MIAMI-DADE COUNTY BACKGROUND STUDY

PRESENTED TO THE CONTAMINATED MEDIA FORUM –BACKGROUND WORK GROUP

Presented by
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DERM
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Objectives

1. To illustrate Miami-Dade County's evolving background data set which are centralized and accessible to the regulated community.
2. To present an overview of Miami-Dade County's anthropogenic background study
3. Use MDC's experience as a case study for initiating discussions regarding regulatory framework for addressing the issues and challenges to the use of regional background concentrations.

The need

- Risk assessors and environmental regulators need information regarding the distribution and concentrations of chemicals in soils
  - Naturally occurring or,
  - Resulting from anthropogenic impacts
- Increasing need for specific regional and local information
- More flexible options for closing contaminated sites means the regulatory community needs access to information
- Few studies targeting background soil concentrations locally and nationally

Literature Research

Previous Studies

Previous Studies

- National (non-exhaustive list)
  - *Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States.*

    Shacklette and Boerngen (1984), U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 1270

    http://pubs.usgs.gov/pp/1270/pdf/PP1270_508.pdf

  - *Cadmium, lead, zinc, copper, and nickel in agricultural soils of the United States of America.*

    Holmgren G.G.S, M.W Meyer, R.L.Chaney, R.B. Daniel, 1993

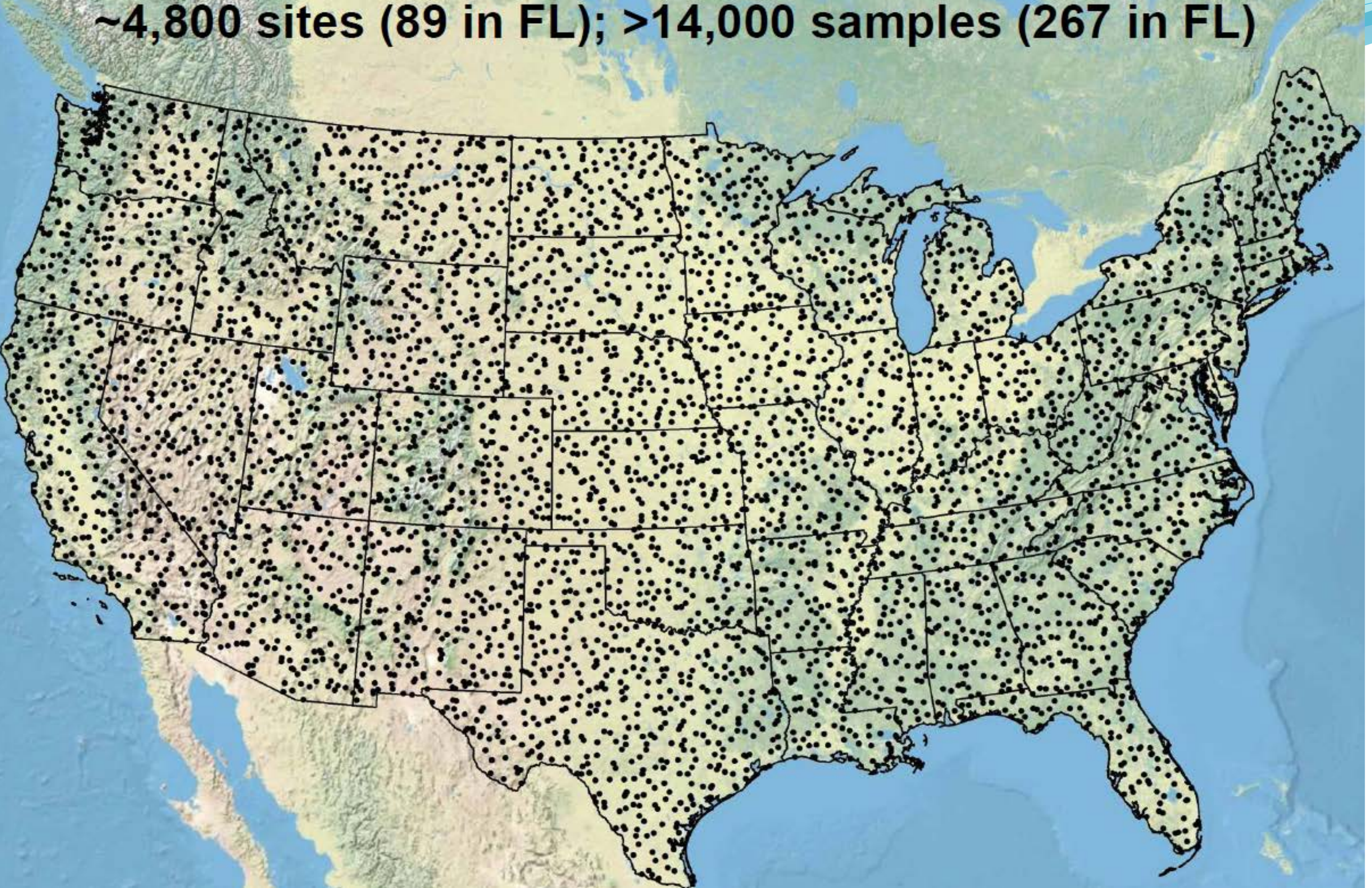
    http://nature.berkeley.edu/classes/espm-120/Website/Holmgren1993.pdf

  - *Major- and Trace-Element Concentrations in Soils from Two Continental-Scale Transects of the United States and Canada*

    D.B. Smith et al. (2005) U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 1253

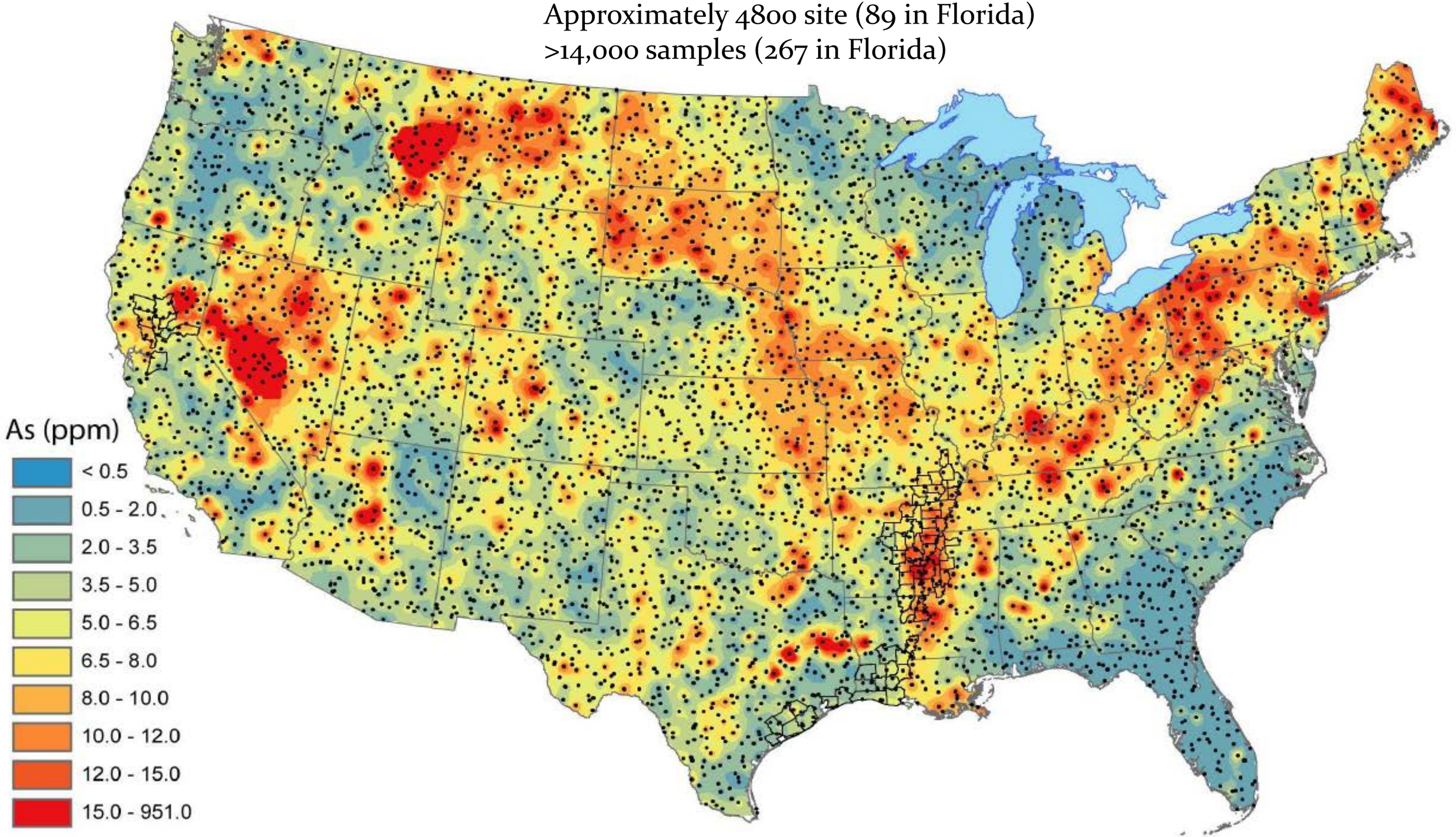
    http://pubs.usgs.gov/of/2005/1253/

~4,800 sites (89 in FL); >14,000 samples (267 in FL)



ARSENIC IN SURFACE (0-5 CM) SOIL

Approximately 4800 site (89 in Florida)
>14,000 samples (267 in Florida)



Previous Studies

- States
  - Several states provide generic statewide background values for inorganic chemicals and allow the use of these background values in lieu of site specific backgrounds. However, this information is not necessarily centrally located and easily accessible.
  - Although Florida does not have published generic state background numbers several studies have been conducted

Florida Studies

Non exhaustive list

- Ma, et al. (1997)
  Concentrations and Distributions of Eleven Metals in Florida Soils
  http://lqma.ifas.ufl.edu/PUBLICATION/Ma-97c.pdf

- Chirenje, Ma, Chen and Zillioux (2002)
  Comparison between background concentrations of arsenic in urban and non-urban areas of Florida
  http://lqma.ifas.ufl.edu/Publication/Tait-03b.pdf

- Ming Chen, Lena Q. Ma and Willie G. Harris (1999)
  Baseline Concentrations of 15 Trace Elements in Florida Surface Soils
  http://lqma.ifas.ufl.edu/PUBLICATION/Chen-99.pdf

- Schropp, S.J. and H.L. Windom. 1988.
  A guide to the interpretation of metal concentrations in estuarine sediments.
  Coastal Zone Management Section. Florida Department of Environmental Regulation. Tallahassee,

- Scarlatos and Scarlatos (1997)
  Ecological impact of arsenic and other trace metals from application of recovered screen material on Florida soils. FCSHWM special waste publication No. 97-5.

