Preliminary Estimate Distribution of Exide's Lead Emissions in Soil

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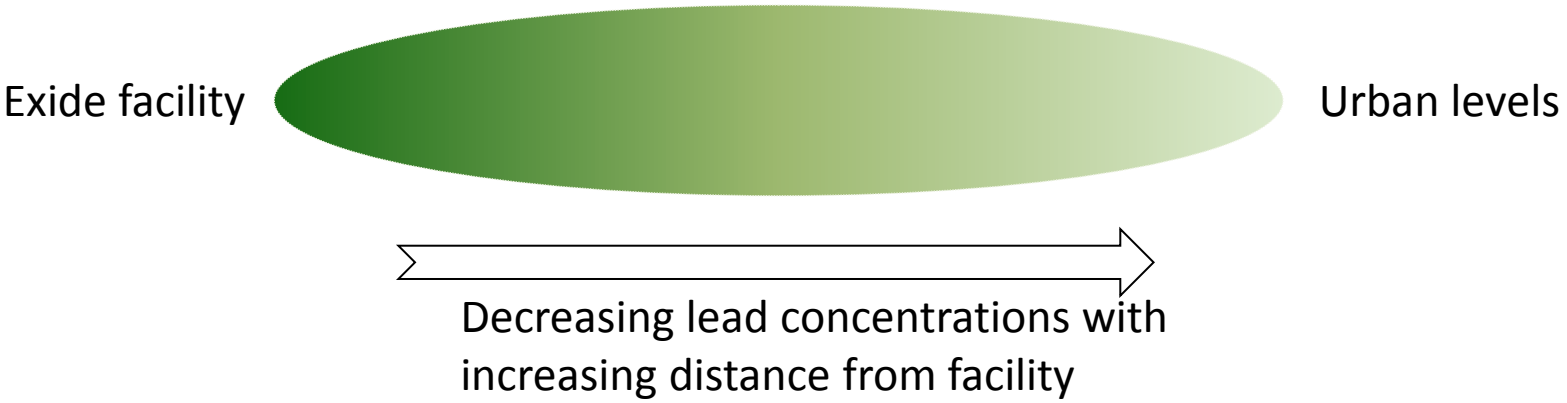
Preliminary

Preface

- Goal: Assess and document distribution of Exide's lead emissions in soil
  - Data evaluation approach is different from methods used to assess risk to human health and the environment.
  - Rather, looking for distance from Exide facility at which Exide's lead emissions are no longer present
- Findings presented today are preliminary.
  The evaluation is on-going.
- Based on data evaluation approach to be presented here, preliminary estimates show distribution of Exide's emissions beyond initial Assessment Area

Preliminary

Conceptual Site Model for Distribution of Exide's Lead Emissions in Soil



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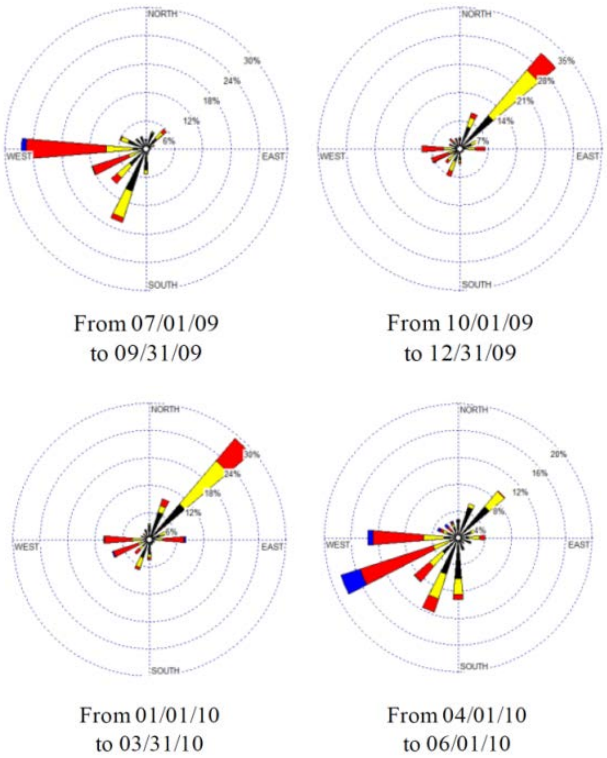
Conceptual Site Model for Distribution of Exide's Lead Emissions in Soil



Source: SCAQMD, 2012, Ambient Measurements of Air Toxic Pollutants at Resurrection Catholic High School, Final Report, April, 2012.

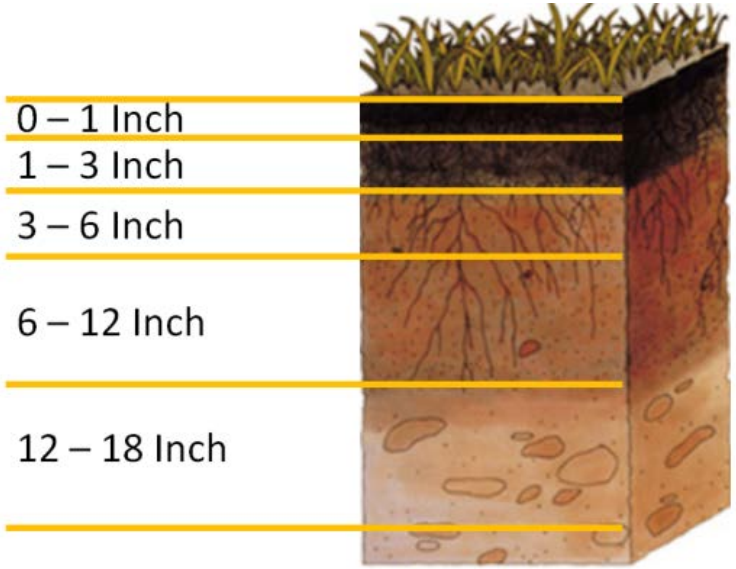
Carried further in downwind directions.

Higher soil lead concentrations expected to the:

- North
- Southwest
- Northeast
- East

Preliminary

Conceptual Site Model for Distribution of Exide's Lead Emissions in Soil



Picture courtesy of Wikipedia

Decreasing lead concentrations with depth

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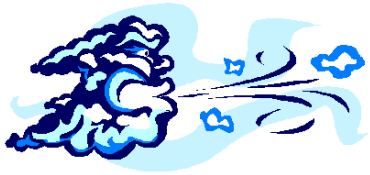
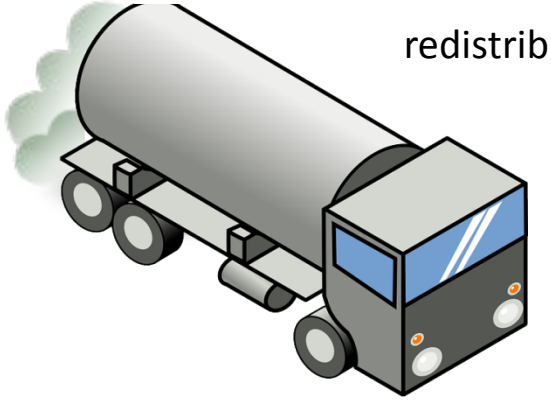
Expected Pattern of Soil Lead Distribution Modified by Activities and Processes in Area

earth work

collection in drip zones





redistribution

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Other Considerations

Table of Contents from USEPA's report entitled
"Sources of Lead in Soil: A Literature Review"
(EPA 747-R-98-001a)

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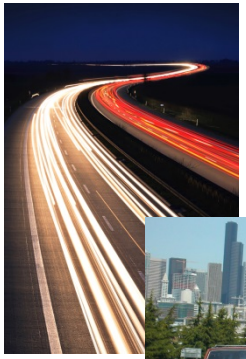

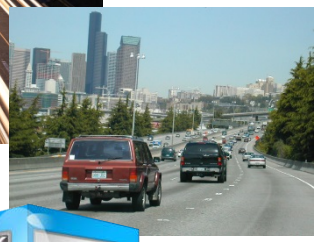

DTSC's focus is holding Exide accountable for its lead emissions in soil.

