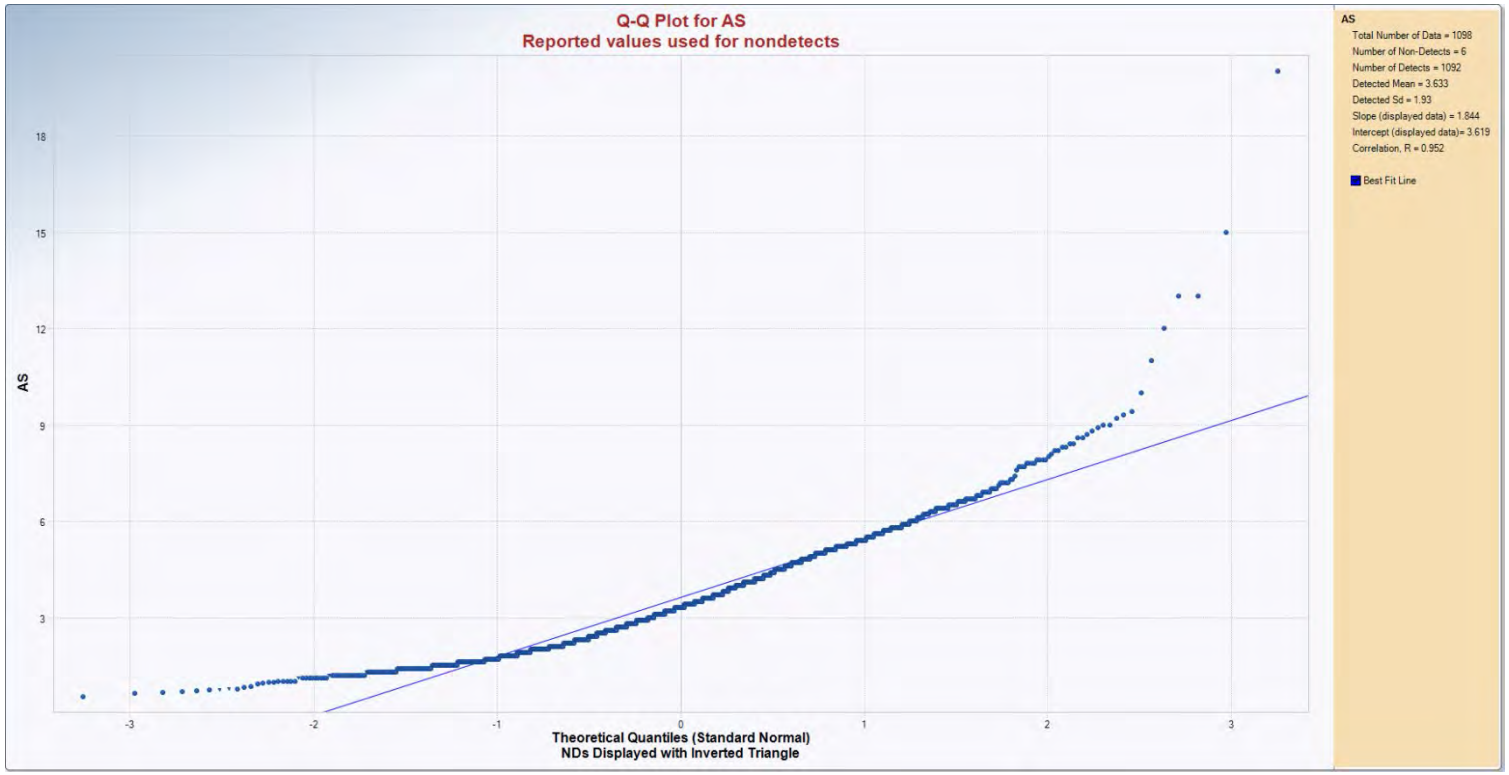
1. Source: van den Berg et al. (1998); available at: http://www.cerc.usgs.gov/pubs/center/pdfDocs/90970.pdf

Appendix A. Summary Statistics, Outlier Removal, and Q-Q Plots

Arsenic

Arsenic Summary Statistics - all data (mg/kg)

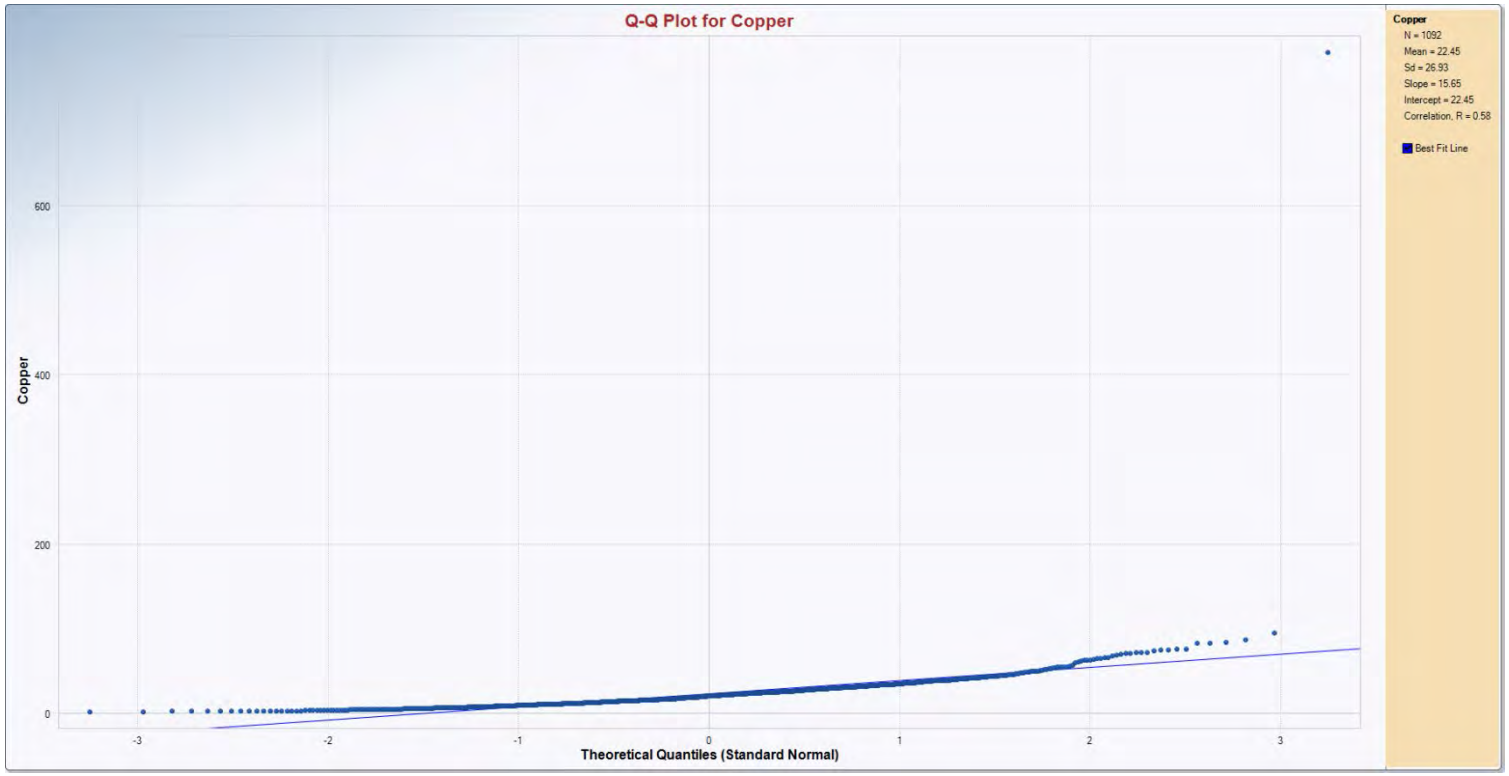
Depth	n	# NDs	Minimum	Maximum	Mean	95%UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	439	2	0.65	9	3.73	4.1	6.4	6.8	nonparametric
15-60cm	322	2	0.54	20	3.59	3.8	7.0	7.9	nonparametric
>60cm	337	2	0.63	13	3.55	3.7	7.2	7.5	gamma
All	1098	6	0.54	20	3.63	3.9	6.8	7.2	nonparametric