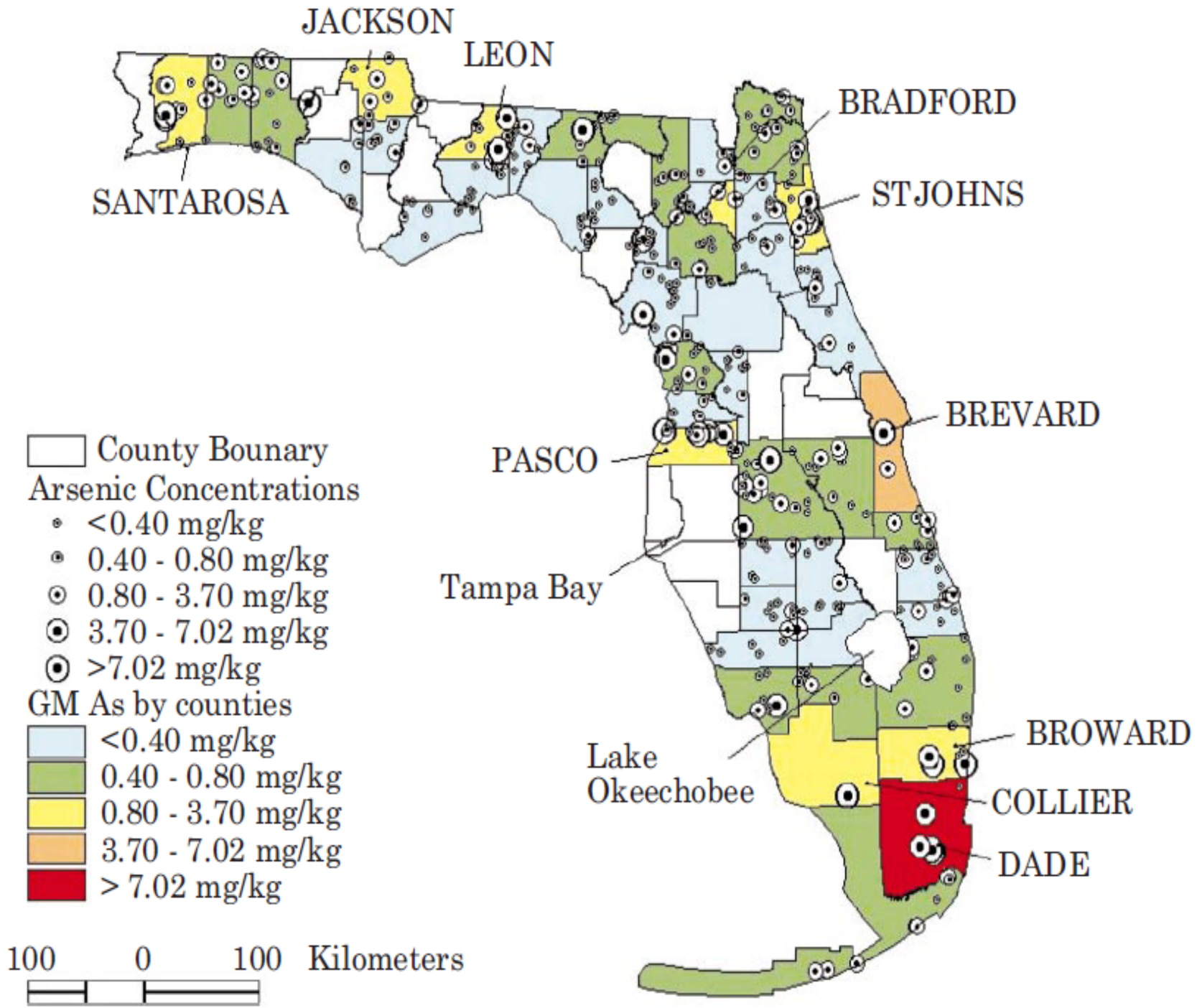

JACKSON
LEON
BRADFORD
SANTAROSA
ST JOHNS
BREVARD
PASCO
Tampa Bay
Lake
Okeechobee
BROWARD
COLLIER
DADE
County Bounary
Arsenic Concentrations
<0.40 mg/kg
0.40 - 0.80 mg/kg
0.80 - 3.70 mg/kg
3.70 - 7.02 mg/kg
>7.02 mg/kg
GM As by counties
<0.40 mg/kg
0.40 - 0.80 mg/kg
0.80 - 3.70 mg/kg
3.70 - 7.02 mg/kg
> 7.02 mg/kg
100 0 100 Kilometers

Table 1. Summary statistics for soil arsenic concentrations in different land uses in Gainesville and Miami (all calculations done after eliminating outliers).

Statistic	Residential	Commercial	Public parks	Public buildings	Combined
	mg kg^{-1}				
			Miami		
Samples	58	60	60	59	237
AM	5.37	2.56	4.67	3.46	4.00
ASD	5.72	3.21	0.67	3.41	4.34
Median	3.47	2.11	3.29	2.39	2.60
Geomean	3.72	1.93	3.49	2.49	2.80
Lgmean [As]	0.57	0.28	0.54	0.42	0.46
Lgstdev	0.35	0.30	0.33	0.39	0.02
			Gainesville		
Samples	79	39	38	40	196
AM	0.68	1.19	0.52	0.57	0.73
ASD	0.53	2.23	0.67	0.34	1.13
Median	0.52	0.52	0.35	0.48	0.50
Geomean	0.46	0.63	0.23	0.34	0.40
Lgmean [As]	−0.35	−0.20	−0.65	−0.27	−0.34
Lgstdev	0.49	0.41	0.68	0.83	0.05

† AM, arithmetic mean; ASD, arithmetic standard deviation; Geomean, geometric mean; Lgmean [As] and Lgstdev, mean of log-transformed concentrations and standard deviation.

Table 2. The upper confidence limit (UCL), 95th percentile, and percentage of soil samples with arsenic concentrations exceeding the soil cleanup target level (SCTL) (residential and commercial) in different land uses in Florida.

Statistic	Residential	Commercial	Public parks	Public buildings	Combined
			Miami		
UCL	6.47	2.90	5.70	4.30	4.32
95th percentile	25.3	4.73	16.3	15.4	16.4
Percent > 0.8 mg kg^{-1}†	100	88.3	98.3	91.7	94.6
Percent > 3.7 mg kg^{-1}‡	48.3	10.0	43.3	28.3	32.5
			Gainesville		
UCL	1.25	1.59	1.38	1.03	0.99
95th percentile	1.74	5.65	1.86	1.65	3.53
Percent > 0.8 mg kg^{-1}	30.4	30.0	26.3	29.5	29.4
Percent > 3.7 mg kg^{-1}	0.00	10.0	2.63	9.10	4.00

† The Florida soil clean up target level for residential areas.
‡ The Florida soil clean up target level for commercial areas.

The data from referenced studies indicated

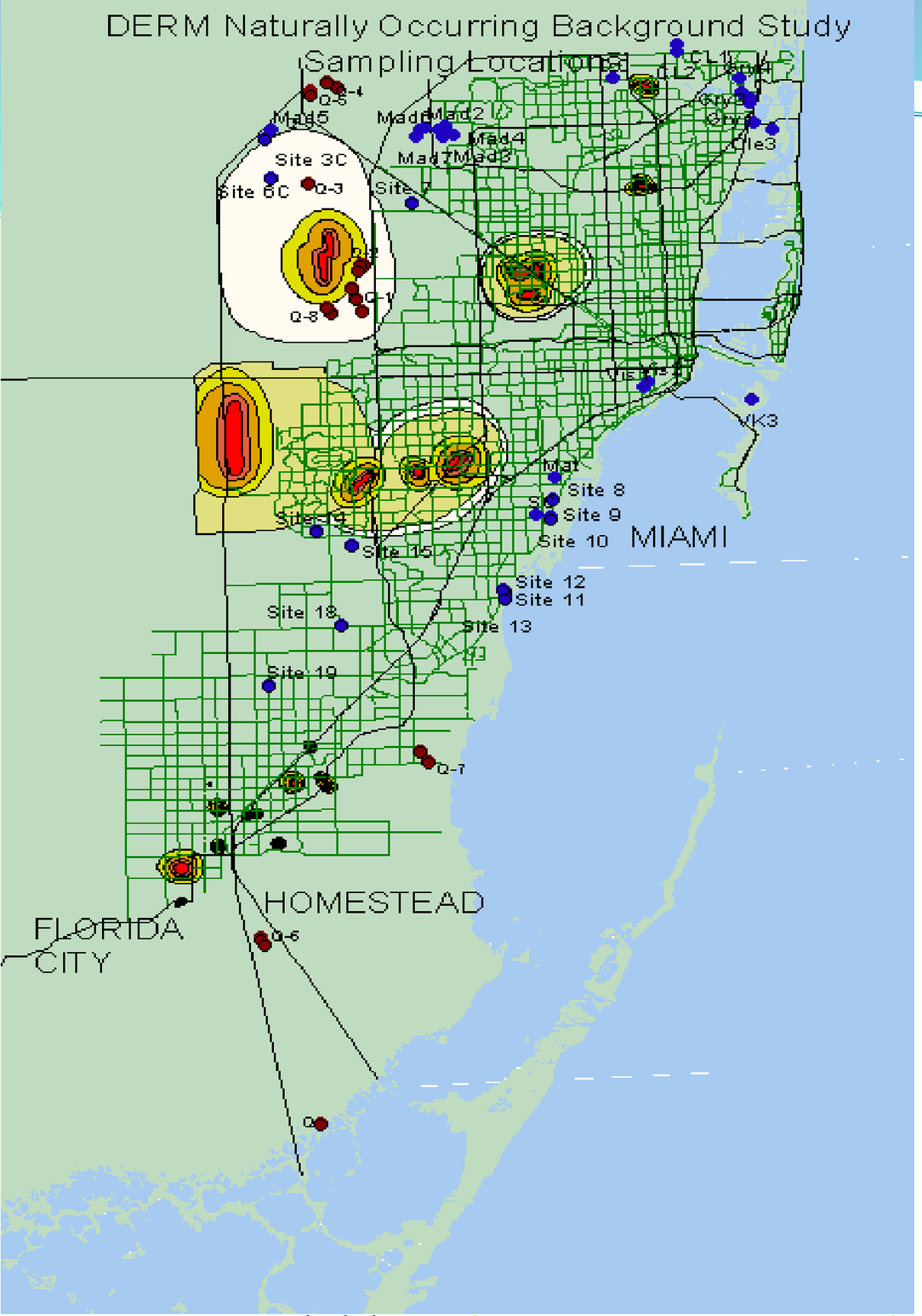
- Concentrations were significantly influenced by soil geochemistry as well as land use.
- A need for a better understanding of distribution at local levels to establish local and sub-regional soil background levels