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Approach for Analyzing Geographic Distribution of Exide's Lead Emissions in Soil

- Let data speak for itself
- Use straightforward data evaluation methods
- Develop multiple lines of evidence to estimate distribution of Exide's emissions
  - Lead
  - Other metals
- Work with 0 to 6 inch depth interval because all data sets were sampled in this interval

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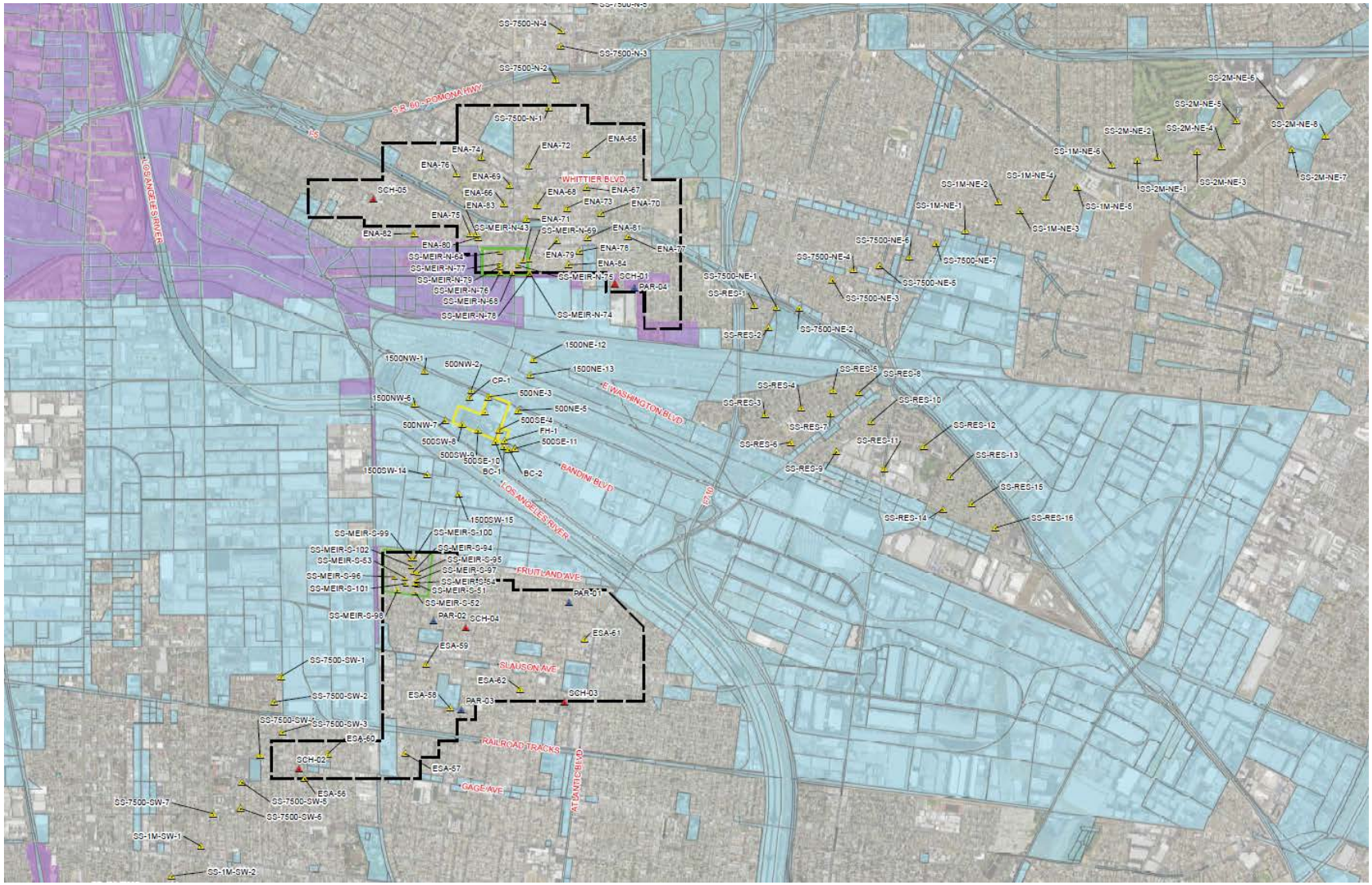
Geographic Distribution of Metals Data



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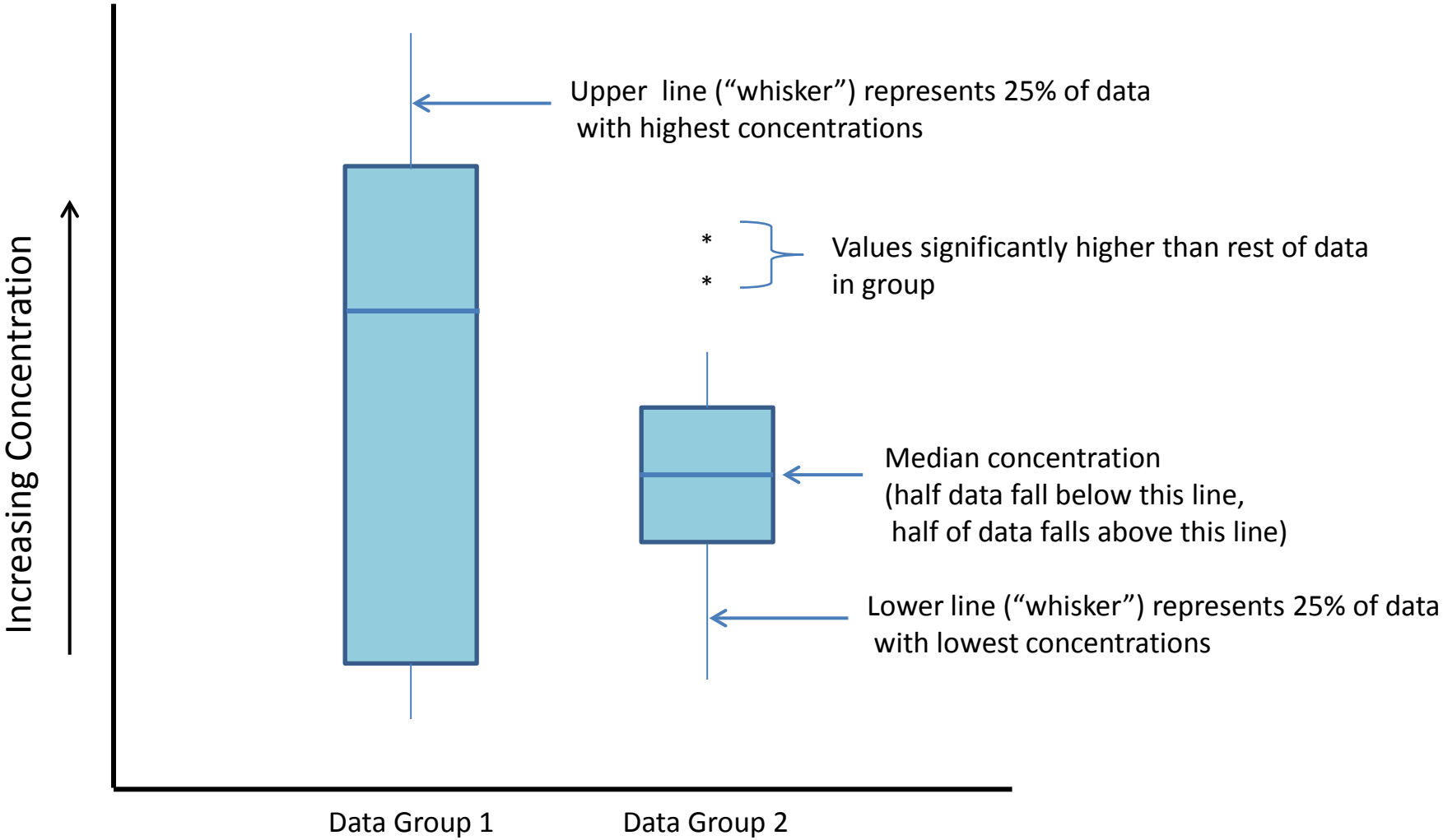
Summary of Soil Lead Data

