Appendix E

Tool for Evaluating Stormwater Data

From: ***DEQ Guidance for Evaluating the Stormwater Pathway at Upland Sites***

Cleanup Program
700 NE Multnomah
Portland, OR 97232
Phone: 503-229-5696
800-452-4011
Fax: 503-229-6762

www.oregon.gov/DEQ

DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.

DEQ
State of Oregon
Department of
Environmental
Quality

APPENDIX E:
TOOL FOR EVALUATING STORMWATER DATA

For the sake of readability, the term "stormwater" refers to all types of samples used to create this tool, including stormwater, catch basin sediment and suspended sediment samples.

The following charts were created using contaminant concentration data from stormwater samples collected at Portland Harbor-area industrial sites. They are intended to be used as a screening tool for distinguishing "typical" industrial stormwater from stormwater containing potentially elevated contaminant concentrations. Elevated contaminant concentrations are an indication that contamination may be present at the site and that additional investigation and source control may be needed.

There are two sets of charts – one for water and one for solids. Charts were developed for 12 contaminants and Total Suspended Solids (water only). The contaminants include:

Arsenic	Copper	Silver
Bis(2-Ethylhexyl)phthalate	Lead	Total PAHs
Cadmium	Mercury	Total PCBs
Chromium	Nickel	Zinc

While the charts can be used to identify samples that "stand out from the crowd" they *do not* provide an indication of the potential for stormwater discharges to result in waterbody impacts. The charts were not developed to support that type of determination.

Section 1 Basis for Using the Charts as a Screening Tool

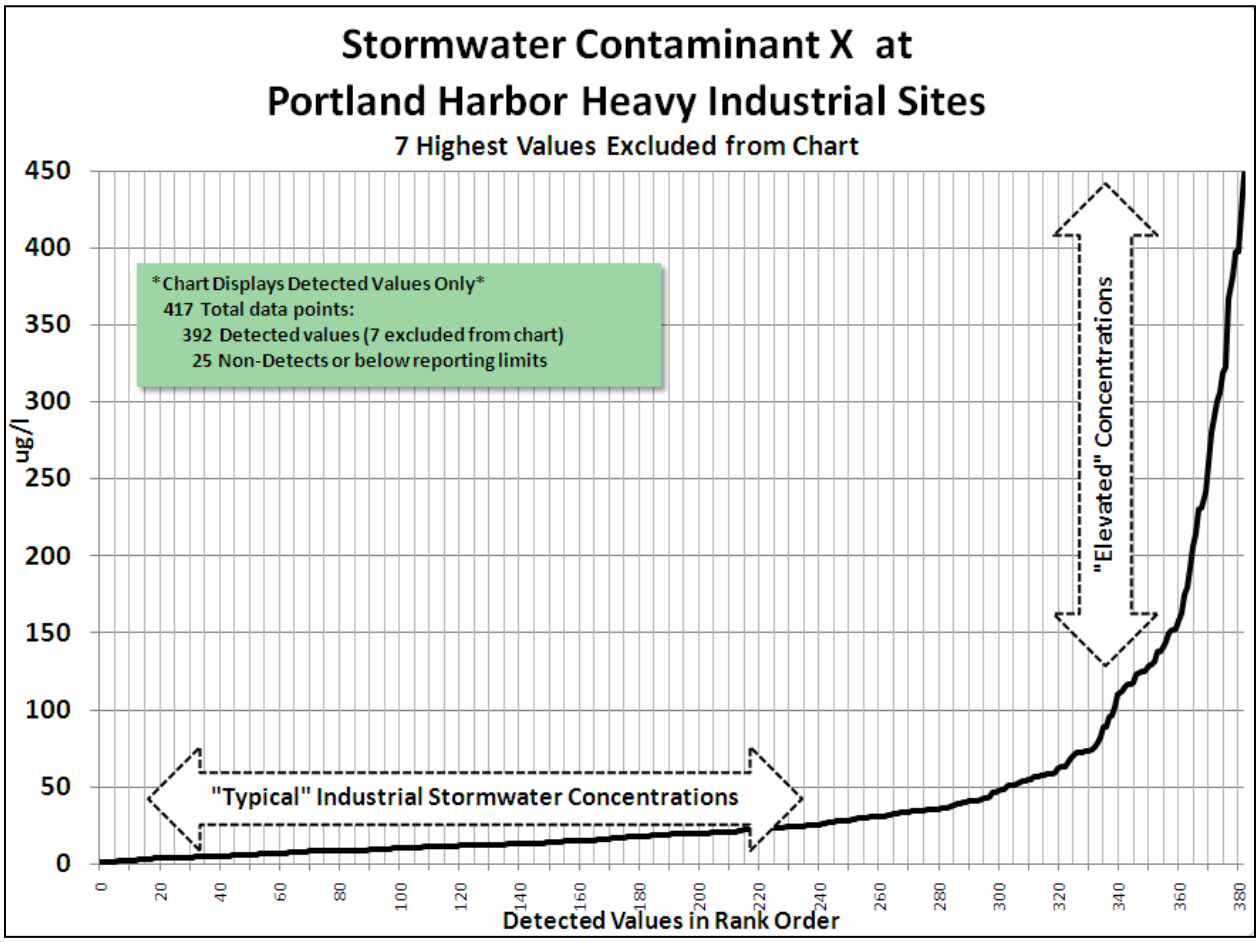
The use of these charts as a screening tool is based on the premise that many kinds of industrial materials and activities have the potential to result in minor releases of contaminants, such as petroleum products in drips of oils, greases and fuels used for vehicles and machinery, phthalates off-gassing from paints and PVC piping, and zinc from galvanized building materials. Off-site sources, including highway traffic, operations at neighboring sites and atmospheric deposition, can also contribute to the contaminant load in stormwater runoff from a site.

As a result, industrial stormwater is likely to contain a somewhat predictable list of contaminants within a predictable concentration range even when good stormwater management practices are being implemented. If contaminant concentrations exceed these ranges, DEQ considers this to be a potential indicator of an uncontrolled source of contaminants at the site.

Due to the highly variable nature of stormwater, interpretations made using these charts should only be considered in the context of other lines of evidence and should not be presumed to provide conclusive evidence of the presence or absence of contamination at a site.

Section 2 Screening Stormwater Data Using the Charts

An example of a typical chart for a stormwater contaminant is provided below. In most charts there is a definitive "knee" in the curve and the majority of data points fall within the relatively flat portion of the curve below the knee. To screen stormwater data from a specific site, determine where the contaminant concentrations fall along the curve on the relevant chart.



The upper and lower bounds of the "knee" are purposefully left undefined on the charts to help avert a misinterpretation of the screening results. Defining these bounds might suggest that the charts were developed with more statistical rigor than was the case, or that the range of typical vs. elevated concentrations is the same for all sites.

Section 3 Interpreting the Results

Stormwater data are one line of evidence to consider when conducting a stormwater pathway evaluation and the charts are a tool for interpreting the data.

- Concentrations falling within the **upper/steeper portion of the curve** are an indication that uncontrolled contaminant sources may be present at the site and additional evaluation and/or source control measures may be warranted. The objective would be to determine the source(s) of the elevated concentrations and, based upon that, whether and what types of source control measures are needed.

- Concentrations falling within the **lower/flatter portion of the curve** suggest that stormwater is not being unusually impacted by contaminants at the site and is therefore representative of "typical" industrial stormwater for Portland Harbor sites. However, this interpretation should not be considered to be a conclusive line of evidence. A determination that no additional source control or evaluation is necessary should be corroborated by other lines of evidence.

Section 4 Additional Considerations

The screening results need to be evaluated based upon the characteristics of the site. Some sites can be expected to have higher concentrations of certain types of contaminants simply as a result of the type of operations (e.g., phthalates associated with painting activities, PAHs associated with heavy equipment and fueling). Slightly higher concentrations of specific contaminants might be considered to be "normal" at these sites but indicate potential contamination at others. However, neither *typical* nor *normal* is the same as *acceptable*. As stated above, these charts were developed for identifying potentially contaminated sites and helping to guide source control evaluations. They are not designed to be used for evaluating the potential waterbody impacts of stormwater discharges.

An additional consideration when evaluating stormwater data is whether the data are likely to be representative of typical stormwater discharges from the site. Stormwater samples taken from the same location can show widely varying concentrations depending on the duration and intensity of the storm events that were sampled, whether the sample was collected early or late in the storm, the length of the dry period preceding the storms, and the activities occurring at the site since the previous storm event or catch basin cleanout. This should be considered when determining how much weight to apply to stormwater data in the course of a stormwater evaluation and/or whether additional data are needed to support a decision.

Section 5 Process and Quality Assurance Steps for 2015 Update

This Appendix E tool was first made available in October 2010. DEQ completed an update of theses curves in October 2015. The update improved the tool by enhancing the datasets represented with additional data collected at the same sites as well as new sites that drain to the Portland Harbor Superfund study area. Section 5 was added to document the process and quality control and assurance steps taken to improve confidence in the reliability of this screening tool.

Data Compilation

The first step was to compile stormwater and stormwater solids data collected since the 2009 development of the original tool. DEQ contacted representatives at sites engaged in stormwater source control work and requested submittal in Excel format of all stormwater and stormwater solids data collected since 2009. In early 2015, DEQ received data from 25 sites – 9 new sites and 16 sites with data previously included in the original curves. Data was checked to make sure it was not already in the original graphs. Sample results entered into master spreadsheets were checked to ensure they had been correctly copied over from the site provided data set files.

Compiled data were culled to remove individual results that were not compatible with the master set. Data removed included:

- NPDES data
- Dissolved concentrations (only total concentrations were included)
- Duplicate samples
- Erodible soil samples
- Samples of groundwater infiltration into stormwater pipes (dry weather flow samples)
- Isolated roof runoff samples

For results with individual PCBs and PAHs, DEQ calculated total values by summing all detectable measurements. If all measurements were below the method detection limit (MDL), DEQ classified the sample as a non-detect and use the largest individual MDL as the sample's value. If calculated totals were provided, DEQ confirmed the same methodology was used or else recalculated.

DEQ then reformatted the new data into the configuration used to create the original charts, standardized analyte names, checked for unit continuity, eliminated extraneous information, checked for errors and backed up the new master dataset. After creating a master spread sheet of both new and old data, new versions of all charts were generated and these were reviewed by several staff and compared against the original charts.

Comparison to Original Charts and Additional QA/QC

Y-The vertical axis were scaled so as to allow a meaningful direct comparison to the original charts; outlier results were confirmed, excluded and accounted for; and the horizontal axes were scaled so as to include only the number of samples represented. Other observations led to an addition QA/QC round. These included:

- Random sampling indicated there might be some repeated entries in the stormwater datasets. DEQ confirmed that data was not repeated or removed any confirmed to be repeated.
- Many of the curves looked remarkably similar to the previous charts created in 2010, so DEQ double-checked that the master datasets included all data.
- The chart for PCBs in stormwater solids does show a visually significant shift from the 2010 version. Because the PCB datasets in the original stormwater and stormwater solids charts were the smallest datasets, DEQ suspected that additional data might shift these curves. DEQ re-verified the PCBs solids curve to ensure this visually apparent difference is accurate. The 2015 chart appears to have a point of increasing curvature around 200 ug/kg, where previously increasing curvature was noted around 170 ug/kg.

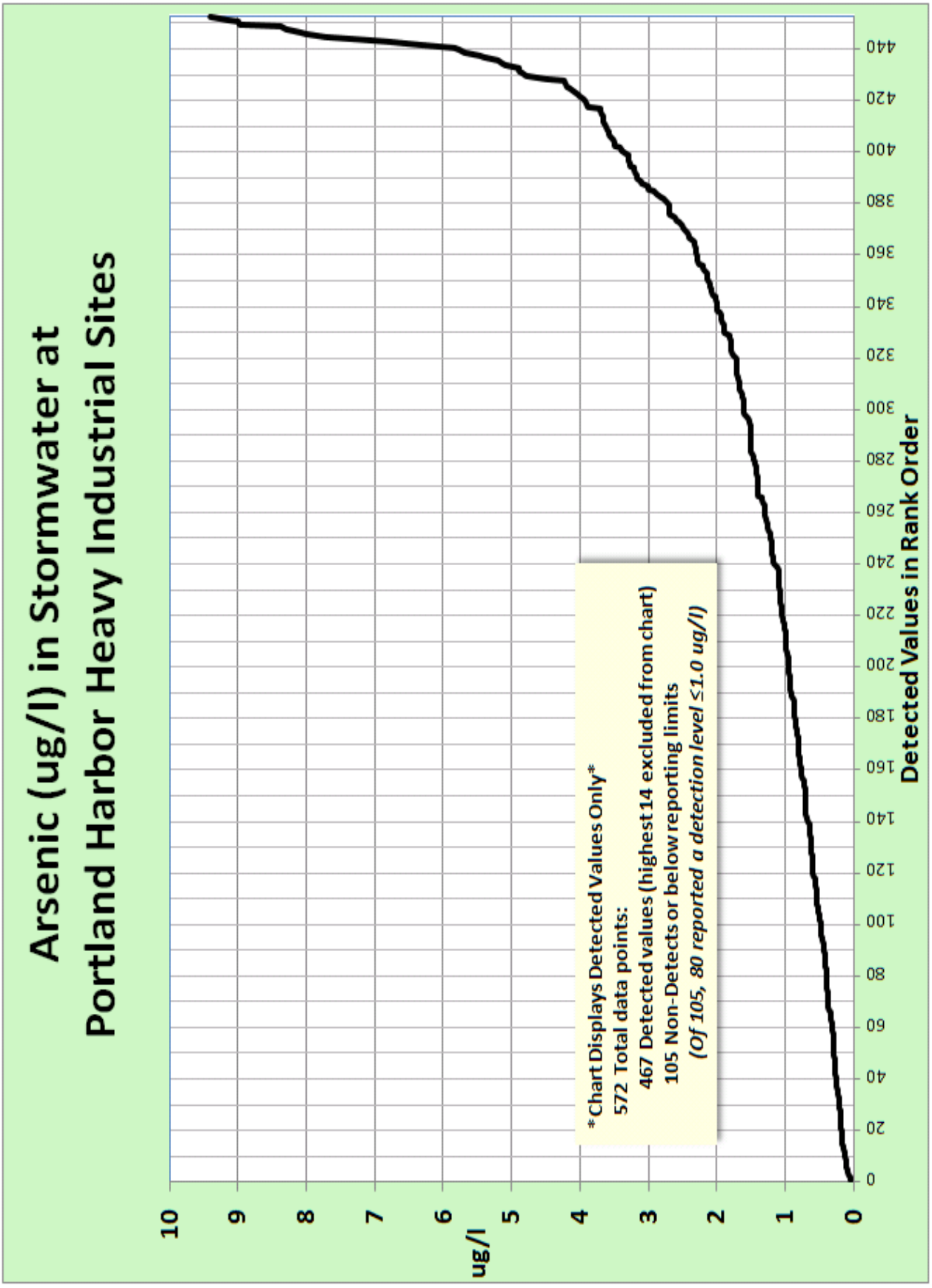
In evaluating the above issues, DEQ determined that 192 stormwater data points with detected results were potential repeats, or approximately 3 percent, mostly found in the original curves data sets. No stormwater solids repeats were identified. Because these were mainly from the original data as compiled, they were removed to avoid expendind the effort to recheck each individual original dataset. Charts were created again following removal of the potential repeated data. In addition, some repeated data were identified among the non-detected stormwater results, which were removed from the master datasets. Because non-detected values are excluded from the charts, however, this change has no effect on the charts.