Miami-Dade County

Studies

Miami-Dade Studies

- 2001 – County wide natural background
- 2001 - Lime rock quarry material
- 2004 - Barrier Island Background Soil Concentrations
- Specific anthropogenic background
  - 2002 - Golf Course Study
  - 2002, 2003 and 2013 - Area wide atmospheric deposition – 3 former incinerators
- Muck soils (various)



MDC COUNTYWIDE NATURAL BACKGROUND STUDY

(2001)

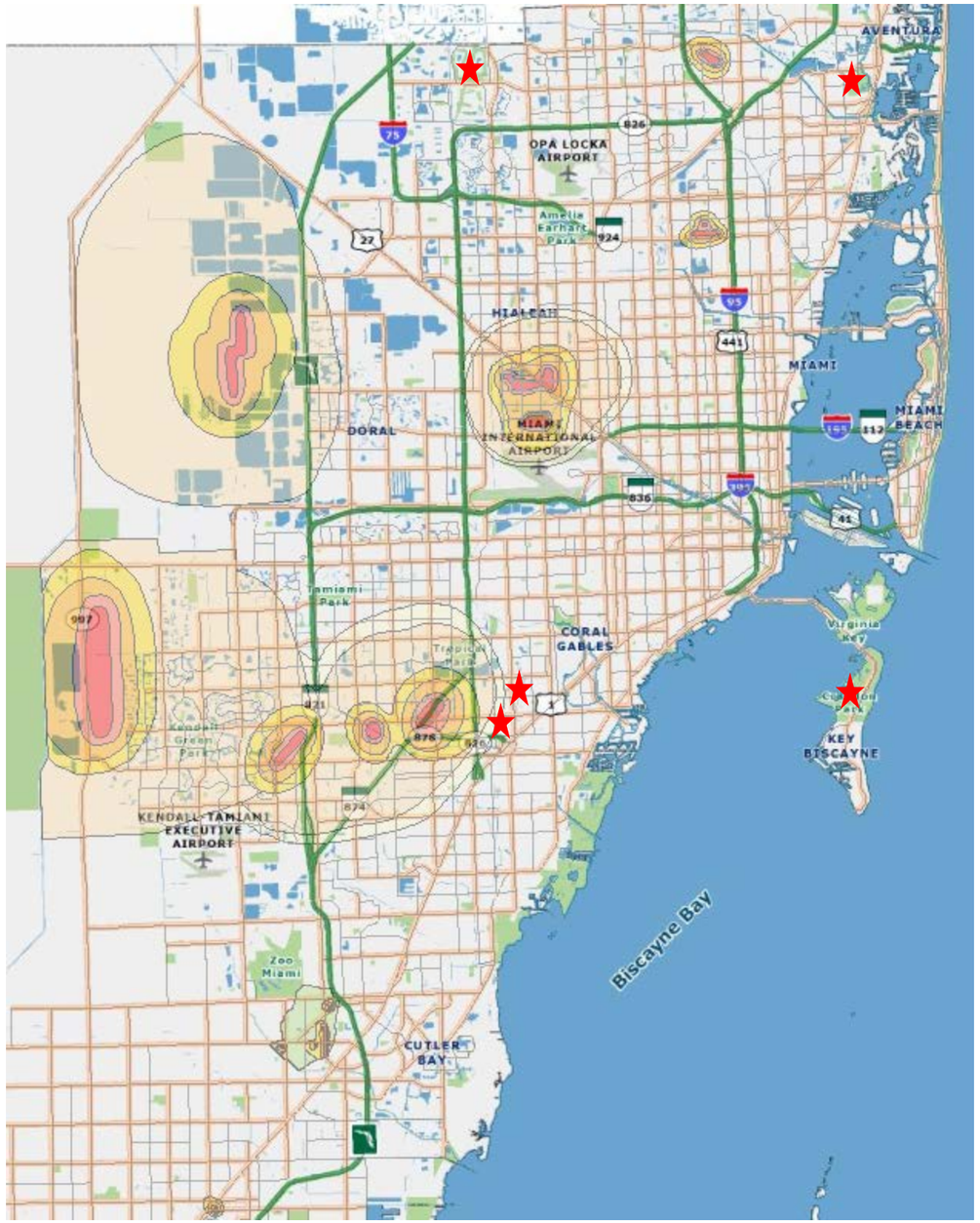
- 38 sampling locations (hardwood hammocks, pinelands, lowland)
- Undisturbed (natural) protected areas
- 0-2 feet interval
- Inorganics - 14 trace elements
- Arsenic - only element consistently exceed SCTL

Chemical Name	Natural Background Concentration (mg/kg)	Chemical Name	Natural Background Concentration (mg/kg)
Arsenic	1.2	Lead	26
Aluminum	2656	Manganese	55
Barium	7	Mercury	0.08
Cadmium	0.1	Nickel	2.1
Chromium	6.8	Selenium*	<0.45
Copper	4.1	Silver*	<0.025
Iron	2176	Zinc	12

* The data for selenium and silver were not analyzed statistically because all of the selenium results were below the detection limit and silver was detected in only one sample.

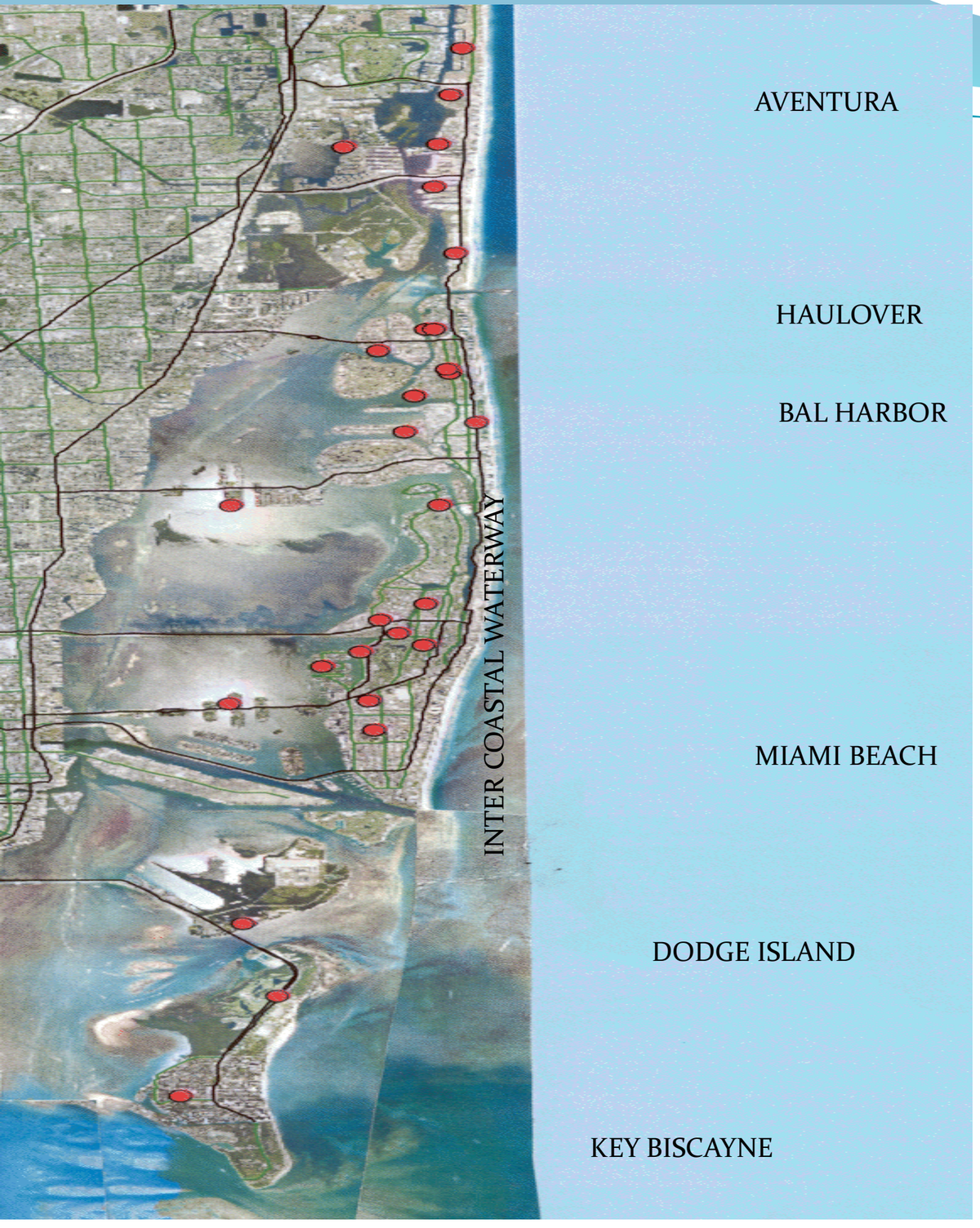
Available at http://www.miamidade.gov/environment/research-reports.asp

Golf Course Study



- 5 public golf courses
- COC's Inorganics and pesticides
- Arsenic only COC consistently above RSCTL

	Mixing/Loading Area	Play Area
N	10	31
Min	0.3	0.2
Max	33.5*	54.8
Mean	10	16
MVUE	11.8	25.1
95% UCL	32.6	26.3



MIAMI-DADE COUNTY BARRIER ISLANDS BACKGROUND STUDY (2004)

