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Speciation & Attenuation of Arsenic and Selenium, and Fate of Mercury in CCPs

DOE/NETL Mercury Control Technology R&D Program Review

Pittsburgh, PA
July 12-14, 2005

Ken Ladwig
Program Manager
Environment

Project Objectives

- Characterize Field Leachate at CCP Sites
  - Speciation of Hg, As, Se, and Cr
  - Broad characterization for inorganics
- Evaluate Attenuation of As and Se Species in Groundwater

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Field Leachate Study Sites

Symbols indicate number of sites within a state, but do not correspond to location of sampled sites.

	FA		FGD/SDA	
	LF	IMP	LF	IMP
Sites Completed Thru 2005	★	▼	✦	▼

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Site Types

	Bit	Subbit	Lignite	Mixed	Total
Ash Landfills	3	5	2	2	12
Ash Ponds	7	1	0	3	11
FGD/SDA	1	2	2	0	5
Total	11	8	4	5	28

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Sample Location Summary

80 Field Leachate Samples

- leachate wells
- lysimeters
- leachate collection systems
- drive point
- direct push
- pond/seep grab
- sluice lines

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Field Leachate Study Parameters

Major Elements/
Field Parameters

Bicarbonate (calc)
Calcium
Carbonate (calc)
Chloride
Magnesium
Potassium
Sodium
Sulfate
Carbon, total inorganic
Carbon, total organic

Dissolved Oxygen
Electrical Cond.
ORP
pH
Temperature

Minor and Trace Elements

Aluminum
Antimony
Arsenic (total)
Arsenic (III)
Arsenic (V)
Barium
Beryllium
Boron
Cadmium
Chromium (total)
Chromium (VI)
Cobalt
Copper
Iron
Lead
Lithium
Manganese
Mercury (dimethyl)
Mercury (monomethyl, diss.)
Mercury (monomethyl, part.)
Mercury (total, dissolved)
Mercury (total, particulate)
Molybdenum
Nickel
Selenium (total)
Selenium (IV)
Selenium (VI)
Silica
Silver
Strontium
Thallium
Uranium
Vanadium
Zinc

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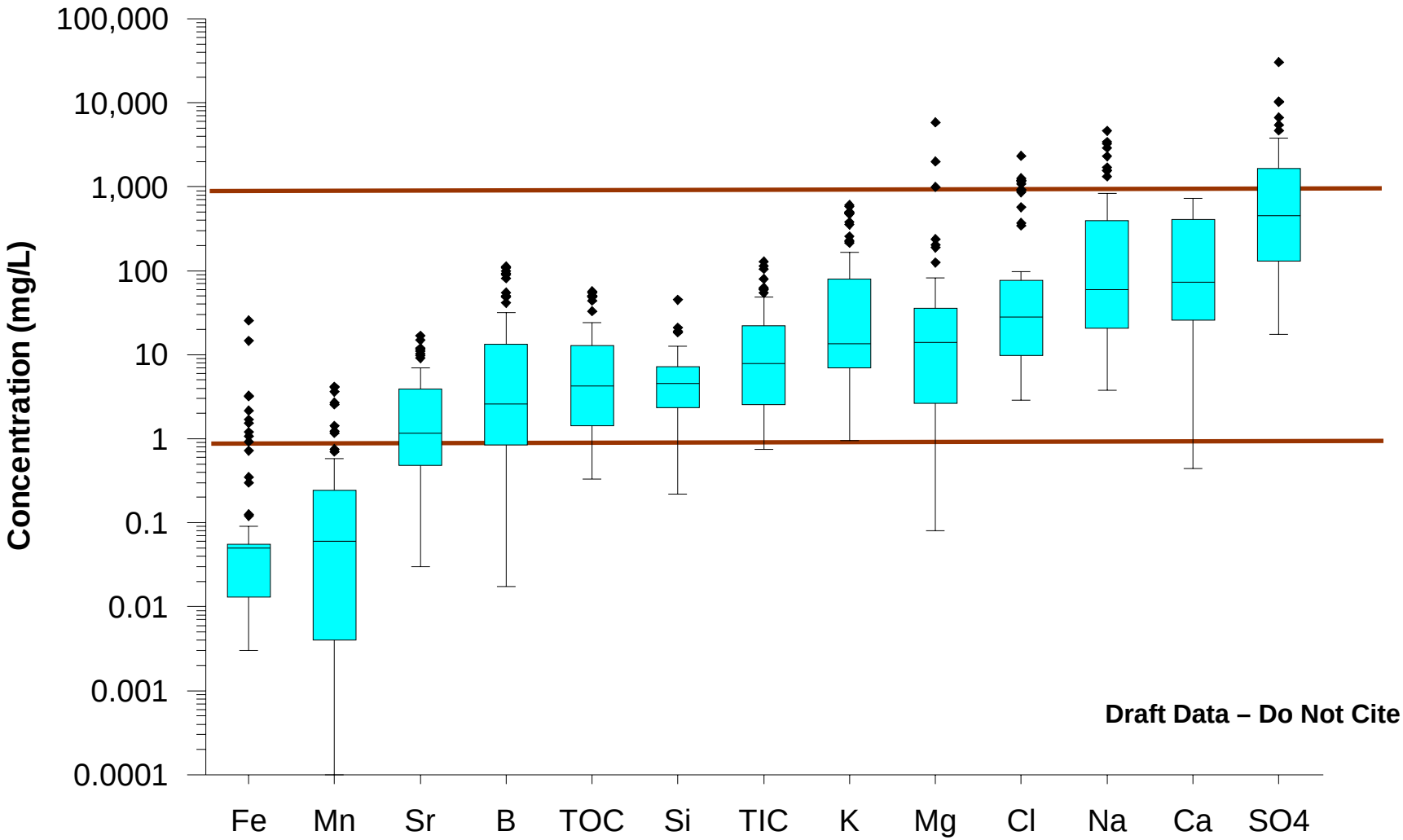
CCP Leachate (All Types)
Major and Minor Constituents