All data points were grouped and recounted as detects, non-detects and excluded outliers, for both the stormwater and stormwater solids datasets. This verified that all original chart data (excluding the repeated results) and all newly compiled data were appropriately displayed.

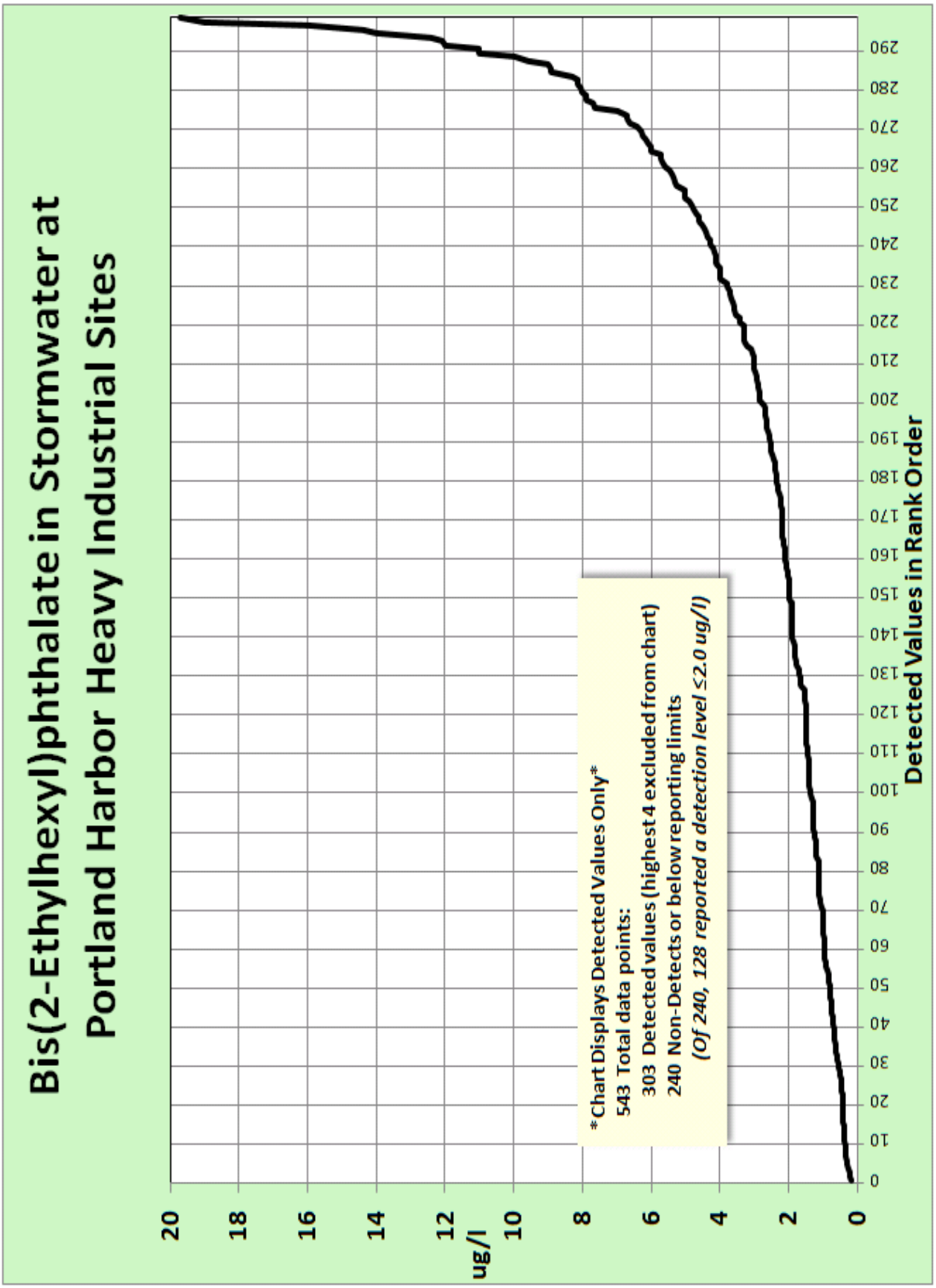
Each old and newly added data point with a detected result in the PCB solids chart was reverified and duplicates were screened for a final time to confirm that the slight shift was an accurate result of the enhancement of the dataset.

STORMWATER CHARTS

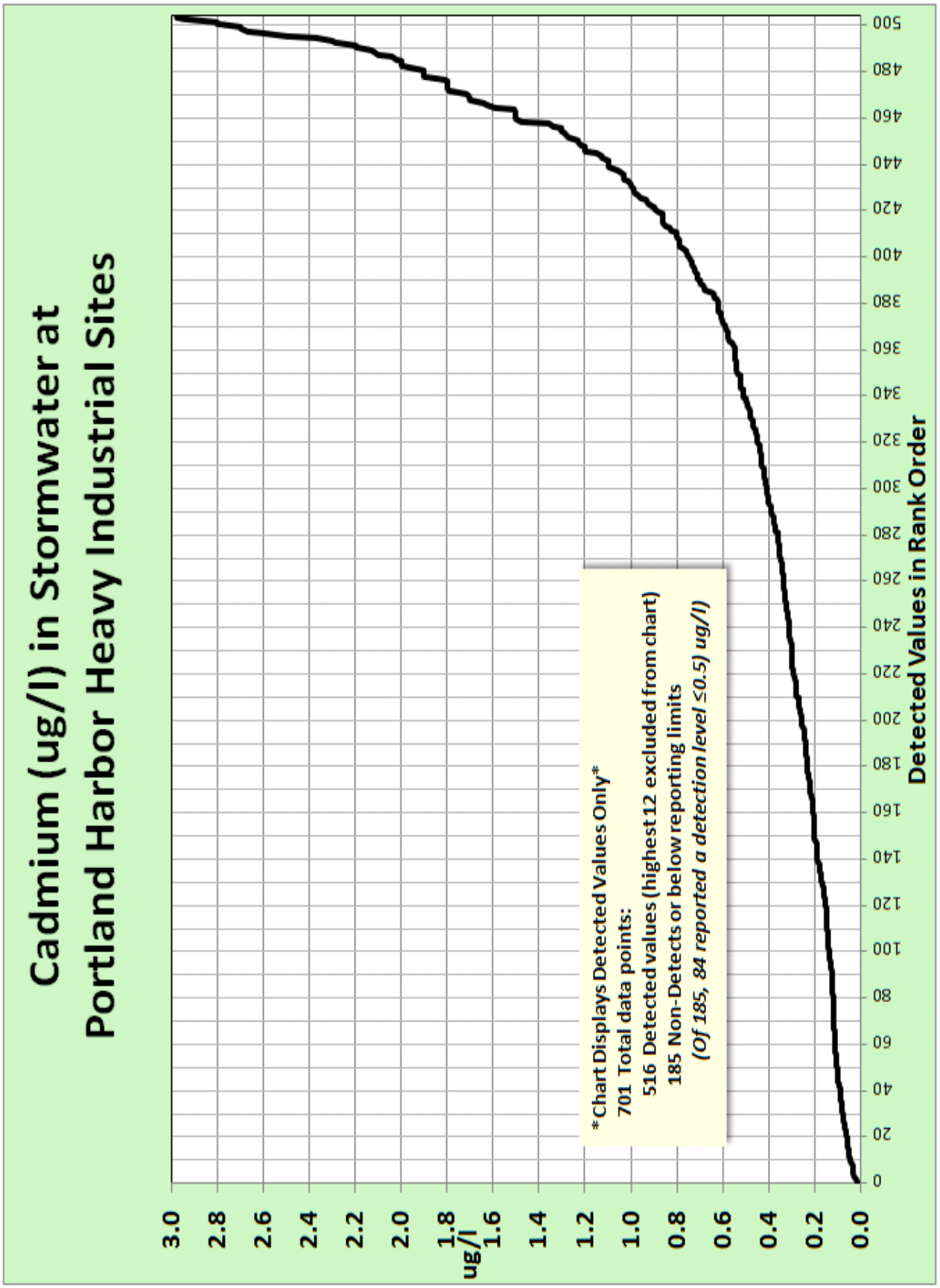
All stormwater data represents whole water/unfiltered samples.


Arsenic (ug/l) in Stormwater at
Portland Harbor Heavy Industrial Sites
ug/l
Detected Values in Rank Order
* Chart Displays Detected Values Only*
572 Total data points:
467 Detected values (highest 14 excluded from chart)
105 Non-Detects or below reporting limits
(Of 105, 80 reported a detection level ≤1.0 ug/l)

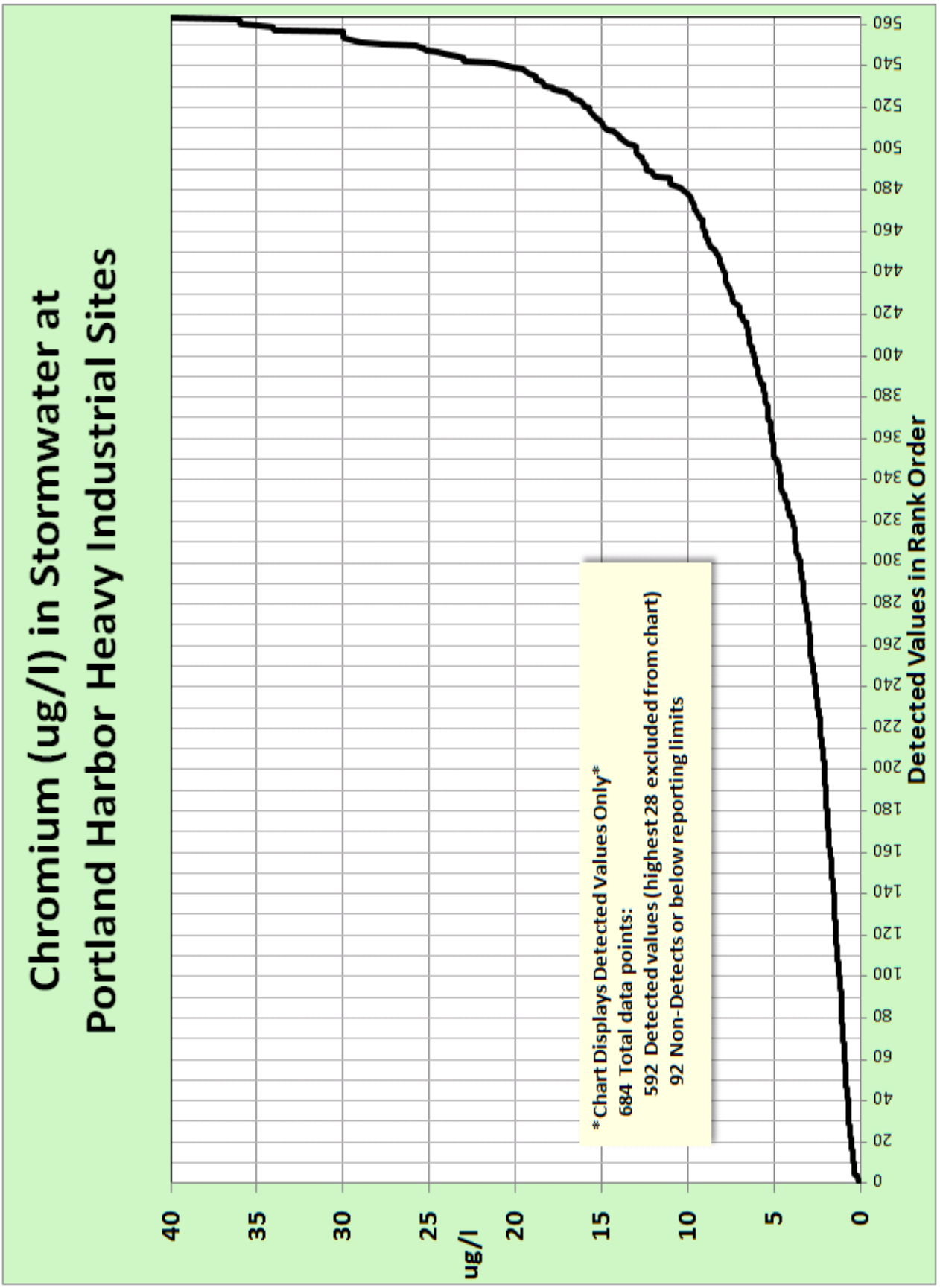
ARSENIC


Bis(2-Ethylhexyl)phthalate in Stormwater at Portland Harbor Heavy Industrial Sites
ug/l
0
2
4
6
8
10
12
14
16
18
20
Detected Values in Rank Order
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
Chart Displays Detected Values Only
543 Total data points:
303 Detected values (highest 4 excluded from chart)
240 Non-Detects or below reporting limits
(Of 240, 128 reported a detection level ≤2.0 ug/l)

