BEST PRACTICES FOR LARGE-SCALE URBAN LEAD INVESTIGATIONS: CHATTANOOGA CASE STUDY

EPA REGION 4

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R4 LEAD-CONTAMINATED SOIL INVESTIGATIONS

Region 4 has been involved in several large-scale urban lead soil investigations

Drawing from these experiences, we've worked to:

- Develop best practices for collecting soil samples
- Develop, field test, and improve XRF capabilities for analyzing soil
- Better understand urban background conditions
- Document, share, and improve our approaches

FORMER CHATTANOOGA FOUNDRIES

60+ foundries historically located in Chattanooga.

Foundries generated spent sand and baghouse dust over many decades.

FORMER CHATTANOOGA FOUNDRIES

PREVIOUS EPA INVOLVEMENT

- 2011: resident presented at ER with lead poisoning
- 2011: EPA removal assessment
- 2012-2013: EPA removal at 84 residences in Read Avenue area
- Limited geographic area
- Extent of contamination beyond removal areas (if any) unknown

UNFINISHED BUSINESS?

During removal action, EPA became aware that additional areas may be similarly impacted

- Recon
- Anecdotal

TDEC raised concerns about lead-contaminated foundry waste potentially located in other residential areas

- TDEC data from Brownfields and local development projects, state voluntary oversight program

Tennessee Department of Health data indicating a *relatively* high % of children with elevated blood lead *(in some neighborhoods compared to surrounding areas)*.

Is there a "CERCLA release" (vs. anthropogenic background)?

Can this situation be addressed under CERCLA?

What is the potential scope and severity? (Is Pb <u>everywhere</u>?)

Is this a removal or remedial situation?

QUESTIONS: POTENTIALLY LARGE URBAN LEAD SITE

OBJECTIVES OF THE SITE INVESTIGATION

Establish urban Pb background levels

Identify sampling locations

Collect data to support decisions:

- Identify need for time-critical removal
- Determine eligibility for NPL (HRS scoring)
- “Rule in” or “rule out” each area for further response

Utilize SI data for ER, Risk Assessment and future RI (avoid resampling yards)

Use best practices in sample collection, preparation, analysis

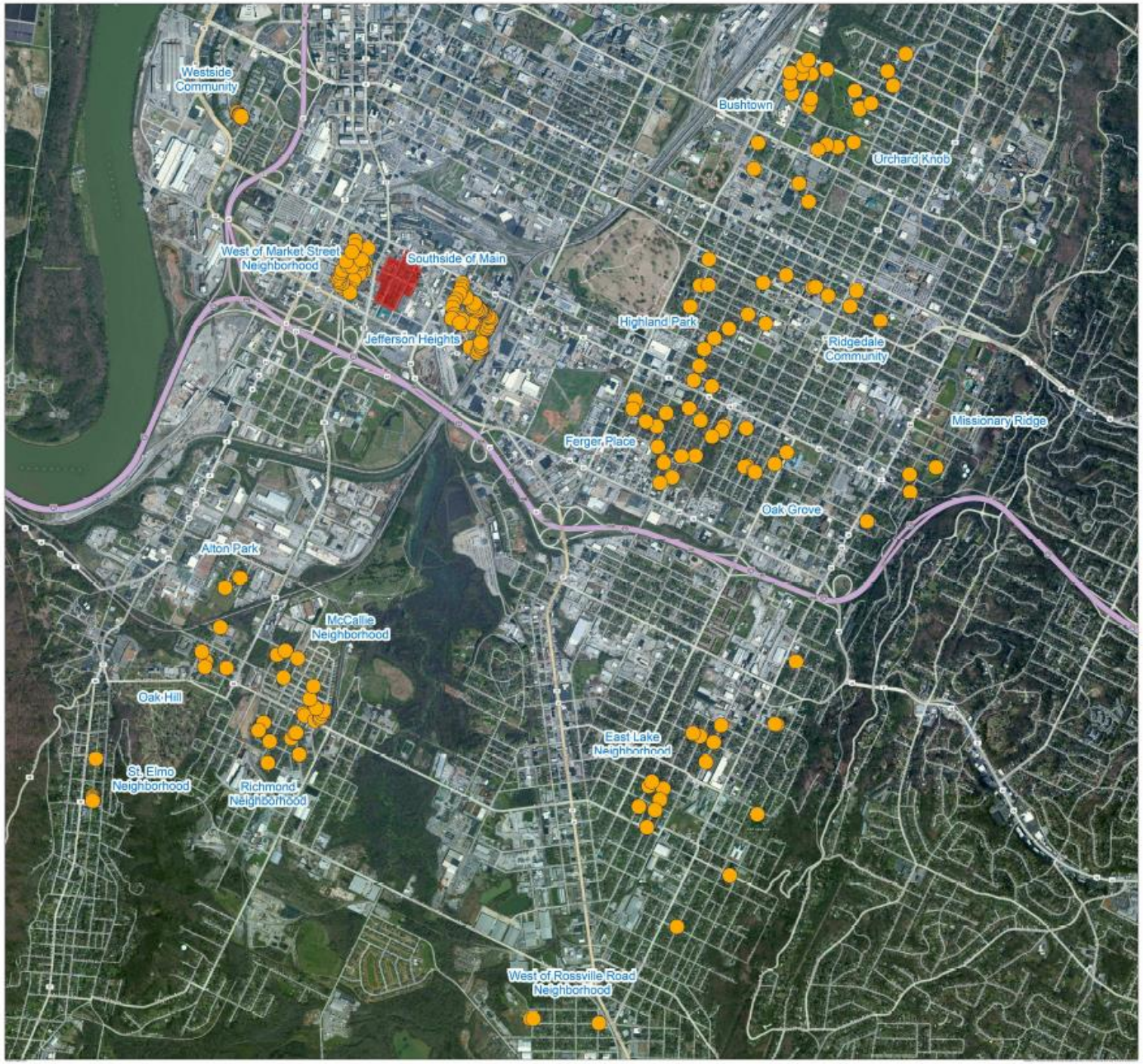
SELECTING STUDY AREAS

Analyzed information from several sources:

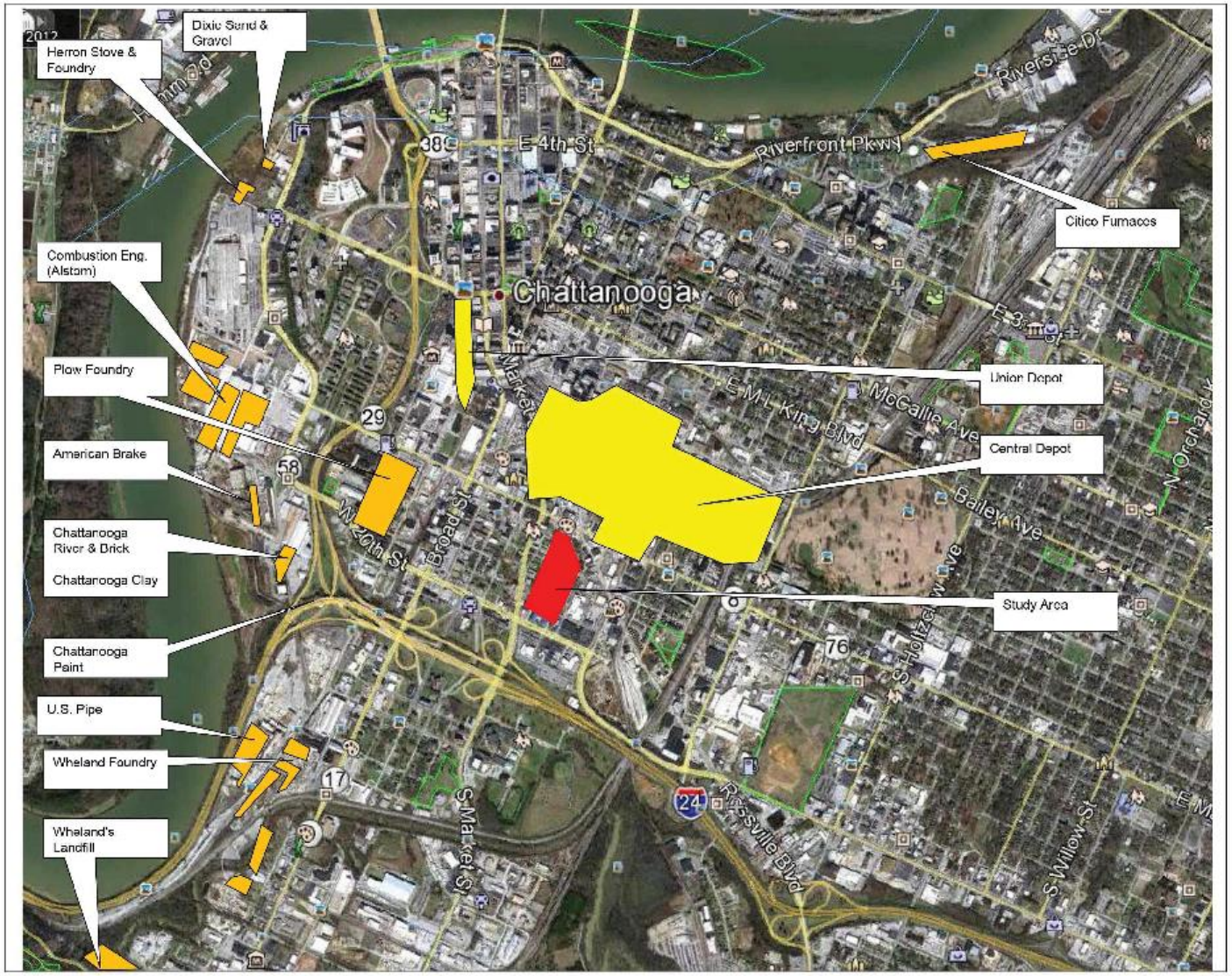
- TDEC data
- EPA data from previous studies
- Historical figures; foundries
- Department of Health blood lead information
- Demographic and census data

DOWNTOWN CHATTANOOGA

EXISTING DATA



Historical Information



Legend

- Area of Concern
- Historical Industries
- Rail Yards and Depots

SOURCE: MODIFIED FROM Google Earth 2012

Disclaimer: This map is intended for visual orientation use only. In no way is this map to be used for precise locational use.

United States Environmental Protection Agency

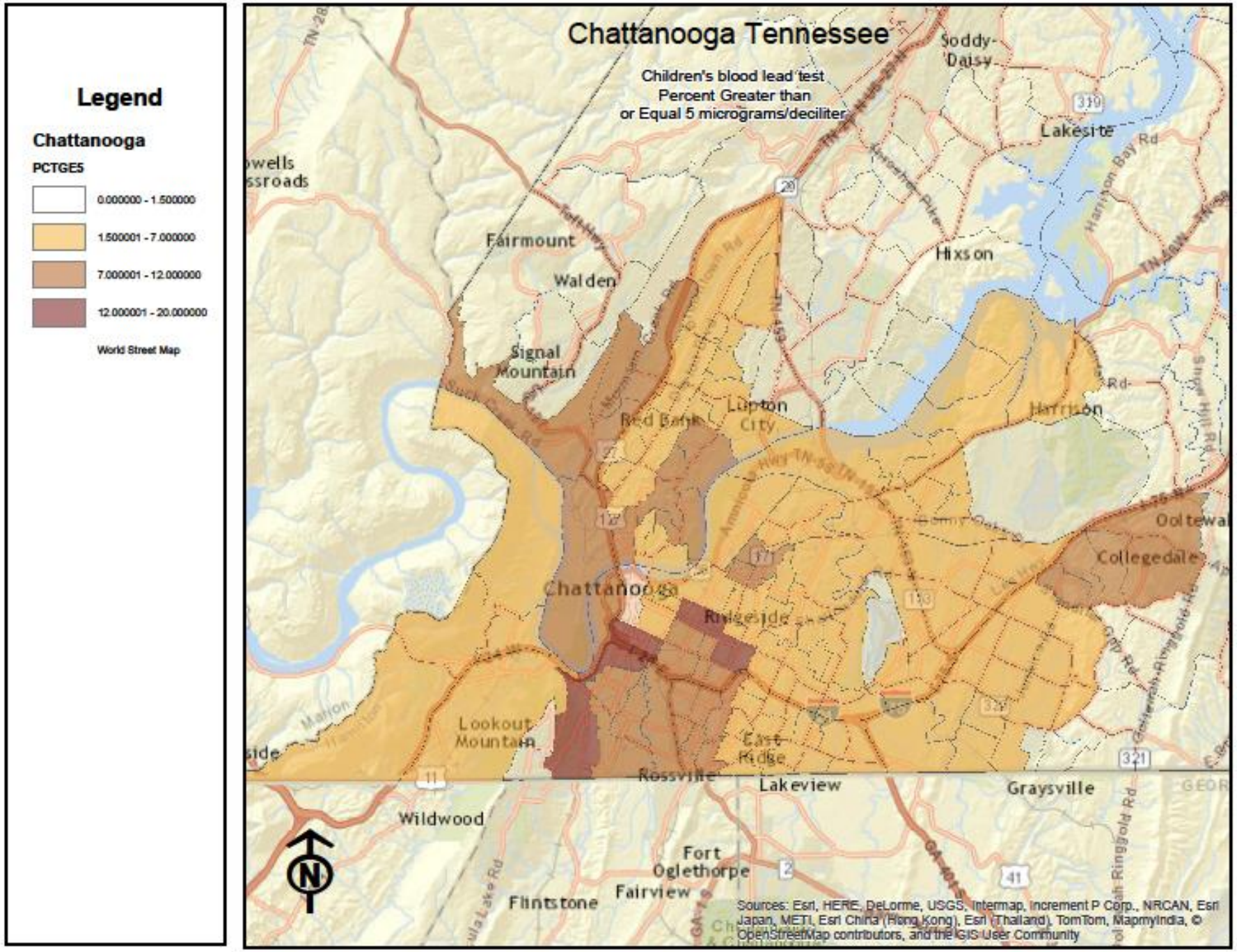
Read Avenue Lead Removal
Chattanooga, Hamilton County, Tennessee
TDD No. TNA-05-001-0173