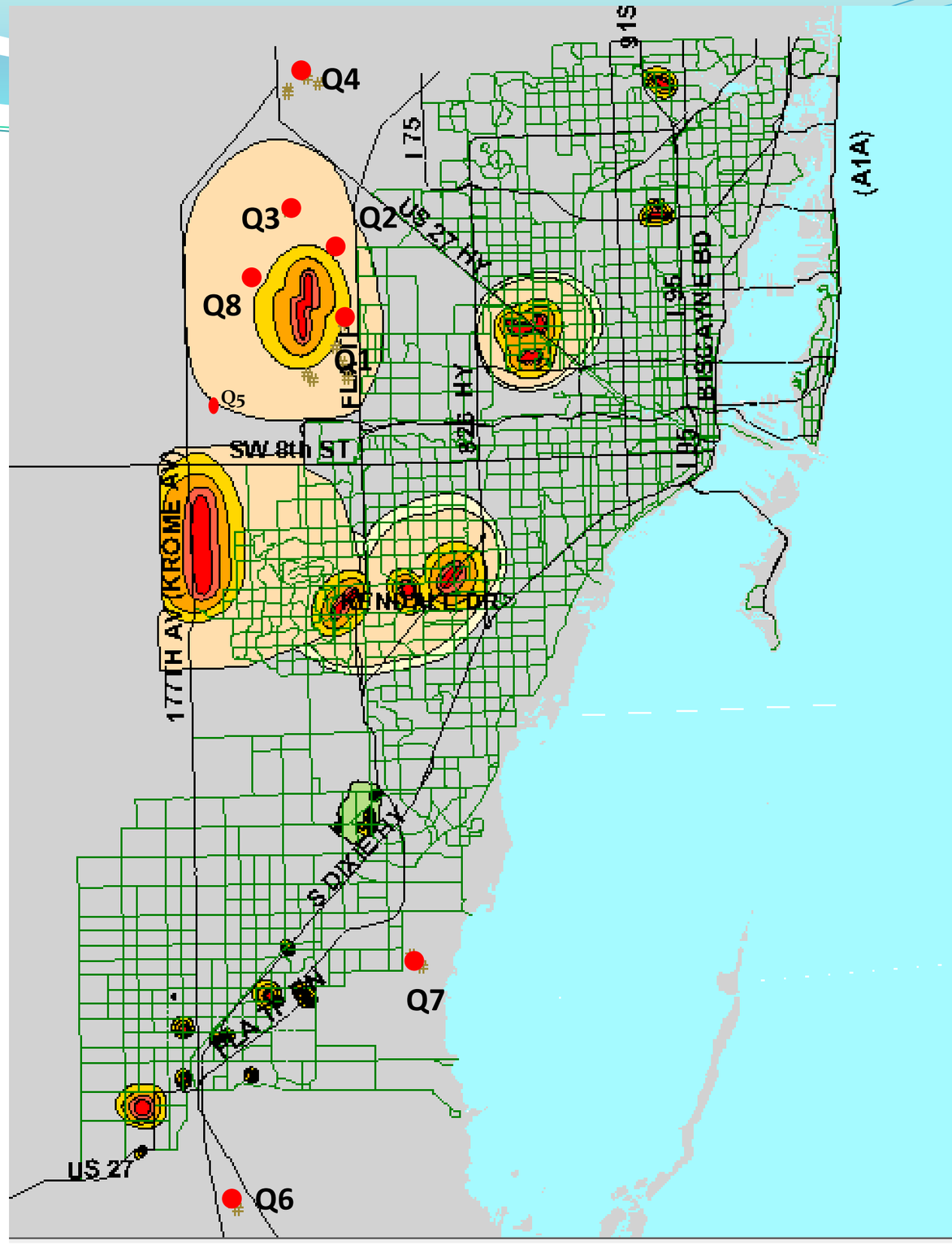
- 51 sampling locations (residential lawns)
- Inorganics only
- 0-1 foot and 1-2 feet intervals sampled
- In presenting the data the intervals were combined if not statistically different

Chemical Name	Natural Background Concentration (mg/kg)	
	0-2 ft interval	
Arsenic	5.2	
Aluminum	798.7	
Cadmium	0.3	
Iron	2050.7	
Selenium**	<0.5	
Zinc	13.1	
Silver*	0.4	
	0-1 ft interval	1-2 ft interval
Barium	8.1	5.9
Chromium	7.9	5.7
Copper	5.4*	2.3*
Lead	15.0	5.2*
Mercury	0.054	0.026*
Nickel	1.08*	0.66*

Available at http://www.miamidade.gov/environment/research-reports.asp

MDC Background Concentration of Trace Elements in Native Quarry Material

- 8 sampling locations (rock mining quarries in MDC),
- 22 samples (from dragline bucket, stockpiled material and processed material
- 13 inorganic.
- All results below RSCT
- Arsenic below detection in all samples (MDL 0.2mg/kg)



- Quarry sample locations

HWR-542
Arsenic

HWR-625/626
Arsenic

IW5-679
Arsenic

HWR-554
Arsenic

HWR-170
Ammonia

HWR-205
Arsenic

UT-6527
Arsenic & Vinyl Chloride

SW-1276
UT-6504
Iron & Arsenic

UT-6331
Arsenic

UT-5185
Arsenic

UT-134
Arsenic

IW5-5300
Arsenic

UT-430
Arsenic

IW5-8065
Arsenic

SW-1392
Ammonia

UT-515
Arsenic

HWR-566
Arsenic

Site Specific Background Studies

Former Incinerator
1 Mile Radius Study Areas

- 10-53 locations sampled.
- 0-6 and 6-24 inch interval
- Metals, Dioxin and PCBs
- Arsenic primary contaminant of concern.

MIAMI-DADE COUNTY

Anthropogenic Background

161
Locations
sampled and
reported

119 Parks

27 Private Residence

15 Public Libraries

2 vertical intervals

0-6 inches, 6-24 inches

COC’c

METALS

PAH’s

PESTICIDES*

DIOXIN*

* 10% of samples analyzed for dioxin and pesticides

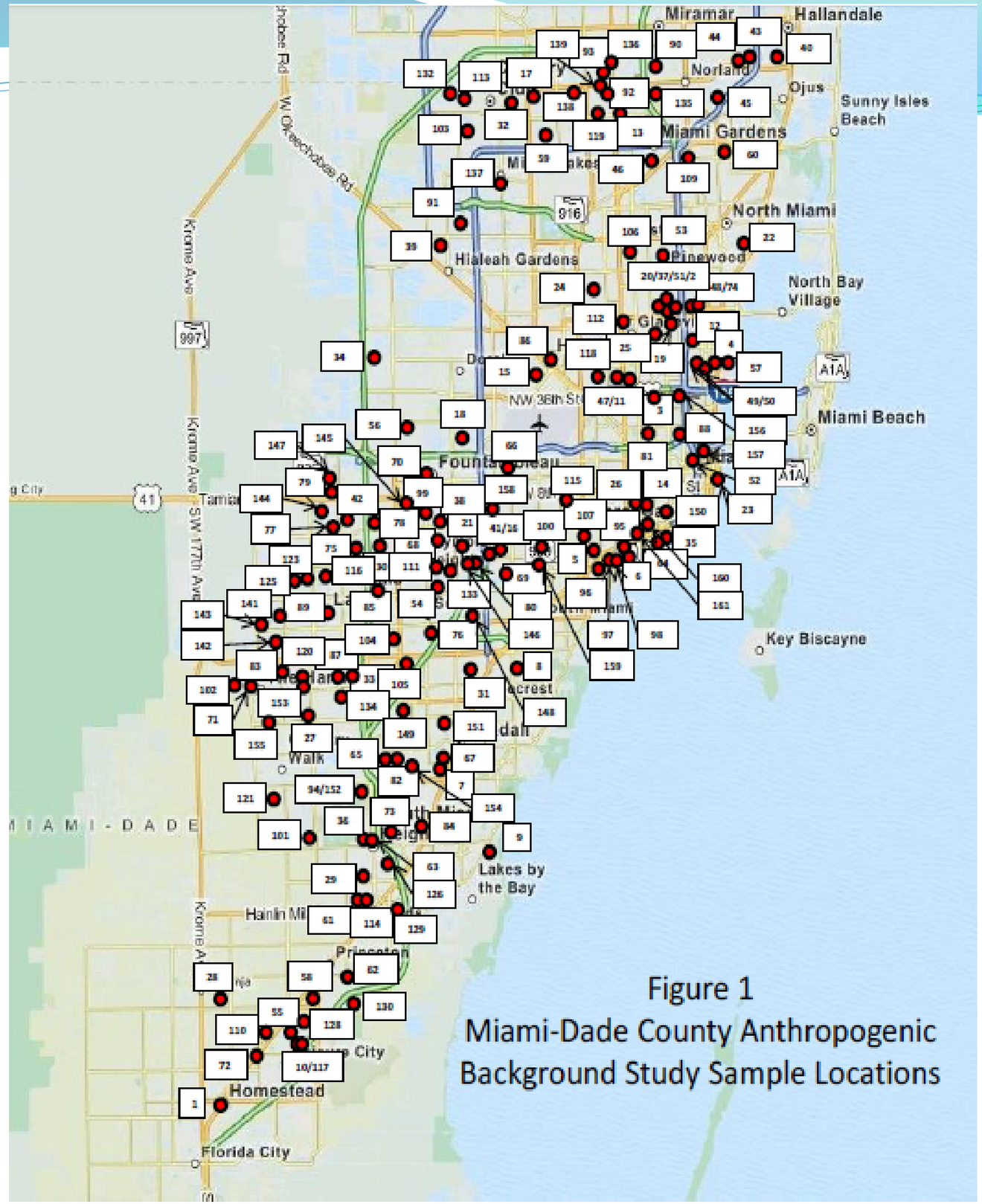


Figure 1
Miami-Dade County Anthropogenic Background Study Sample Locations

RESULTS

Arsenic and PAHs are the only COC with concentrations exceeding direct exposure SCTL