Statistic	Near	Northern Assessment Area	Northern Expanded Area	Northern Transect	Southern Assessment Area	Southern Expanded Area	Southwest Transect	Northeast Transect	Eastern Area
Median (mg/kg)	280	220	195	130	155	156	110	130	91

Based on all samples collected from 0-6 inch depth interval
"Near" samples collected from facility perimeter and 2,640 feet.
mg/kg is milligrams per kilogram

Preliminary

Example Boxplot



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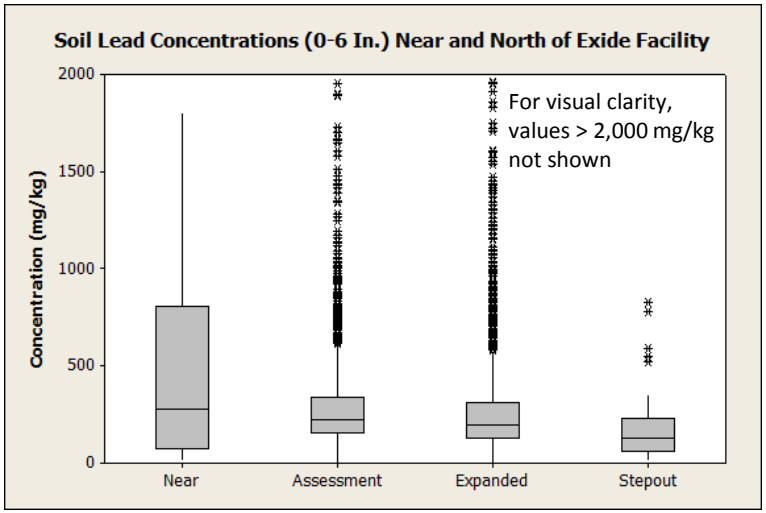
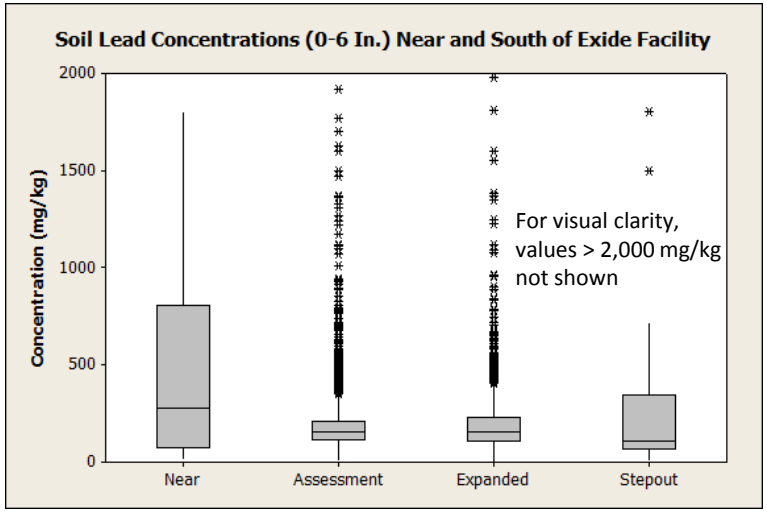
Summary of Soil Lead Data

Near and North of Exide

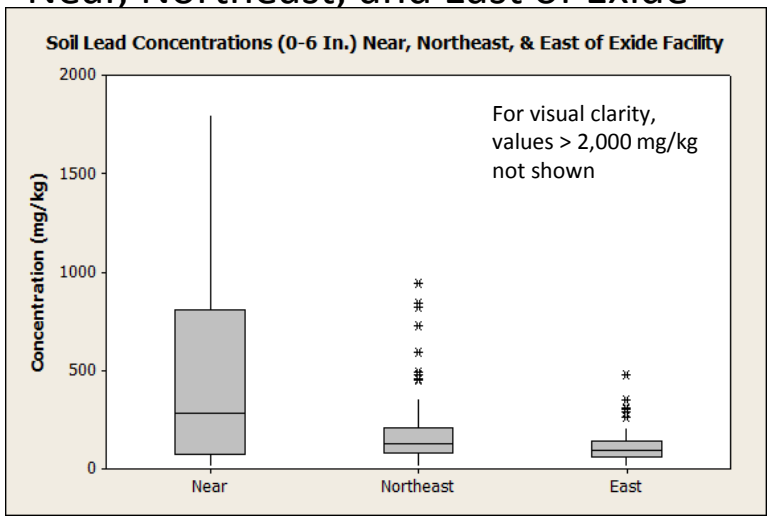


milligrams per kilogram (mg/kg)