FIGURE 1
Historical Industries

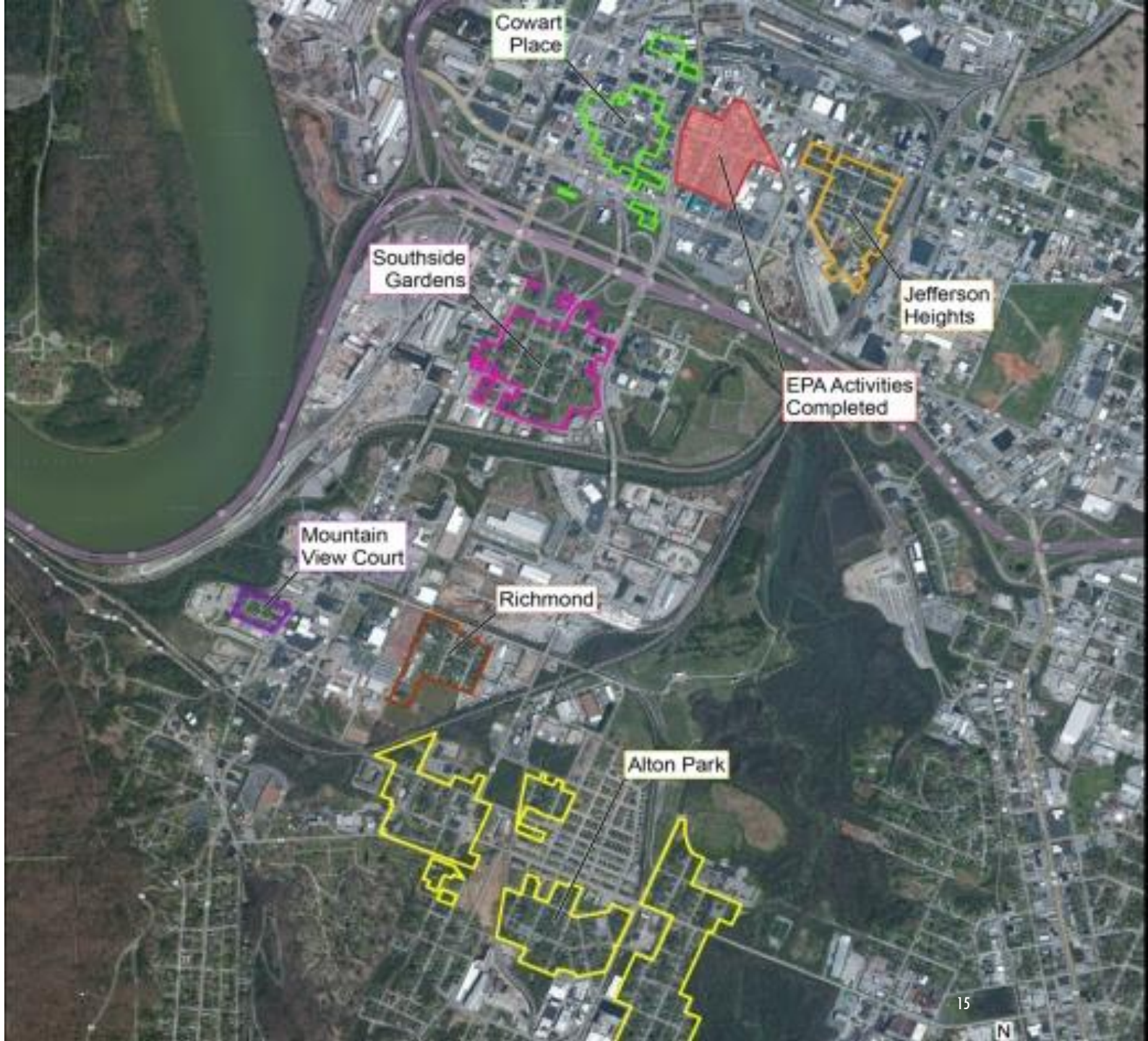
OTIE

ADD CENSUS TRACTS

BLOOD LEAD LEVELS BY CENSUS TRACT



RESULT: IDENTIFICATION OF SEVEN PRIORITY AREAS



ESTABLISH CHATTANOOGA URBAN BACKGROUND LEVEL FOR LEAD

- Used SAP/QAPP template from larger R4 urban background study
- 5x5 mile grid; 50 randomly selected cells
- Excluded flood plain areas, study areas, known industry
- Piloted “best practices sampling and analytical” methods

BEST SAMPLING & ANALYTICAL PRACTICES

Sought lessons learned from similar Region 4 sites

Sought lessons learned from other regions

- Region 8 – Pueblo Smelter Site
- Region 10 – Bunker Hill Site

Considered new OLEM Guidance

- Sieving
- *In Vitro* Bioavailability

Considered draft Region 4 XRF Field Operations Guide

OLEM LEAD SIEVING DIRECTIVE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUL 1 - 2016

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE
NOW
OFFICE OF LAND
AND EMERGENCY
MANAGEMENT

MEMORANDUM **OLEM Directive 9200.1-128**

SUBJECT: Recommendations for Sieving Soil and Dust Samples at Lead Sites for Assessment of Incidental Ingestion

Recommendations for Sieving Soil and Dust Samples at Lead Sites for Assessment of Incidental Ingestion

OLEM LEAD SIEVING DIRECTIVE

- Lead TRW recommends < 150 µm particle size.
- Incidental ingestion greater for fine particles.
- Dermal adherence greater for fine particles.
- Increased contaminant concentration, mobility, and bioavailability in fine particles.