Chromium and Lead sporadically exceeded groundwater leachability SCTL

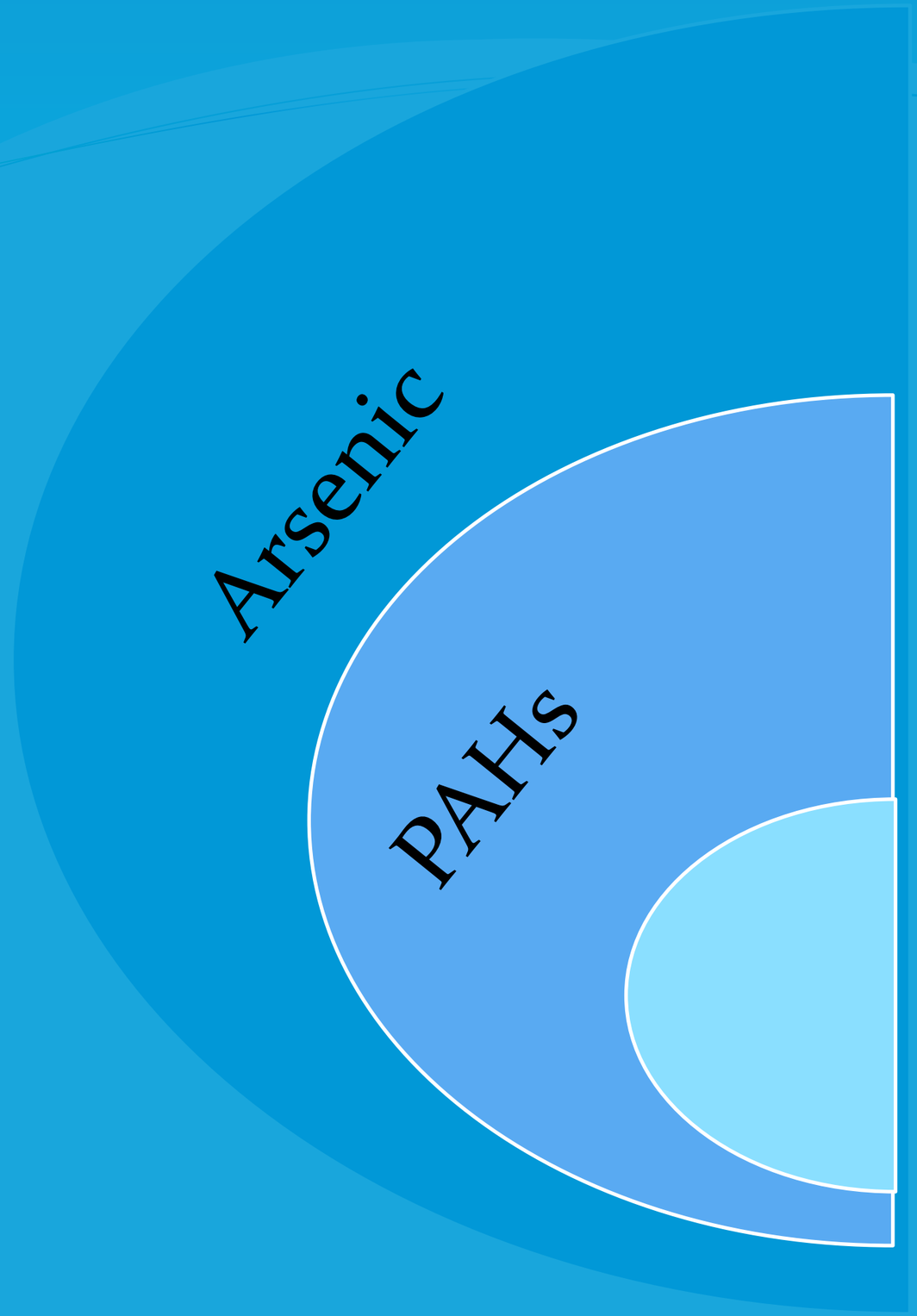
MIAMI-DADE COUNTY ANTHROPOGENIC BACKGROUND STUDY

SUMMARY STATISTICS

(Contaminants with no exceedence of the Residential Soil Cleanup Target Level)

	Al		Ba		Cd		Cr		Cu		Pb	
	0 - 6"	6 - 24"	0 - 6"	6 - 24"	0 - 6"	6 - 24"	0 - 6"	6 - 24"	0 - 6"	6 - 24"	0 - 6"	6 - 24"
Number of Samples	155	147	160	147	156	147	157	147	151	146	160	147
Minimum	84	81.3	2.1	0.56	0.04	0.01	1.27	0.57	1.2	0.3	0.15	0.15
Maximum	24700	27600	93.5	79.5	2.5	1.2	57.4	62.9	53.9	37.6	158	176
Mean	2539	2334	12.1	9.42	0.27	0.15	13.7	10.52	9.75	6.05	25.5	16.9
MVUE	2510	2345	11.91	9.18	0.28	0.15	12.7	10.6	9.77	6.39	26	16
95% UCL	3483	2740	15.23	13.13	38	0.21	13.96	11.97	10.99	7.89	31.2	20.4
Distribution	NonP	LogN	NonP	NonP	NonP	NonP	LogN	LogN	LogN	LogN	LogN	LogN

	Fe		Hg		Mn		Ni		Zn	
	0 - 6"	6 - 24"	0 - 6"	6 - 24"	0 - 6"	6 - 24"	0 - 6"	6 - 24"	0 - 6"	6 - 24"
Number of Samples	155	147	154	147	147	147	149	145	149	146
Minimum	119	56	0.11	0.006	5.86	1	0.25	0.09	4	1
Maximum	14600	16100	1.2	0.81	36.6	273	12.1	12.7	249	231
Mean	2624	2108	0.35	0.36	55	35.1	2.3	2.1	44.3	24.3
MVUE	2629	2170	0.4	0.4	53.9	35.9	2.2	2.1	39.6	23.2
95% UCL	3390	2510	0.42	0.42	61.2	43.3	2.9	2.7	44.9	28.8
Distribution	LogN	LogN	NonP	NonP	LogN	LogN	NonP	NonP	LogN	LogN



DATA

EVALUATION

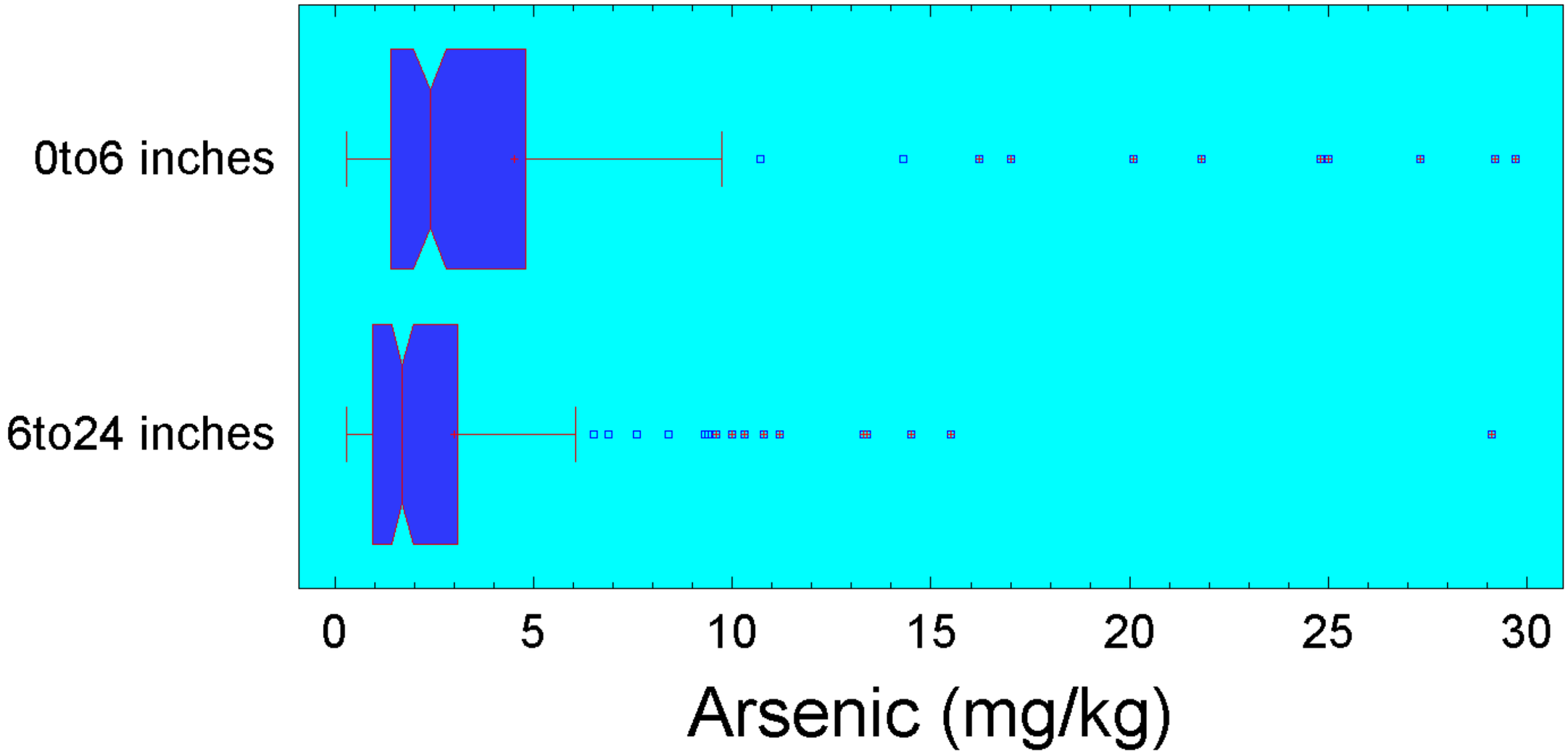
VERTICAL PROFILE

LAND USE

ARSENIC CONCENTRATION DISTRIBUTION

SPATIAL DISTRIBUTION

Arsenic Vertical Distribution



Kolmogorov-Smirnov Test

- K-S statistic = 2.03437
- Approximate P value = 0.000508435
- Given P value less than 0.05, the conclusion is that there is significant difference between the two distributions are at the 95% confidence level