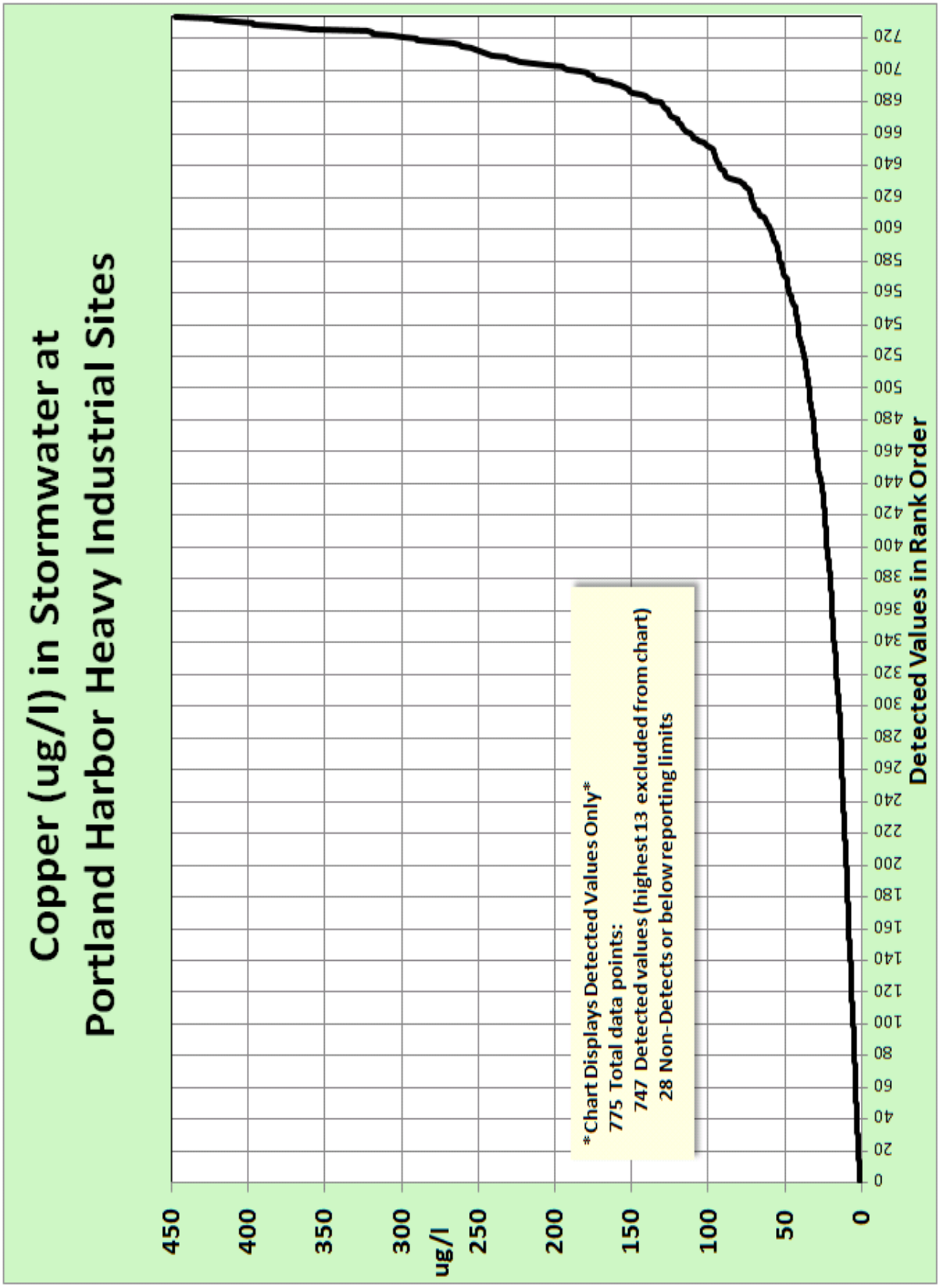
BEHP


Cadmium (ug/l) in Stormwater at Portland Harbor Heavy Industrial Sites
ug/l
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Detected Values in Rank Order
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
Chart Displays Detected Values Only
701 Total data points:
516 Detected values (highest 12 excluded from chart)
185 Non-Detects or below reporting limits
(Of 185, 84 reported a detection level ≤0.5) ug/l)

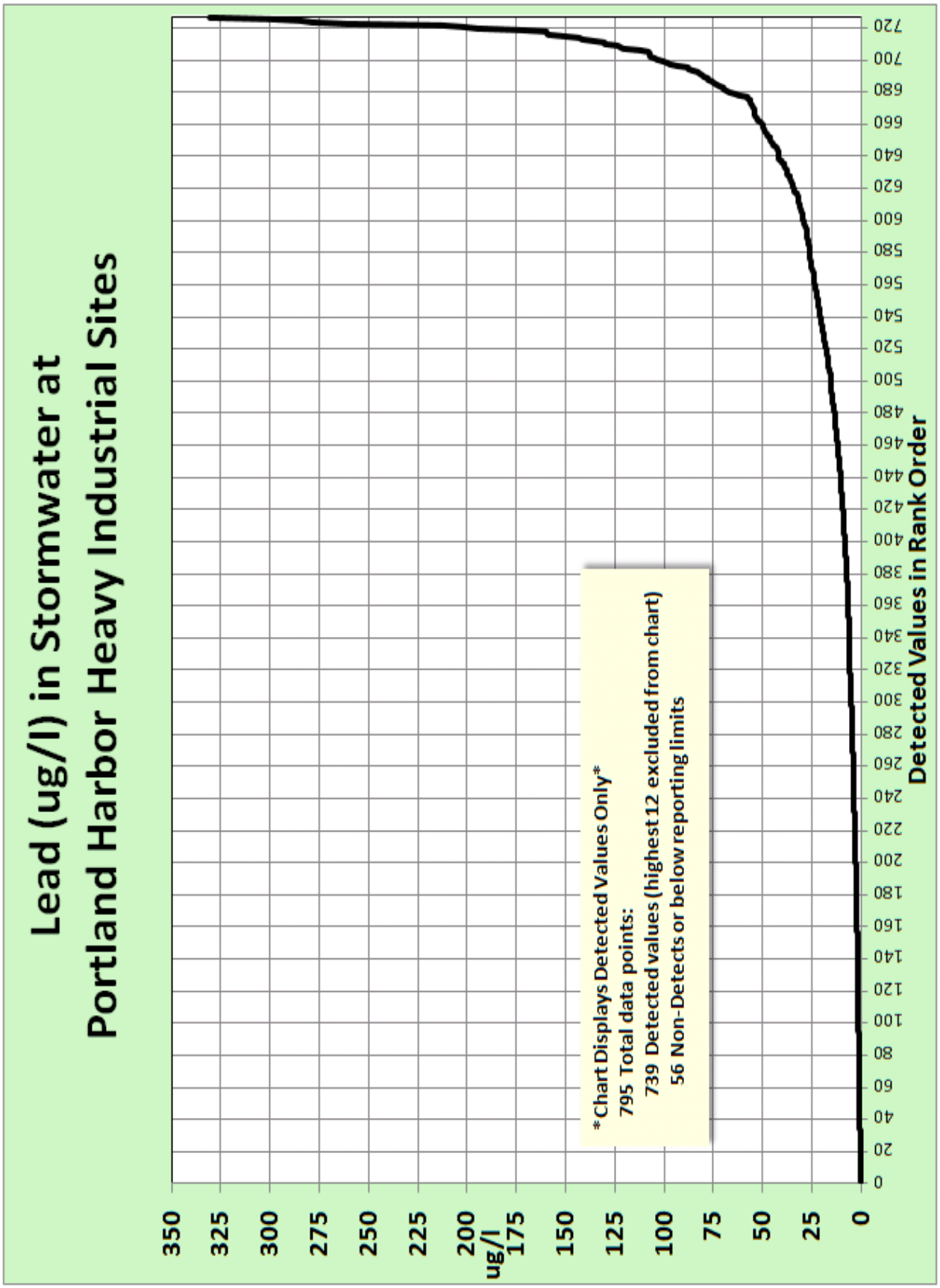
CADMIUM


Chromium (ug/l) in Stormwater at Portland Harbor Heavy Industrial Sites
ug/l
40
35
30
25
20
15
10
5
0
Detected Values in Rank Order
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
Chart Displays Detected Values Only
684 Total data points:
592 Detected values (highest 28 excluded from chart)
92 Non-Detects or below reporting limits

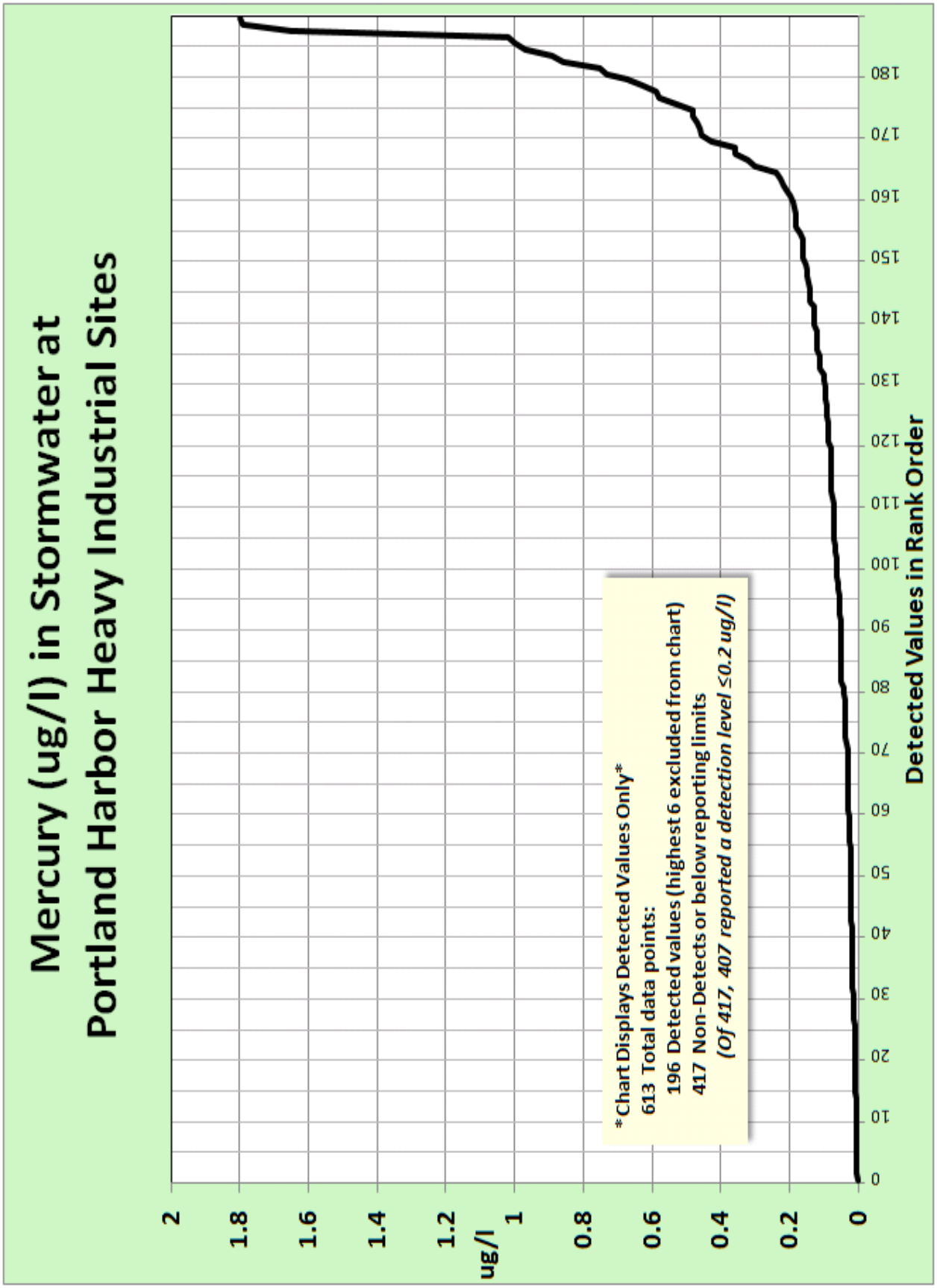
CHROMIUM


Copper (ug/l) in Stormwater at
Portland Harbor Heavy Industrial Sites
ug/l
450
400
350
300
250
200
150
100
50
0
Detected Values in Rank Order
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
680
700
720
Chart Displays Detected Values Only
775 Total data points:
747 Detected values (highest 13 excluded from chart)
28 Non-Detects or below reporting limits

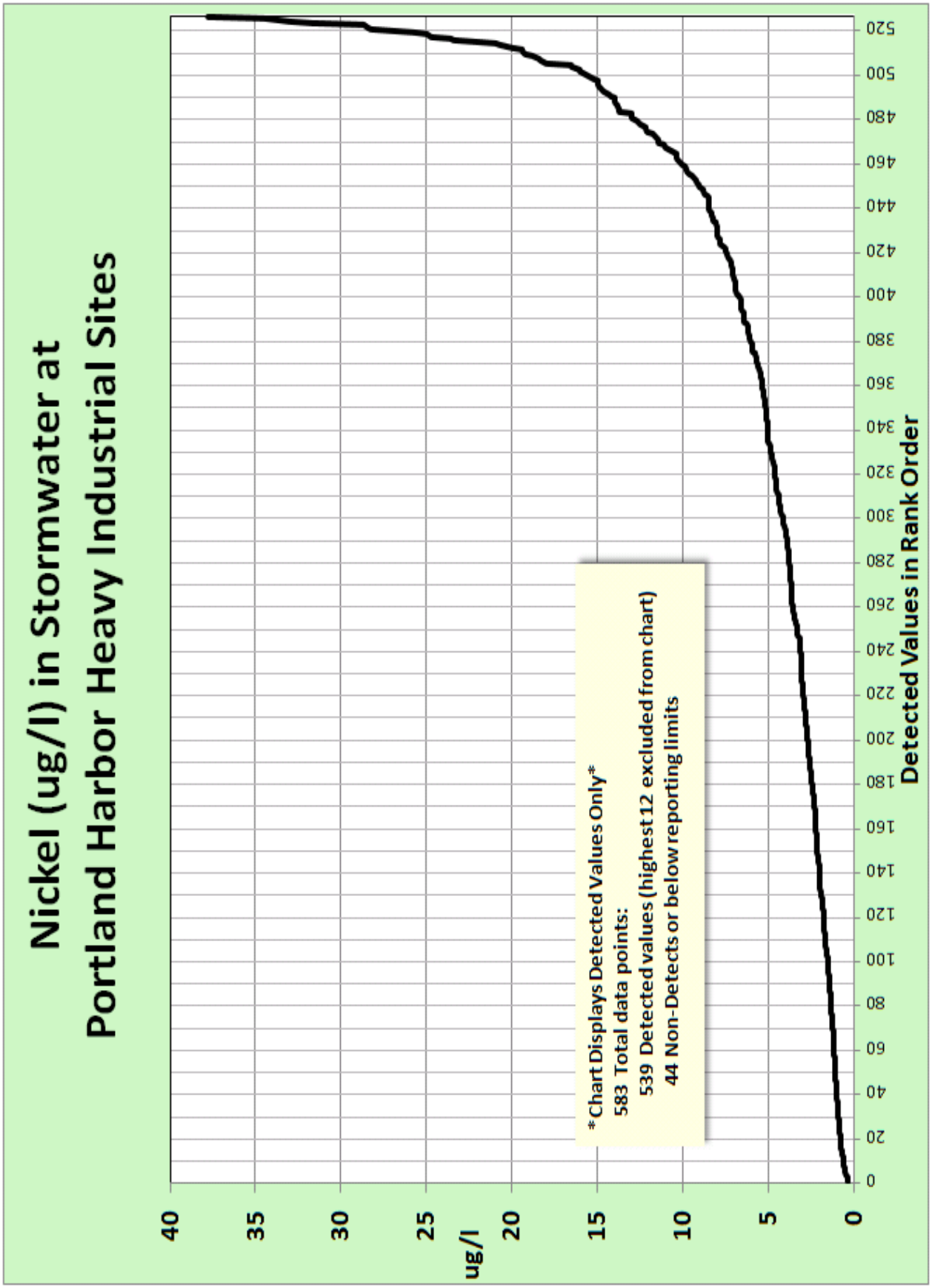
COPPER


Lead (ug/l) in Stormwater at
Portland Harbor Heavy Industrial Sites
ug/l
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
Detected Values in Rank Order
720
700
680
660
640
620
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Chart Displays Detected Values Only
795 Total data points:
739 Detected values (highest 12 excluded from chart)
56 Non-Detects or below reporting limits