Near and South of Exide



Near, Northeast, and East of Exide



"Near" data set is provided for reference on each graph

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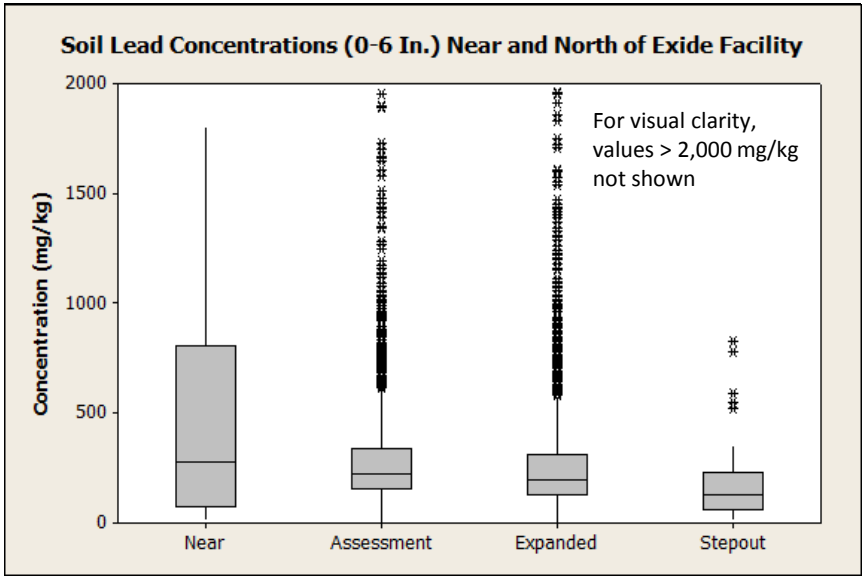
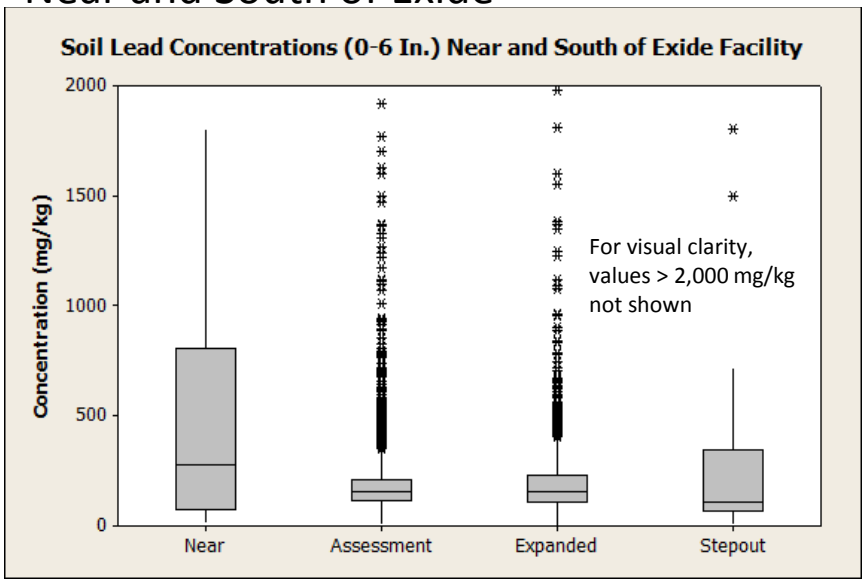
Summary of Lead Data

Near and North of Exide



Near and South of Exide



milligrams per kilogram (mg/kg)

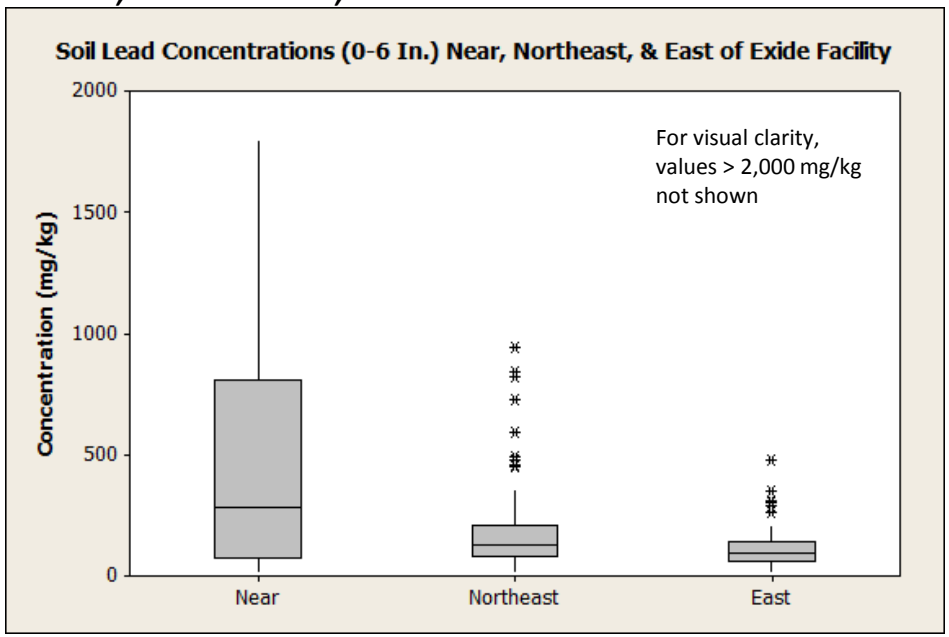
Statistic	Near	Northern Assessment	Northern Expanded	N Stepout
No. Samples	48	2650	2988	63
Median (mg/kg)	280	220	195	130
Mean (mg/kg)	636	289	286	174
95% UCL (mg/kg)	874	312	324	209

Statistic	Near	Southern Assessment	Southern Expanded	SW Stepout
No. Samples	48	3702	2270	66
Median (mg/kg)	280	155	156	110
Mean (mg/kg)	636	193	194	377
95% UCL (mg/kg)	874	218	211	504

Preliminary

Summary of Lead Data

Near, Northeast, and East of Exide



Statistic	Near	NE Stepout	East
No. Samples	48	63	48
Median (mg/kg)	280	130	91
Mean (mg/kg)	636	205	122
95% UCL (mg/kg)	874	269	146

milligrams per kilogram (mg/kg)

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Summary of Lead Data

- In general, data fit conceptual site model that concentrations are decreasing with increasing distance from Exide facility.
  - Mean concentration for data from southwest transect does not follow expected pattern and requires further evaluation.
- Further evaluate data with other methods.

Statistic	Near	Northern Assessment Area	Northern Expanded Area	Northern Transect	Southern Assessment Area	Southern Expanded Area	Southwest Transect	Northeast Transect	Eastern Area
Median (mg/kg)	280	220	195	130	155	156	110	130	91

Based on all samples collected from 0-6 inch depth interval
"Near" samples collected from facility perimeter and 2,640 feet.
mg/kg is milligrams per kilogram

Preliminary

Other Methods Used to Evaluate Lead Data

- Evaluate data based on
  - distance from facility
  - direction from facility, particularly in downwind directions (N, SW, NE, E)
- Descriptive statistics
- Scatterplots
- Statistical comparisons