Land Use Evaluation

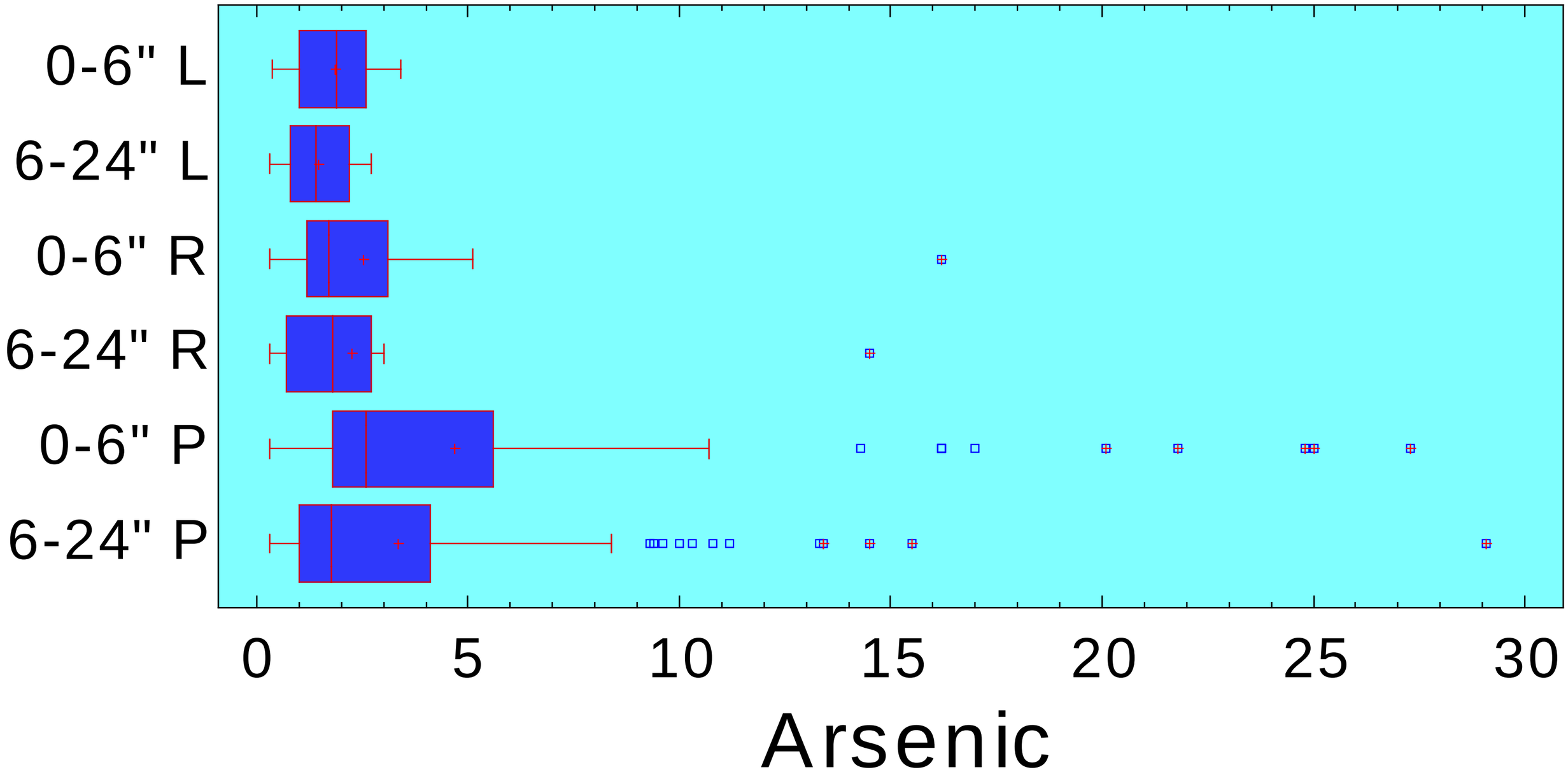
- Parks vs Libraries vs Residence

  There is a statistically significant difference amongst the medians at the 95.0% confidence level. Parks population different from libraries and residence

- Libraries vs residence:

  There is not a statistically significant difference between the two distributions at the 95.0% confidence level.

Land Use Versus Vertical Profile



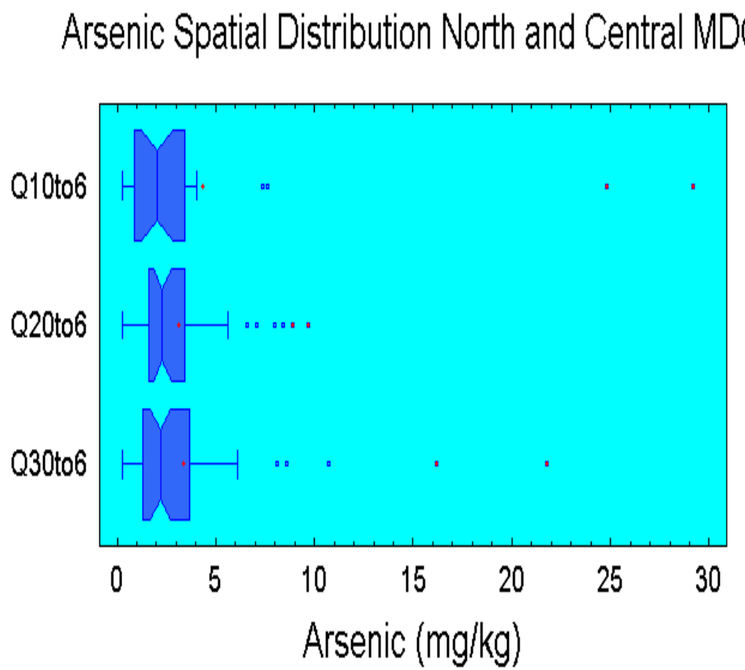
L: Library, R: Residence, P: Park

Spatial Evaluation

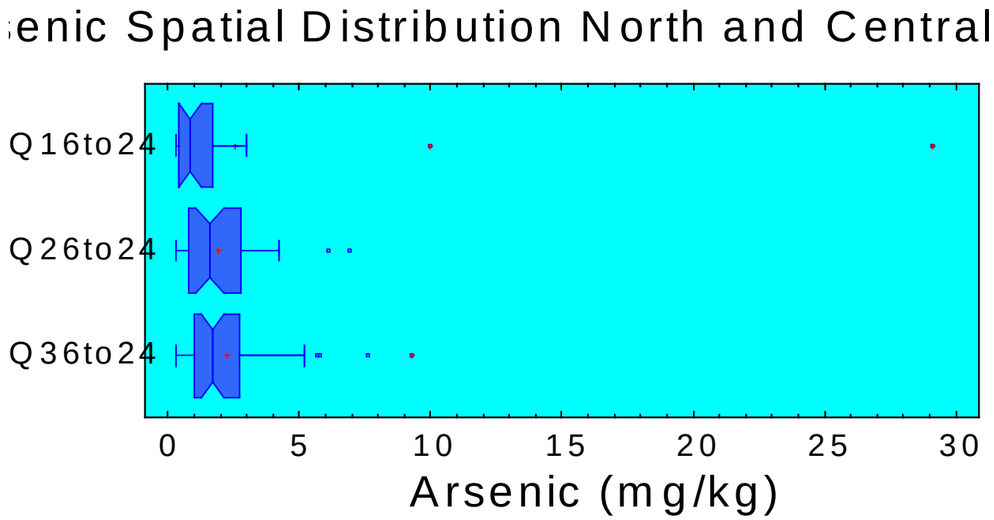
- For this evaluation the county was divided into four quadrants along the north/south axis.
  - Q1: Countyline Road to NW 135th Street
  - Q2: NW 135th Street to West Flagler Street
  - Q3: West Flagler Street to SW 88 Street (South Kendall Drive)
  - Q4: South of SW 88th Street

- An evaluation of the data indicated a statistically significant difference in the median concentration of the data set for south of SW 88th Street (Q4) vs the rest of the county.

Spatial Evaluation



Kruskal-Wallis test
Test statistic = 0.546622 P-Value = 0.760856
Since the P-value is greater than or equal to 0.05, there is not a statistically significant difference amongst the medians at the 95.0% confidence level.



Kruskal-Wallis test
Test statistic = 5.44012 P-Value = 0.065870
Since the P-value is greater than or equal to 0.05, there is not a statistically significant difference amongst the medians at the 95.0% confidence
level.

Spatial Evaluation

Table 2: MIAMI-DADE COUNTY ANTHROPOGENIC BACKGROUND STUDY
ARSENIC SUMMARY STATISTICS

	Arsenic- County-Wide			Arsenic-North of SW 88 Street			Arsenic-South of SW 88Street		
	0 - 6"	6 - 24"	0-2 ft*	0 - 6"	6 - 24"	0-2 ft*	0 - 6"	6 - 24"	0-2 ft*
Number of Samples	153	142	142	111	100	100	40	39	39
Minimum	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Maximum	27.3	14.5	16.2	24.8	10.0	13.7	27.3	14.5	16.2
Mean	3.9	2.6	2.9	3.3	1.9	2.2	5.9	4.2	4.7
MVUE	4.2	2.9	3.0	3.5	2.1	2.3	7	5	5.2
95% UCL	5.6	3.5	3.7	4.8	2.6	2.8	10.6	7.1	7.9

Concentrations in mg/kg
Outliers removed for data analysis
* Weighted Concentration