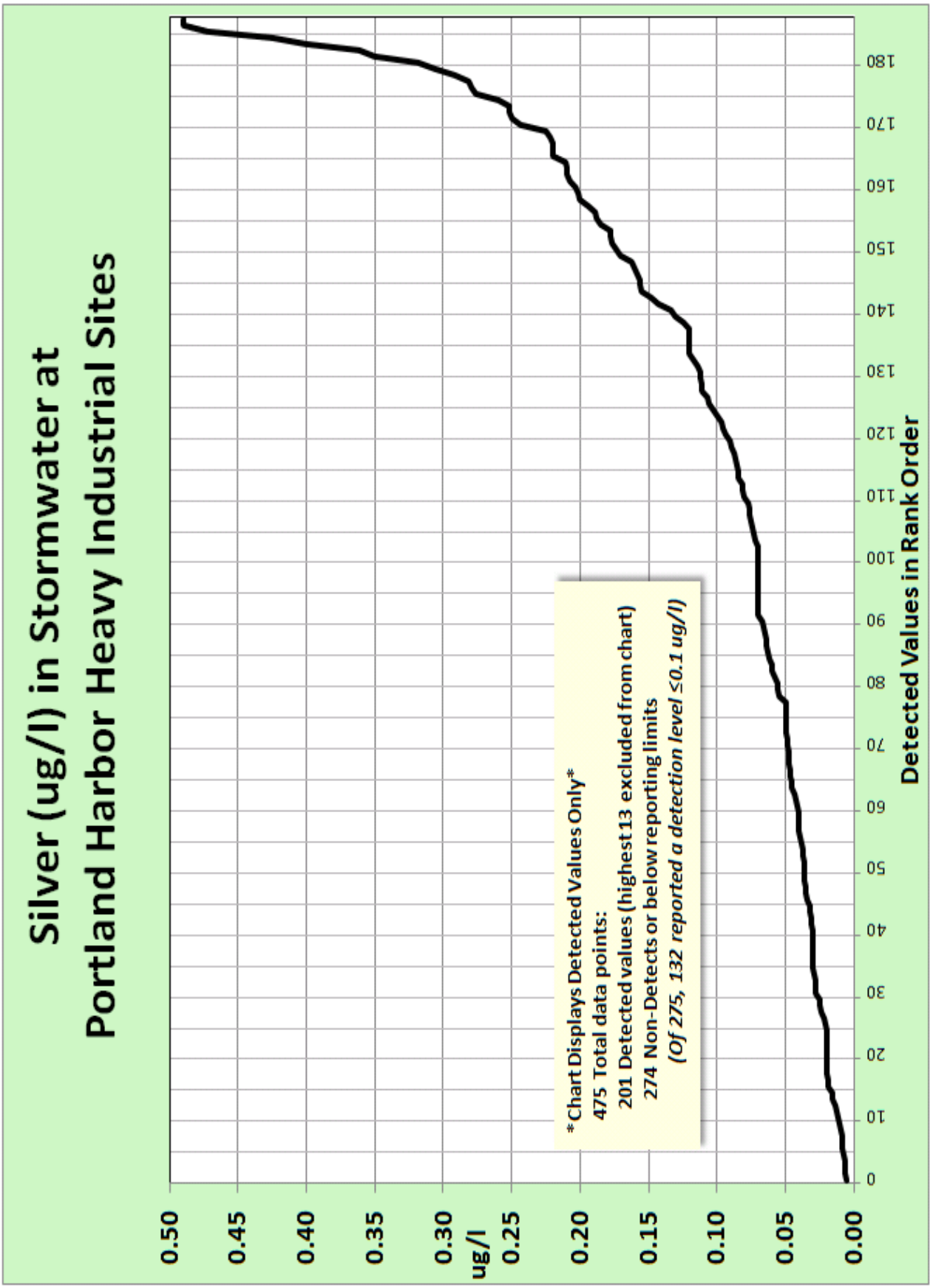
LEAD


Mercury (ug/l) in Stormwater at
Portland Harbor Heavy Industrial Sites
ug/l
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Detected Values in Rank Order
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Chart Displays Detected Values Only
613 Total data points:
196 Detected values (highest 6 excluded from chart)
417 Non-Detects or below reporting limits
(Of 417, 407 reported a detection level ≤0.2 ug/l)

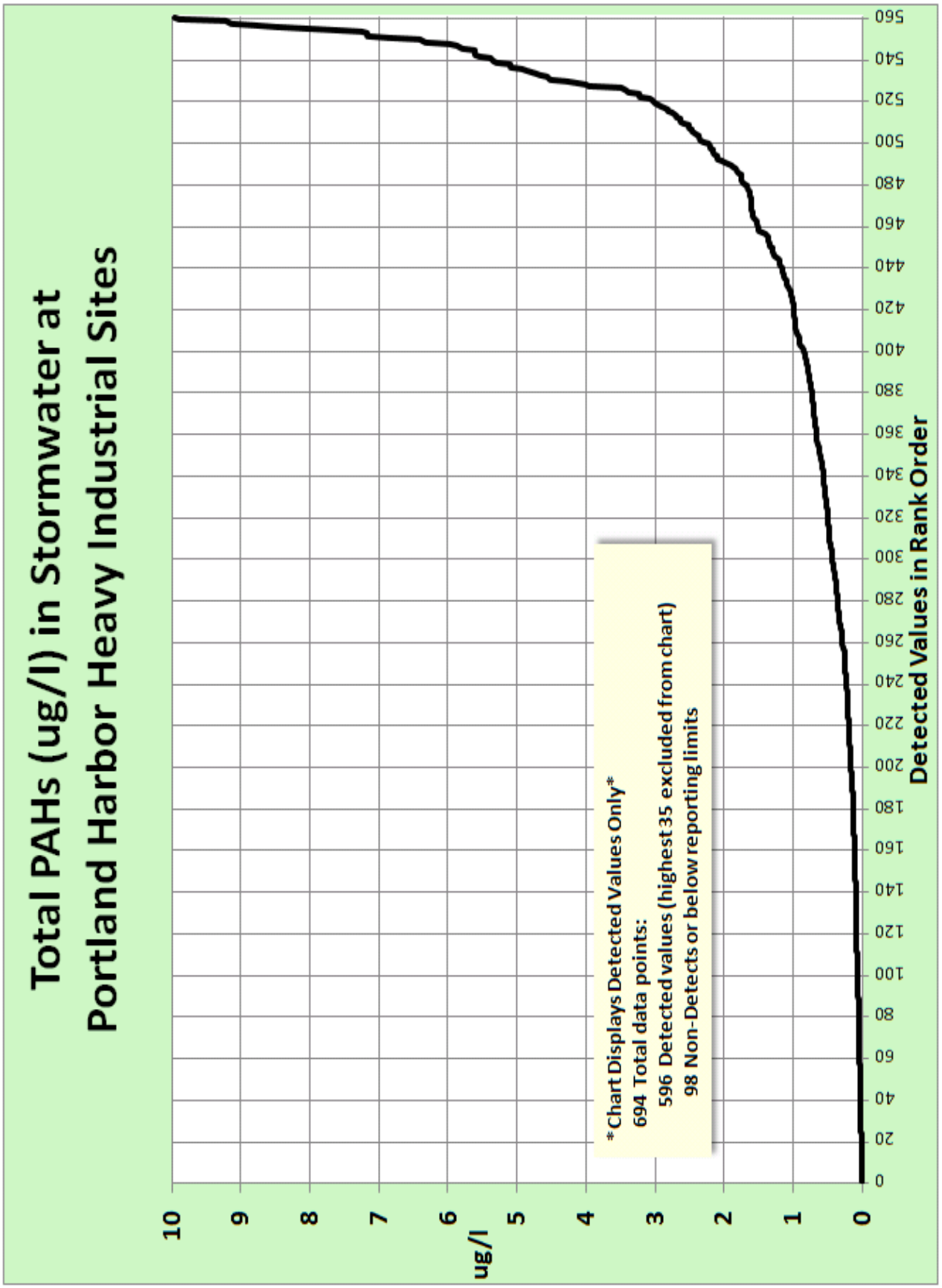
MERCURY


Nickel (ug/l) in Stormwater at
Portland Harbor Heavy Industrial Sites
ug/l
40
35
30
25
20
15
10
5
0
Detected Values in Rank Order
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Chart Displays Detected Values Only
583 Total data points:
539 Detected values (highest 12 excluded from chart)
44 Non-Detects or below reporting limits

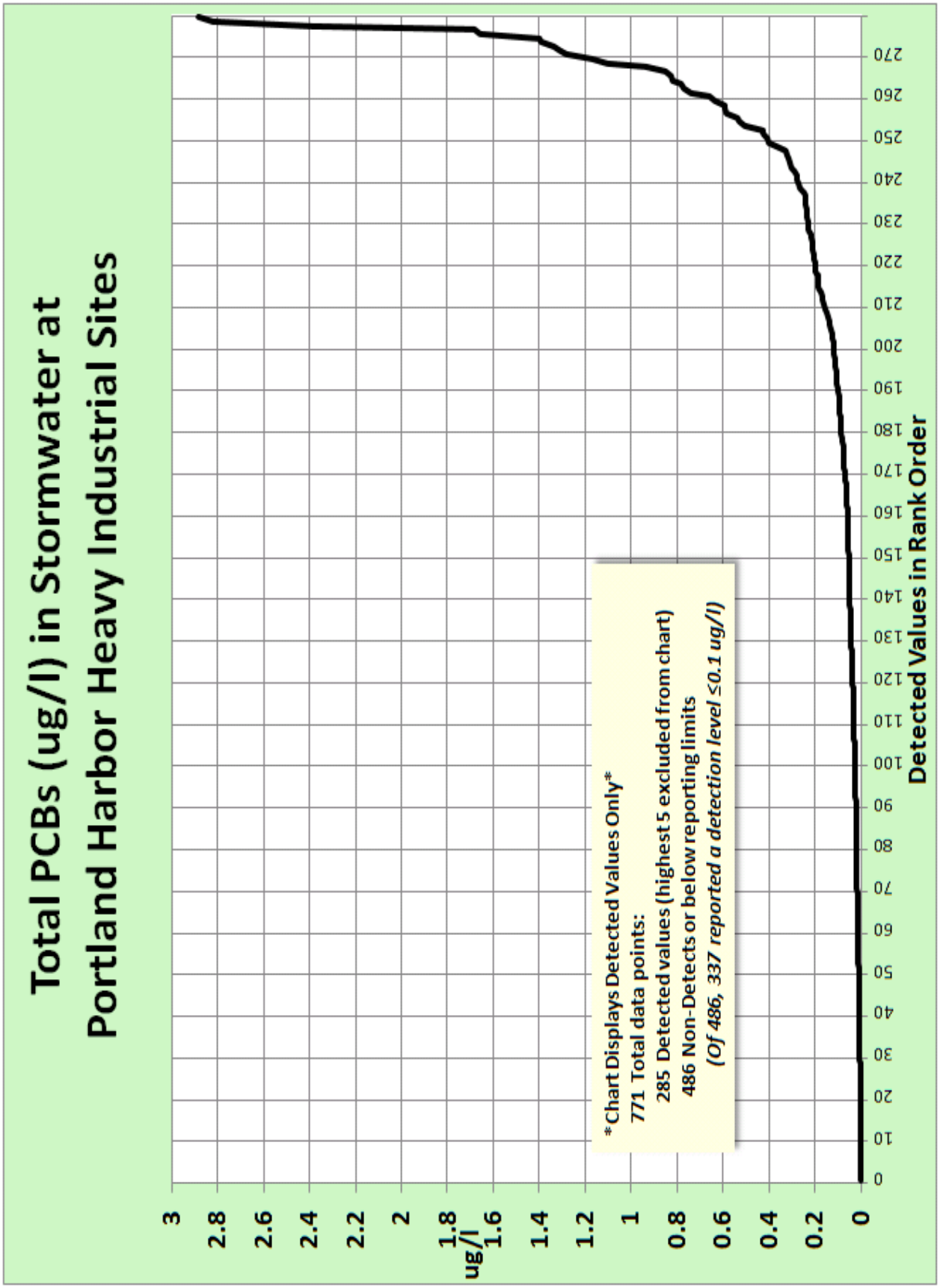
NICKEL


Silver (ug/l) in Stormwater at
Portland Harbor Heavy Industrial Sites
ug/l
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Detected Values in Rank Order
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Chart Displays Detected Values Only
475 Total data points:
201 Detected values (highest 13 excluded from chart)
274 Non-Detects or below reporting limits
(Of 275, 132 reported a detection level ≤0.1 ug/l)