Copper

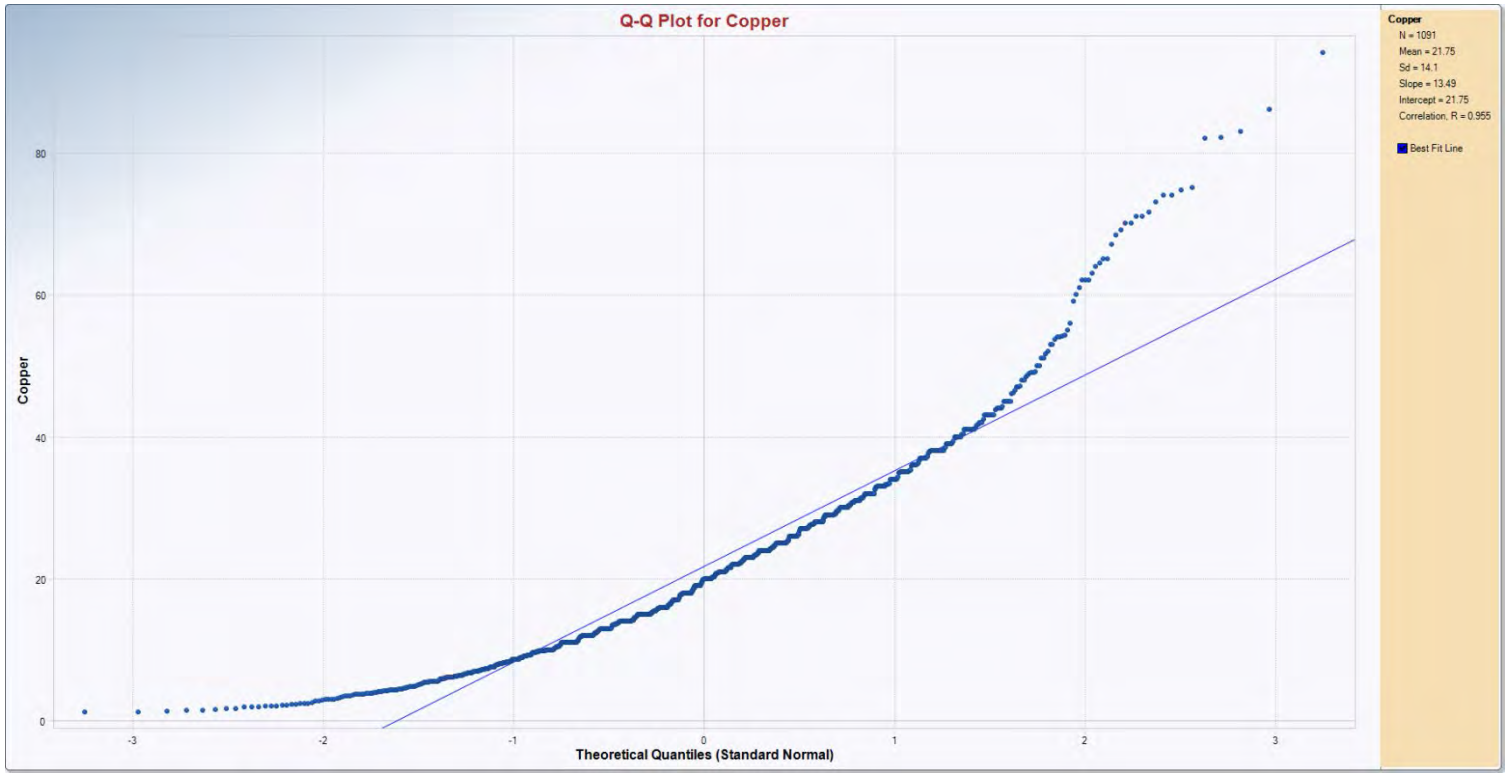
Copper Summary Statistics - all data (mg/kg)

Depth	n	# NDs	Minimum	Maximum	Mean	95%UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	438	0	1.5	780	25	33	54	62	nonparametric
15-60cm	320	0	1.3	94	21	23	45	51	gamma
>60cm	334	0	1.3	83	20	21	42	46	gamma
All	1092	0	1.3	780	22	26	47	50	nonparametric



Copper Summary Statistics - one outlier removed (mg/kg)

Depth	n	# NDs	Minimum	Maximum	Mean	95%UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	437	0	1.5	86	24	27	53	62	nonparametric
15-60cm	320	0	1.3	94	21	23	45	51	gamma
>60cm	334	0	1.3	83	20	21	42	46	gamma
All	1091	0	1.3	94	22	24	47	50	nonparametric



Chromium

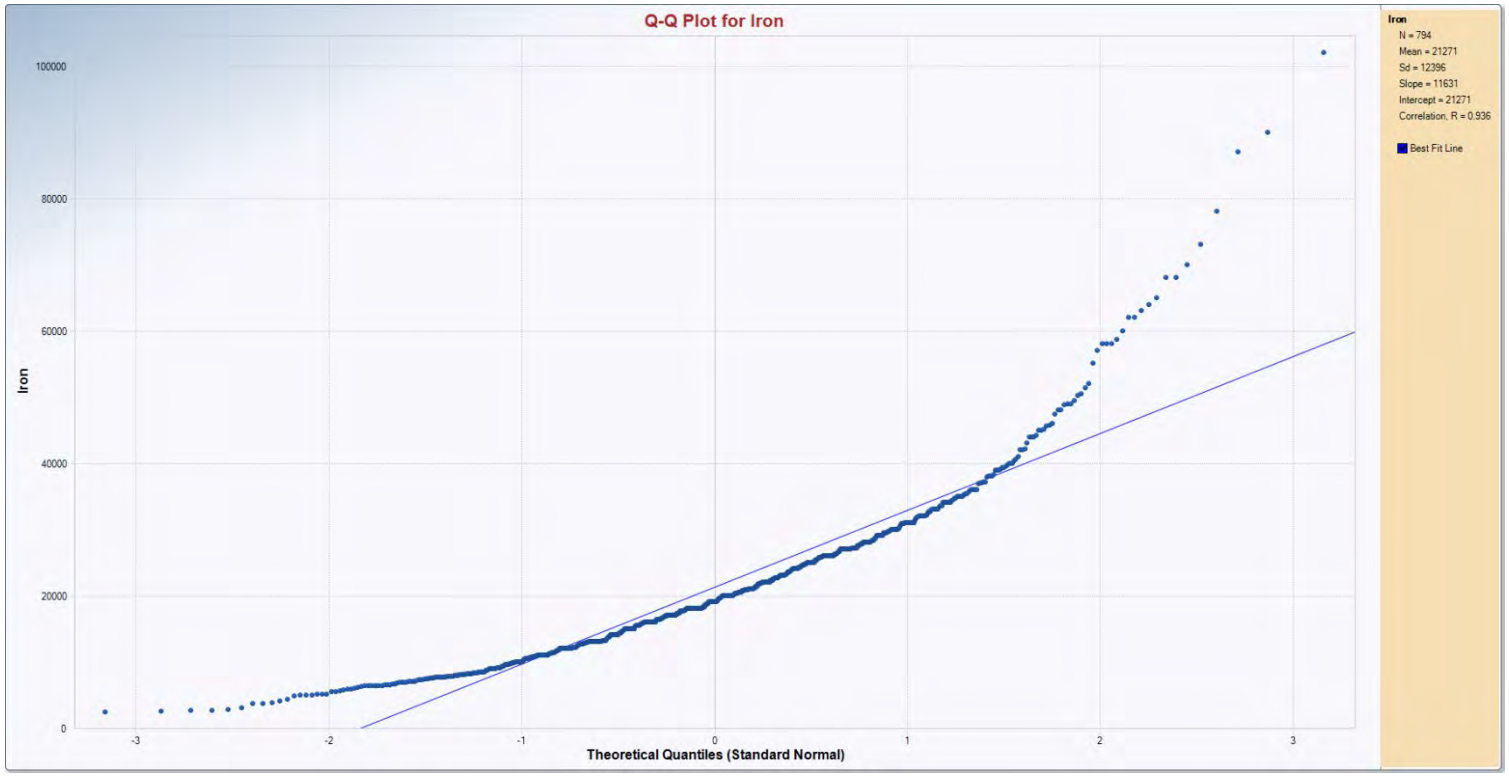
Chrome Summary Statistics - all data (mg/kg)

Depth	n	# NDs	Minimum	Maximum	Mean	95%UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	438	0	2.7	64	25	28	47	49	nonparametric
15-60cm	321	0	2.4	84	24	27	42	46	nonparametric
>60cm	334	0	2.4	98	25	26	46	52	gamma
All	1093	0	2.4	98	25	26	46	47	nonparametric

Iron

Iron Summary Statistics (mg/kg)

Depth	n	# NDs	Minimum	Maximum	Mean	95% UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	289	0	2,990	102,000	22,176	23,344	42,000	46,770	gamma
15-60cm	223	0	2,670	87,000	21,113	22,448	44,080	46,080	gamma
>60cm	282	0	2,430	90,000	20,470	23,886	43,910	58,700	nonparametric
All	794	0	2,430	102,000	21,271	21,971	43,935	44,910	gamma



Lead

Lead Summary Stats - all data (mg/kg)

Depth	n	# NDs	Minimum	Maximum	Mean	95% UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	432	0	1	240	25	31	73	82	nonparametric
15-60cm	317	0	0.85	328	22	25	68	75	nonparametric
>60cm	330	0	0.75	250	19	26	69	80	nonparametric
All	1079	0	0.75	328	22	26	72	76	nonparametric

