Assessing Background Arsenic in Portland Harbor Sediment and Riverbank Soil

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Portland Harbor Superfund Site encompasses 10 miles of the lower Willamette River that has been contaminated by decades of industrial use.

PORTLAND HARBOR SUPERFUND SITE

The site was contaminated with PCBs, dioxins/furans, pesticides, heavy metals, and other substances after decades of industrial activity.

Declared a Superfund site in 2000, the site is divided into multiple project areas over which sediment remedial design is being completed by various parties.

CHALLENGE

The cleanup level (CUL) for arsenic in sediment and soil of 3 mg/kg is exceeded across the site in areas with no known arsenic releases. This situation creates several challenges for remediation parties:

- Impacts to remedial design if parties cannot design a remedy that meets the CUL
- Impacts to long-term monitoring of the site and the ability of project areas to meet sediment remedial action objectives
- Difficulty finding capping material that meets criterion for remediation

Figure 1: A) Western Oregon showing the Oregon Department of Environmental Quality (DEQ) South Willamette and Portland Basin physiographic provinces; B) Portland Harbor Superfund Site and delineation of the Downtown Reach and Upriver Reach.[a]

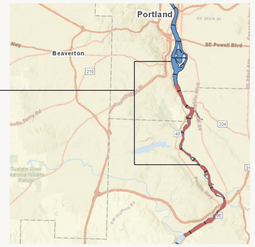
Many inorganic materials, like arsenic, naturally occur in soil and sediment or come from nonspecific human-related sources, with cleanup levels set to protect human health and the environment.

APPROACHES TO ASSESSING BACKGROUND CONCENTRATIONS OF ARSENIC IN PORTLAND HARBOR

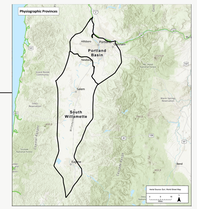
According to U.S. Environmental Protection Agency (EPA) guidelines, central tendency statistics (95% UCL) of background data should be used to compare average values. Upper limit statistics (95% UTL/UPL/USL) should be used for point-by-point individual site observation comparisons.

Arsenic in sediment in the Upriver and Downtown Reaches	Downtown Reach	Upriver Reach	Combined Reaches	Units
Summary Statistics				
N	160	132	297	
Outliers Excluded	5	5	5	
Minimum (detected)	1.1	1.9	1.1	mg/kg
Maximum	9.0	7.1	10.0	mg/kg
Median	3.0	3.3	3.2	mg/kg
Mean, ND=DL	3.2	3.4	3.4	mg/kg
Std. Dev. (ND=DL)	1.3	0.9	1.4	mg/kg
Upper Range Statistics				
95% Upper Tolerance Limit (UTL)	6.0	5.2	7.3	mg/kg
95% Upper Simultaneous Limit (USL)	10.6	7.4	10.0	mg/kg
Central Tendency Statistics				
95% Upper Confidence Limit (UCL), Mean	3.3	3.5	3.5	mg/kg

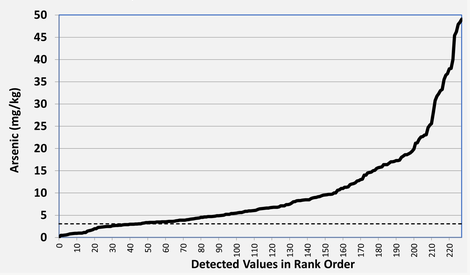
1 Comparison to upstream sediment from the Downtown Reach (RM11.8–RM16.6) and Upriver Reach (RM16.6–RM28.4)



2 Comparison to background metals in soil in the Portland Basin and upstream in the South Willamette Valley

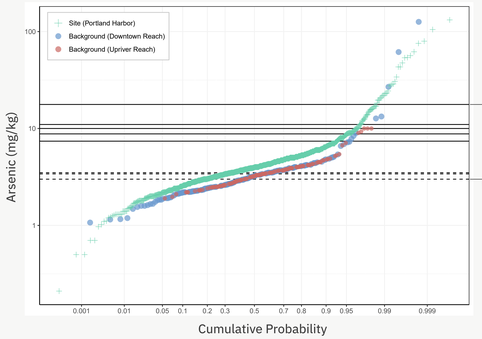


3 Comparison to stormwater solids in industrial areas that discharge into Portland Harbor



Rank order curve of concentration of arsenic in stormwater solids from industrial sites around Portland Harbor [b]

Arsenic in Surface Sediment in Portland Harbor



Cumulative probability curve of arsenic in the Upriver Reach, the Downtown Reach, and Portland Harbor surface sediment

Background Statistics for Screening Individual Samples (mg/kg)[b]

Oregon DEQ, South Willamette Valley	17.7
Calculated, Downtown Reach*	11
Calculated, Combined Reaches*	10
Oregon DEQ, Portland Basin	8.8
Calculated, Upriver Reach*	7.4

Background Statistics for Areawide Comparisons (mg/kg)[b]

Calculated, Combined Reaches	3.5
Calculated, Upriver Reach*	3.5
Calculated, Downtown Reach*	3.4
EPA, Cleanup Level	3

* Calculated with statistical outliers excluded

Conclusion

Naturally occurring arsenic concentrations in the Portland Harbor and upriver sediments consistently exceed the 3 mg/kg cleanup level; therefore, screening and remediation goals need revision or a technical impracticability waiver should be issued.

- Updated background target concentrations reflecting local background conditions support 3.4–3.5 mg/kg for areawide comparisons based on average concentration.
- Industrial stormwater solids into Portland Harbor generally exceed the CUL for arsenic in sediments. Source control efforts by Oregon DEQ do not manage arsenic in stormwater to as low as the CUL.
- Screening individual samples of sediment or soil should be compared against a background threshold value, which ranges from 17.7–7.4 mg/kg. We recommend the 10 mg/kg based on combined samples from downtown and upriver reaches.

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[a] *OR DEQ Development of Oregon Background Metals Concentrations in Soil, 2013* [b] *OR DEQ Guidance for Evaluating the Stormwater Pathway at Upland Sites, Appendix E: Tool for evaluating stormwater data, 2009*