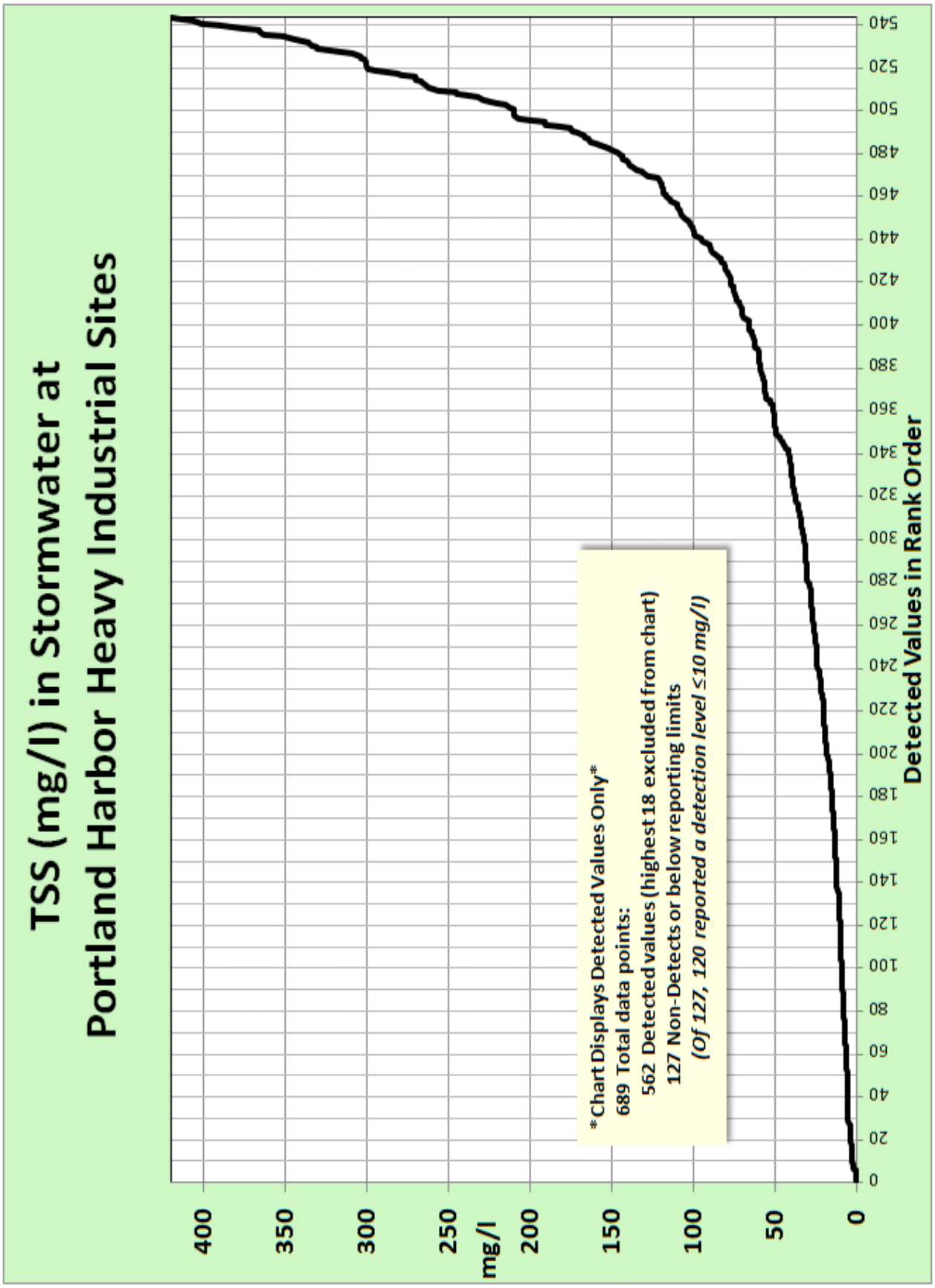
SILVER


Total PAHs (ug/l) in Stormwater at Portland Harbor Heavy Industrial Sites
ug/l
10
9
8
7
6
5
4
3
2
1
0
Detected Values in Rank Order
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Chart Displays Detected Values Only
694 Total data points:
596 Detected values (highest 35 excluded from chart)
98 Non-Detects or below reporting limits

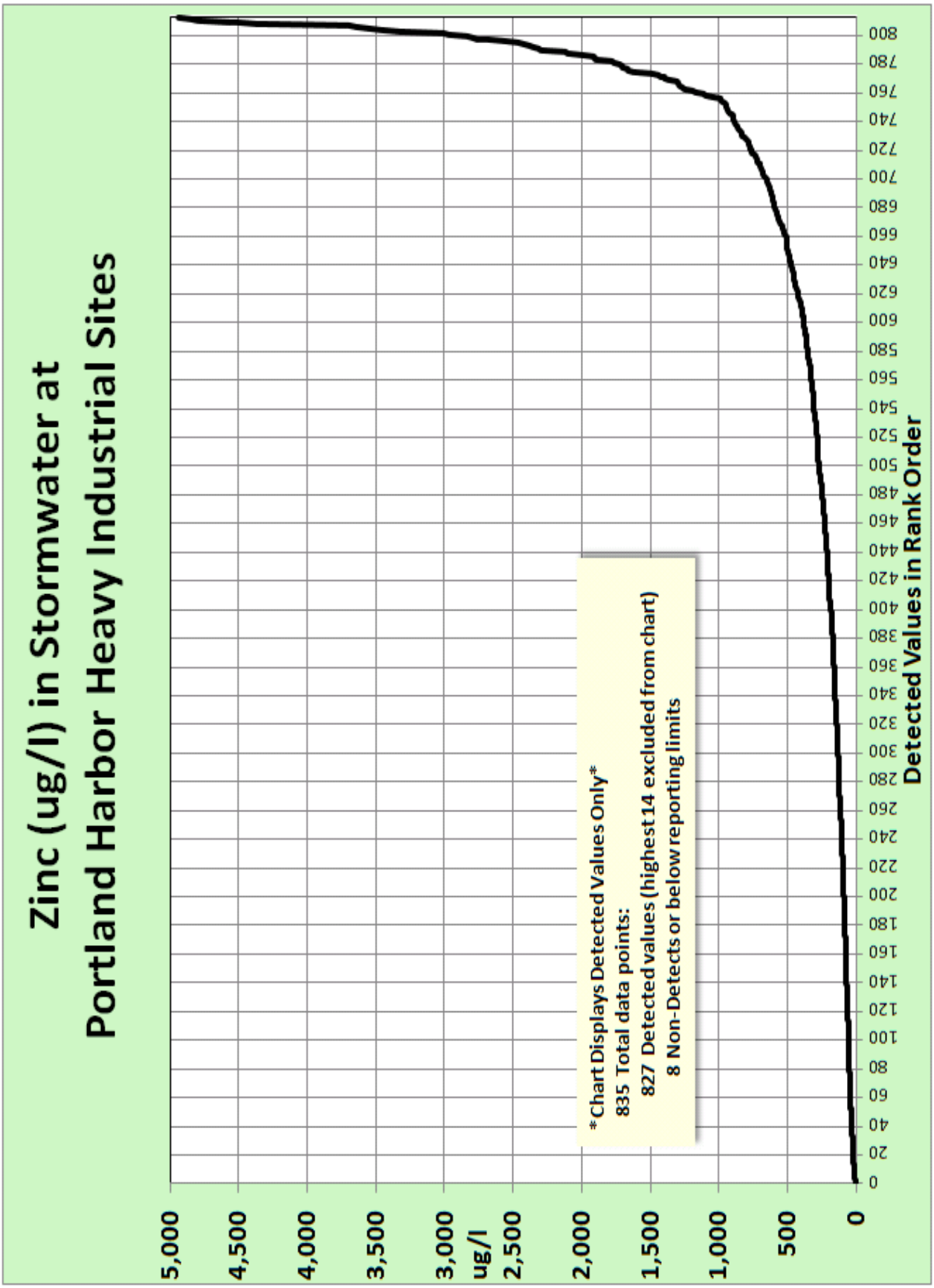
TOTAL PAHs


Total PCBs (ug/l) in Stormwater at Portland Harbor Heavy Industrial Sites
ug/l
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Detected Values in Rank Order
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
Chart Displays Detected Values Only
771 Total data points:
285 Detected values (highest 5 excluded from chart)
486 Non-Detects or below reporting limits
(Of 486, 337 reported a detection level ≤0.1 ug/l)

TOTAL PCBs


TSS (mg/l) in Stormwater at
Portland Harbor Heavy Industrial Sites
mg/l
400
350
300
250
200
150
100
50
0
Detected Values in Rank Order
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
* Chart Displays Detected Values Only*
689 Total data points:
562 Detected values (highest 18 excluded from chart)
127 Non-Detects or below reporting limits
(Of 127, 120 reported a detection level ≤10 mg/l)

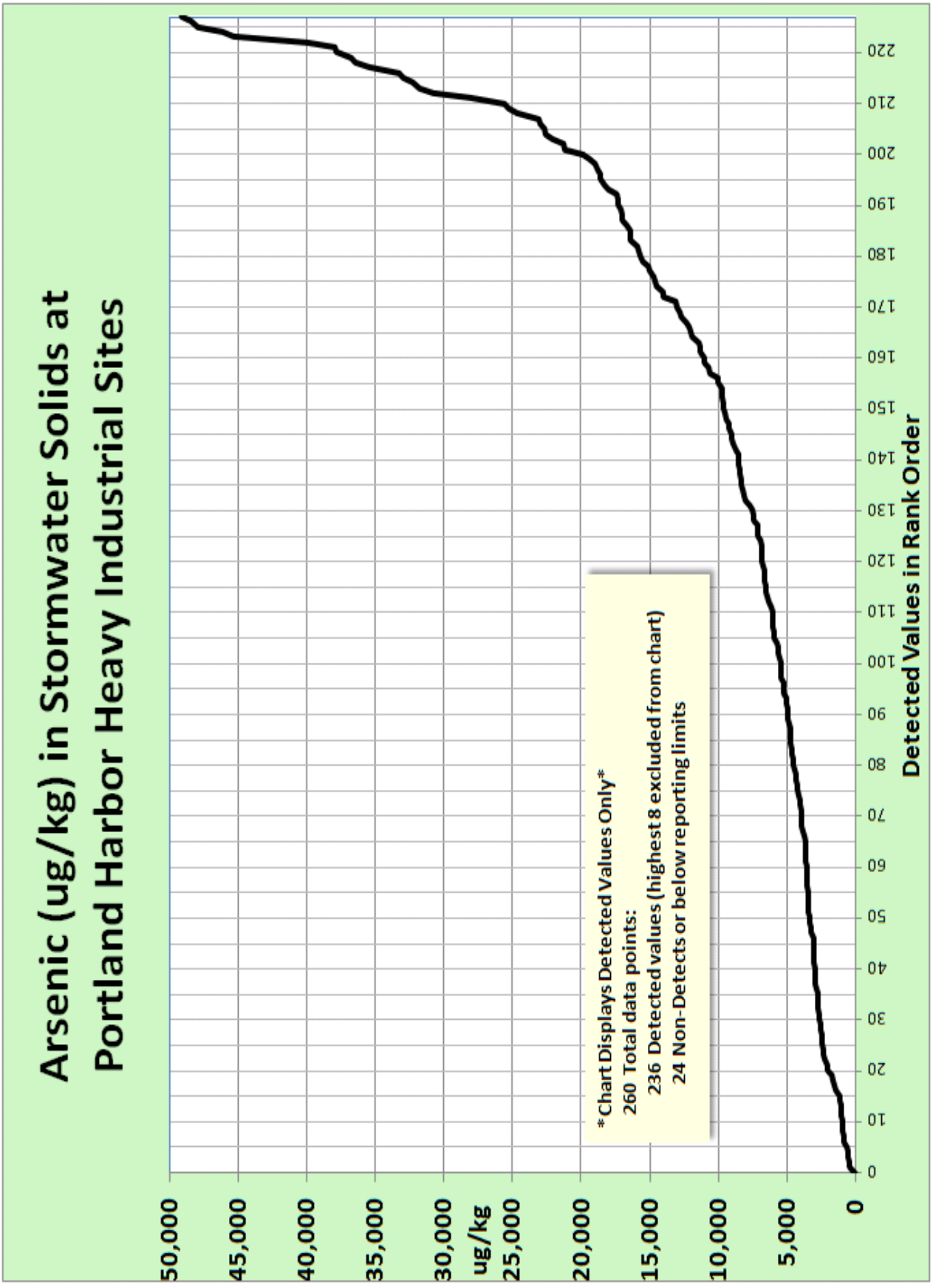
TSS


Zinc (ug/l) in Stormwater at
Portland Harbor Heavy Industrial Sites
* Chart Displays Detected Values Only*
835 Total data points:
827 Detected values (highest 14 excluded from chart)
8 Non-Detects or below reporting limits
ug/l
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Detected Values in Rank Order
800
780
760
740
720
700
680
660
640
620
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0