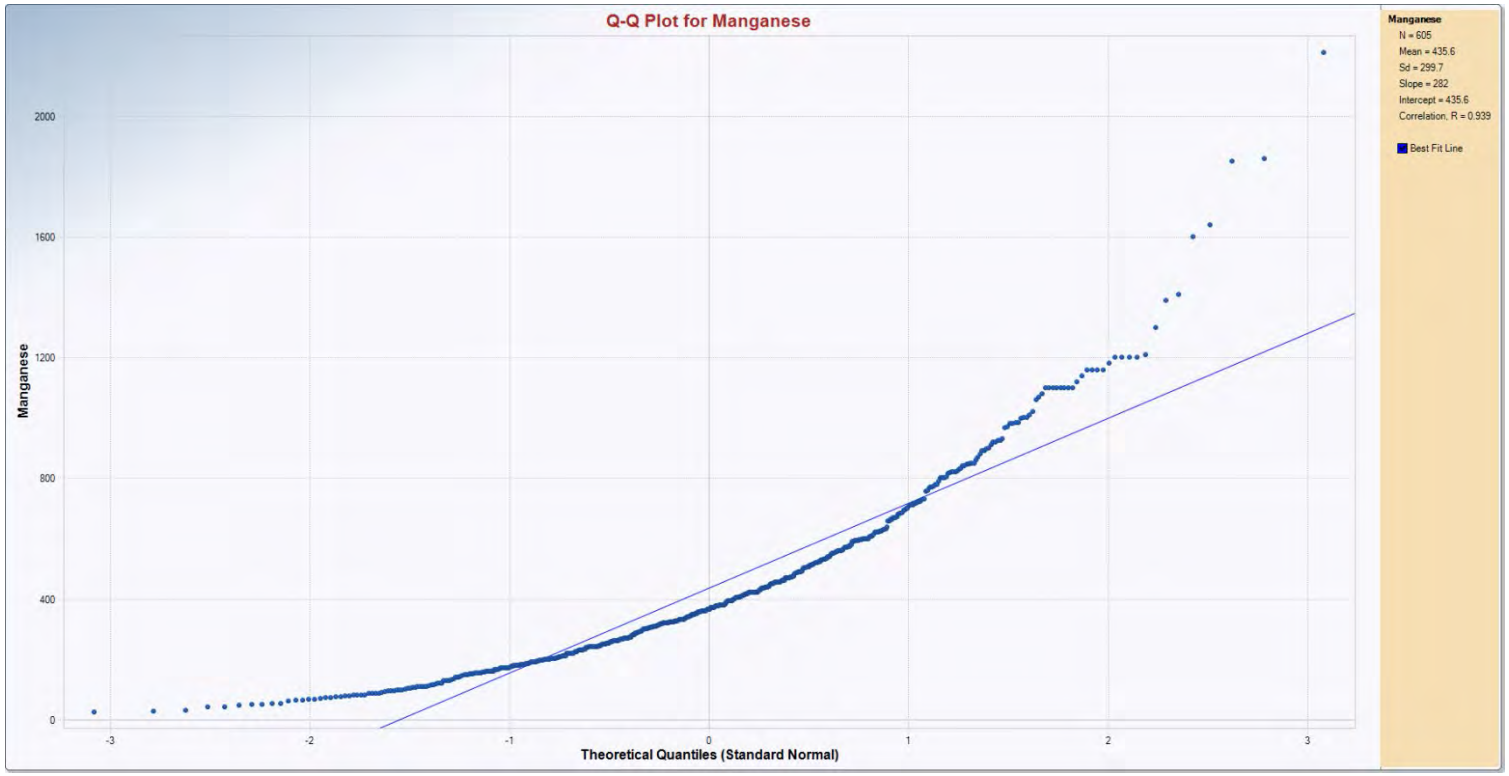
Lead Summary Stats - outliers removed - first round (mg/kg)

Depth	n	# NDs	Minimum	Maximum	Mean	95% UCL	95%ile	BTV	Distribution
0-15cm	432	0	1	240	25	31	73	82	nonparametric
15-60cm	316	0	1	160	21	26	67	74	nonparametric
>60cm	330	0	1	250	19	26	69	80	nonparametric
All	1078	0	1	250	22	26	72	75	nonparametric

Manganese

Manganese Summary Stats - all data (mg/kg)

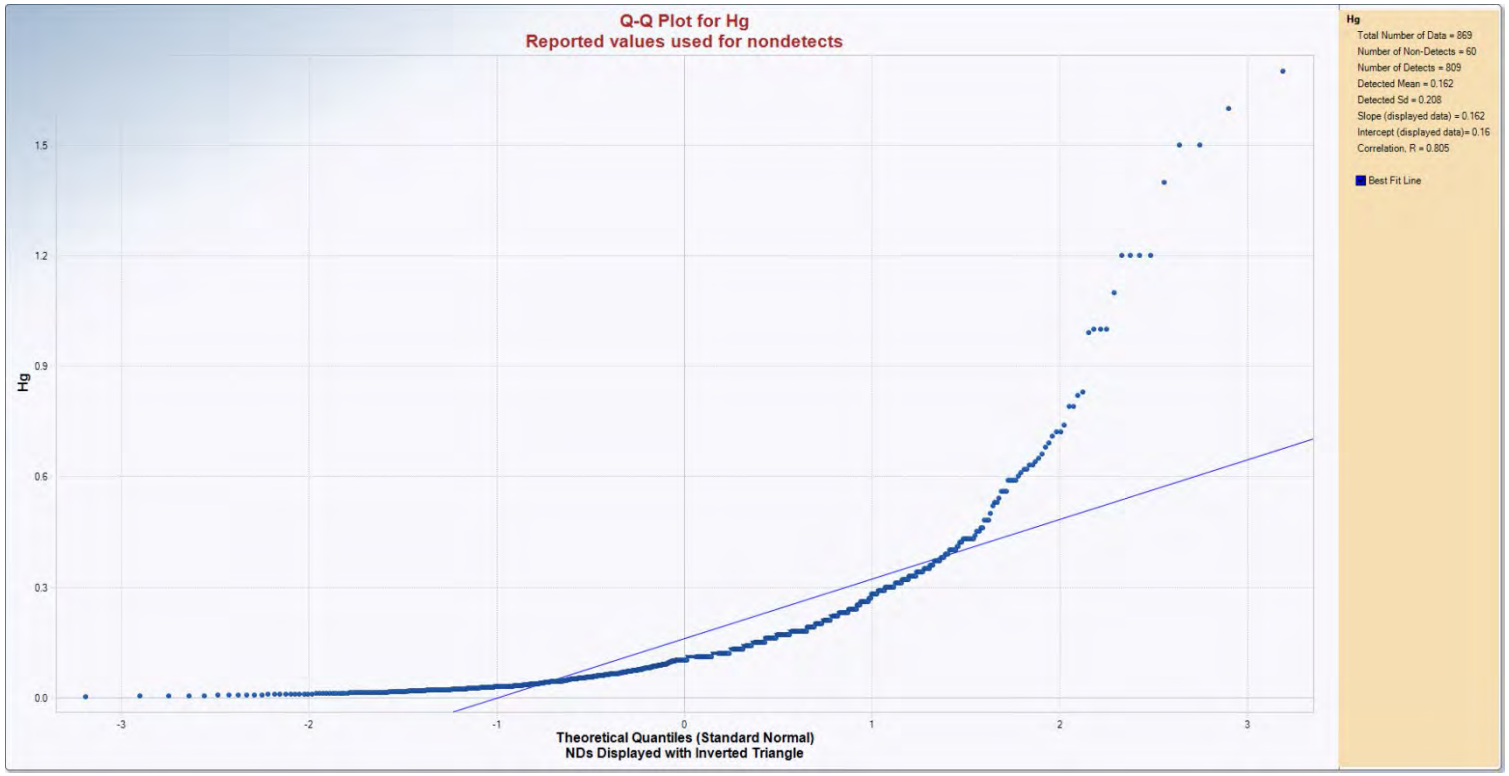
Depth	n	# NDs	Minimum	Maximum	Mean	95% UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	176	0	53	2,210	531	577	1,160	1,316	gamma
15-60cm	178	0	30.8	1,200	406	441	1,003	1,006	gamma
>60cm	251	0	25.7	1,850	390	465	953	1,100	nonparametric
All	605	0	25.7	2,210	436	456	1,052	1,039	gamma



Mercury

Mercury Summary Stats - all data (mg/kg)