DERMAL ADHERENCE

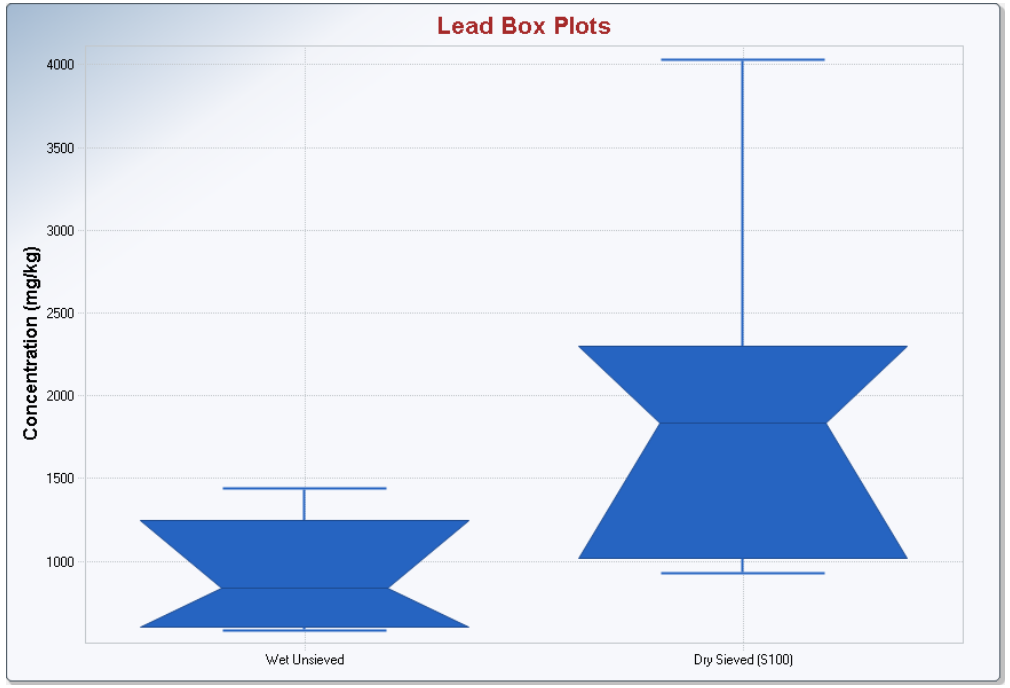
SIEVE OF STACKED MESH (#10 AND #100)

DISAGGREGATION AND DRYING

FINE FRACTION <150 MICRONS

FOUNDRY SAND: SIEVED VS UNSIEVED

Unsieved	Sieved
603	1016
837	1832
1434	4021
1245	2300
591	936



FIELD FUME HOOD

SAMPLE COLLECTION: INCREMENTAL SAMPLING METHODOLOGY (ISM)

Why ISM?

Superior method to derive an unbiased estimate of the mean concentration of a given area (i.e. yard)

One ISM sample is collected for each yard (yard = exposure unit)

Each sample is comprised of 30 same-sized aliquots, and produces one result that represents the entire yard

Statistically defensible data on which to base decisions

COLLECTING SAMPLES: TIME & EFFORT

One 30-point sample from a residential yard takes about 8 minutes to collect

ANALYSIS: R4 XRF FIELD OPERATING GUIDE (FOG)

Standardized methodology for collecting high-quality field data

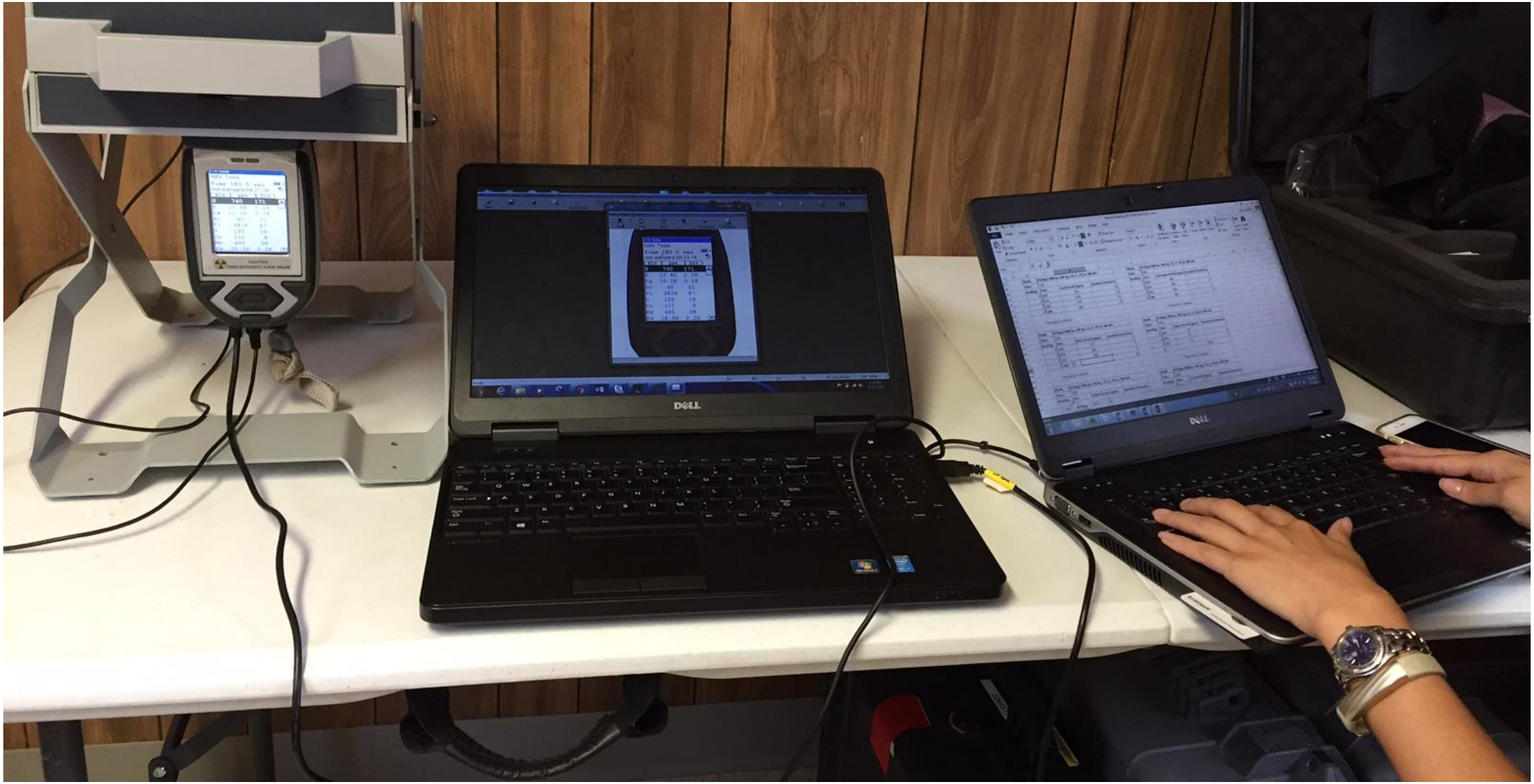
Generates real time QA/QC measures

Provides real-time data

Multiple readings lead to reproducible results (especially in conjunction with sieving protocols)

https://www.epa.gov/risk/regional-4-superfund-x-ray-fluorescence-field-operations-guide