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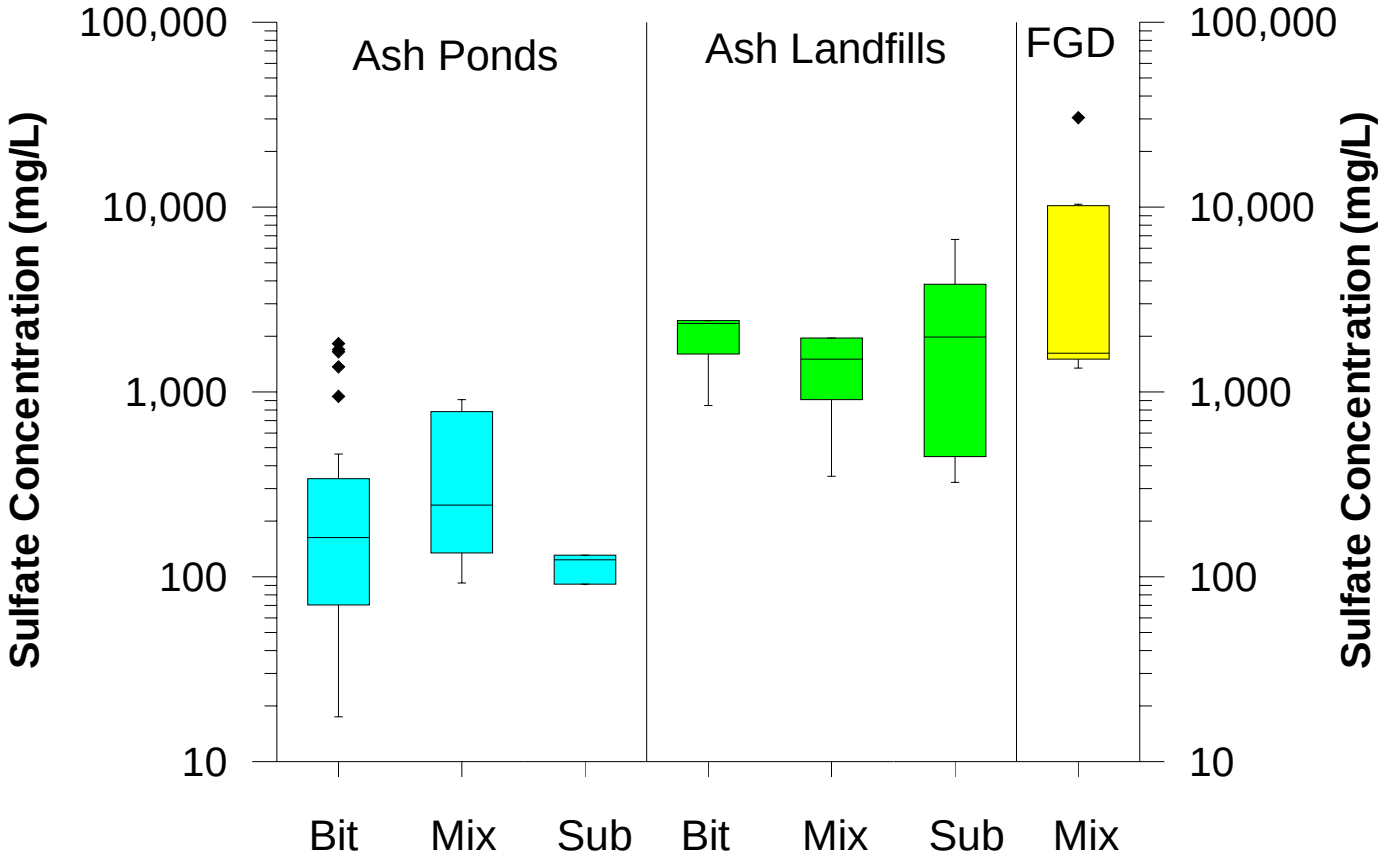
Field Leachate - Sulfate



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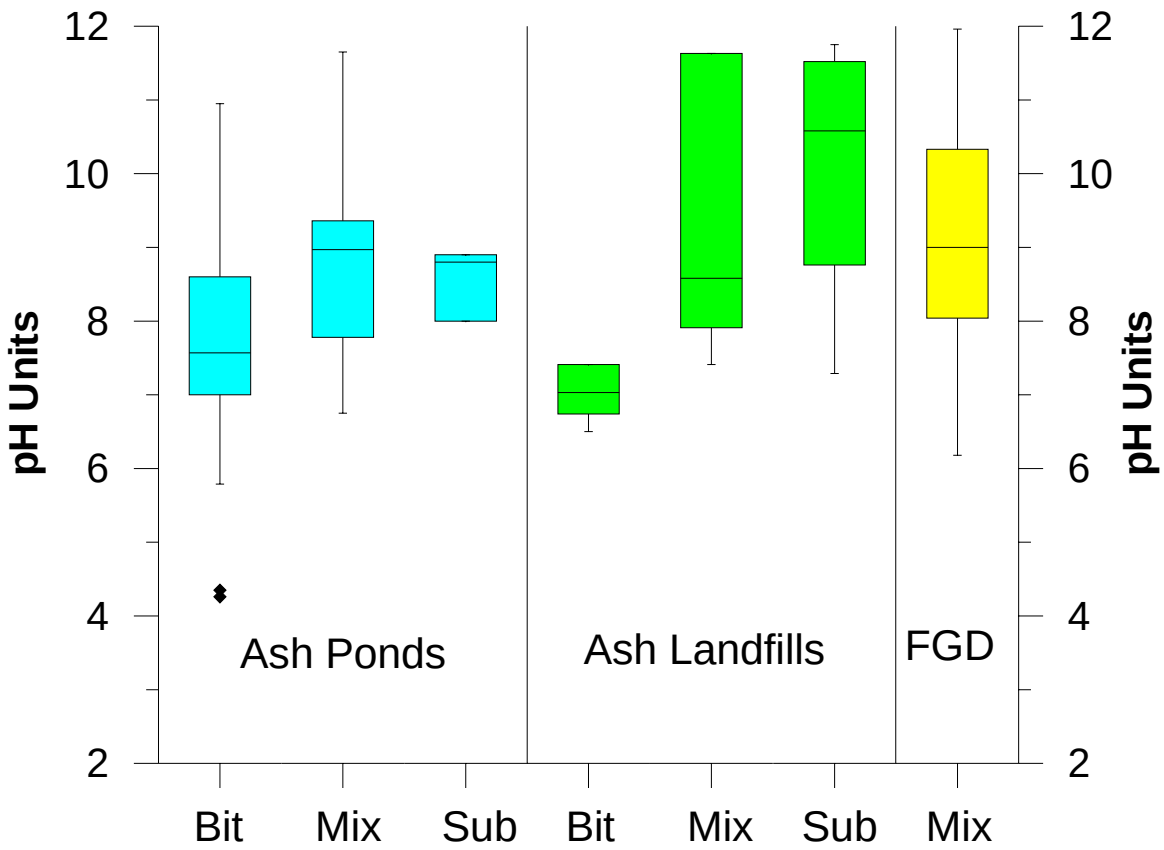
Field Leachate - pH