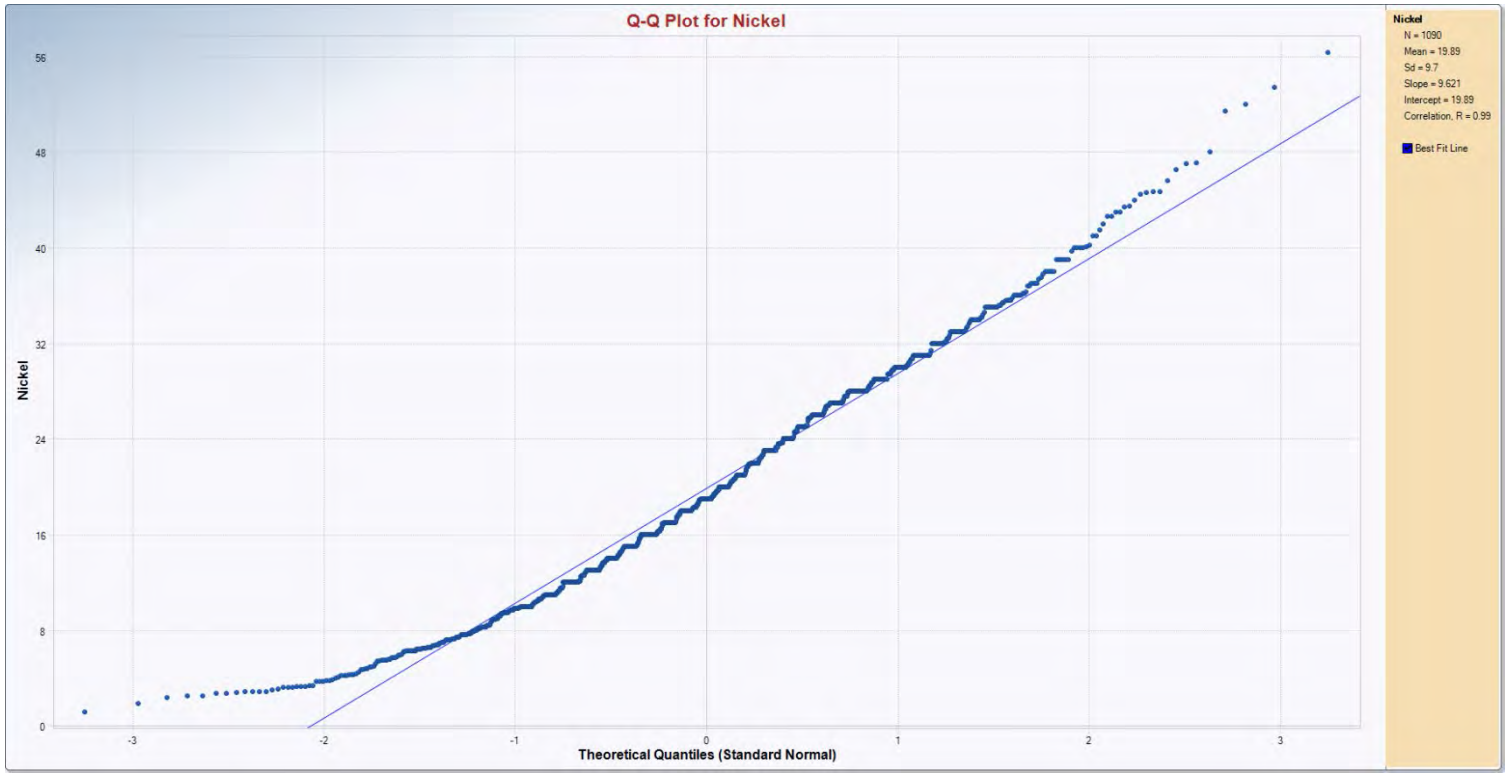
Depth	n	# NDs	Minimum	Maximum	Mean	95% UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	371	16	0.0024	1.5	0.16	0.20	0.50	0.65	nonparametric
15-60cm	259	12	0.0041	1.6	0.16	0.19	0.48	0.59	nonparametric
>60cm	239	32	0.0032	1.7	0.16	0.20	0.56	0.63	nonparametric
All	869	60	0.0024	1.7	0.16	0.18	0.51	0.59	nonparametric



Nickel

Nickel Summary Stats - all data (mg/kg)

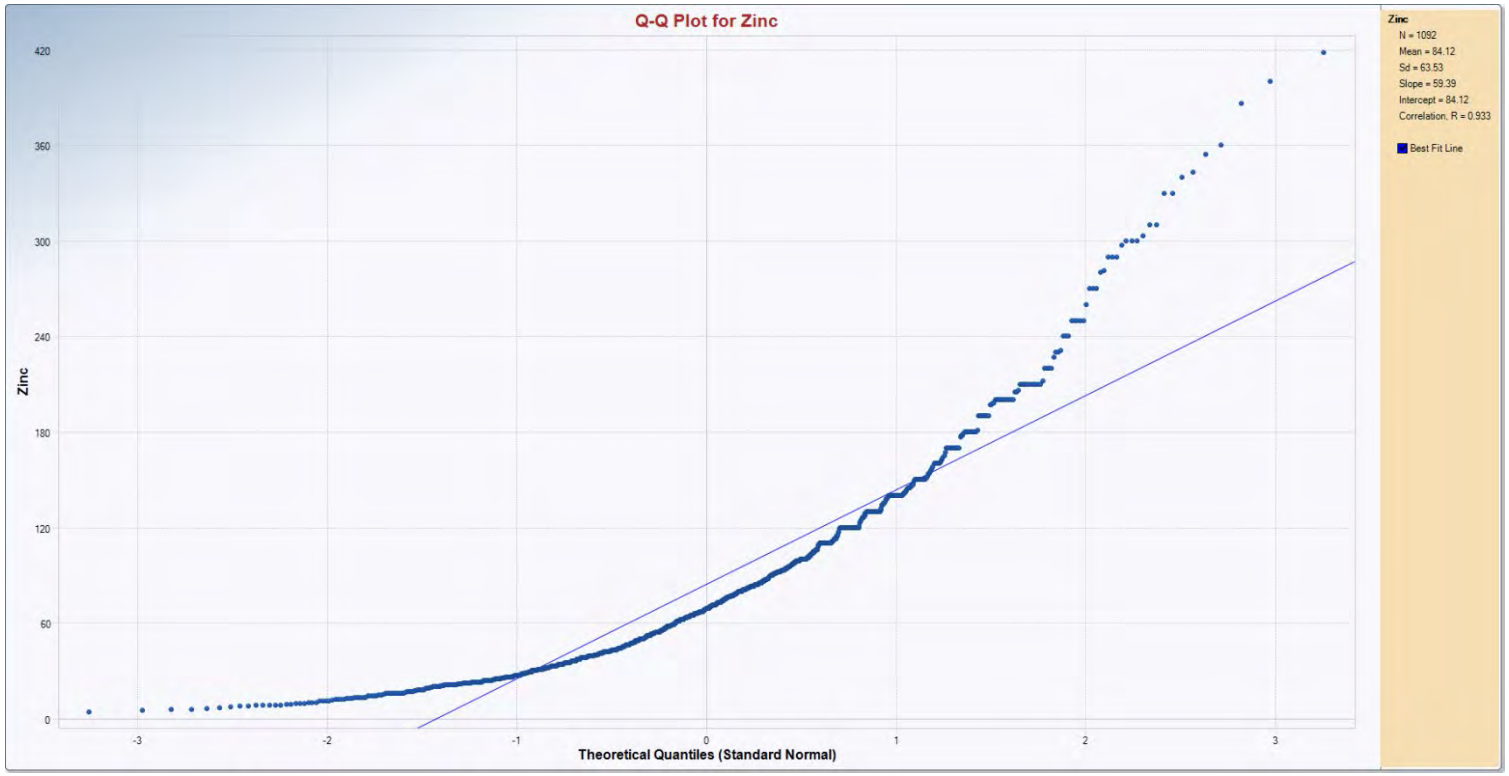
Depth	n	# NDs	Minimum	Maximum	Mean	95% UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	439	0	2.5	52	20	22	37	39	nonparametric
15-60cm	319	0	2.4	51	19	22	35	38	nonparametric
>60cm	332	0	1.2	56	20	22	36	39	nonparametric
All	1090	0	1.2	56	20	21	36	38	nonparametric



Zinc

Zinc Summary Stats - all data (mg/kg)

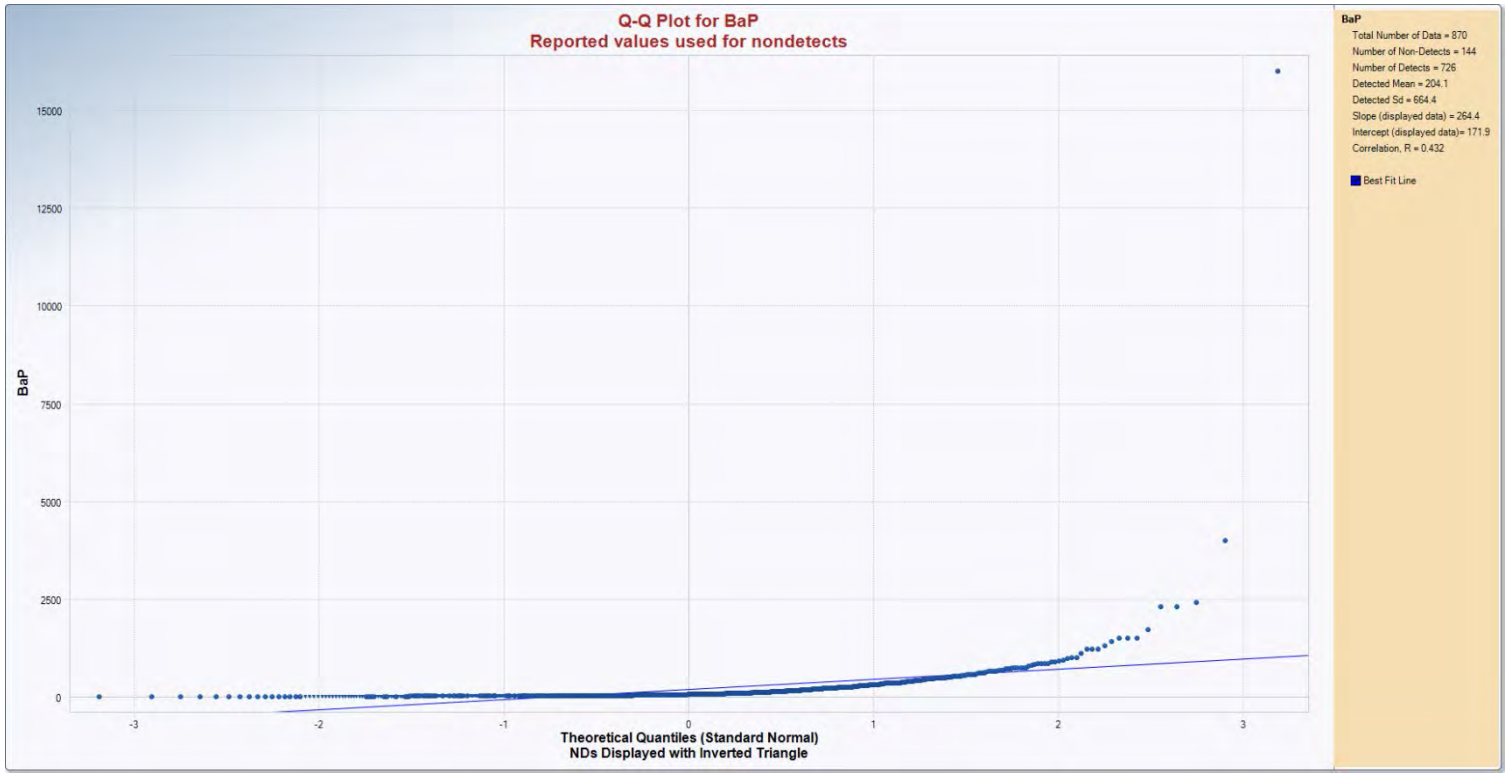
Depth	n	# NDs	Minimum	Maximum	Mean	95% UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	438	0	8.0	343	94	107	210	240	nonparametric
15-60cm	320	0	4.3	400	81	86	190	210	nonparametric
>60cm	334	0	5.2	418	75	81	201	199	gamma
All	1092	0	4	418	84	81	206	210	nonparametric