Soil Moisture Meter
POWER
HOLD
REC
GENERAL
DSMM500


DELL
DELL

DU or Bag ID: Cell 70 S100 **Element:** **As**

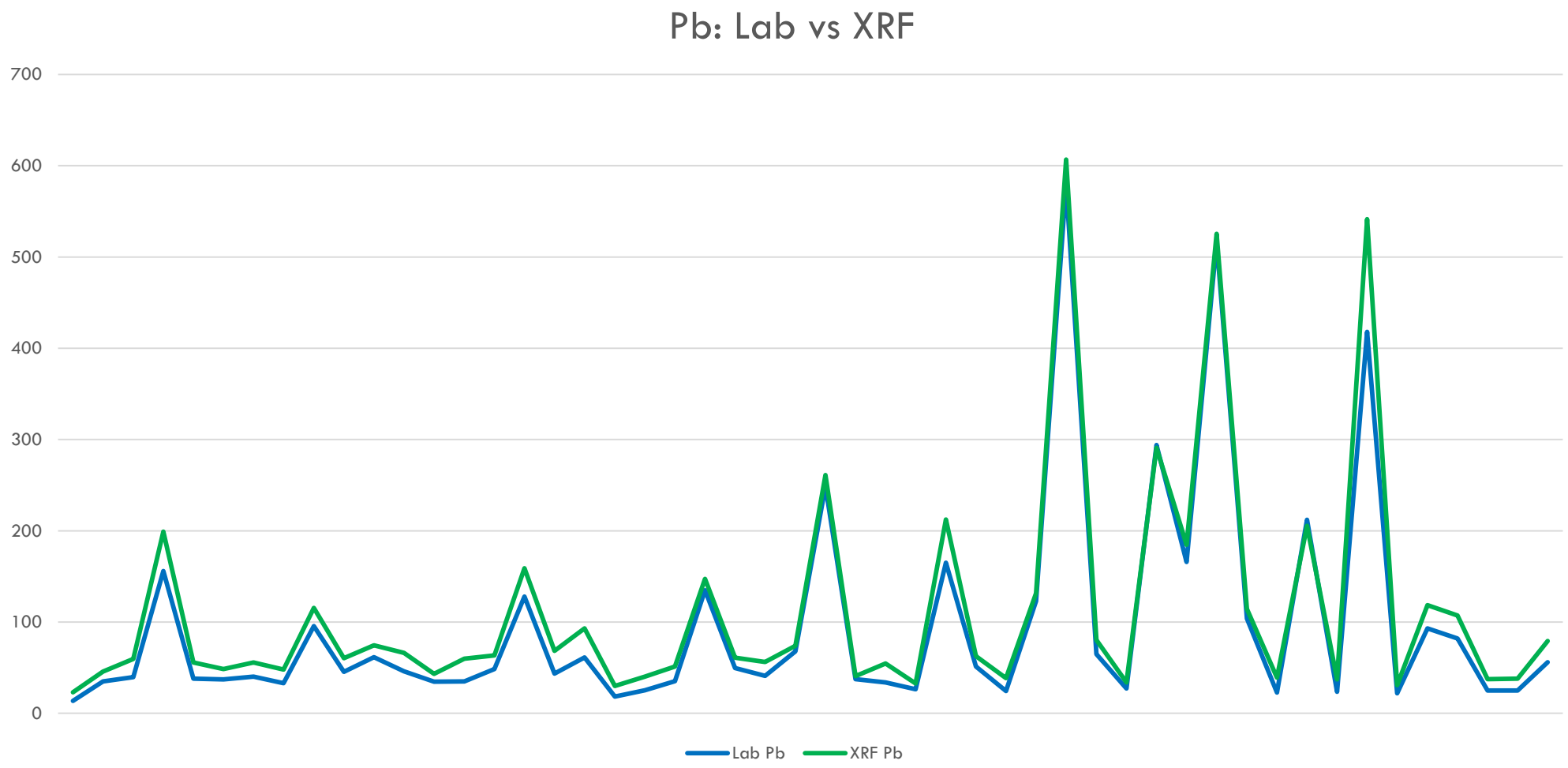
Replicate Bag Readings	Time	Run Time (sec)	Instrument Result (ppm)	Instrument Error (as 1 Std Dev)	Note?
1	1120	30	12		LOD
2	1123	30	16	8	
3	1129	30	14	8	
4	1132	30	13	8	
5 (optional)					
6 (optional)					
7 (optional)					
8 (optional)		#REF!			
9 (optional)		#REF!			
10 (optional)		#REF!			
		Mean	13.8		
		SD	1.71	**Ttl %RSD**	12.4
		n =	4		
		ProUCL distribution =		(optional)	
	2-sided	Sample 95% t-LCL =	11		
	2-sided	Sample 95% t-UCL =	16		
	1-sided	Sample 95% t-LCL =	12		
	1-sided	**Sample 95% t-UCL =**	16		
	1-sided Smple 95% Chebyshev LCL =		10		
	1-sided Smple 95% Chebyshev UCL =		17		
		instrument error =		58.18	as %RSD