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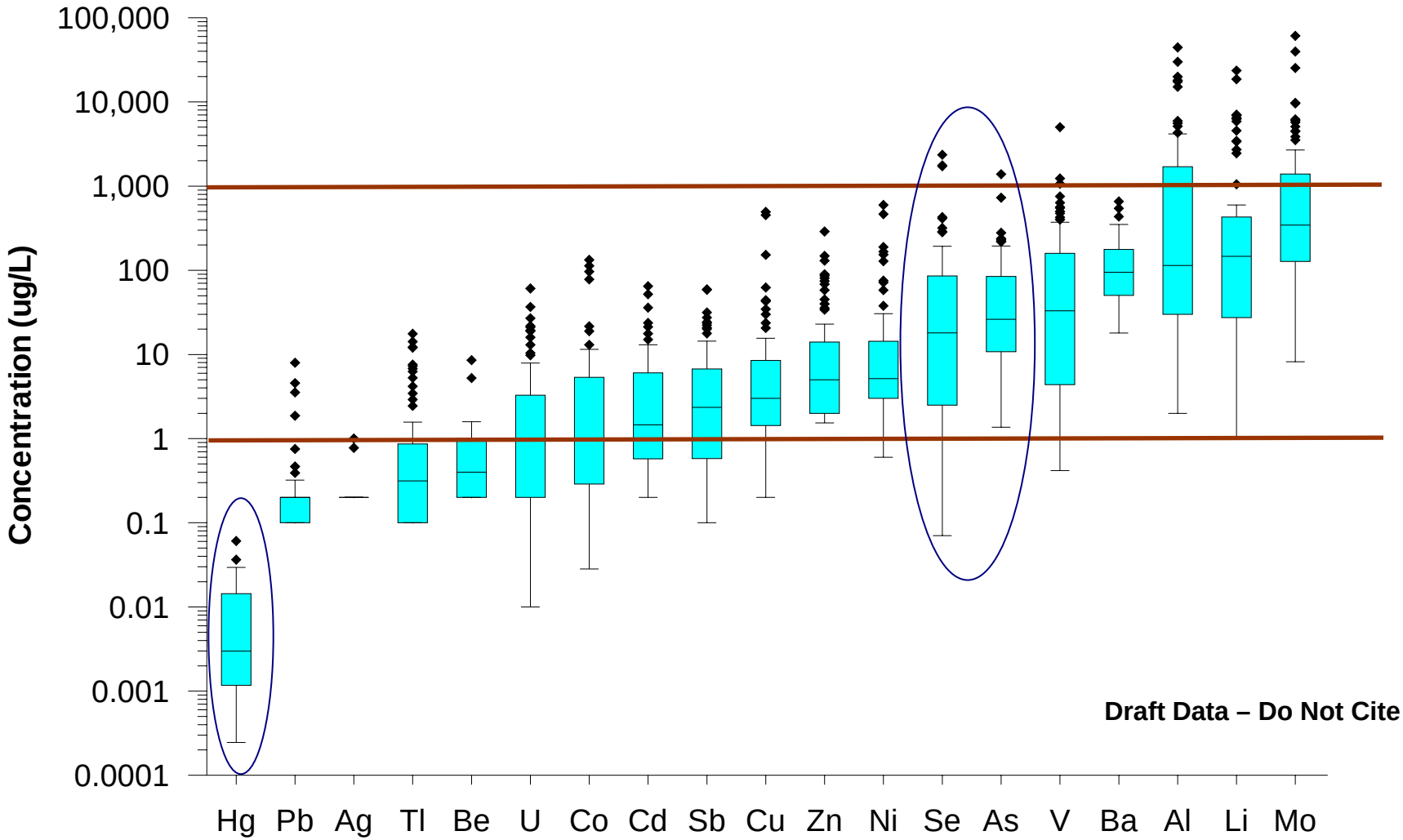
CCP Leachate (All Types)
Trace Constituents