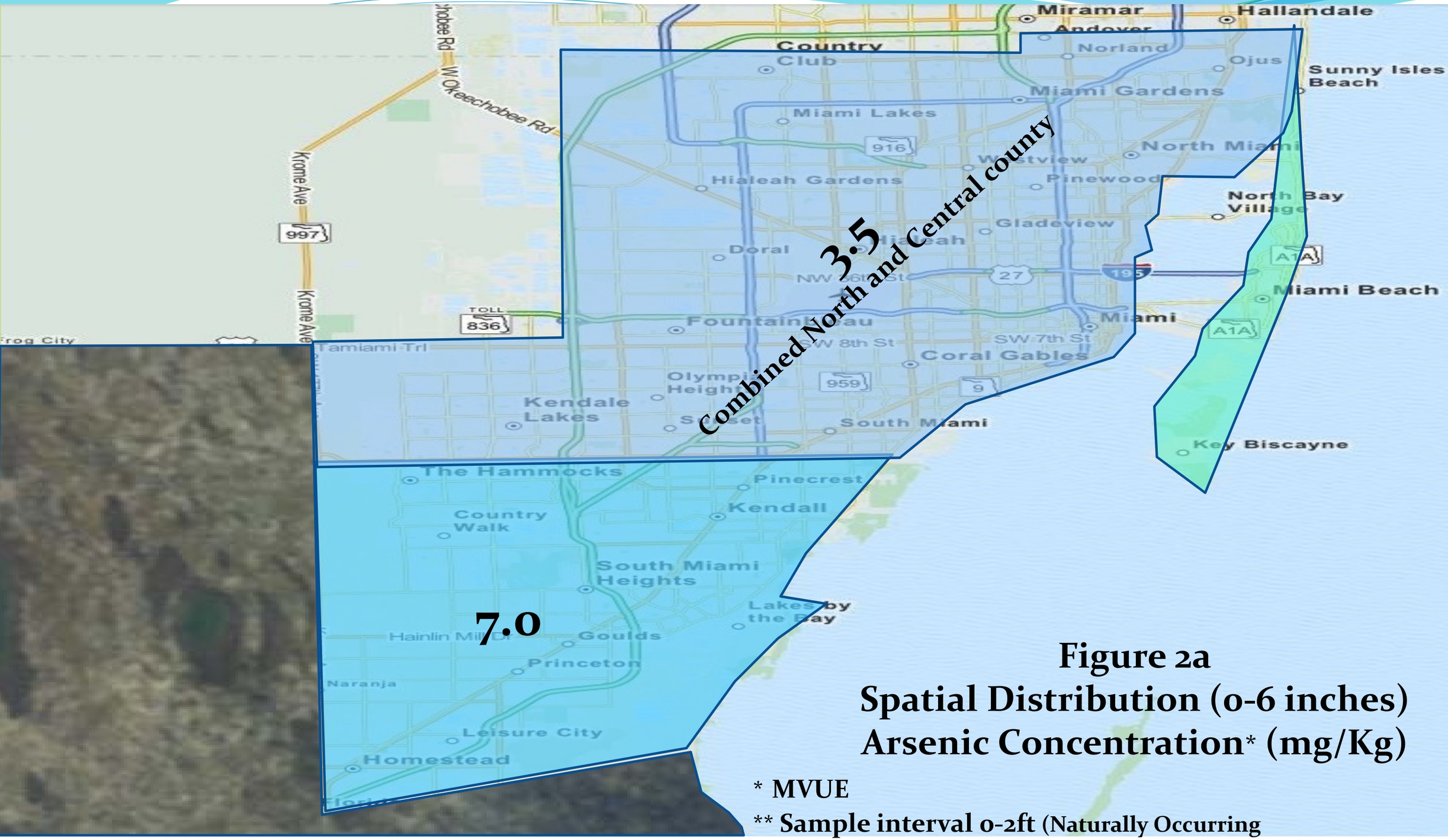


Figure 2a
Spatial Distribution (0-6 inches)
Arsenic Concentration* (mg/Kg)

* MVUE

** Sample interval 0-2ft (Naturally Occurring Background Concentrations)

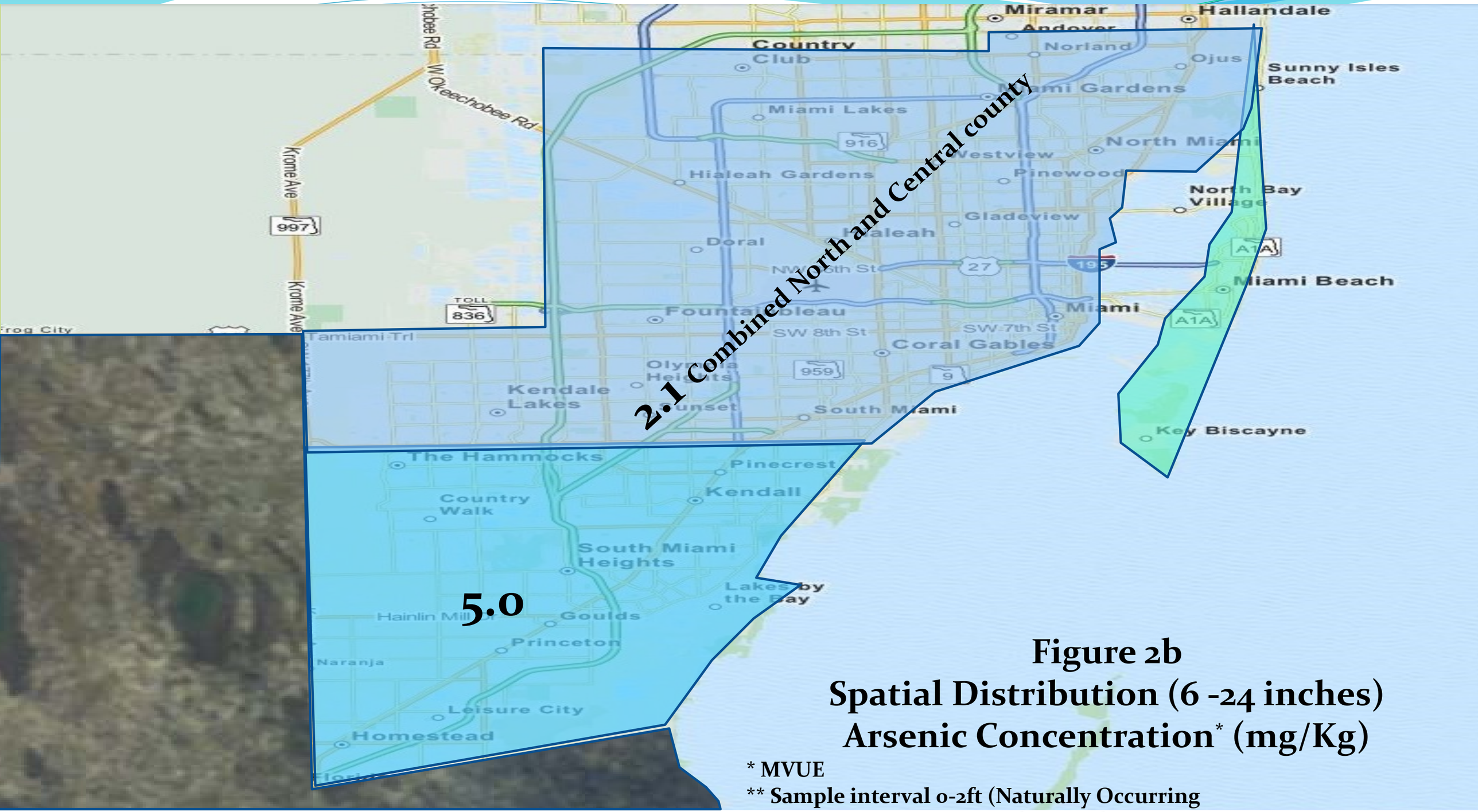


Figure 2b
Spatial Distribution (6 -24 inches)
Arsenic Concentration* (mg/Kg)

* MVUE
** Sample interval 0-2ft (Naturally Occurring Background Concentrations)

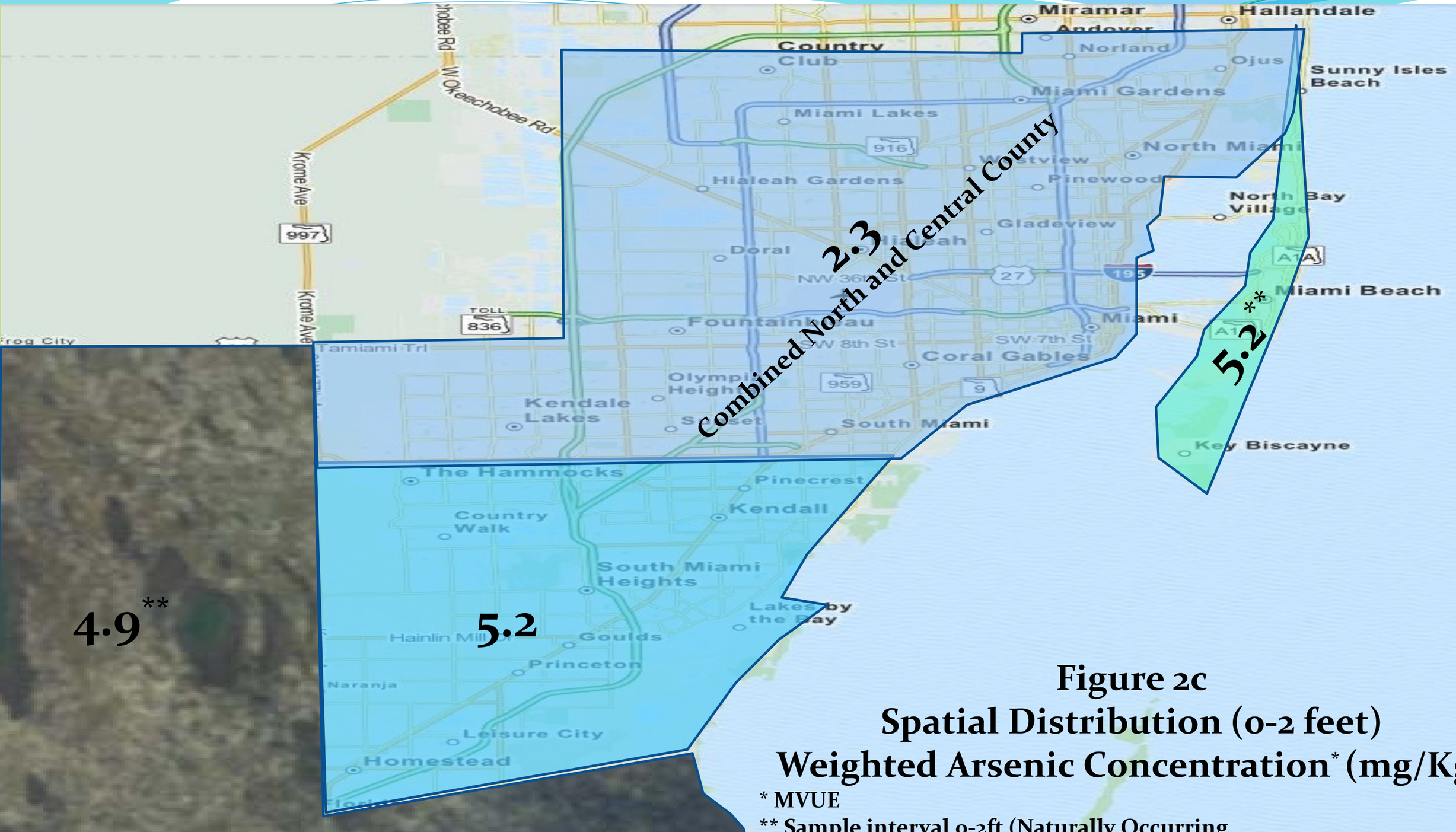
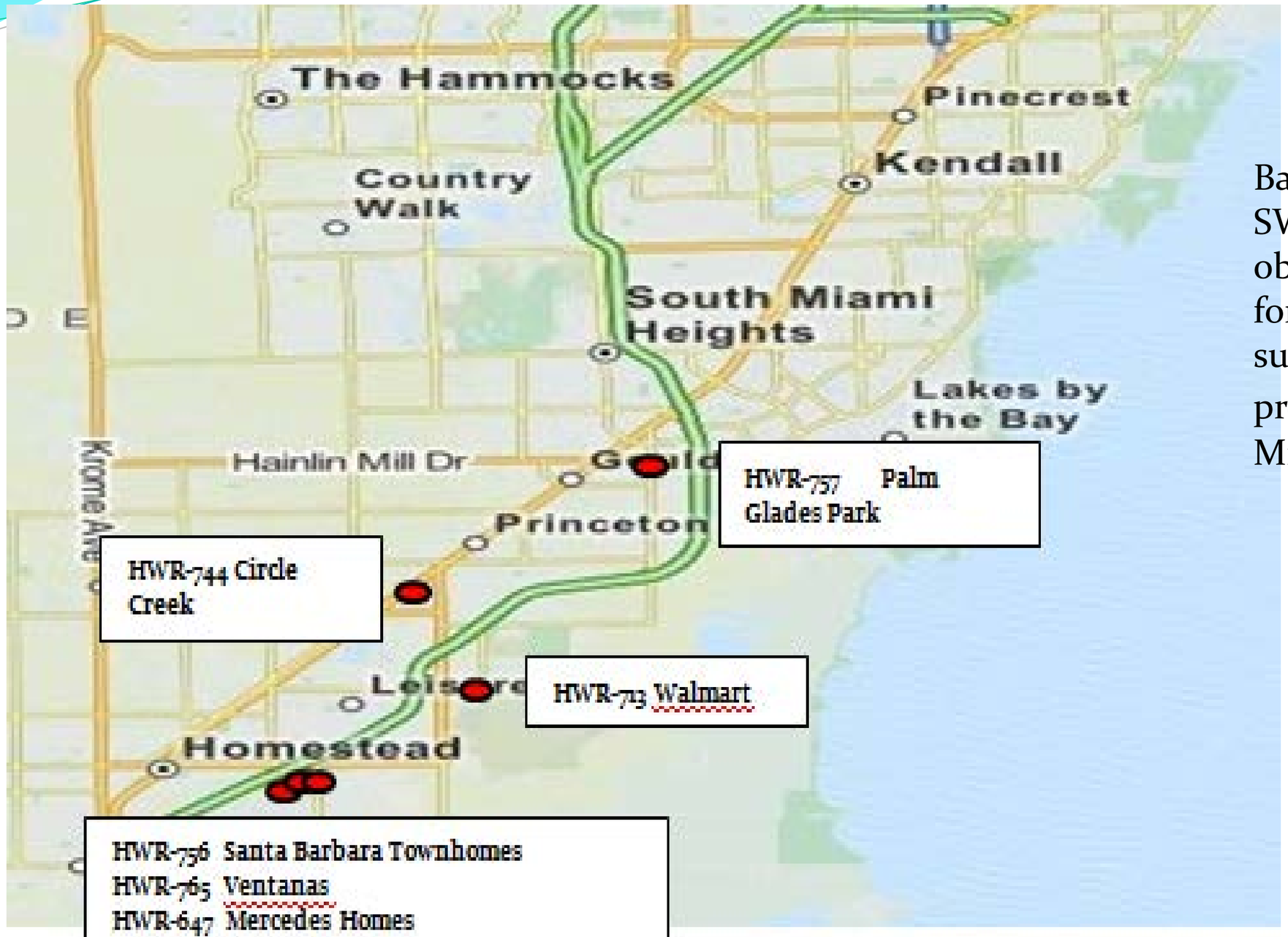