DU or Bag ID: Cell 70 S100 **Element:** **Pb**

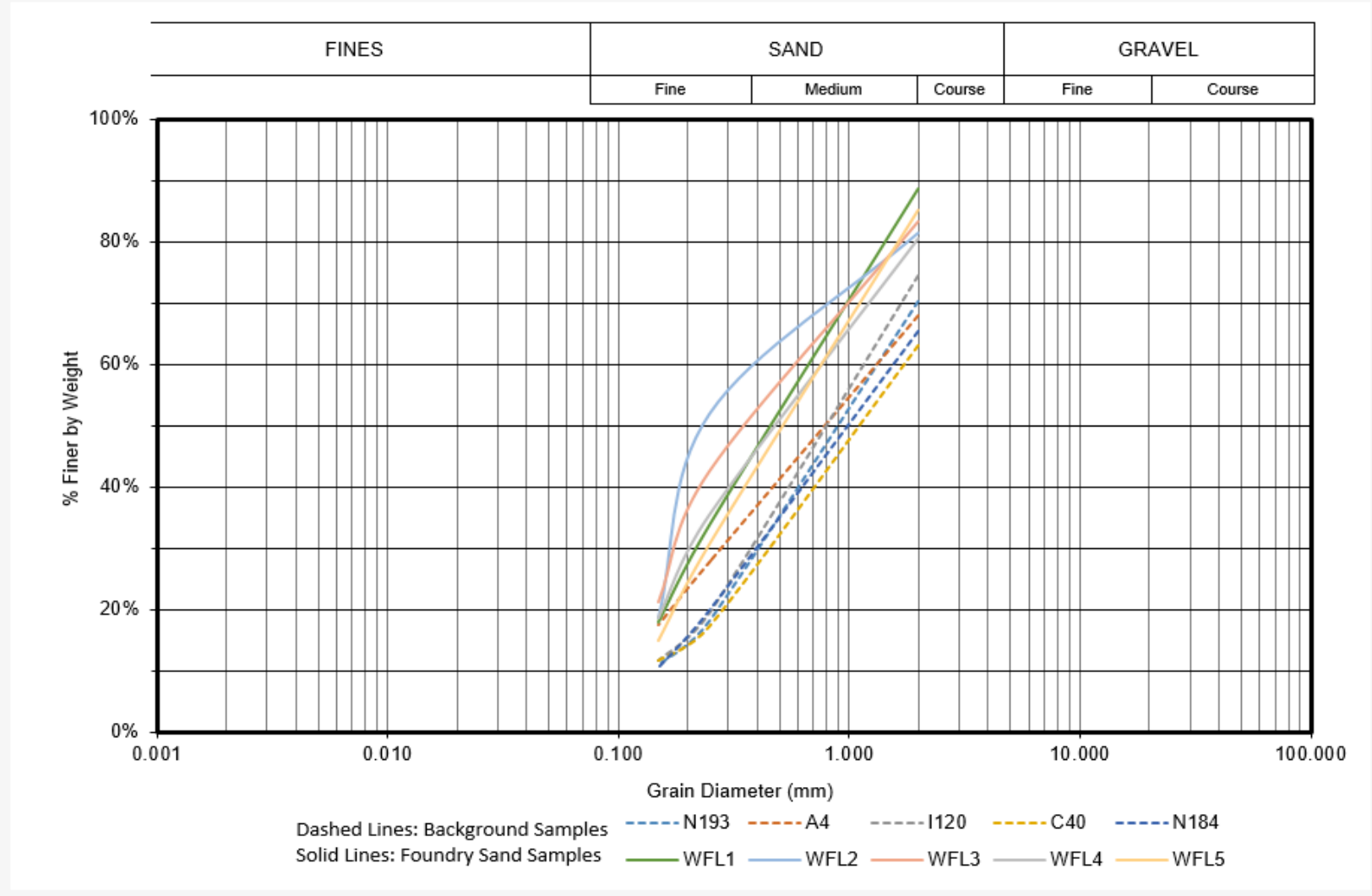
Replicate Bag Readings	Time	Run Time (sec)	Instrument Result (ppm)	Instrument Error (as 1 Std Dev)	Note?
1	1120	30	257	11	
2	1123	30	239	10	
3	1129	30	248	11	
4	1132	30	253	11	
5 (optional)	12:00:00 AM				
6 (optional)	12:00:00 AM				
7 (optional)	12:00:00 AM				
8 (optional)	12:00:00 AM				
9 (optional)	12:00:00 AM				
10 (optional)	12:00:00 AM				
		Mean	246.7		
		SD	7.09	**Ttl %RSD**	2.9
		n =	3		
		ProUCL distribution =			
	-2SD Lower bag limit	Mean - 2 SD =	232.5		
	+2 SD Upper bag limit	Mean + 2 SD =	260.9		
	1-sided	Sample 95% t-LCL =	234.7		
	1-sided	**Sample 95% t-UCL =**	258.6		
	-10% limit	Mean - 10% =	222.0		
	+10% limit	Mean + 10% =	271.3		
		instrument error =		4.36	as %RSD

QA DATA ENTRY IN FIELD

CORRELATION XRF VS LAB DATA: LEAD


Pb: Lab vs XRF
700
600
500
400
300
200
100
0
Lab Pb
XRF Pb

ATTRIBUTION



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MAY - 5 2017

OFFICE OF
SOLID WASTE AND
EMERGENCY RESPONSE

NOW THE
OFFICE OF LAND AND
EMERGENCY MANAGEMENT

MEMORANDUM

SUBJECT: Release of Standard Operating Procedure for an In Vitro Bioaccessibility Assay for Lead and Arsenic in Soil and Validation Assessment of the In Vitro Arsenic Bioaccessibility Assay for Predicting Relative Bioavailability of Arsenic in Soils and Soil-like Materials at Superfund Sites

SOP FOR IN VITRO LEAD AND ARSENIC TESTING RELEASED DURING PROJECT

UNDERSTANDING BIOAVAILABILITY of ARSENIC and LEAD in Soils at Superfund Sites

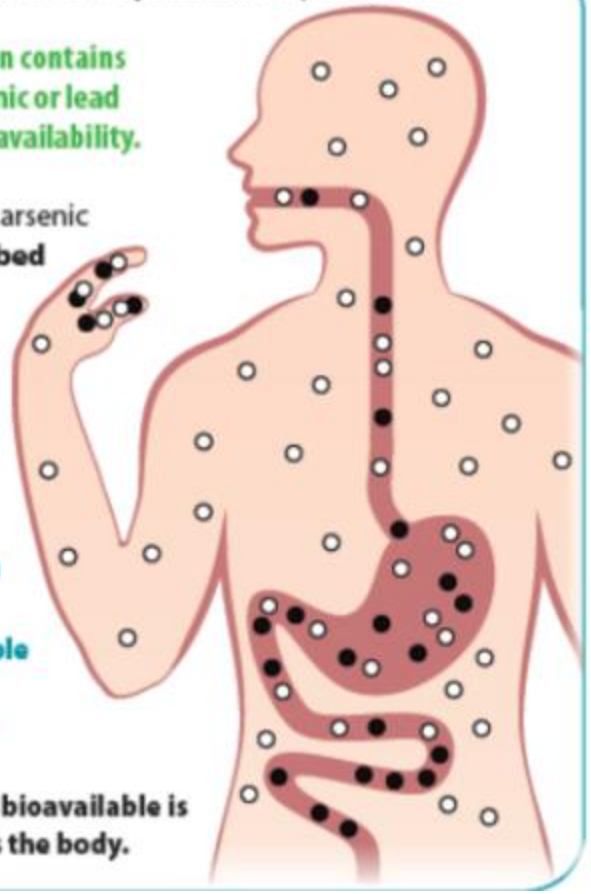
Arsenic and lead present in soil must be bioavailable in order to pose a risk to your health.

Contaminated soil often contains different forms of arsenic or lead that have different bioavailability.