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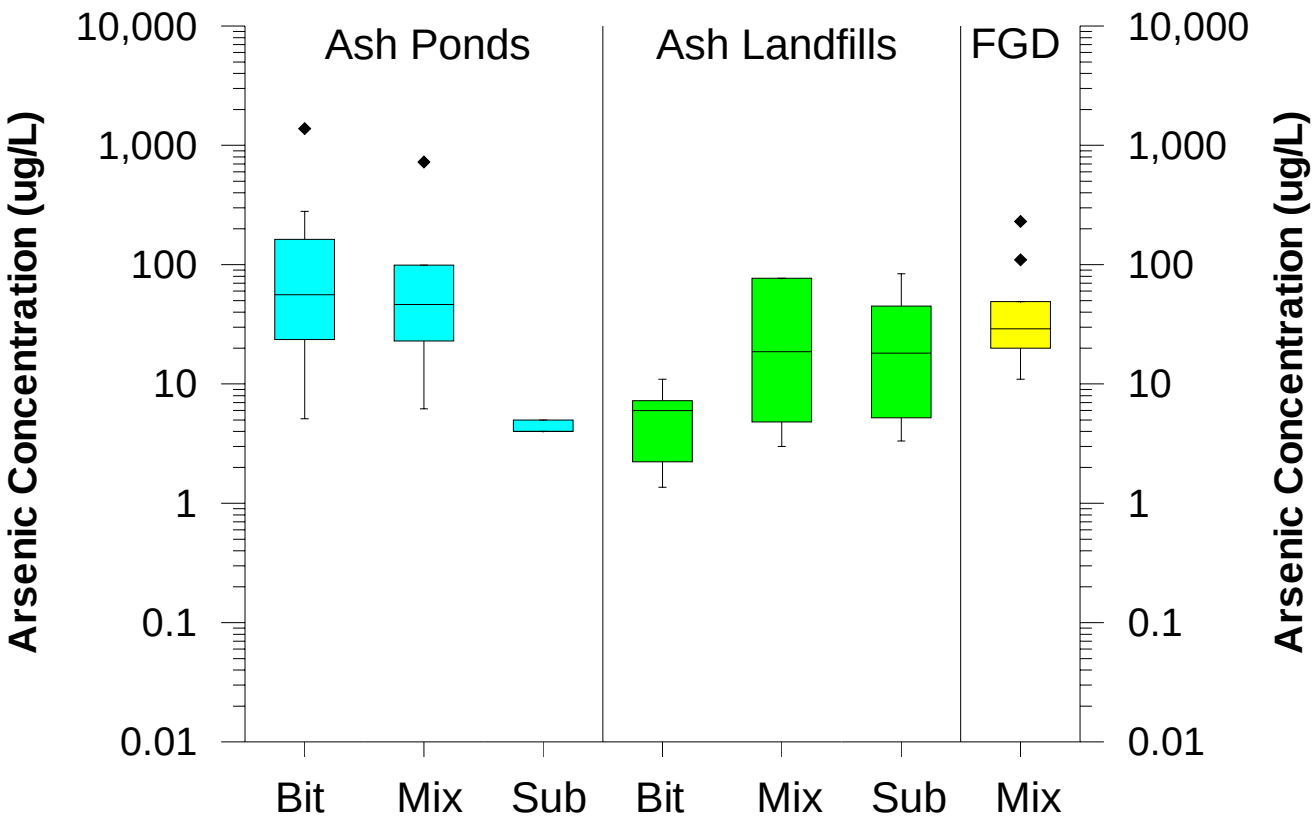
Field Leachate - Arsenic



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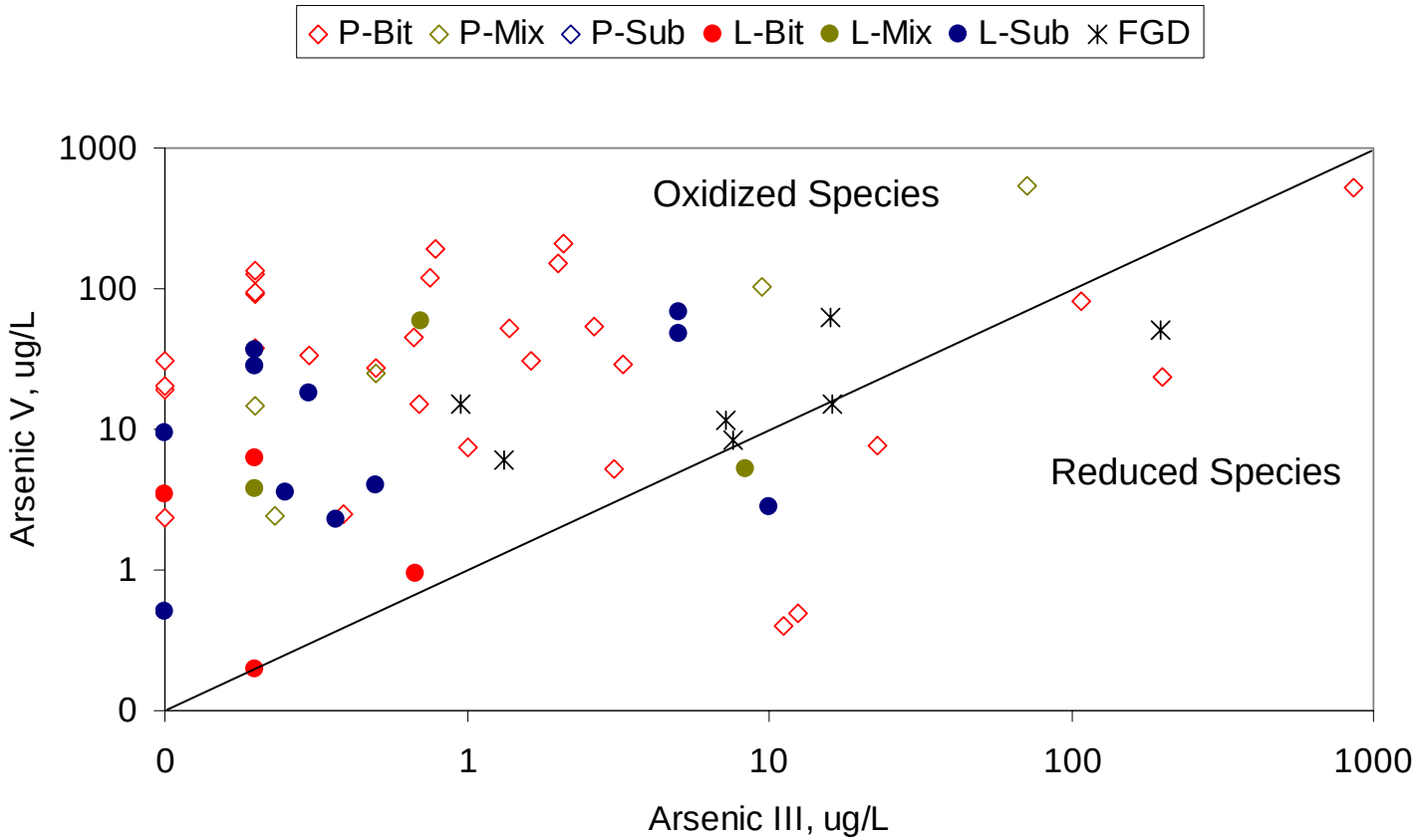
Field Leachate - Arsenic Speciation