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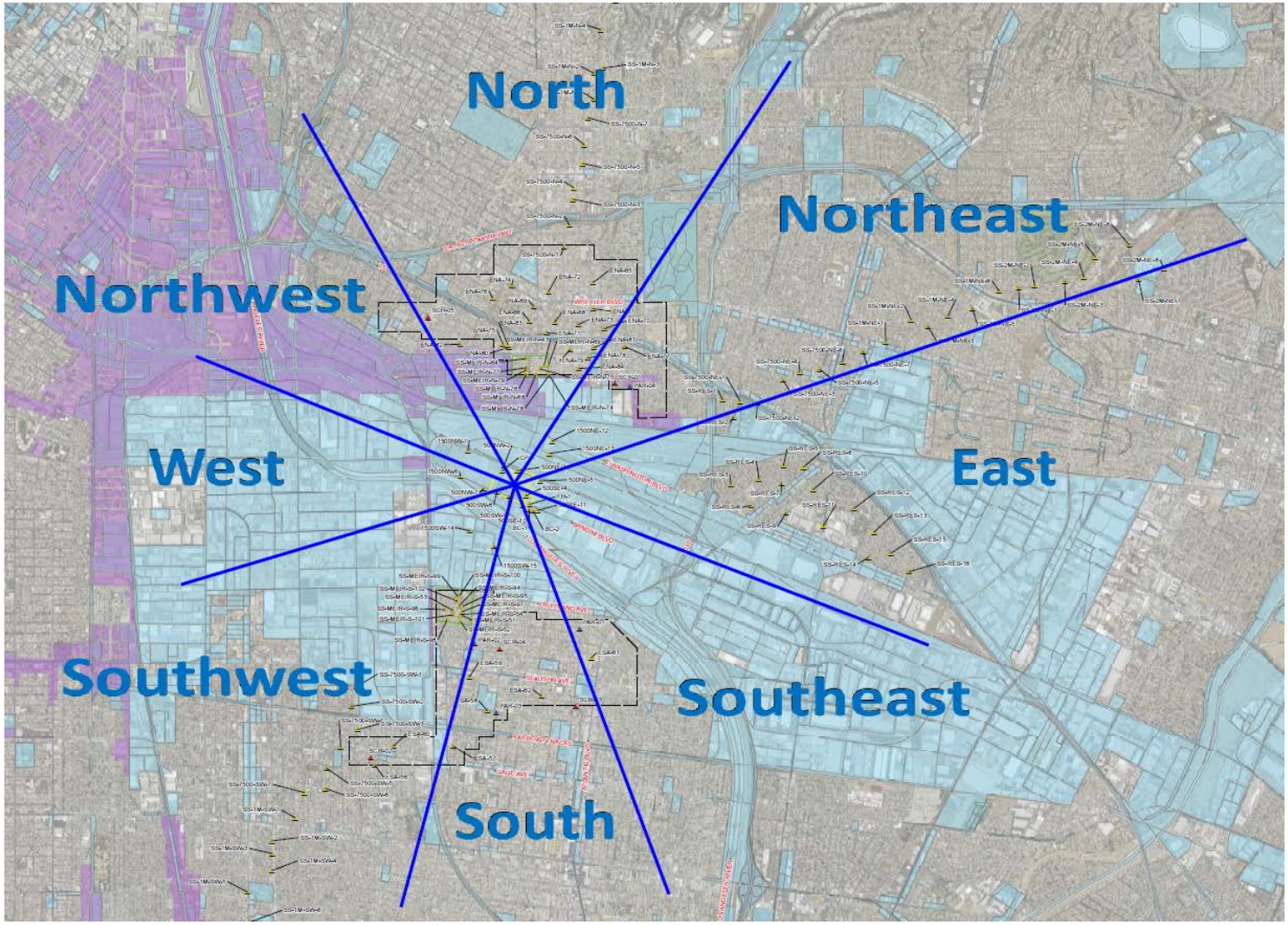
Analyze Data in Groups Based on Direction from Exide Facility



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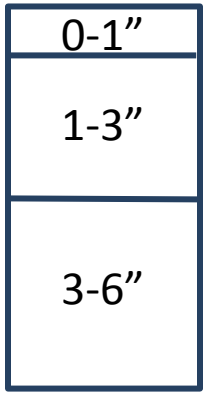
Depth-Weighted Average

- Because this is a large amount of lead data, useful to condense data for each boring location into a single data point for evaluation.
- This approach is suitable for purposes of evaluating distribution of Exide's emissions.
- Normalize concentrations for 0-6 inch depth interval by weighting sample concentration by thickness of soil profile presented by sampling result. For example, the concentration from 3-6 inch interval would count for 50% of depth-weighted average, as shown by the following calculation.



Lead Results for Sample X
0-1": 100 mg/kg
1-3": 50 mg/kg
3-6": 25 mg/kg

Depth-Weighted Average Concentration:

$$\frac{(100\ \text{mg/kg})(1\ \text{inch}) + (50\ \text{mg/kg})(2\ \text{inches}) + (25\ \text{mg/kg})(3\ \text{inches})}{6\ \text{inches}} =$$

$$\frac{100 + 100 + 75}{6} =$$

45.8 mg/kg

mg/kg is milligrams per kilogram

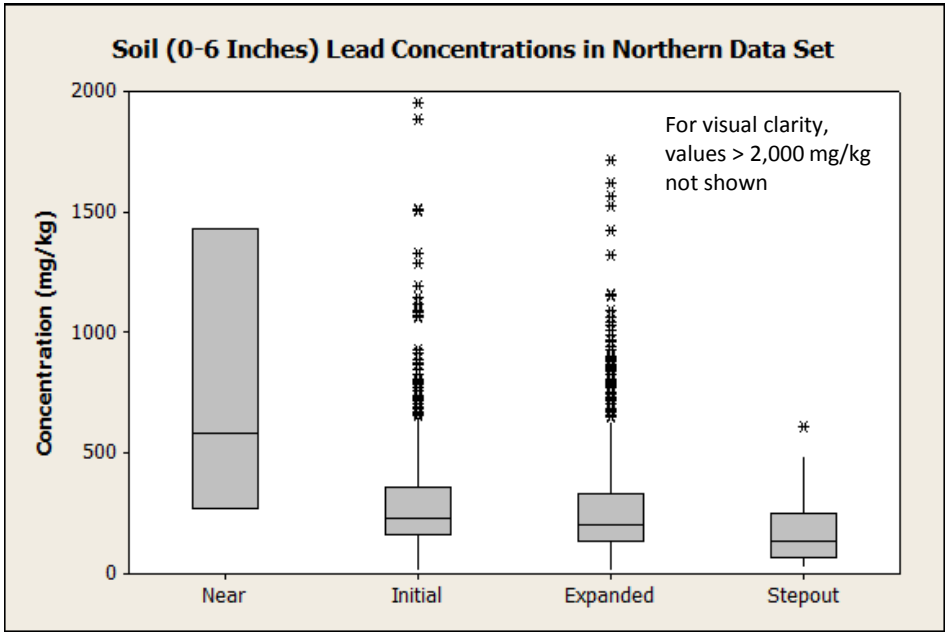
Preliminary

Lead Data Evaluation: Descriptive Statistics

Example: Northern Data Set

(one data point per boring location)

Data Group	No. of Data Points	Mean (mg/kg)	Median (mg/kg)	Range (mg/kg)
Near	3	764	585	273 - 1433
Initial Area	885	294	229	11 - 2338
Expanded Area	758	291	202	13 - 4858
Step-out	21	181	135	26 - 612



Depth-weighted average concentrations
mg/kg is milligrams per kilogram.