Bioavailable forms of arsenic and lead will be **absorbed into the body and processed or stored** following ingestion of contaminated soil.

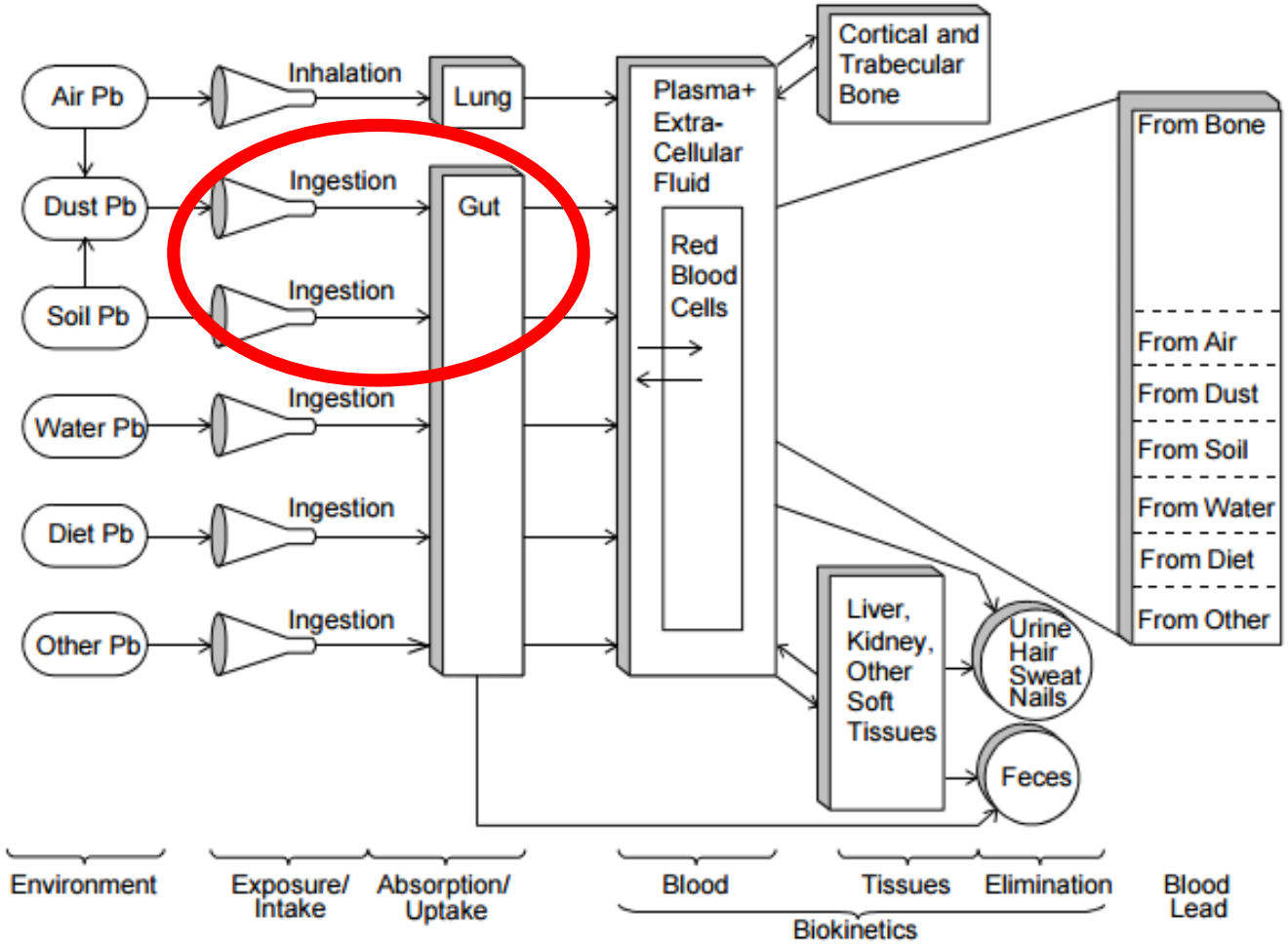
Bioavailable arsenic or lead (light circle ○)

Non-bioavailable arsenic or lead (dark circle ●)



A contaminant that is **not bioavailable is not absorbed, and leaves the body.**

BIOAVAILABILITY INFORMS RISK & CLEAN-UP GOALS



RESULTS AND OUTCOMES

URBAN LEAD BACKGROUND

REGION 4 URBAN BACKGROUND STUDY

An Inter-Agency Research Project

The U.S. Environmental Protection Agency (USEPA) and Southeastern states are conducting a collaborative research project. The purpose of the project is to document background concentrations of selected environmental parameters in surface soils of urban areas of the Southeastern United States. Surface soil, the top two inches of the soil profile, is assumed to be the primary human exposure source via ingestion. The selected parameters are chemicals that are typically found in all urban environments.

Because the goal is to collect a database of the background concentrations of these chemicals, the study is purposefully designed to avoid sampling areas of known or suspected contaminant releases. The intended use of the data collected from this project is to inform and provide context to environmental investigations conducted by USEPA and its State and local partners. The data will be especially useful for providing background information for Brownfields redevelopment projects, Superfund projects, and other environmental restoration projects that aim to restore contaminated property to beneficial reuse.

Cities were selected for inclusion in this research project based upon the input and recommendations of representatives from the participating States. Currently data has been collected for eight cities, but there may be additional sampling efforts performed that may add to this database. In each of the cities, potential sampling locations were identified through use of a sampling grid and a random selection process. The potential sample locations were then vetted to the extent possible to ensure that the sampled locations were representative of background urban conditions. If any locations were thought to be unsuitable for the purposes of the project, they were replaced with the next randomly selected grid cell. A summary presentation and the Sampling and Analysis Plan (SAP) can be obtained by clicking on the "Urban Background Study Webinar" hyperlink below. Explanations of the decision process for selecting sampling locations and the methods employed for sample collection are provided in the SAP. All samples are assumed to represent local background conditions and are assumed to not have resulted from releases from contaminated sites.

A map of the Southeast States and sampled cities is provided under the "Locations" worksheet and can be accessed by hyperlink below. From the "Locations" worksheet, one can then access a data summary for "All Cities" or individual city data summaries and sampling grid maps.

EPA United States Environmental Protection Agency

Kentucky Energy & Environment Cabinet

TN Department of Environment & Conservation

dhec Healthy People. Healthy Communities.