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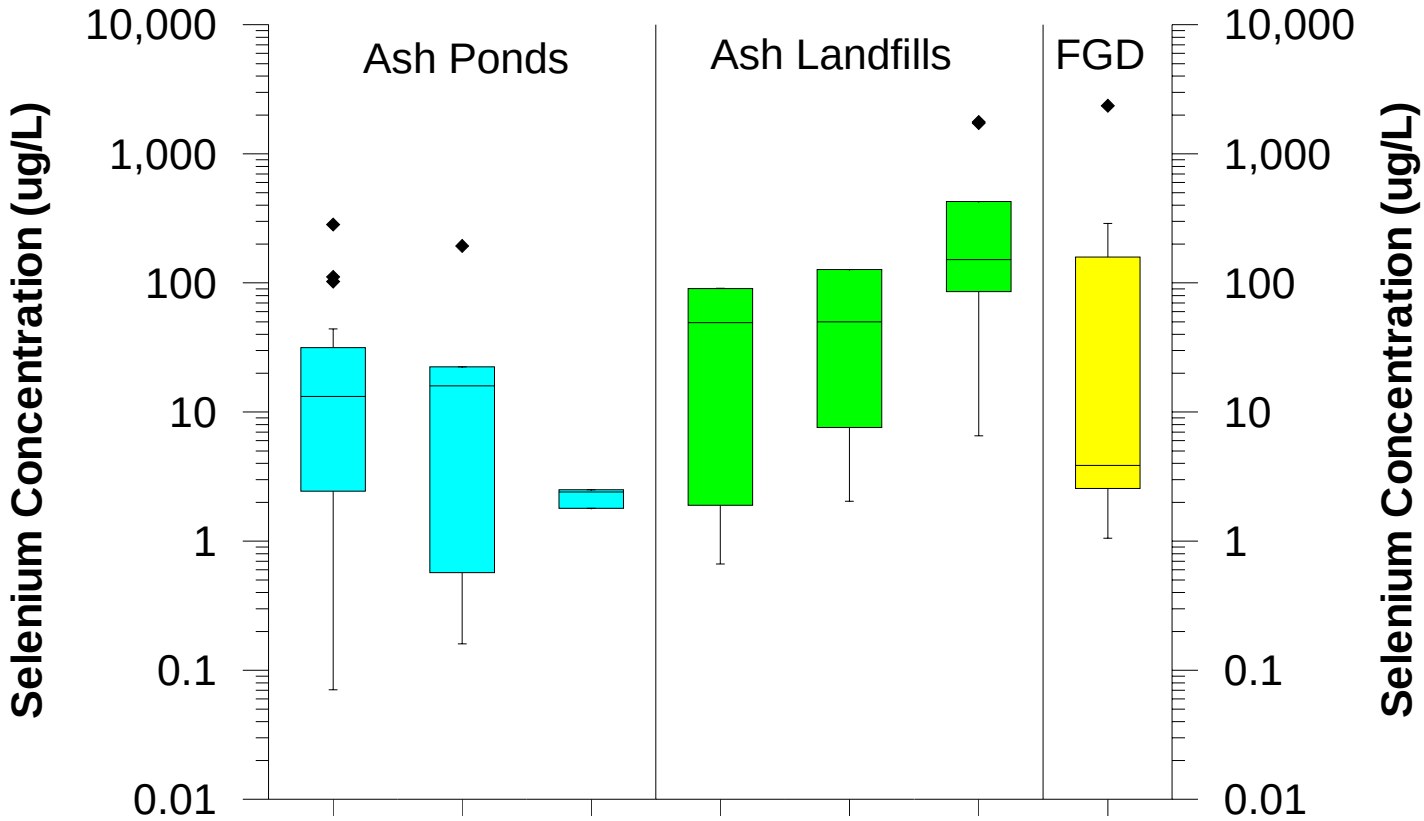
Field Leachate - Selenium



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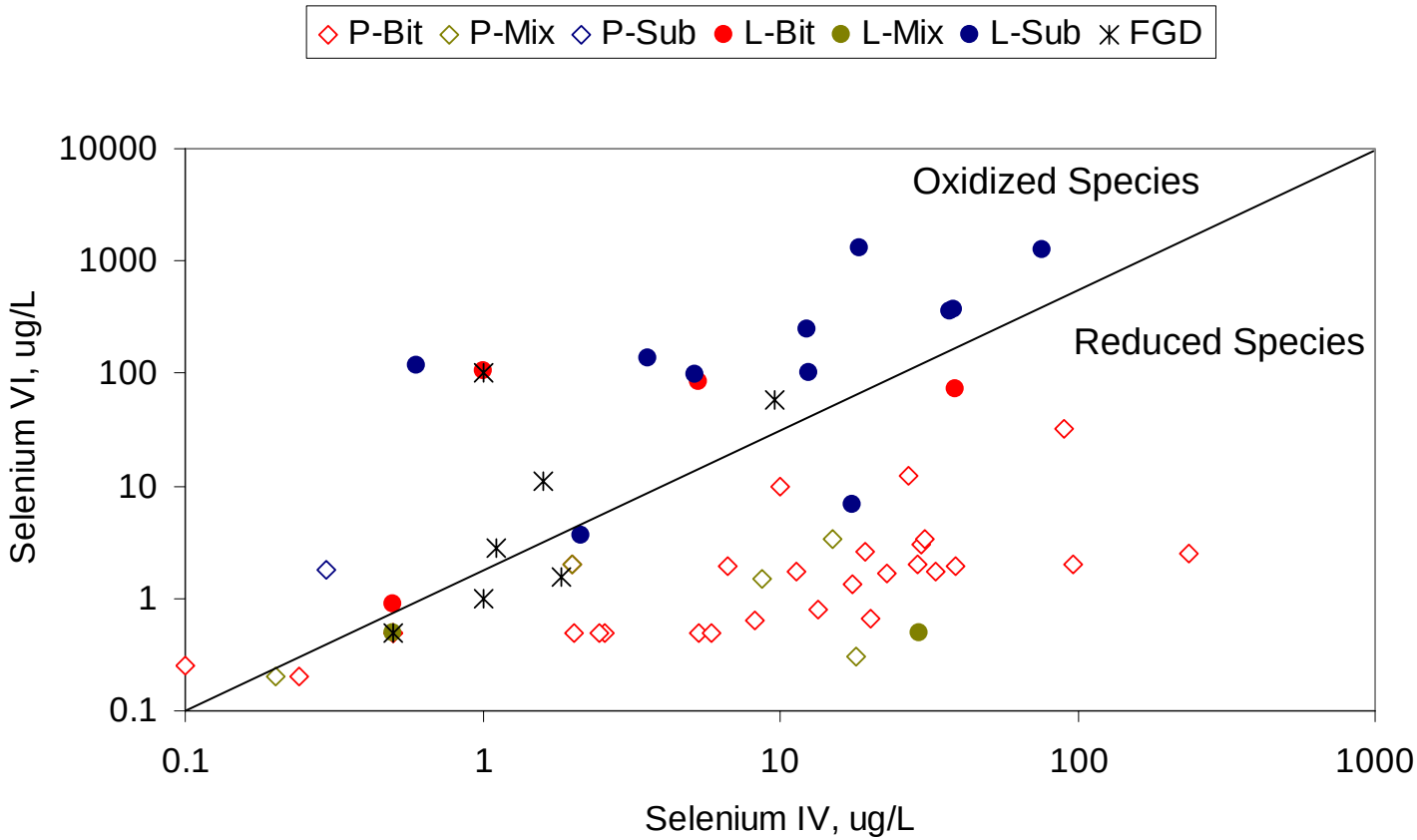
Field Leachate - Selenium Speciation