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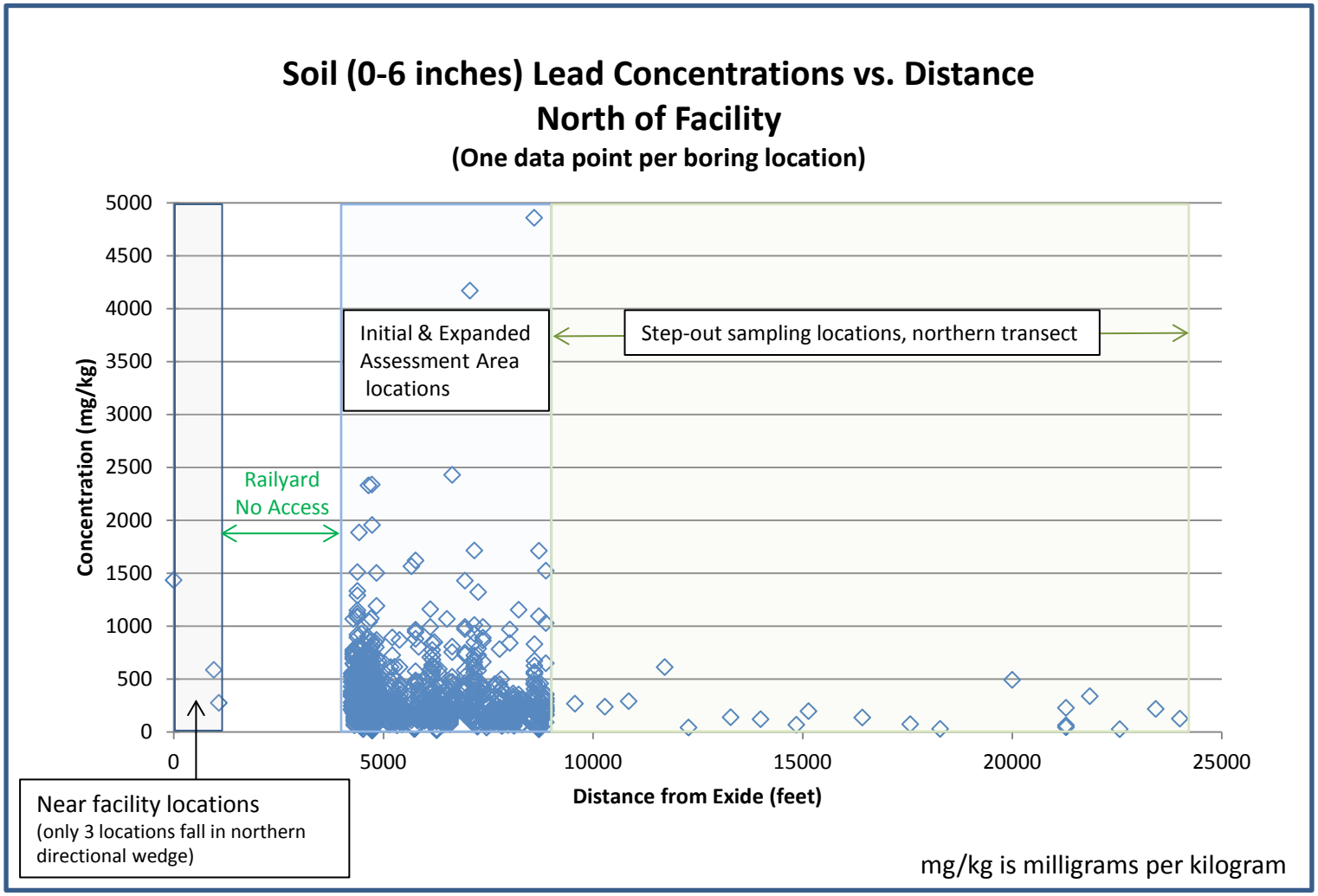
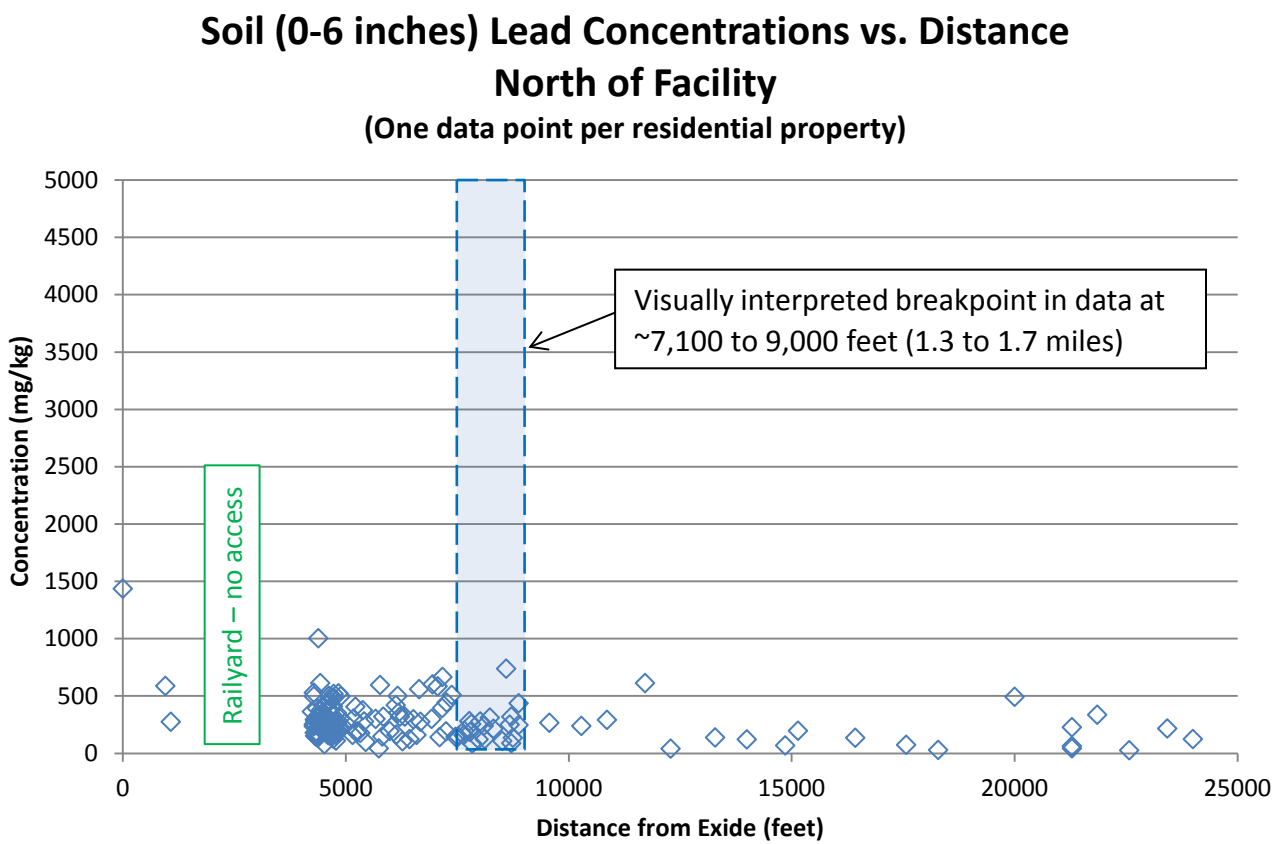
Lead Data Evaluation: Scatterplot



Preliminary

Lead Data Evaluation: Scatterplot



Data fits conceptual site model:
Decreasing concentrations with increasing distance from facility.

mg/kg is milligrams per kilogram

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Statistically Compare Amounts of Lead Closer to and Farther From Facility

- Similar to graphical approach shown on previous slide
- Compares mean concentrations from data group closer to facility vs. data group farther from facility
  - At some distance, amount of lead in soil closer to the facility will be higher than amount of lead in soil farther from facility

Preliminary

Statistically Compare Amounts of Lead Closer to and Farther From Facility

North of Facility

Closer Data Group

Distance Range (feet)	No. Data Points	Mean (mg/kg)
900-5000	87	291
900-8000	132	288
900-8500	137	286
900-9000	146	287

Farther Data Group

Distance Range (feet)	No. Data Points	Mean (mg/kg)
5000-7000	29	284
8000-24000	34	225
8500-24000	29	224
9000-24000	20	186

Finding

Comparison Results
Closer = Farther
Closer > Farther
Closer > Farther
Closer > Farther

milligrams per kilogram (mg/kg)

Finding: Breakpoint in soil lead concentrations between 7,000 and 9,000 feet (1.3 to 1.7 miles) north of Exide facility