Benzo(a)pyrene

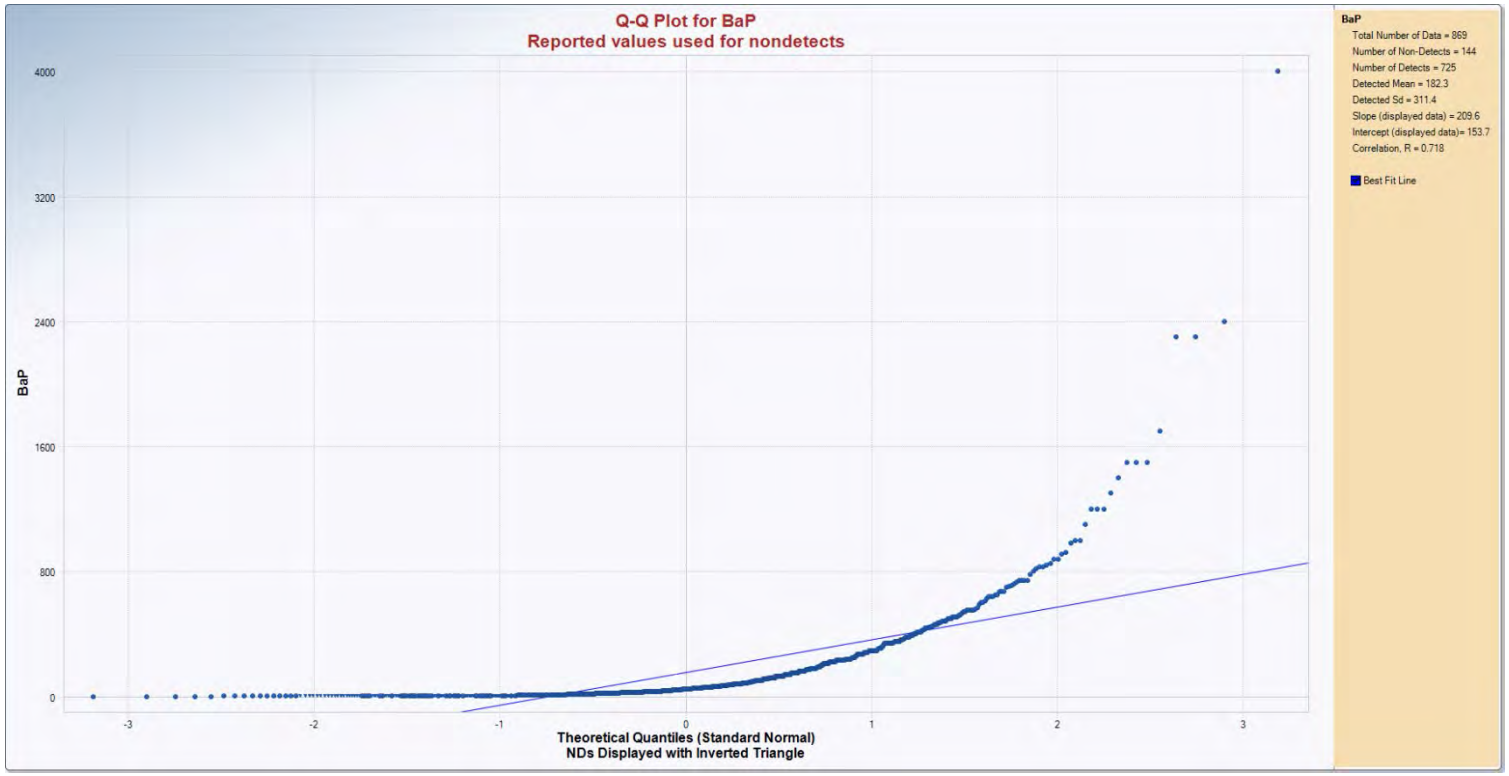
Benzo(a)pyrene Summary Stats - all data (µg/kg)

Depth	n	# NDs	Minimum	Maximum	Mean	95% UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	368	19	0.72	2,300	181	269	663	820	nonparametric
15-60cm	263	40	0.62	4,000	162	223	550	670	nonparametric
>60cm	239	85	0.81	16,000	317	509	655	840	nonparametric
All	870	144	0.62	16,000	204	261	640	720	nonparametric



Benzo(a)pyrene Summary Stats - outliers removed - first round (µg/kg)

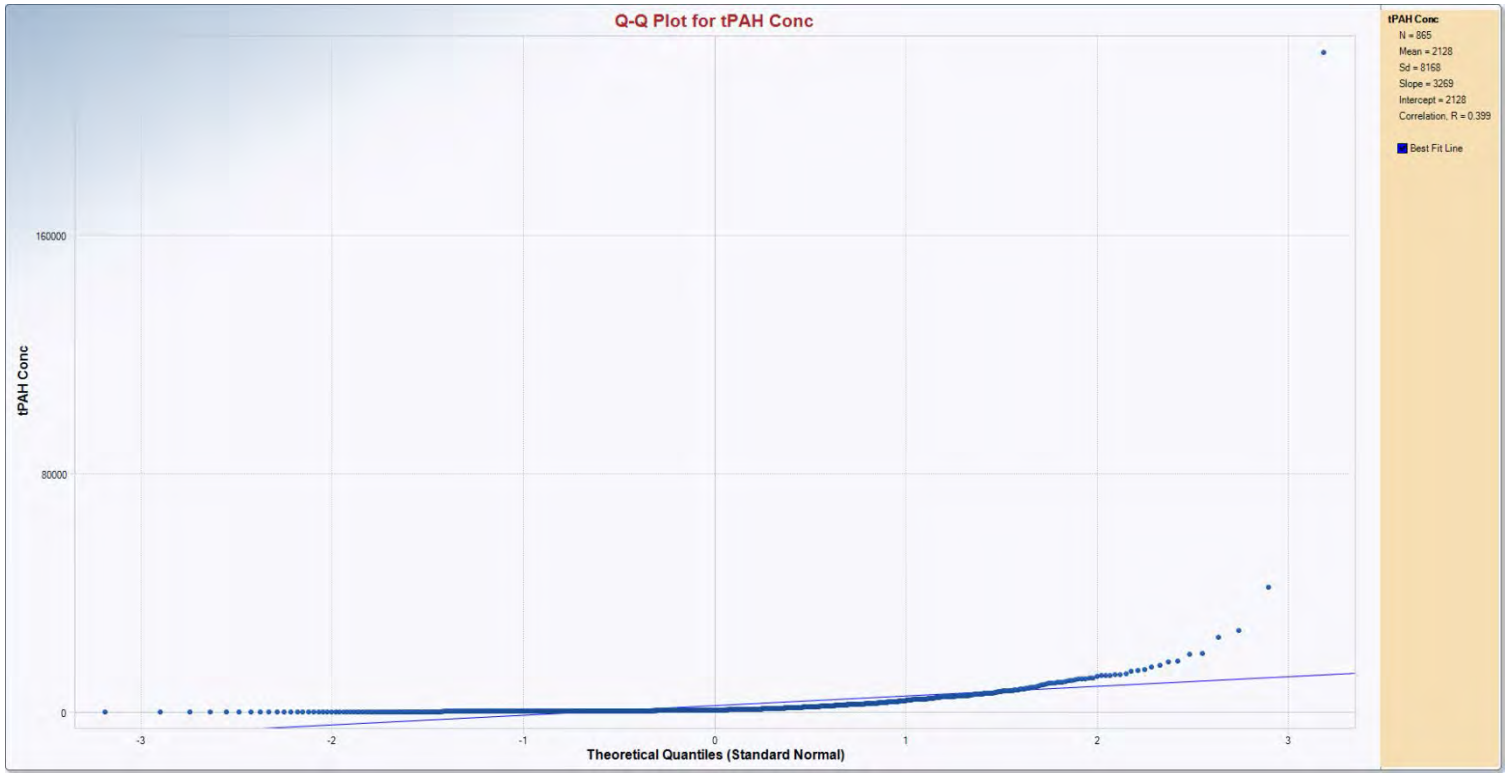
Depth	n	# NDs	Minimum	Maximum	Mean	95% UCL	95%ile	BTV	Distribution
0-15cm	368	19	0.72	2,300	181	269	663	820	nonparametric
15-60cm	263	40	0.62	4,000	162	223	550	670	nonparametric
>60cm	238	85	0.81	2,400	214	224	642	830	nonparametric
All	869	144	0.62	4,000	182	196	640	710	nonparametric