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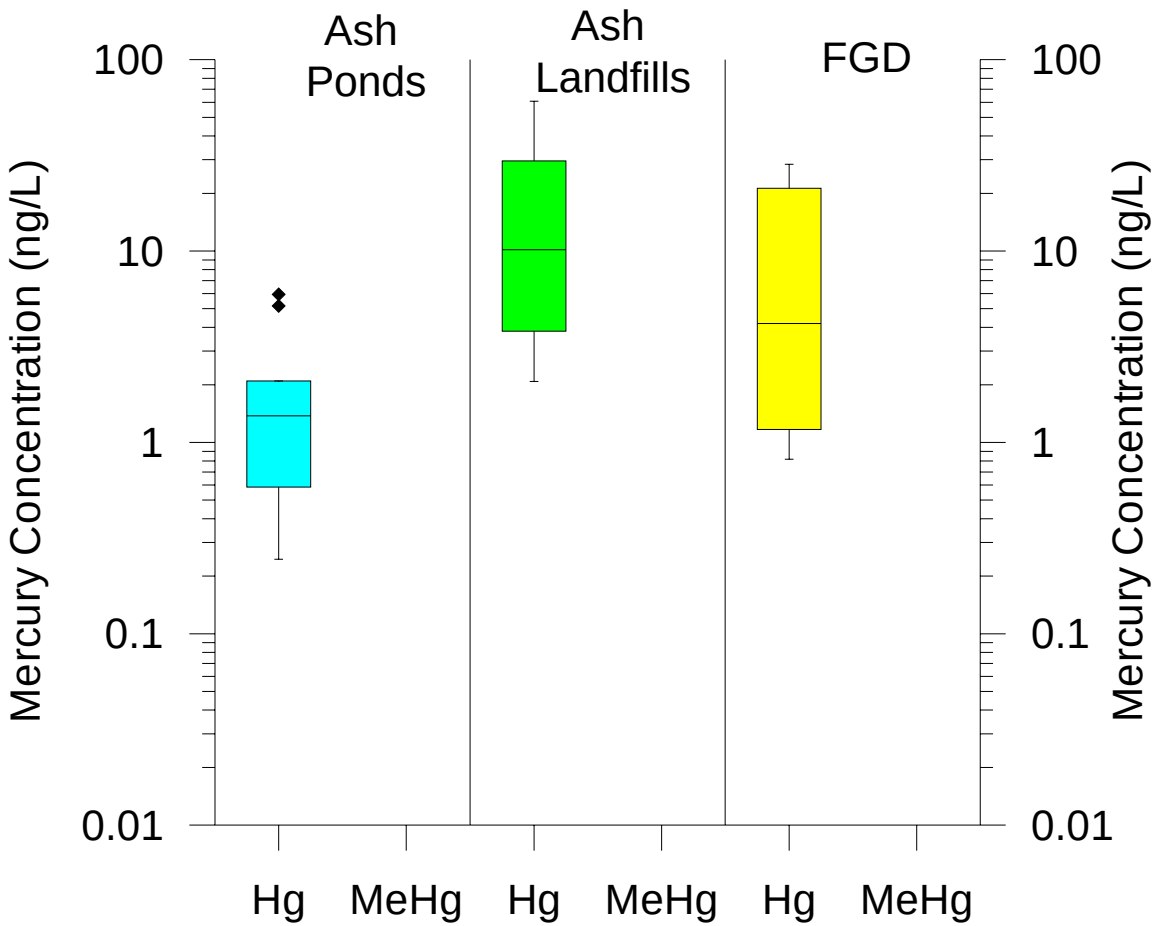
Field Leachate – Mercury Speciation