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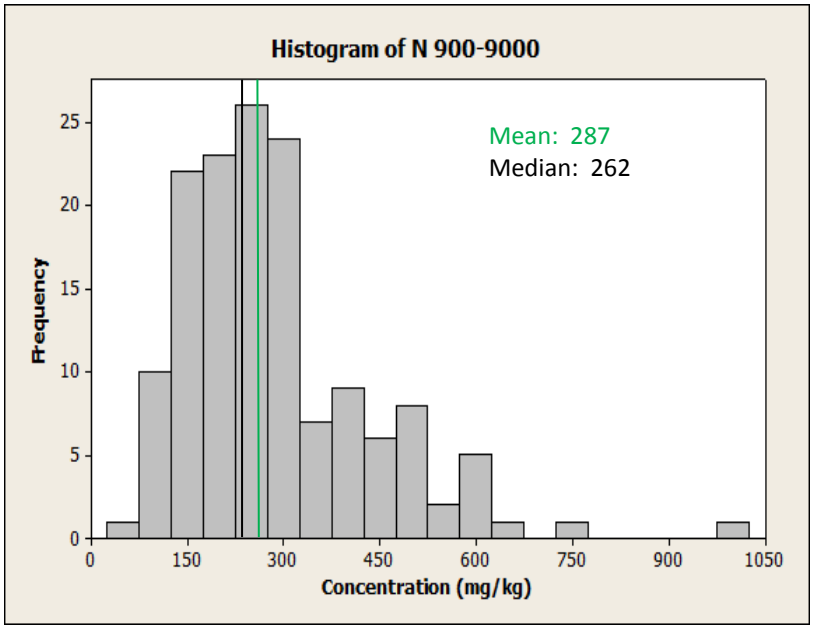
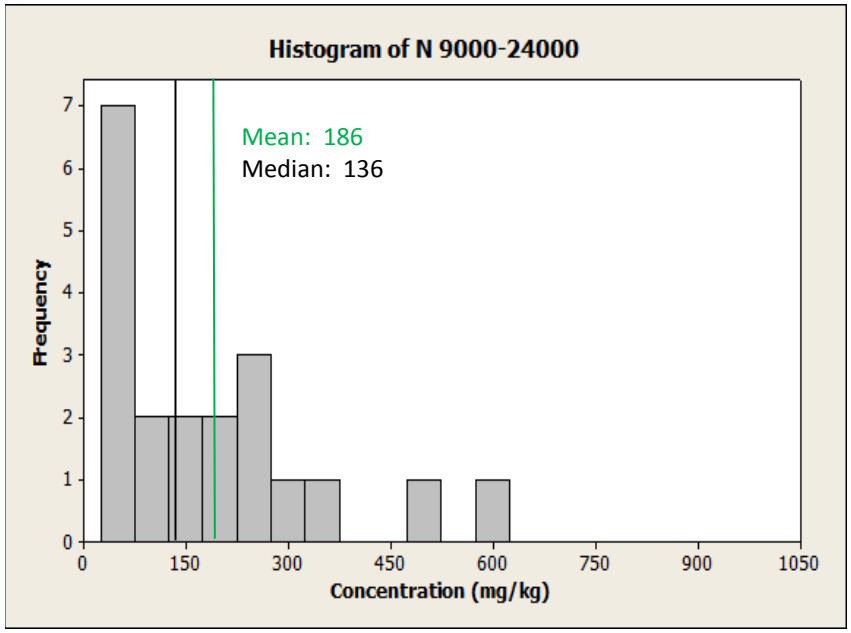
Soil Lead Concentrations in Areas Estimated to be Inside and Outside of Exide Emissions

North of Facility

Inside Preliminary Estimate of Area of Influence from Exide Emissions



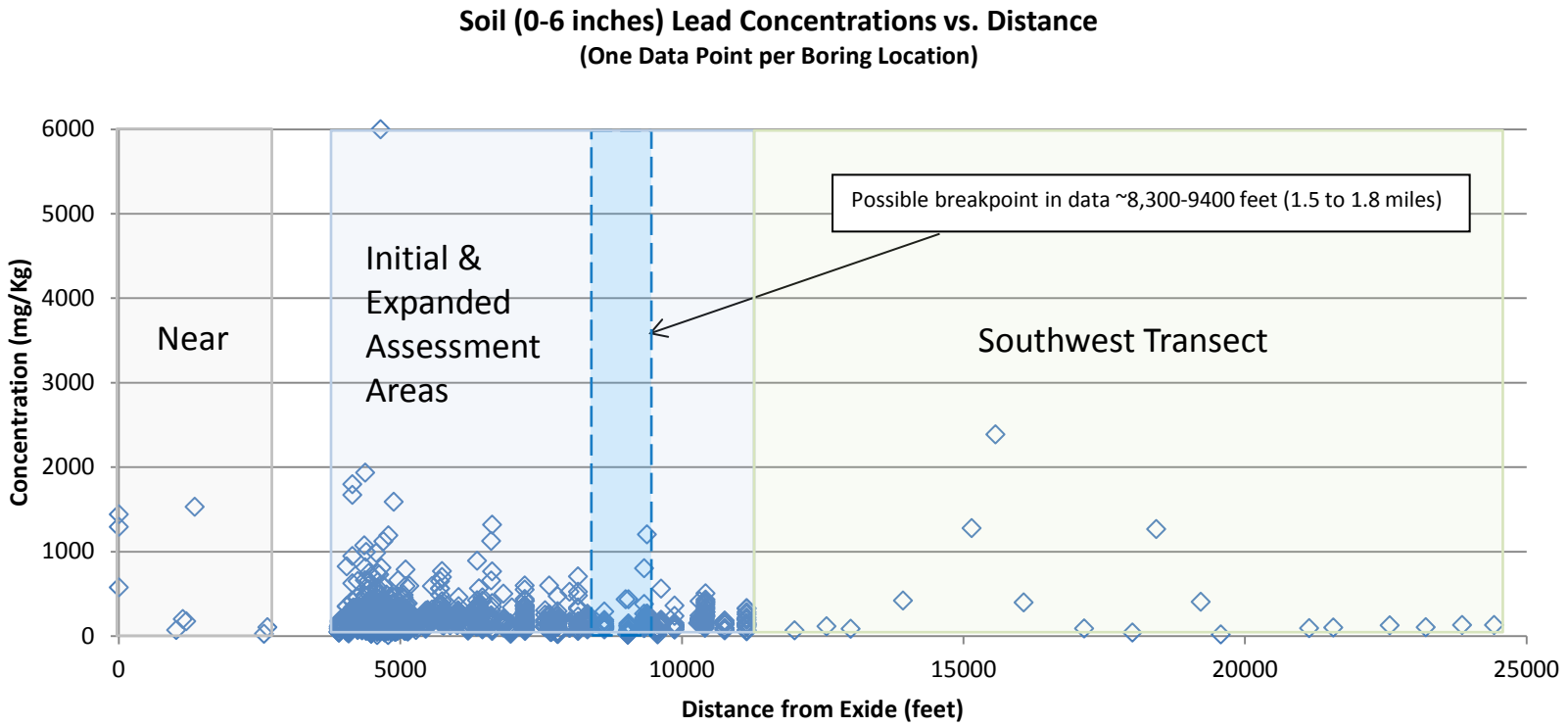
Outside Preliminary Estimate of Area of Influence from Exide Emissions