Total PAH (17)

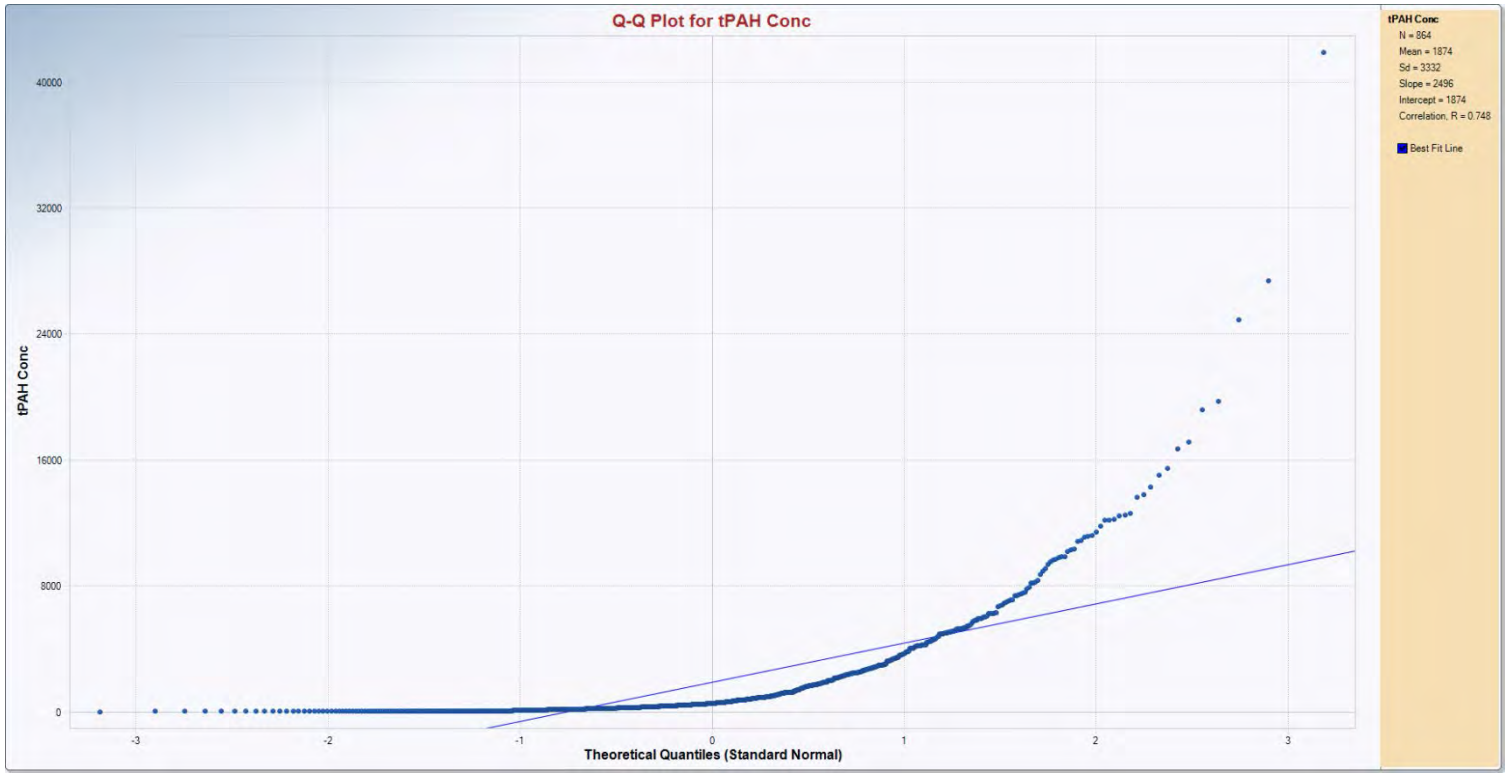
Total PAH Summary Stats - all data (µg/kg)

Depth	n	Minimum	Maximum	Mean	95% UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	362	12	27,361	2,110	2,836	8,710	10,305	nonparametric
15-60cm	259	19.4	41,840	1,833	2,703	7,485	9,354	nonparametric
>60cm	244	25.01	221,240	2,467	6,486	7,335	11,085	nonparametric
All	865	12	221,240	2,128	3,338	7,898	9,635	nonparametric



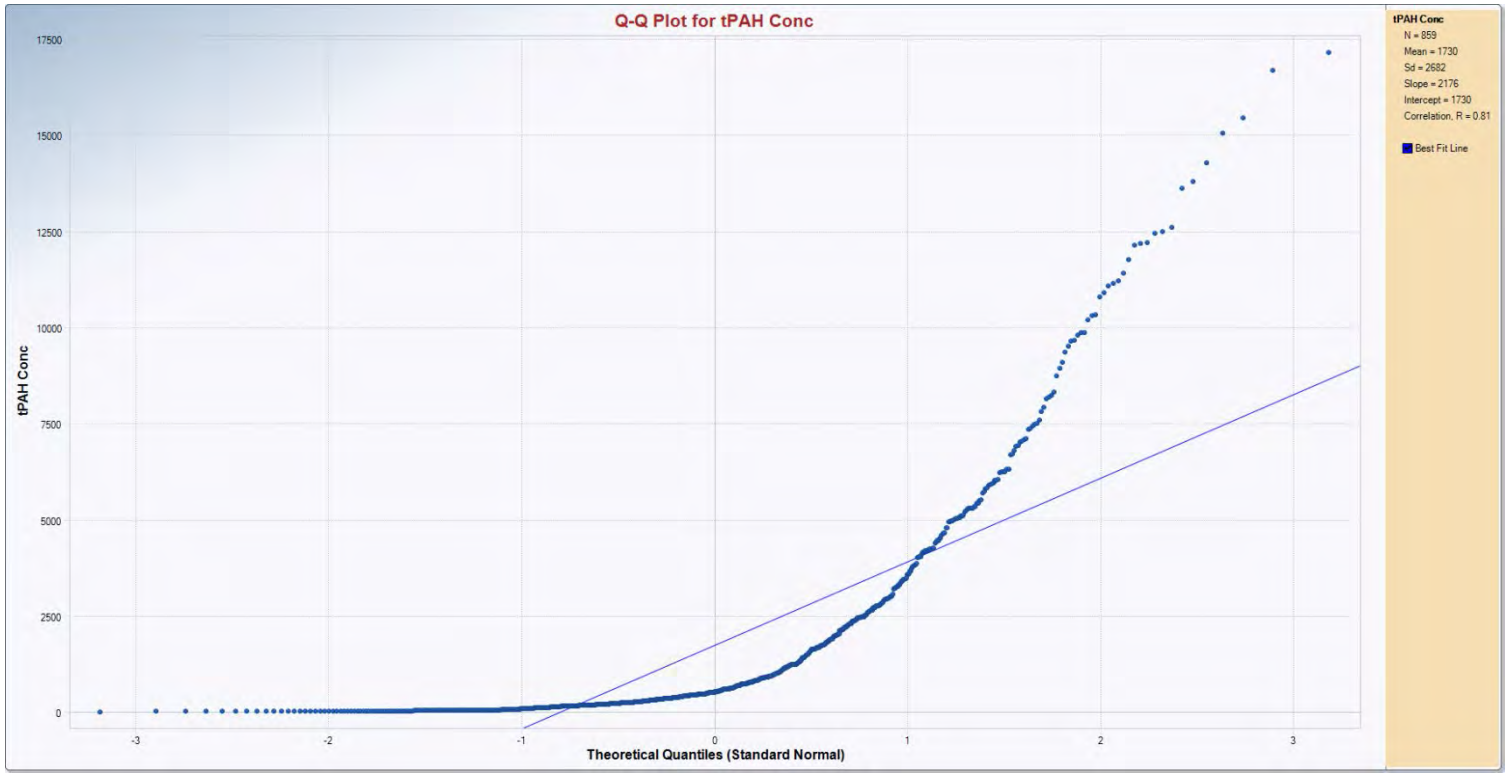
Total PAH Summary Stats - outliers removed - first round (µg/kg)

Depth	n	Minimum	Maximum	Mean	95% UCL	95%ile	BTV	Distribution
0-15cm	362	12	27,361	2,110	2,836	8,710	10,305	nonparametric
15-60cm	259	19.4	41,840	1,833	2,703	7,485	9,354	nonparametric
>60cm	243	25.01	24,900	1,566	2,438	6,716	9,860	nonparametric
All	864	12	41,840	1,874	2,368	7,785	9,505	nonparametric