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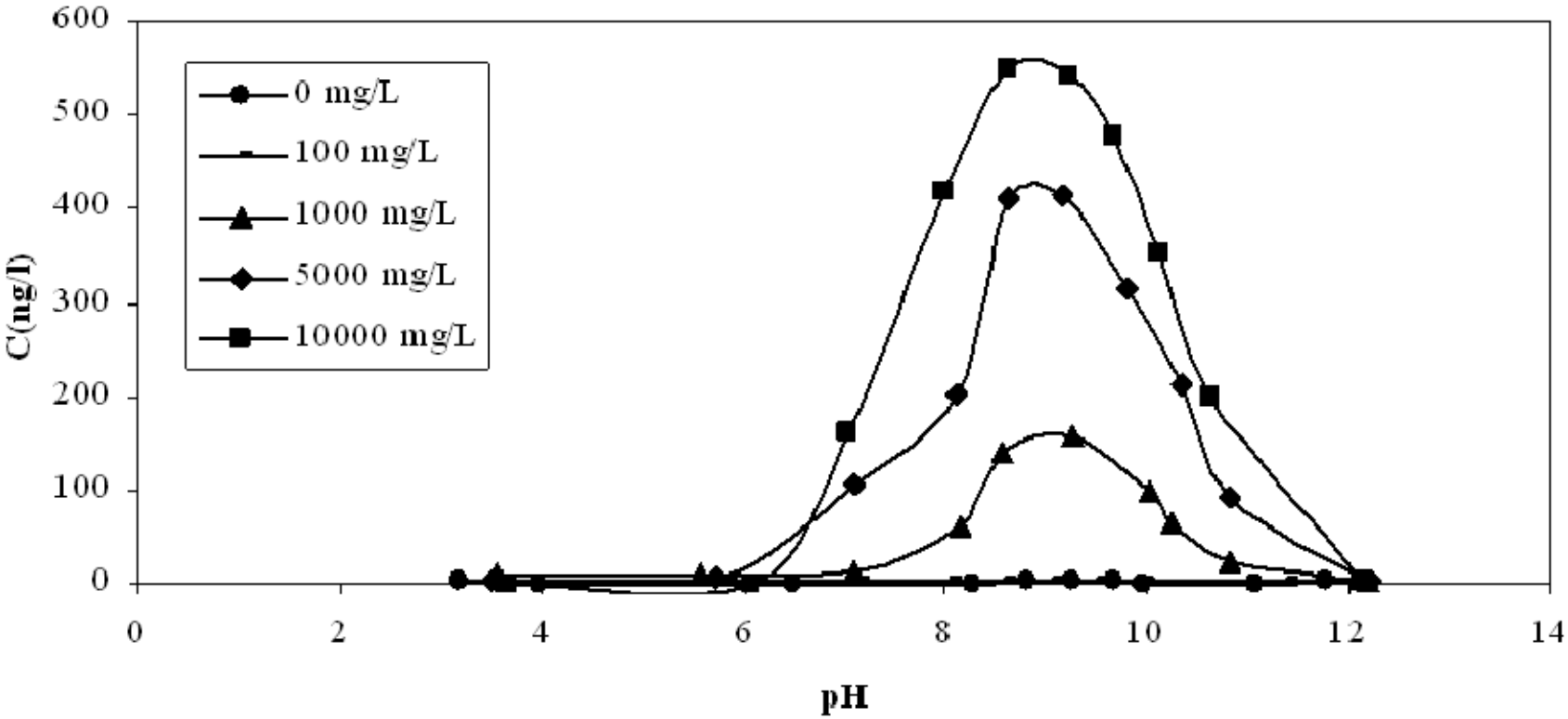
Mercury Leaching in Presence of Ammonia



Sample #86, raw ash with PAC

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As & Se Adsorption Study

Three Ash Landfill Sites

- Northeast, Southeast, Midwest
- Ash Samples
  - Sequential Leaching
  - Kinetic Leaching
- Soil Samples
  - Characterization
  - Adsorption Isotherms
  - Matrix Effects
  - pH Effects

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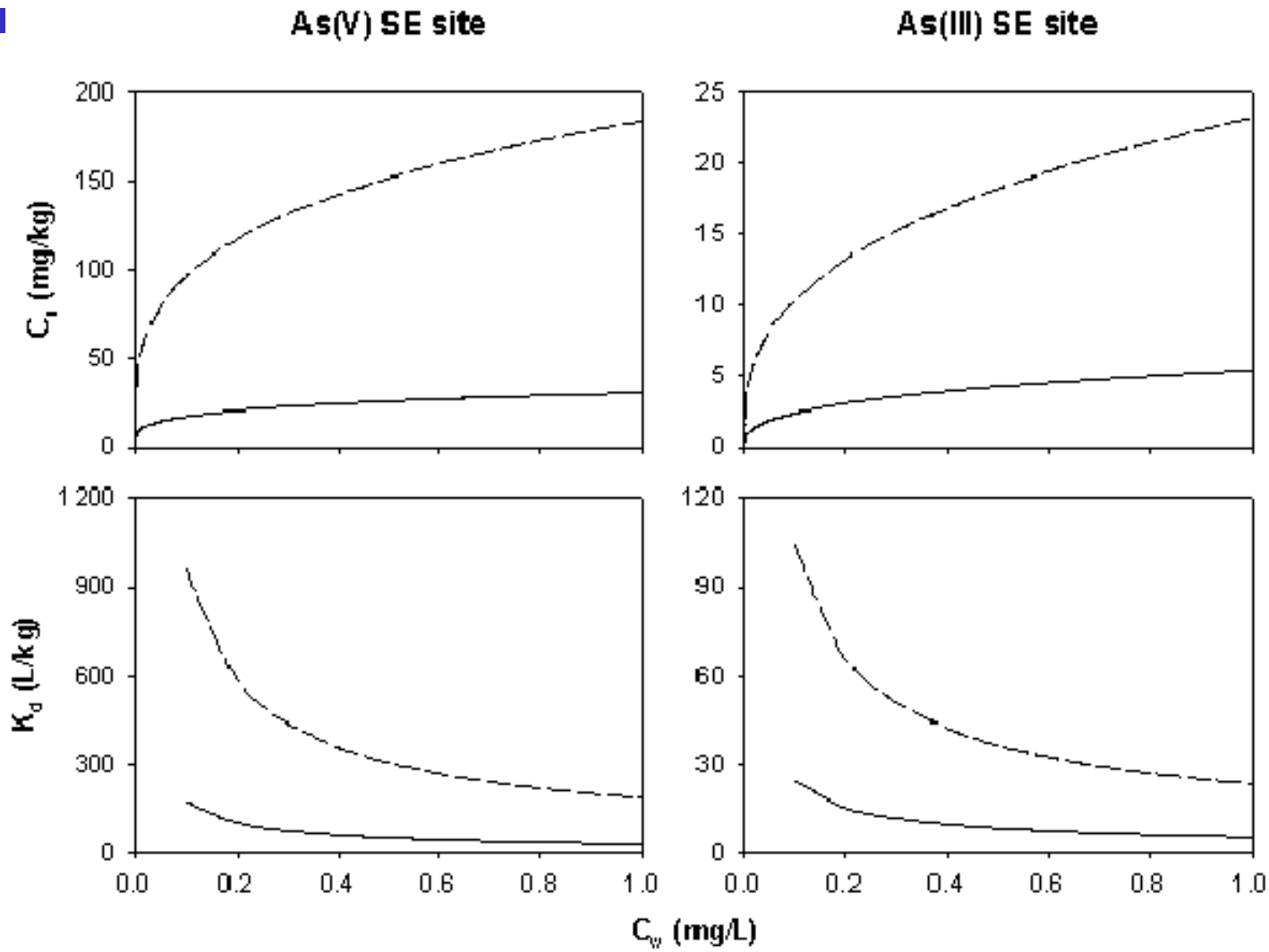
As Adsorption Envelopes – SE Site