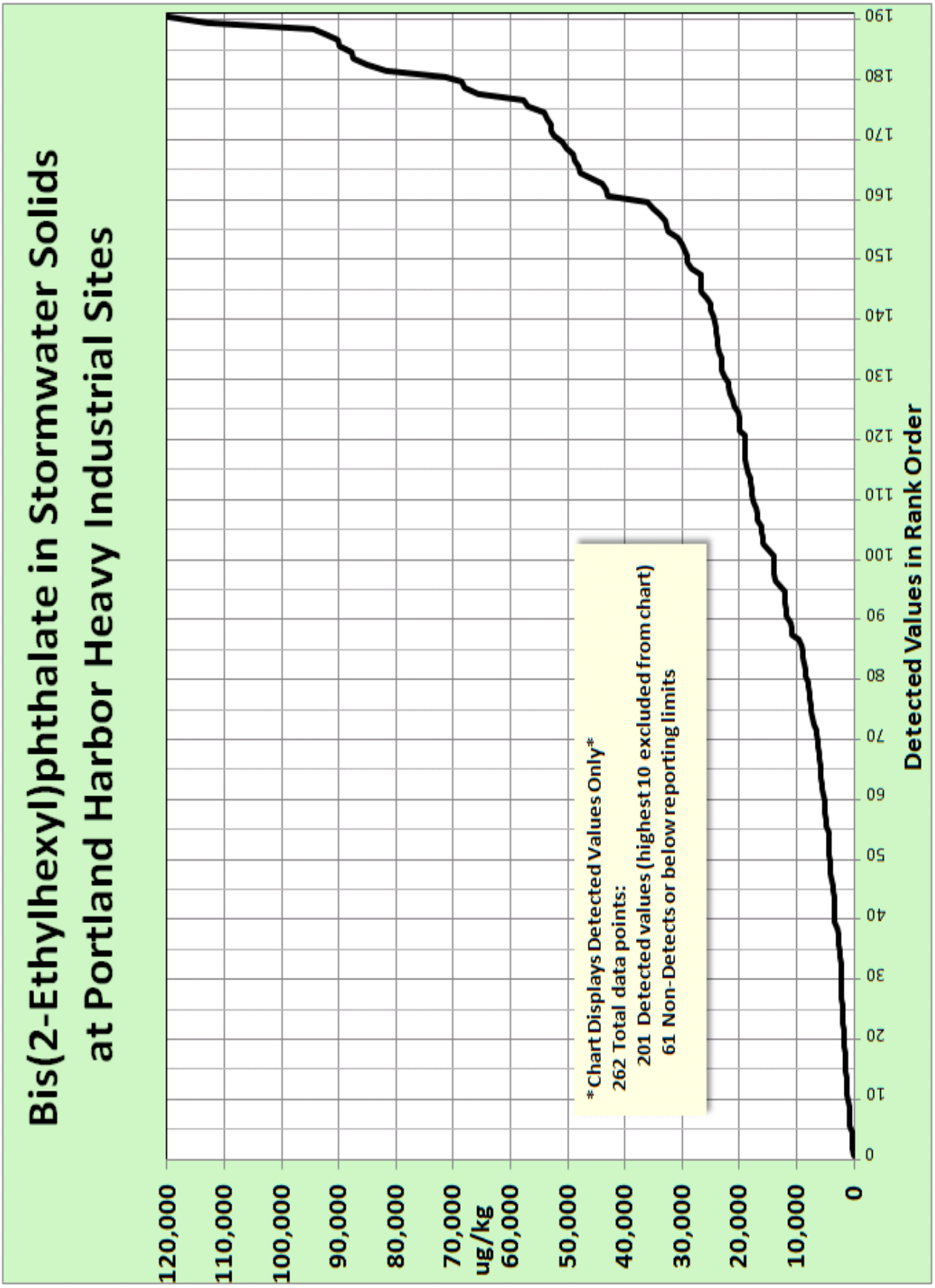
ZINC

SEDIMENT CHARTS

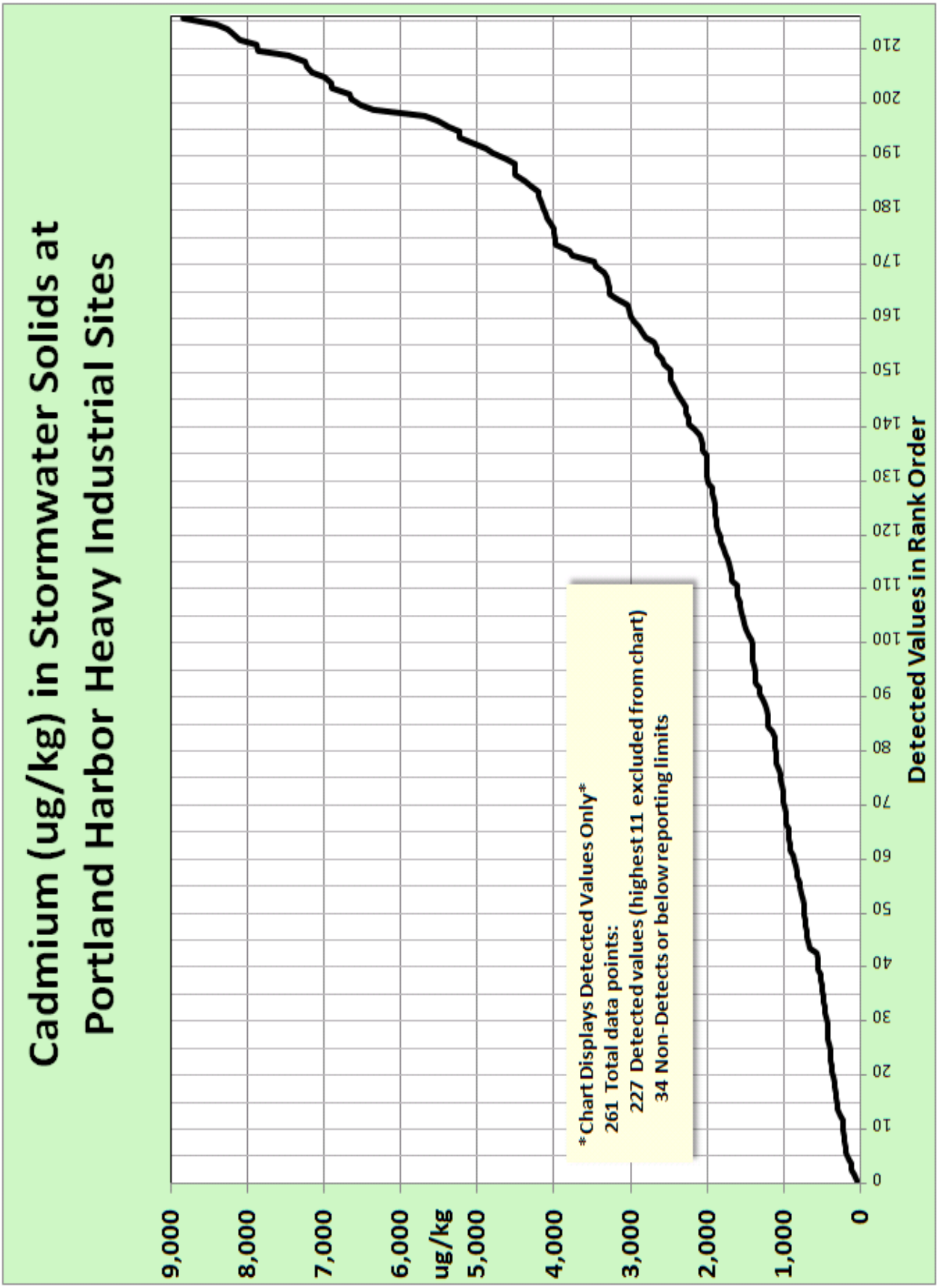
Data used to create the charts include catch basin sediment samples and suspended sediment samples. Suspended sediment samples were collected in sediment traps placed within stormwater pipes for a minimum of three months during the rainy season.


Arsenic (ug/kg) in Stormwater Solids at Portland Harbor Heavy Industrial Sites
Chart Displays Detected Values Only
260 Total data points:
236 Detected values (highest 8 excluded from chart)
24 Non-Detects or below reporting limits
ug/kg
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Detected Values in Rank Order
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220

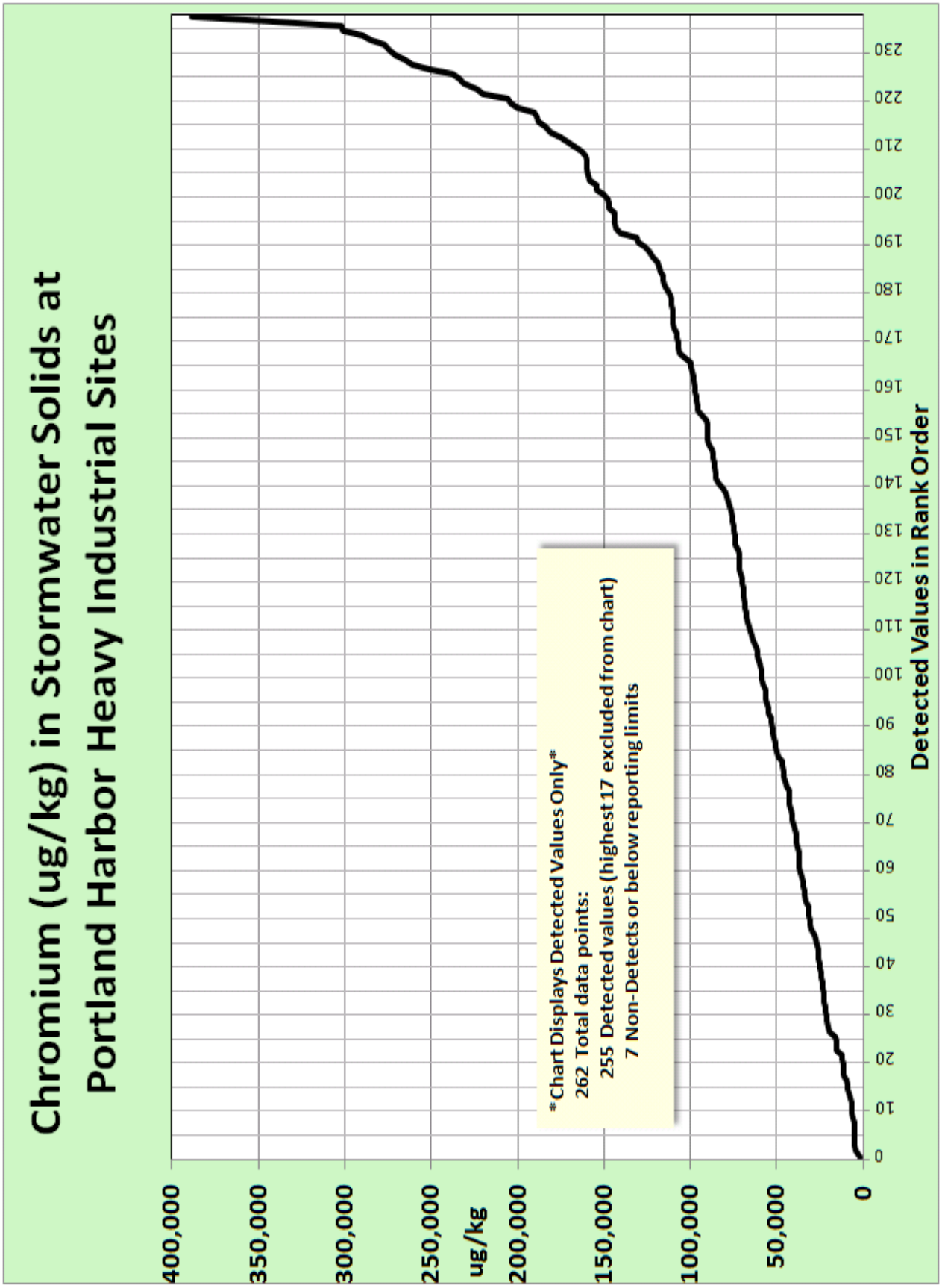
ARSENIC


Bis(2-Ethylhexyl)phthalate in Stormwater Solids
at Portland Harbor Heavy Industrial Sites
Chart Displays Detected Values Only
262 Total data points:
201 Detected values (highest 10 excluded from chart)
61 Non-Detects or below reporting limits
ug/kg
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Detected Values in Rank Order
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

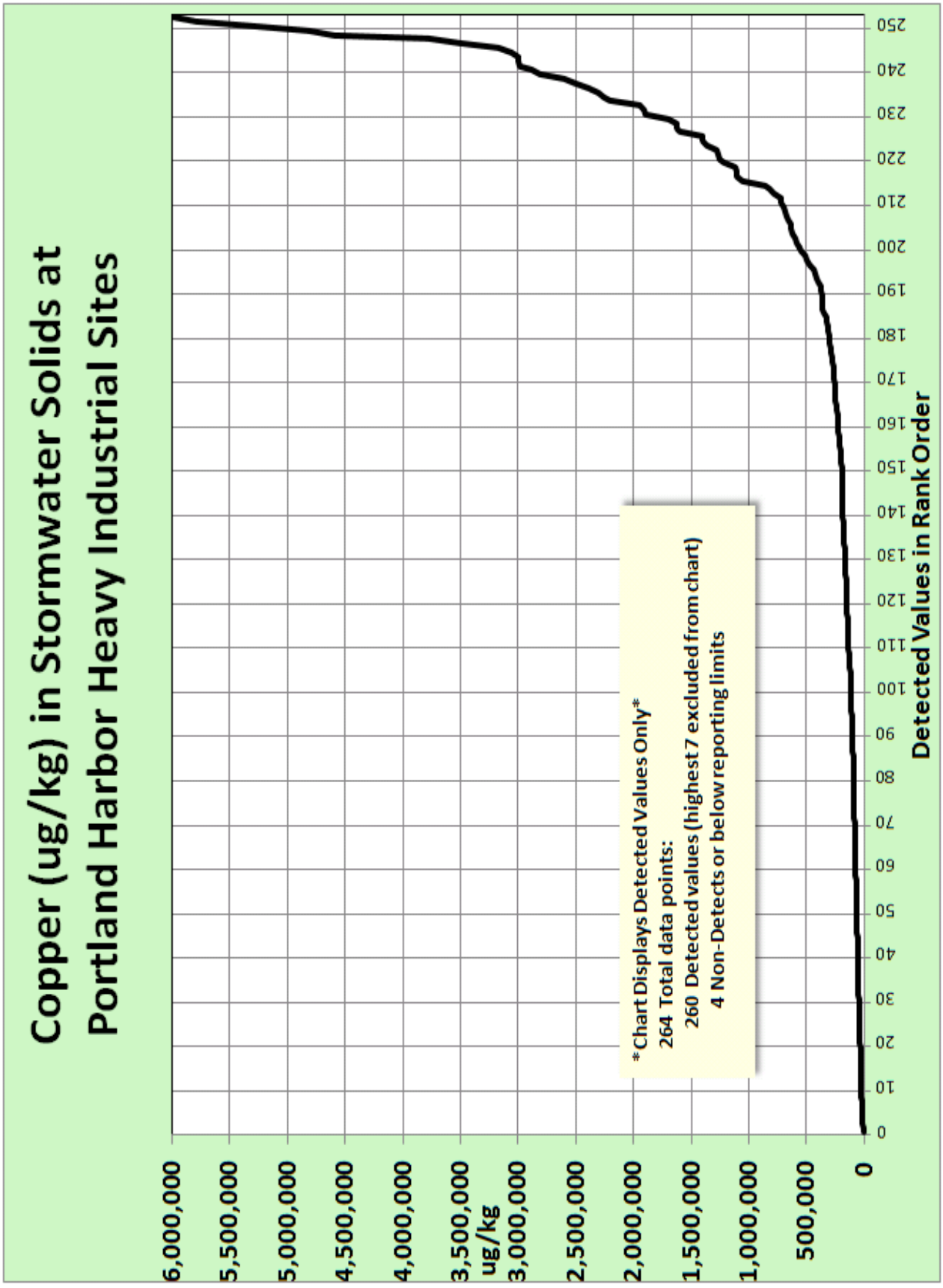
BEHP


Cadmium (ug/kg) in Stormwater Solids at Portland Harbor Heavy Industrial Sites
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
ug/kg
Detected Values in Rank Order
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
Chart Displays Detected Values Only
261 Total data points:
227 Detected values (highest 11 excluded from chart)
34 Non-Detects or below reporting limits