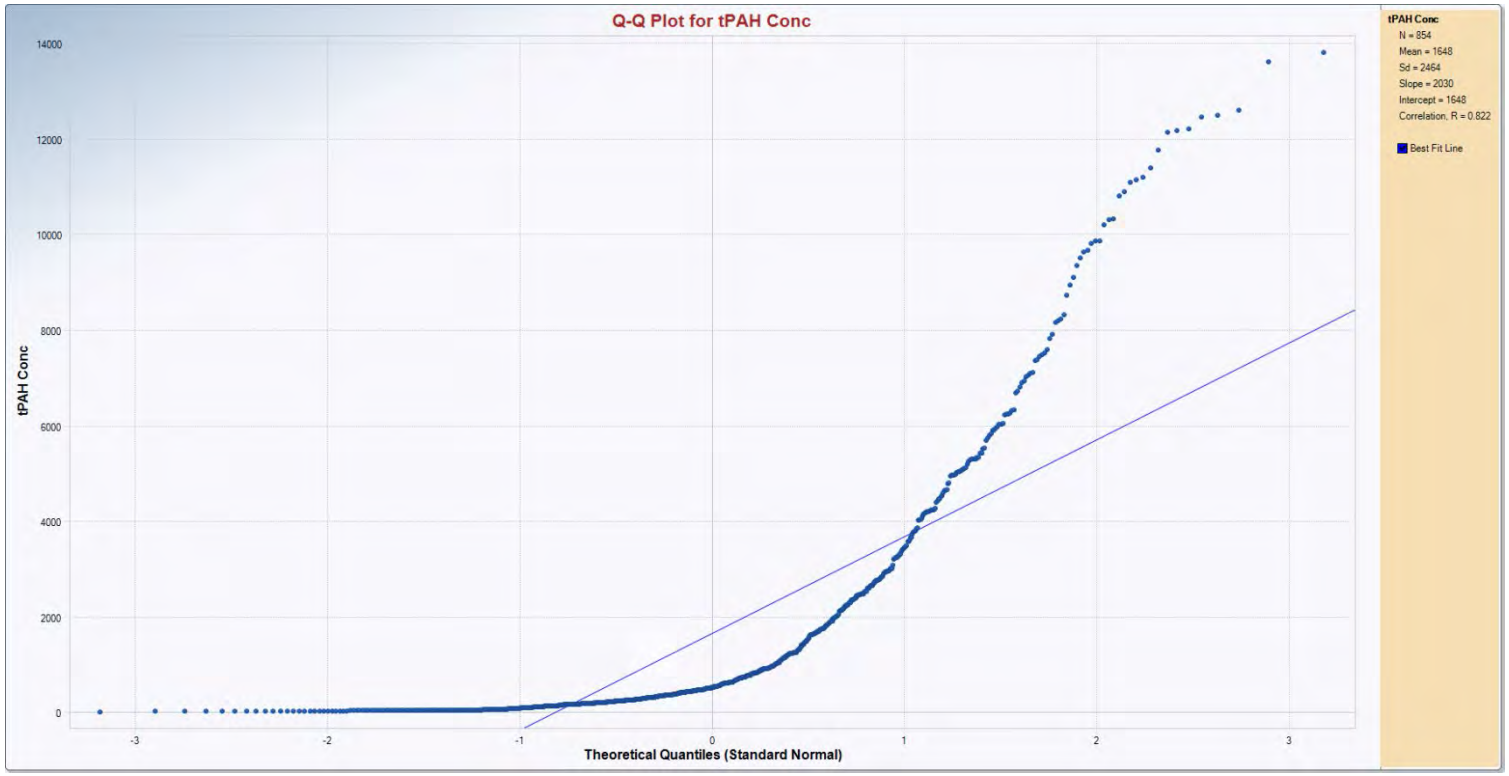
Total PAH Summary Stats - outliers removed - second round (µg/kg)

Depth	n	Minimum	Maximum	Mean	95% UCL	95%ile	BTV	Distribution
0-15cm	360	12	15,446	1,991	2,618	8,228	9,856	nonparametric
15-60cm	257	19.4	15,050	1,610	2,471	7,097	8,190	nonparametric
>60cm	242	25.01	17,137	1,470	2,236	6,662	9,505	nonparametric
All	859	12	17,137	1,730	2,129	7,377	8,322	nonparametric



Total PAH Summary Stats - outliers removed - third round (µg/kg)

Depth	n	Minimum	Maximum	Mean	95% UCL	95%ile	BTV	Distribution
0-15cm	359	12	13,800	1,954	2,561	7,653	9,810	nonparametric
15-60cm	255	19.4	11,772	1,507	2,317	7,024	7,514	nonparametric
>60cm	240	25.01	12,600	1,341	2,003	6,255	7,917	nonparametric
All	854	12	13,800	1,648	2,016	7,026	7,820	nonparametric



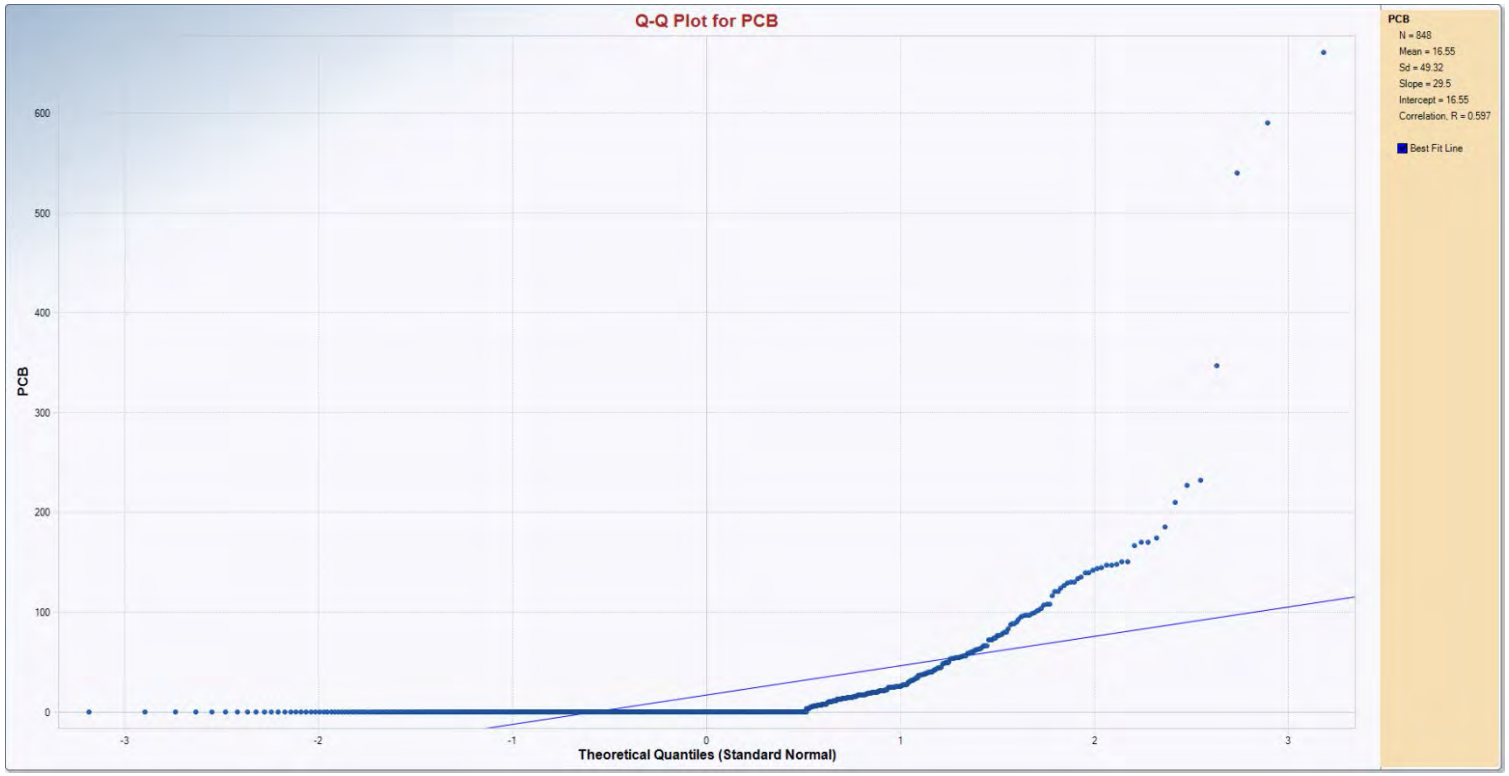
Total PCBs

Total PCB Summary Stats - all data (µg/kg)

Depth	n	# NDs	Minimum	Maximum	Mean	95% UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	358	219	2.8	347	44	37	98	116	nonparametric
15-60cm	259	185	4.6	590	56	22	97	129	nonparametric
>60cm	232	187	5.8	1,000	105	81	88	139	nonparametric
All	849	591	2.8	1,000	58	38	97	108	nonparametric

Total PCB Summary Stats - outliers removed - first round (µg/kg)