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As Adsorption Summary

Kd Values @ 100 ppb

	As+3		As+5	
	Low	**High**	**Low**	**High**
NE Site	30	120	310	1650
SE Site	25	100	150	950
MW Site	19	30	145	165
All Sites	**19**	**120**	**145**	**1650**

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Se Adsorption Summary

Kd Values @ 100 ppb

	Se+4		Se+6	
	Low	**High**	**Low**	**High**
NE Site	200	500	7	18
SE Site	90	250	4	8
MW Site	25	38	3	5
All Sites	**25**	**500**	**3**	**18**

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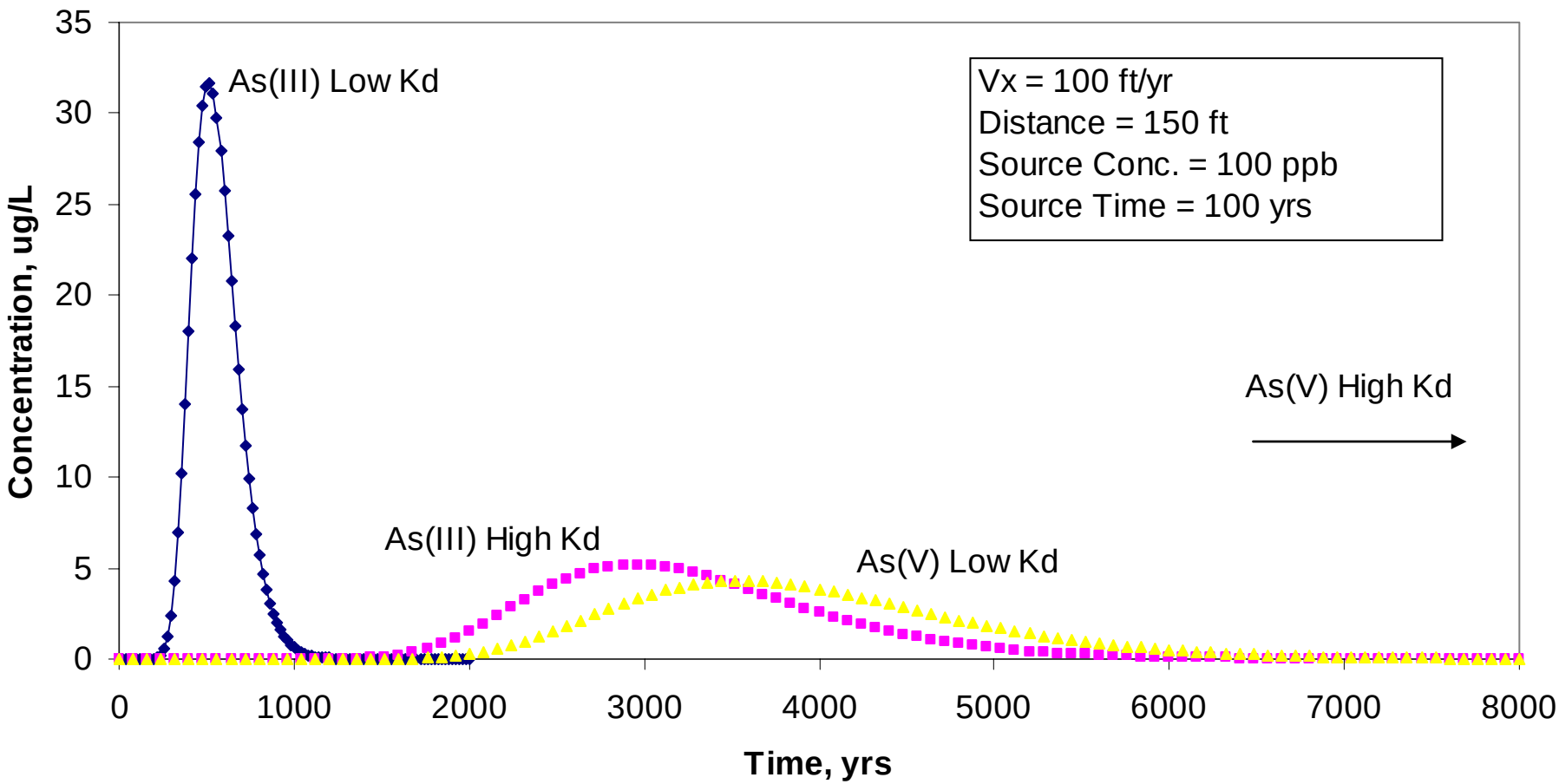
Arsenic Transport Modeling



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Summary

- **Arsenic**
  - 1.4 to 1400 ppb, median 26 ppb
  - Predominantly As(V)
  - Kd: 19 to 1650
- **Selenium**
  - 0.1 to 2400 ppb, median 18 ppb
  - Mixed species
  - Kd: 3 to 500
- **Mercury**
  - 0.25 to 60 ppt, median 3 ppt
  - Methyl mercury generally less than 1 ppt
  - Dimethyl mercury usually non-detect

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Acknowledgements

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