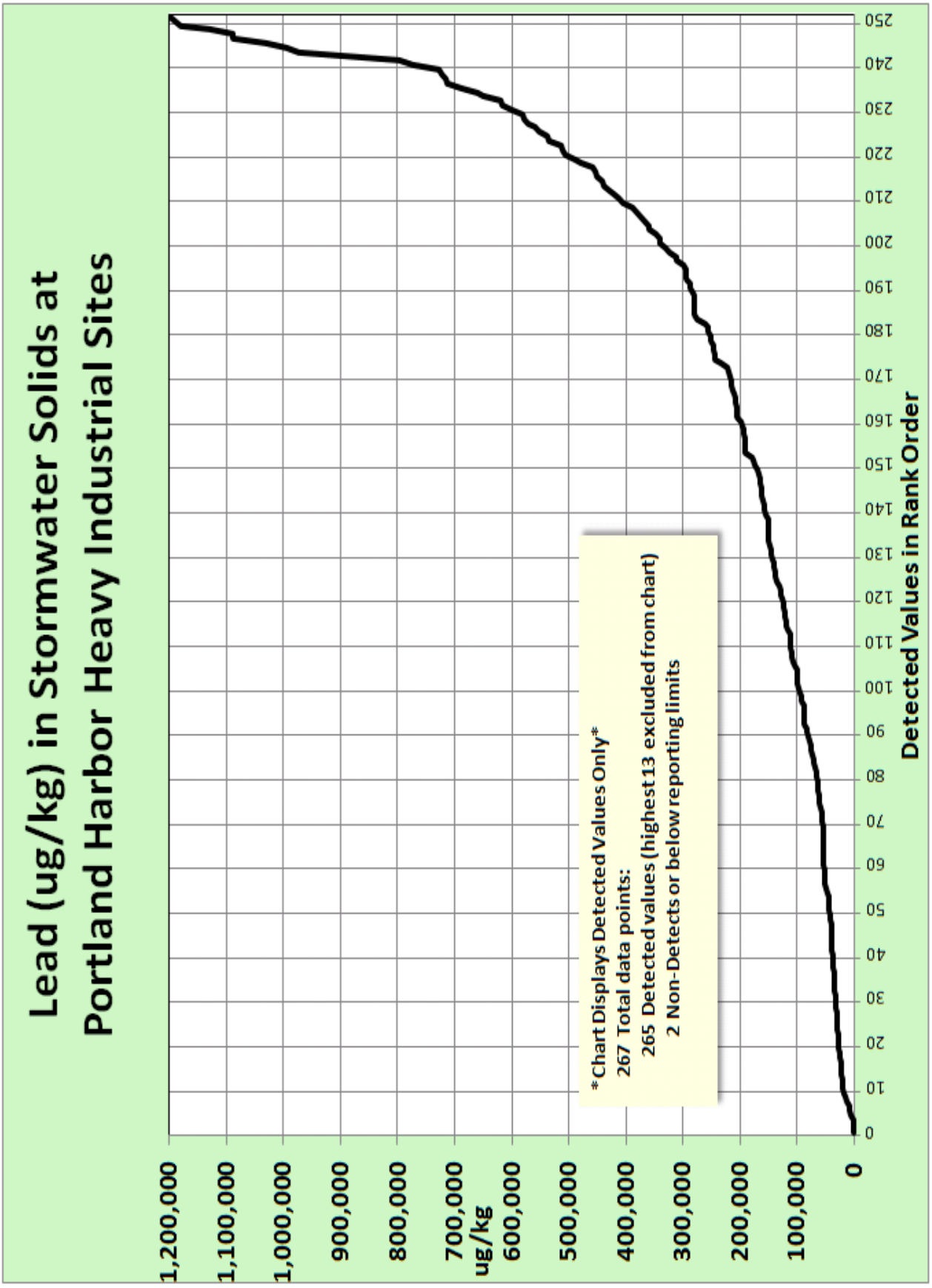
CADMIUM


Chromium (ug/kg) in Stormwater Solids at Portland Harbor Heavy Industrial Sites
400,000
350,000
300,000
250,000
ug/kg
200,000
150,000
100,000
50,000
0
Detected Values in Rank Order
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
Chart Displays Detected Values Only
262 Total data points:
255 Detected values (highest 17 excluded from chart)
7 Non-Detects or below reporting limits

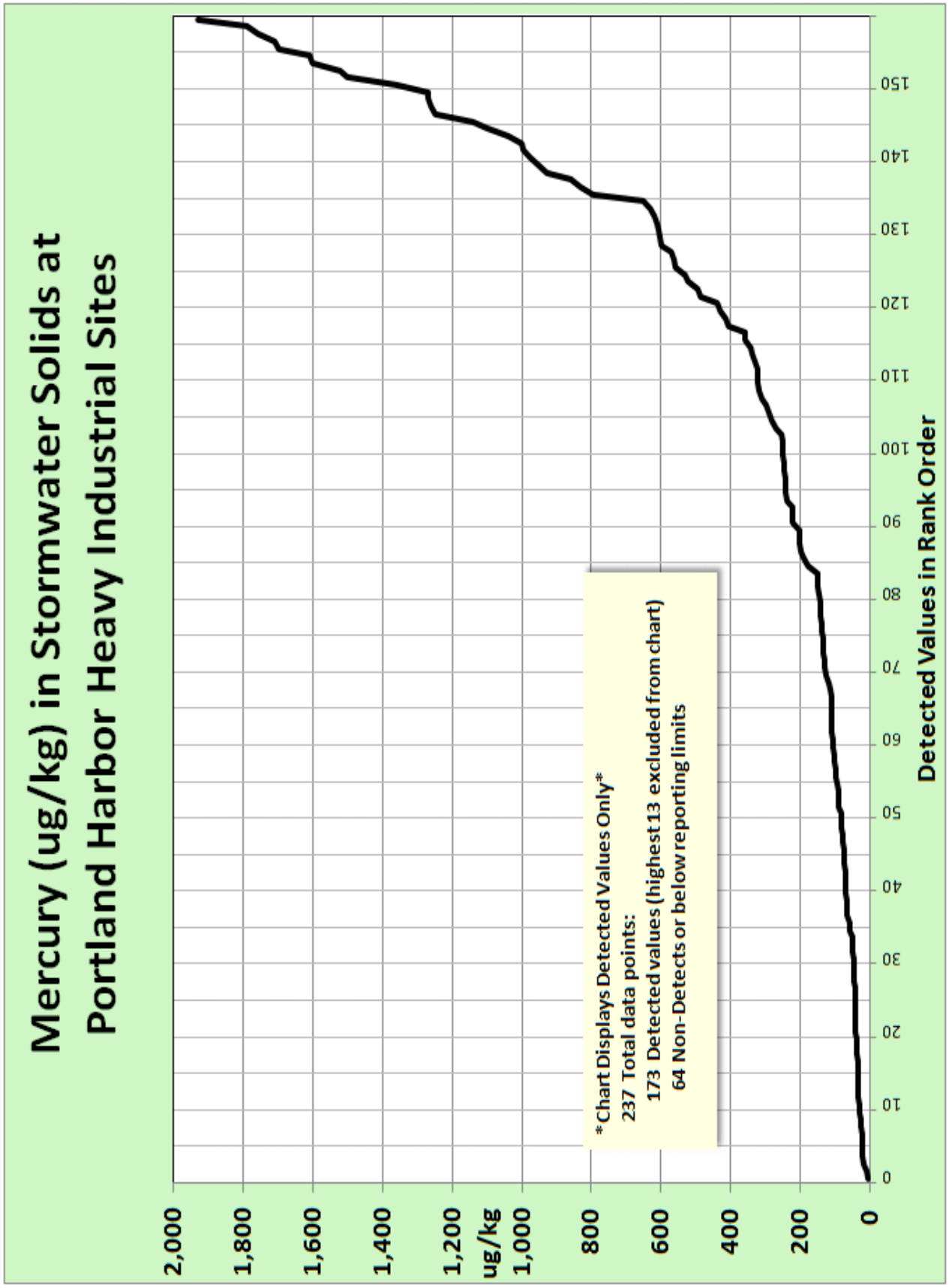
CHROMIUM


Copper (ug/kg) in Stormwater Solids at Portland Harbor Heavy Industrial Sites
Detected Values in Rank Order
ug/kg
6,000,000
5,500,000
5,000,000
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Chart Displays Detected Values Only
264 Total data points:
260 Detected values (highest 7 excluded from chart)
4 Non-Detects or below reporting limits

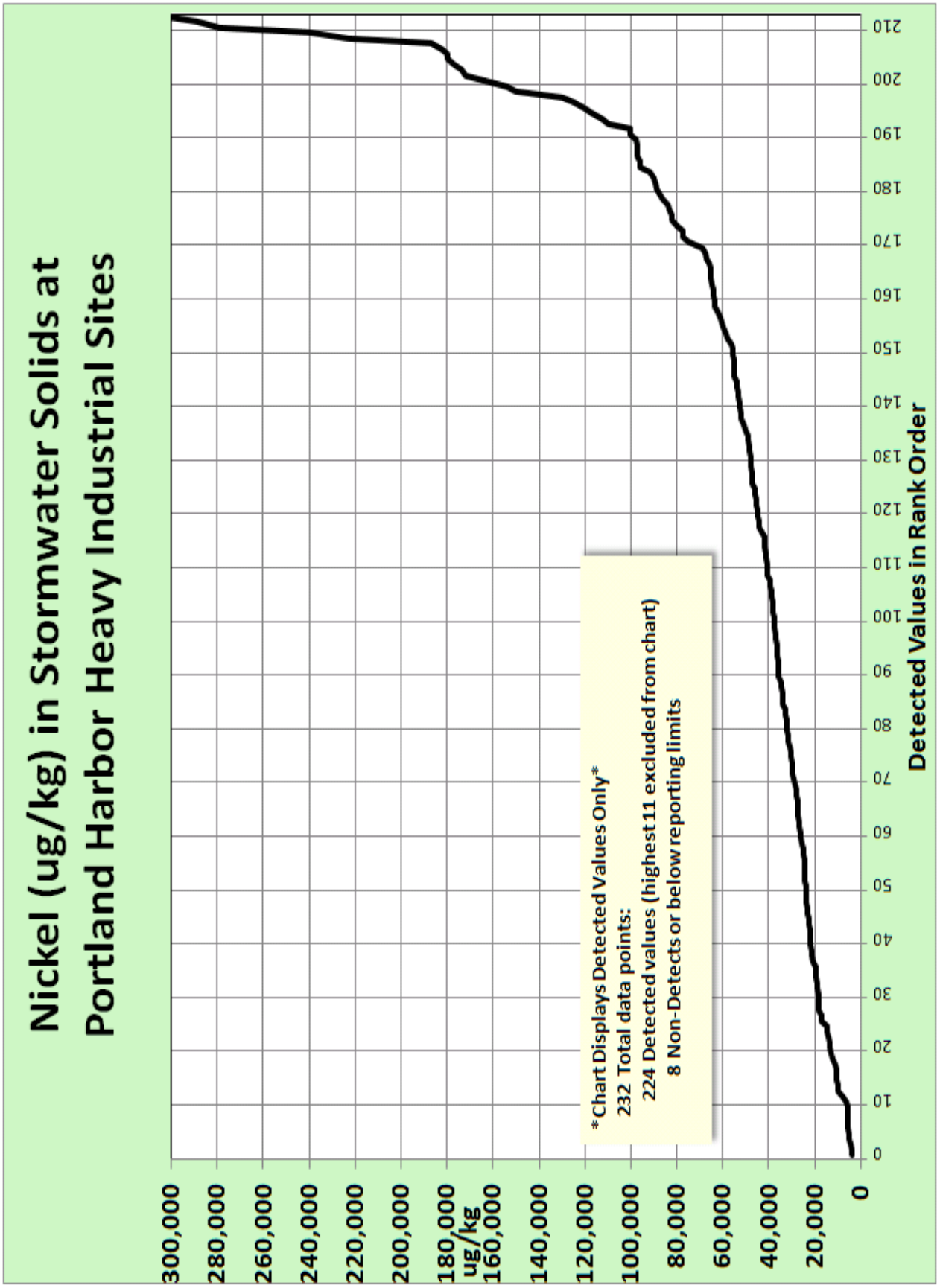
COPPER


Lead (ug/kg) in Stormwater Solids at Portland Harbor Heavy Industrial Sites
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
ug/kg
Detected Values in Rank Order
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
Chart Displays Detected Values Only
267 Total data points:
265 Detected values (highest 13 excluded from chart)
2 Non-Detects or below reporting limits

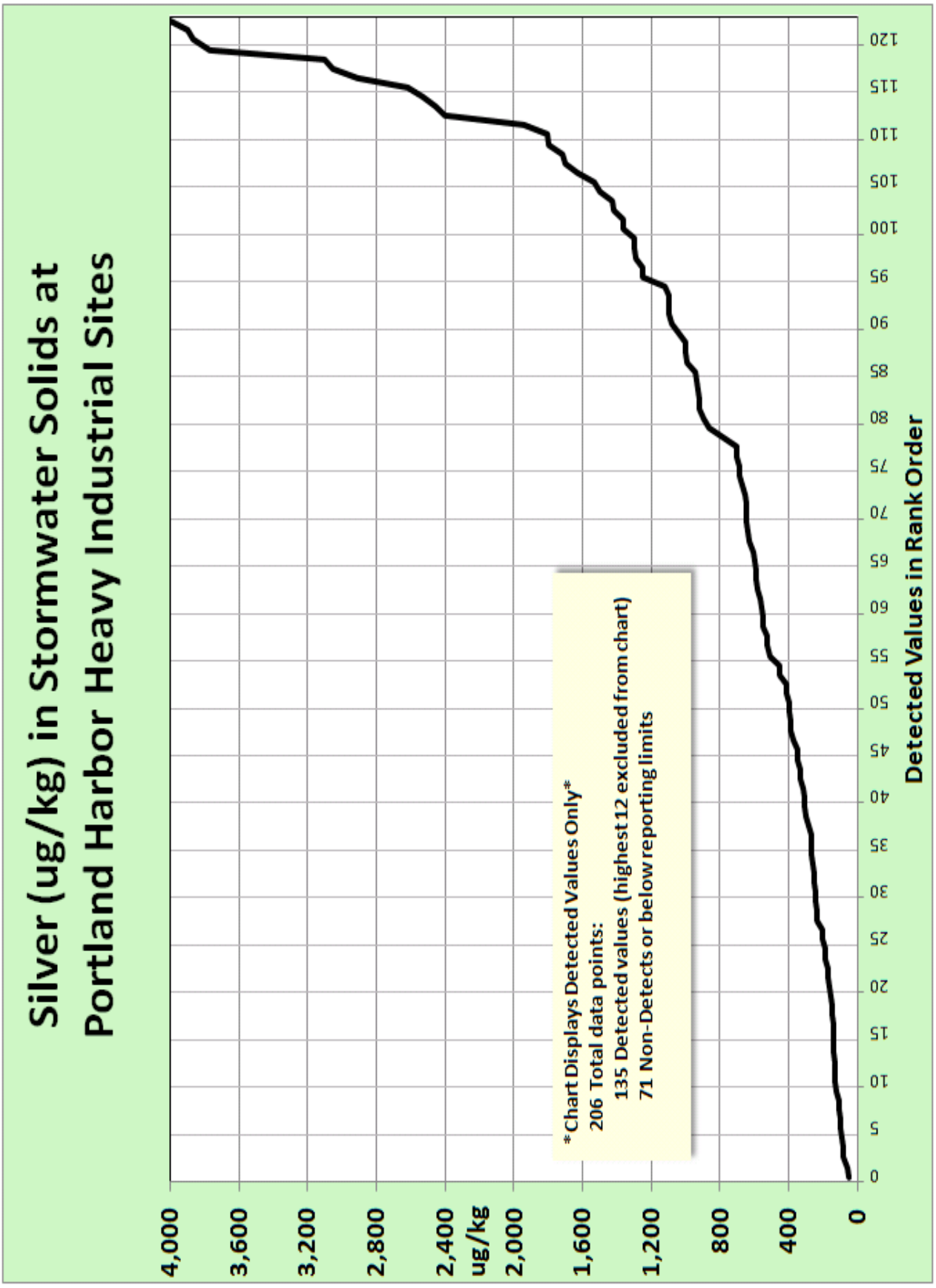
LEAD


Mercury (ug/kg) in Stormwater Solids at Portland Harbor Heavy Industrial Sites
2,000
1,800
1,600
1,400
1,200
ug/kg
1,000
800
600
400
200
0
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Detected Values in Rank Order
Chart Displays Detected Values Only
237 Total data points:
173 Detected values (highest 13 excluded from chart)
64 Non-Detects or below reporting limits