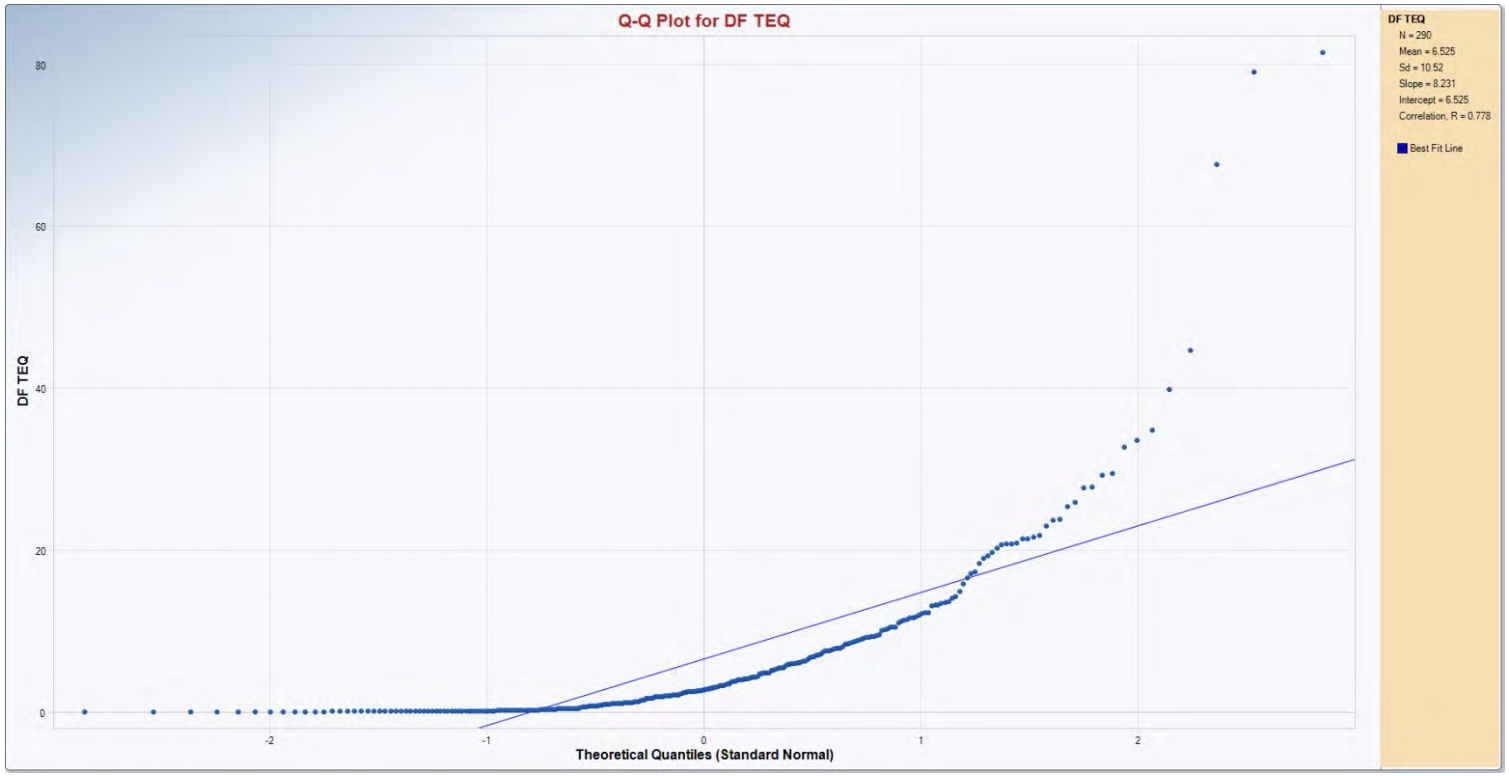
Depth	n	# NDs	Minimum	Maximum	Mean	95% UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	358	219	2.8	347	44	37	98	116	nonparametric
15-60cm	259	185	4.6	590	56	22	97	129	nonparametric
>60cm	231	187	5.8	660	85	26	83	124	nonparametric
All	848	591	2.8	660	55	33	97	108	nonparametric



DF TEQ Fish (WHO 1998)

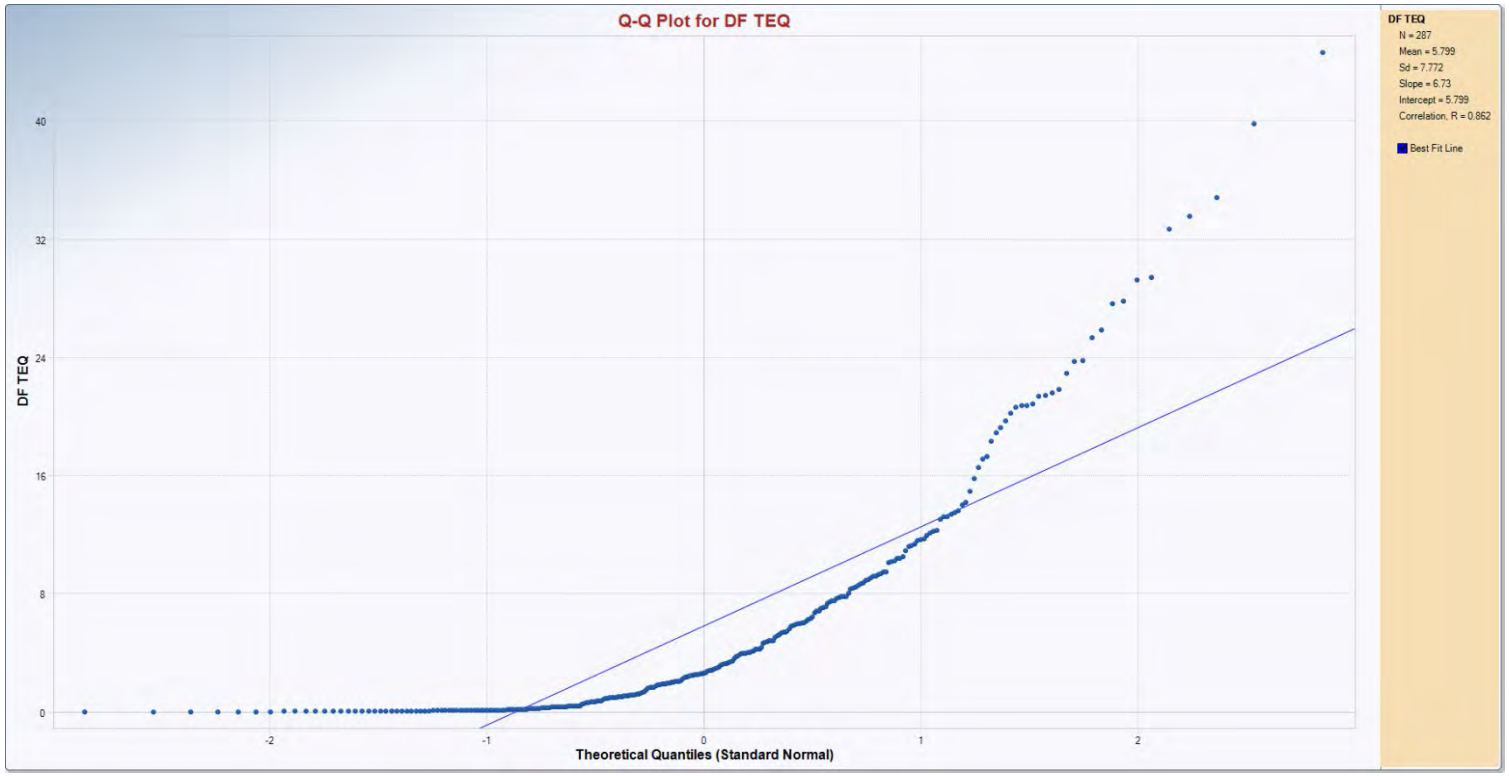
DF TEQ Fish Summary Stats - all data (ng TEQ/kg)

Depth	n	# NDs	Minimum	Maximum	Mean	95% UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	156	0	0	81	6.3	7.5	20	25	gamma
15-60cm	99	2	0	45	6.2	11	29	34	nonparametric
>60cm	35	0	0.0002	79	8.4	27	37	79	nonparametric
All	290	2	0	81	6.5	9.2	24	29	nonparametric



DF TEQ Fish Summary Stats - outliers removed - first round (ng TEQ/kg)

Depth	n	# NDs	Minimum	Maximum	Mean	95% UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	155	0	0	35	5.8	6.9	19	23	gamma
15-60cm	99	2	0	45	6.2	11	29	34	nonparametric
>60cm	33	0	0.0002	24	4.5	12	21	24	nonparametric
All	287	2	0	45	5.8	7.8	22	26	nonparametric



DF TEQ Fish Summary Stats - outliers removed - second round (ng TEQ/kg)

Depth	n	# NDs	Minimum	Maximum	Mean	95% UCL	95%ile	BTV (95/95UTL)	Distribution
0-15cm	155	0	0	35	5.8	6.9	19	23	gamma
15-60cm	97	2	0	34	5.5	9.2	26	29	nonparametric
>60cm	33	0	0.0002	24	4.5	12	21	24	nonparametric
All	285	2	0	35	5.5	7.4	21	24	nonparametric