Figure 2c
Spatial Distribution (0-2 feet)
Weighted Arsenic Concentration* (mg/Kg)

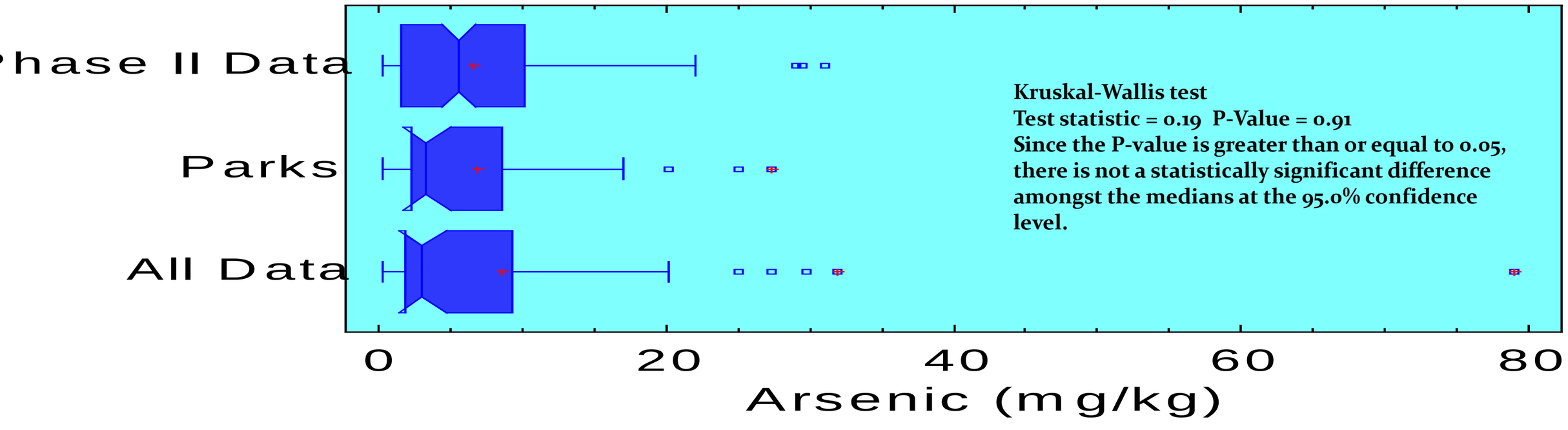
* MVUE
** Sample interval 0-2ft (Naturally Occurring Background Concentrations)

Former Agricultural Sites Phase II

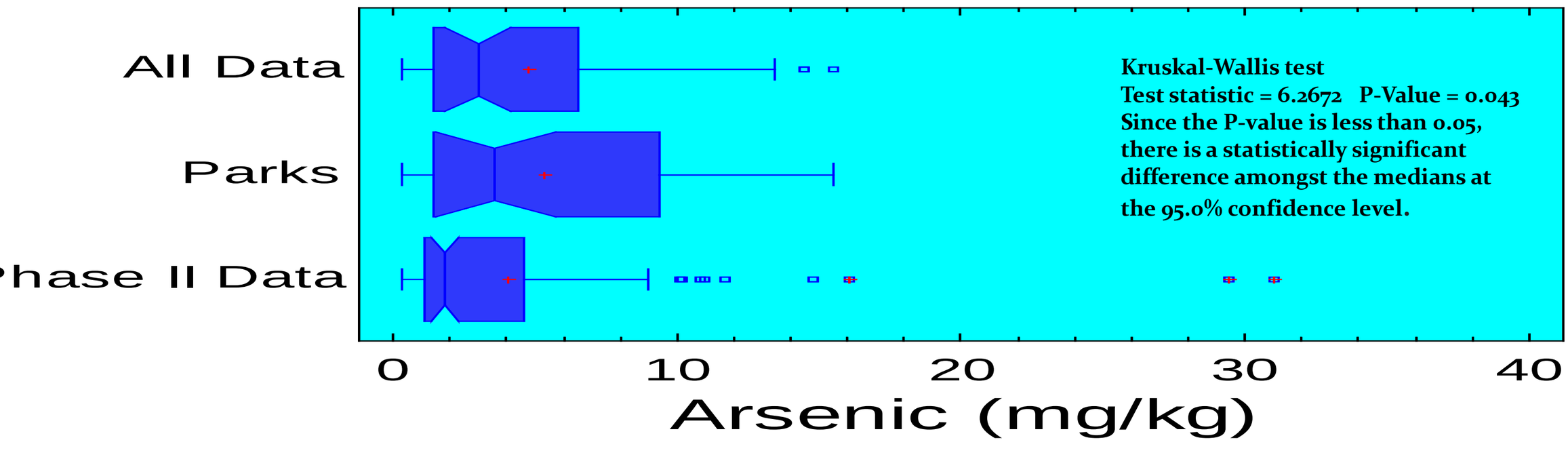


Background data for the area south of SW 88th Street compared to data obtained from DERM's records for Phase II Environmental audits submitted for former agricultural properties located in south west Miami Dade County.

Arsenic Distribution South of Kenda



Arsenic Distribution South of Kendall (6 to 24



PAHs

VERTICAL PROFILE

Concentration gradient
Overall higher concentrations at 0-6 inches

LAND USE

Soil concentration in soils from library sites consistently higher than other land uses

SPATIAL DISTRIBUTION

No spatial trends observed

Vertical Profile

Table 3: MIAMI-DADE COUNTY ANTHROPOGENIC BACKGROUND STUDY
BaPTE SUMMARY STATISTICS

	BaPTE		
	0 - 6"	6 - 24"	0-2 ft*
Number of Samples	146	143	140
Minimum	0.01	0.01	0.01
Maximum	1.38	1.79	1.5
Mean	0.13	0.09	0.1
MVUE	0.14	0.07	0.11
95% UCL	0.2	0.13	0.13

Concentrations in mg/kg

Outliers removed for data analysis

* Weighted Concentration

Land Use Data

	Parks		Residence		Library	
	0-6 in	6-24 in	0-6 in	6-24 in	0-6 in	6-24 in
N	113	109	18	15	15	15
MEAN	0.1	0.1	0.1	0.04	0.37	0.19
MVUE	0.1	0.07	0.1	0.04	0.43	0.19
95% UCL	0.15	0.12	0.22	0.11	1.15	0.52
% Exceed RCSTL	16.8	9.2	16.6	6.6	66	33
Distribution						

- Significant difference between data from libraries when compared to Parks and residences. The difference is indicated at both sampling intervals

Key Site Specific Factors to Consider when Evaluating Potential Subregional Anthropogenic Background Impacts …

Notwithstanding the background data just presented it is critical to understand the site

- Historical land use and former sources
- Historical aerials: former quarries or lakes
- Fill sources
- Adjacent canals sediment quality
- Flooding history
- Lithology of the site and surrounding areas
- Elevation of the site and adjacent properties, roads, swales drainage
- Current use and potential sources
- Horizontal and vertical distribution of the chemicals
- and so much more ….

Report

- April 3, 2014

Miami-Dade County releases background soil concentration report:

http://www.miamidade.gov/environment/library/reports/2014-anthropogenic-background-study.pdf