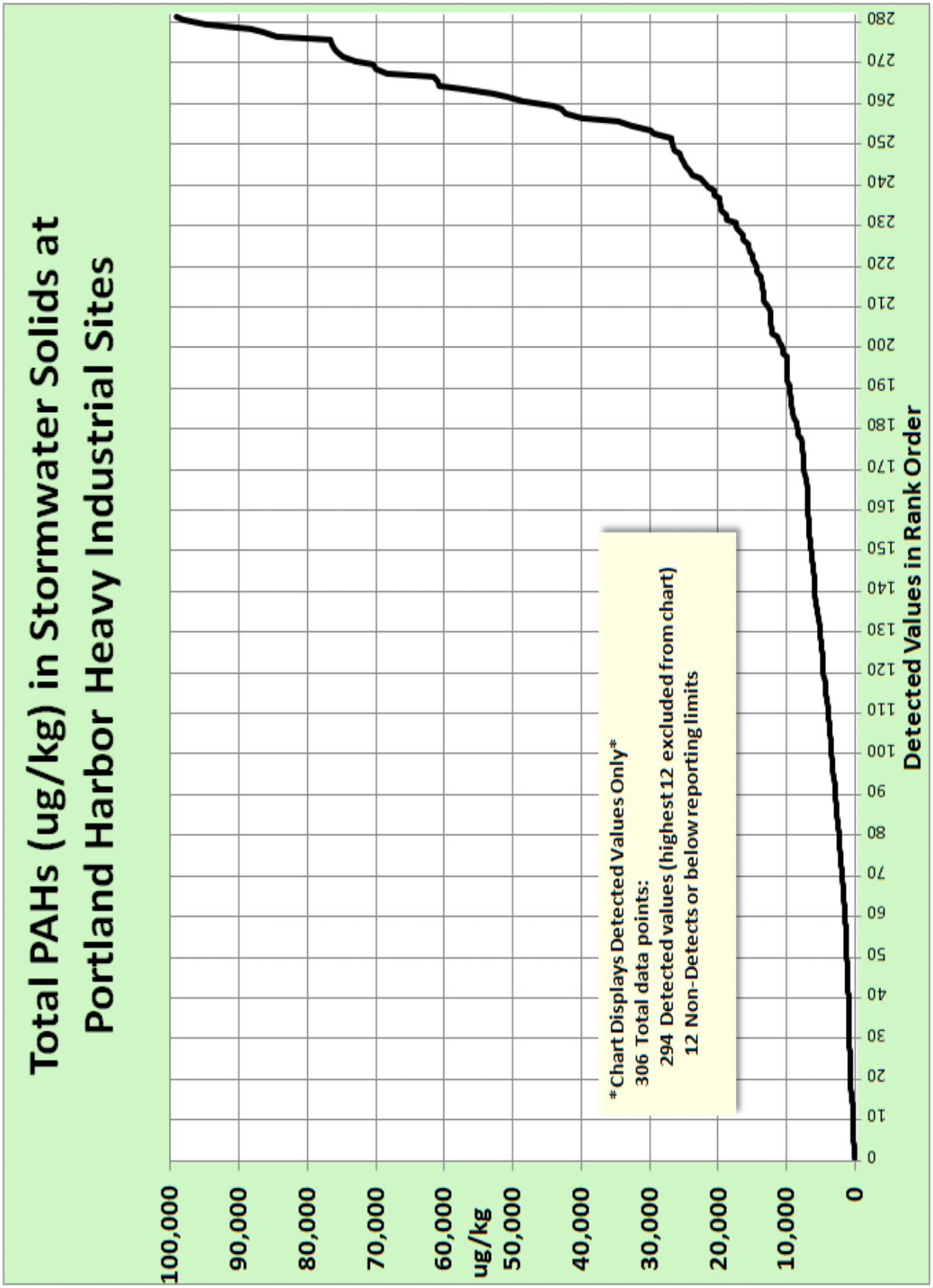
MERCURY


Nickel (ug/kg) in Stormwater Solids at Portland Harbor Heavy Industrial Sites
ug/kg
300,000
280,000
260,000
240,000
220,000
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Detected Values in Rank Order
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
Chart Displays Detected Values Only
232 Total data points:
224 Detected values (highest 11 excluded from chart)
8 Non-Detects or below reporting limits

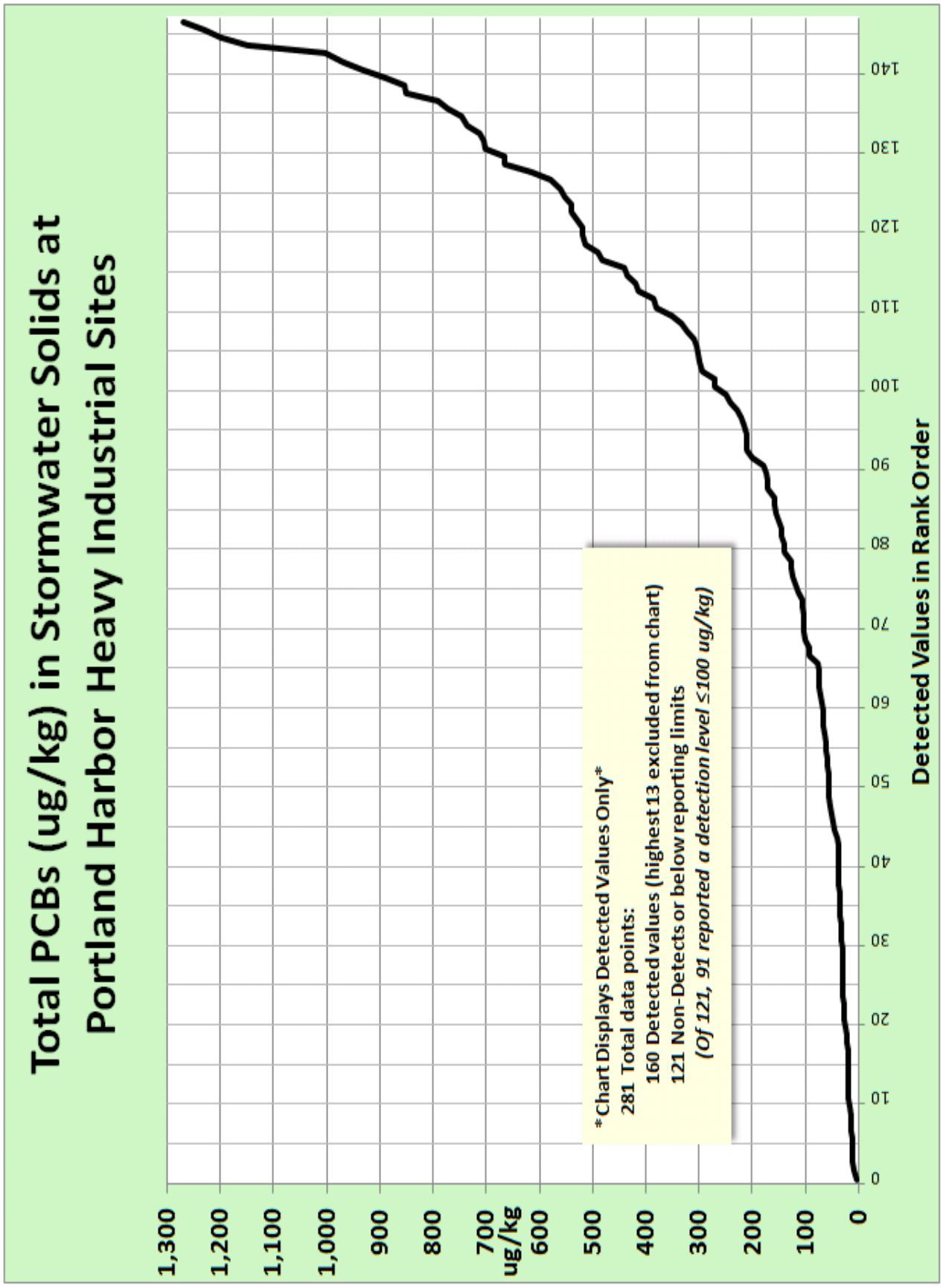
NICKEL


Silver (ug/kg) in Stormwater Solids at Portland Harbor Heavy Industrial Sites
4,000
3,600
3,200
2,800
2,400
2,000
1,600
1,200
800
400
0
ug/kg
Detected Values in Rank Order
Chart Displays Detected Values Only
206 Total data points:
135 Detected values (highest 12 excluded from chart)
71 Non-Detects or below reporting limits

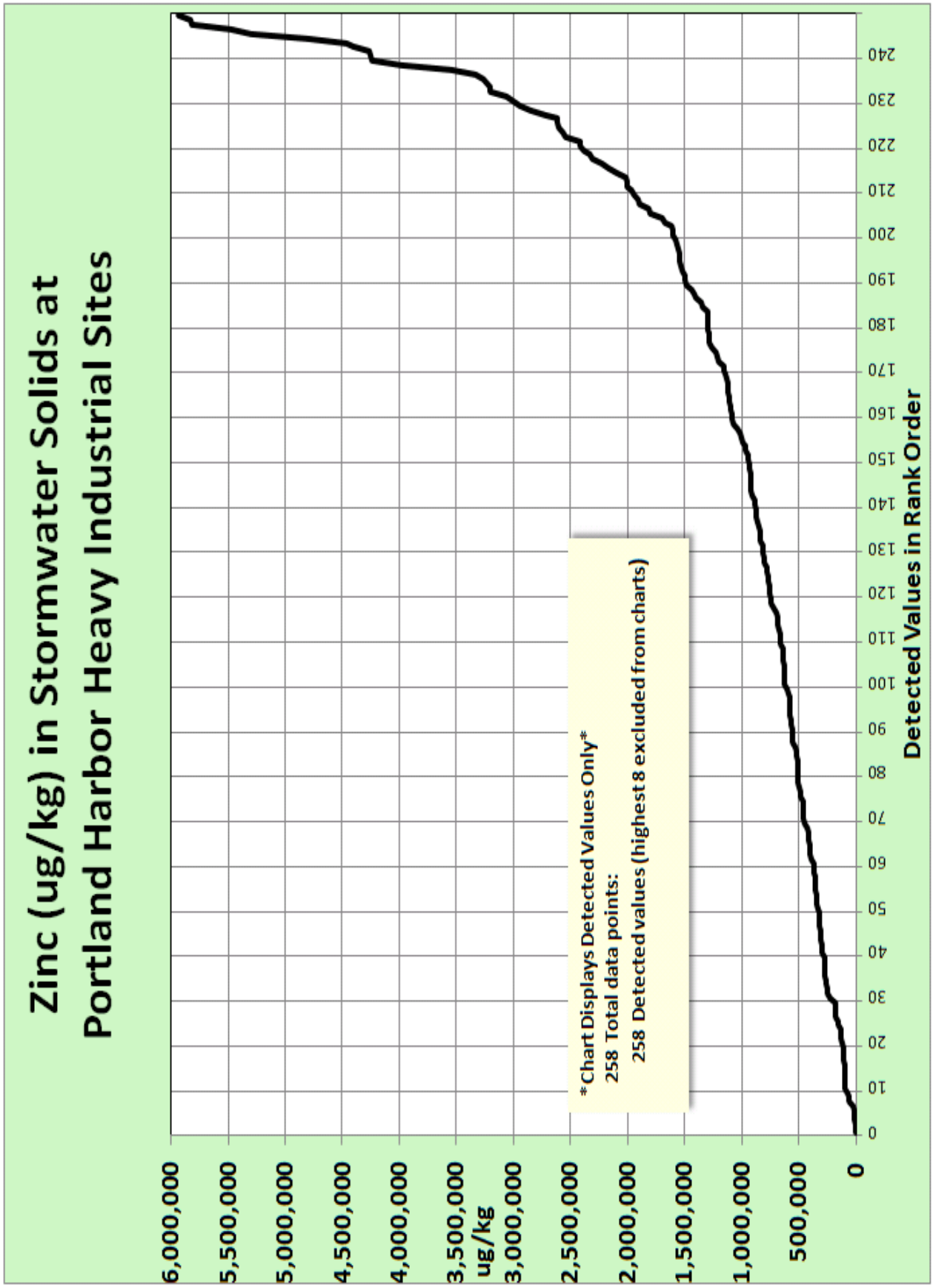
SILVER


Total PAHs (ug/kg) in Stormwater Solids at Portland Harbor Heavy Industrial Sites
Detected Values in Rank Order
ug/kg
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Chart Displays Detected Values Only
306 Total data points:
294 Detected values (highest 12 excluded from chart)
12 Non-Detects or below reporting limits

TOTAL PAHs


Total PCBs (ug/kg) in Stormwater Solids at Portland Harbor Heavy Industrial Sites
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
ug/kg
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Detected Values in Rank Order
* Chart Displays Detected Values Only*
281 Total data points:
160 Detected values (highest 13 excluded from chart)
121 Non-Detects or below reporting limits
(Of 121, 91 reported a detection level ≤100 ug/kg)

TOTAL PCBs


Zinc (ug/kg) in Stormwater Solids at Portland Harbor Heavy Industrial Sites
Detected Values in Rank Order
ug/kg
6,000,000
5,500,000
5,000,000
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Chart Displays Detected Values Only
258 Total data points:
258 Detected values (highest 8 excluded from charts)

ZINC