ADEM Alabama Department of Environmental Management

North Carolina Environmental Quality

Florida Department of Environmental Protection

MDEQ

GEORGIA Department of Natural Resources

Urban Background Study Webinar

Locations

Additional Information:
Tim Frederick
USEPA Region 4
Superfund Division
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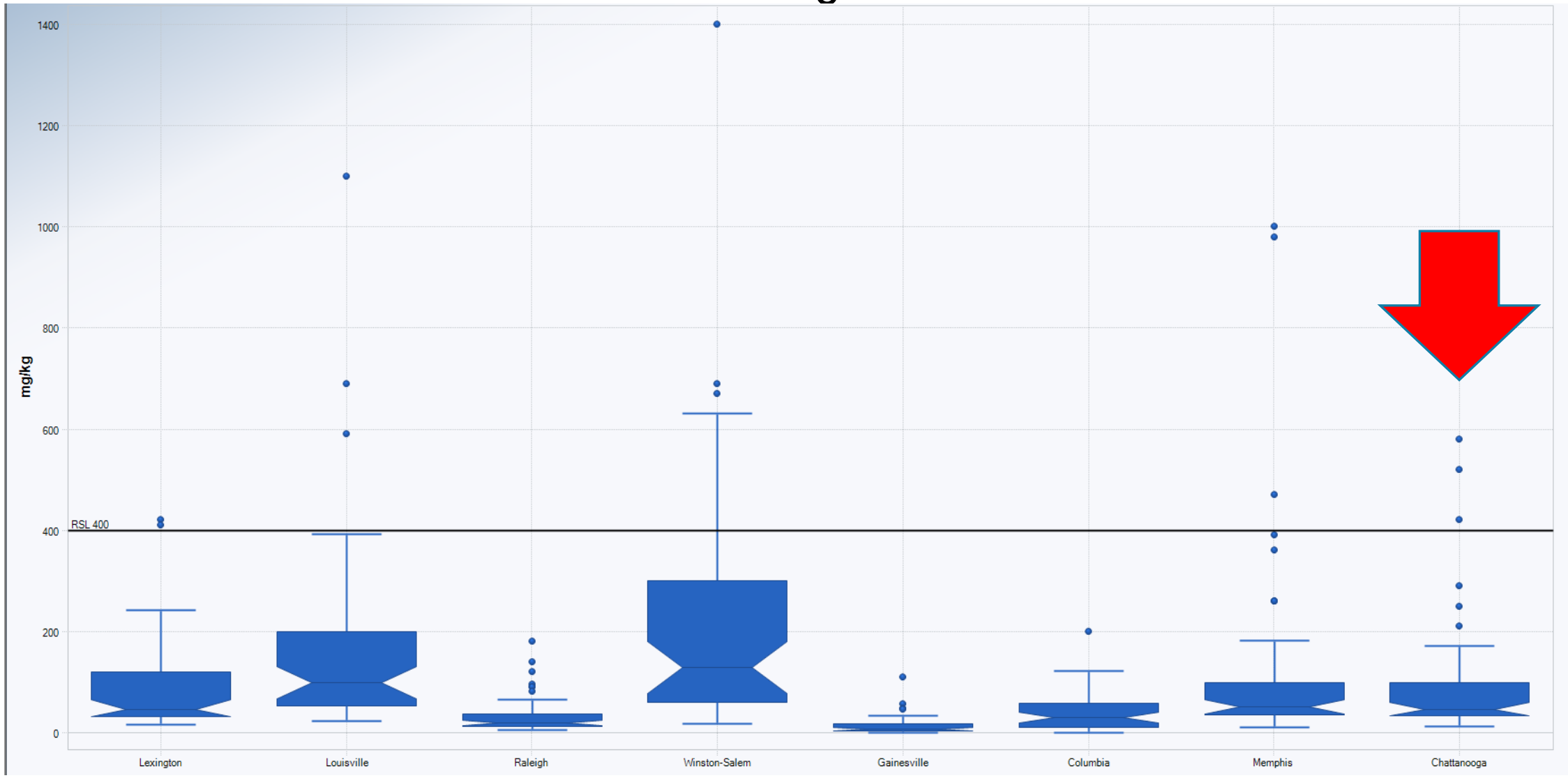
Lead Urban Background Results



XRF USE GOING FORWARD

XRF provides reliable, reproducible & defensible data for this project (n = 300+)

XRF will be used for decision making at the site going forward with minimal laboratory confirmation

Additional efforts to streamline process tested & implemented

Lessons learned used to revise the FOG

LEAD BIOAVAILABILITY

33 soil samples were analyzed for lead bioavailability

IEUBK default BA = 30%

Chattanooga site soils BA = 29-50%; avg. = 36%

↑BA will ↓health-based remedial level

Site specific cleanup levels: < 400 ppm to *well below background levels*, depending on target blood lead level used in model: 360 ppm

SAMPLING COLLECTION AND PROCESSING

- ISM has been adopted by the team as the method for sample collection
- All samples are dried before analysis by XRF
- Developed protocol to determine when sieving is necessary going forward (greatly reduces field effort)

PROJECT STATUS

- Time-critical removal action to address worst yards first (tiered approach used to prioritize residences);
- SI complete;
- Determined to be eligible for the National Priority List and listed in 2017
- Data was used in the Remedial Investigation and Baseline Risk Assessment
- Field methods used in SI refined/improved and continued into RI phase

Historical Sampling (Through Dec 2018)
Summary Table
Southside Chattanooga Lead Site

Neighborhood	Total Yards	Sampled Yards As of 12/12/18	Yards to Sample As of 12/12/18	Properties > 360 ppm	Properties > 1200 ppm
Alton Park	566	265	301	70	2
Cowart Place	232	43	189	15	0
East Lake	1267	36	1231	8	1
Highland Park	857	166	691	99	18
Jefferson Heights	170	123	47	27	16
Oak Grove	327	49	278	24	0
Richmond	55	28	27	10	0
Southside Gardens	145	62	83	20	2
Totals (To Date)	**3619**	**772**	**2847**	**273**	**39**

SOUTHSIDE CHATTANOOGA TEAM MEMBERS

Cathy Amoroso & Robenson Joseph, RPMs

John Nolen, RPM, TN Coordinator

Perry Gaughan, On-scene Coordinator

Kevin Koporec, Human Health Risk Assessor and Lead TWG

Tim Frederick, Scientific Support Section (XRF FOG; Urban Bkg)

Sydney Chan, Human Health Risk Assessor, XRF FOG, Urban Bkg, and Bioavailability TRW

Glenn Adams, Chief, Scientific Support Section

Stephanie Brown and Ron Tolliver, CICs

Region 4 SESD analytical laboratory

Region 4 START contractor (Tetra Tech, Inc.)

Troy Keith, Tennessee Department of Environment & Conservation

Rebecca Gorham, Tennessee Department of Health

Jennifer Wendel, OSRTI

Matt Jefferson, TIFSD

QUESTIONS

Tim Frederick

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