mg/kg is milligrams per kilogram

Preliminary

Lead Data Evaluation: South & Southwest of Facility

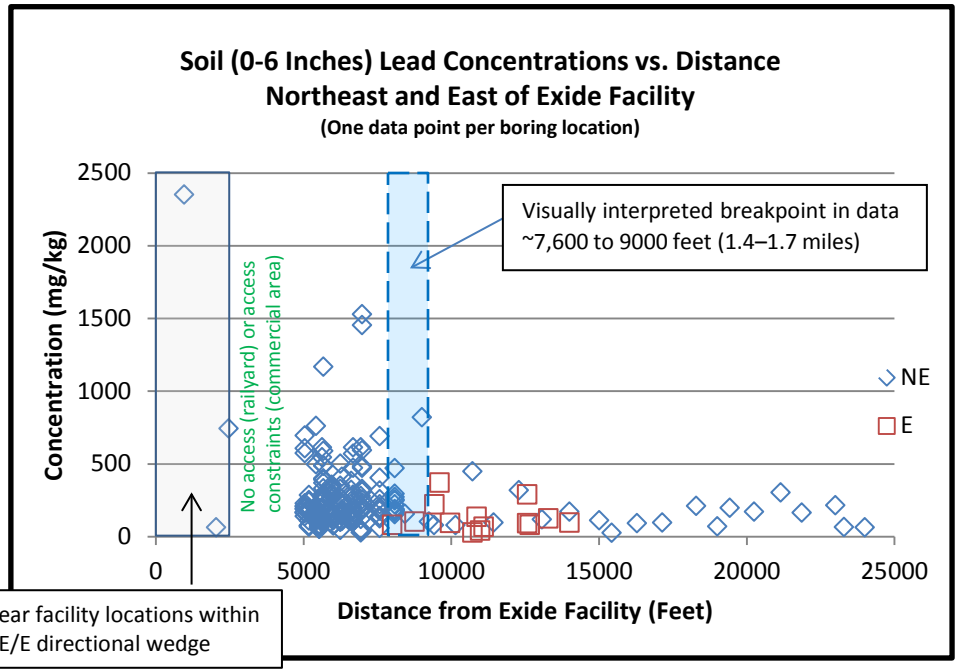


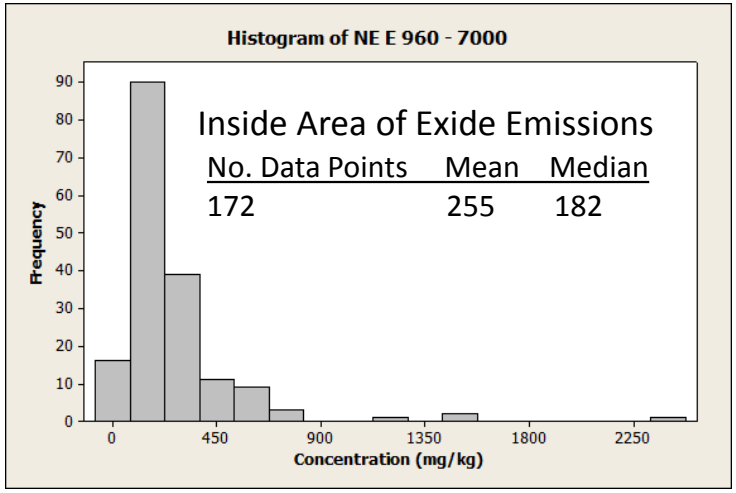
mg/kg is milligrams per kilogram

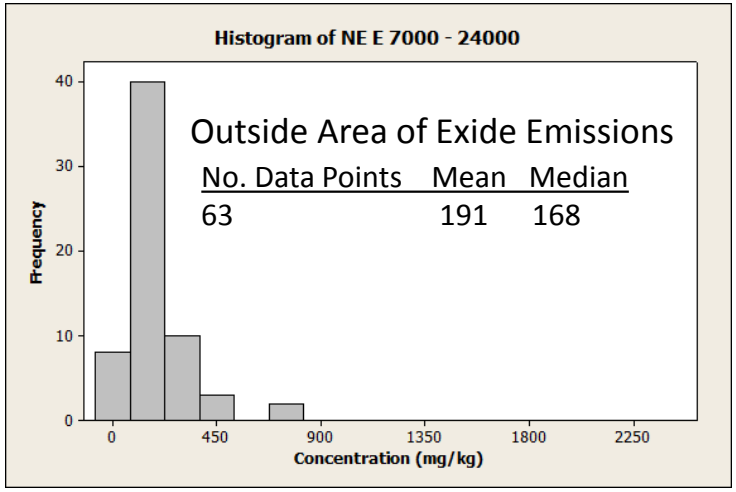
Preliminary statistical comparisons were not conclusive. Additional data required.

Preliminary

Lead Data Evaluation: Northeast and East of Facility







Because smaller data set, more difficult to draw conclusions. More data needed to support statistical comparisons.

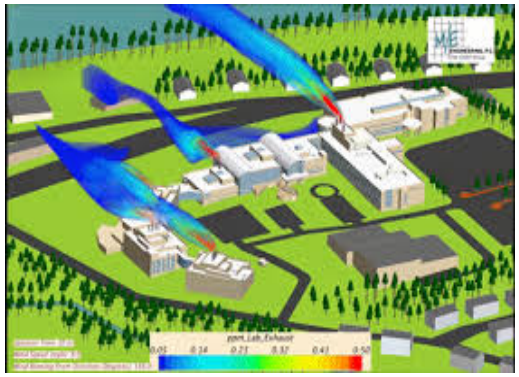
Process underway to obtain more data.

mg/kg is milligrams per kilogram

Preliminary

Emissions from Secondary Lead Smelters Include Other Metals

- Commonly associated metals:
  - Antimony (about 5% of “hard lead”)
  - Arsenic
  - Cadmium
  - Copper
  - Nickel
  - Zinc



- To support evaluation, performed additional analyses for metals on previously collected samples

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Evaluation of Other Metals

- Additional line of evidence to refine estimated distribution
- 0 – 6 inch depth interval
- 1,556 boring locations have metals data in addition to lead
  - Used all available data, even if not specifically collected for this analysis
  - Work with individual data points

Preliminary

Evaluation Methods for Other Metals

- Evaluate groupings of data based on distance and direction from facility
- Descriptive statistics
- Graphing
- Comparison to reference concentrations for California soils
- Literature techniques to look for emission signature

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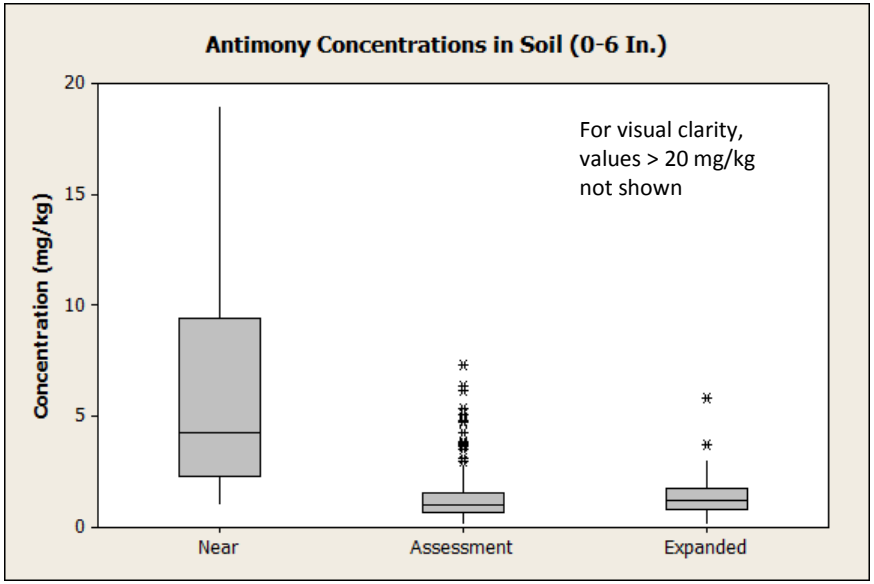
Antimony Concentrations in Soil

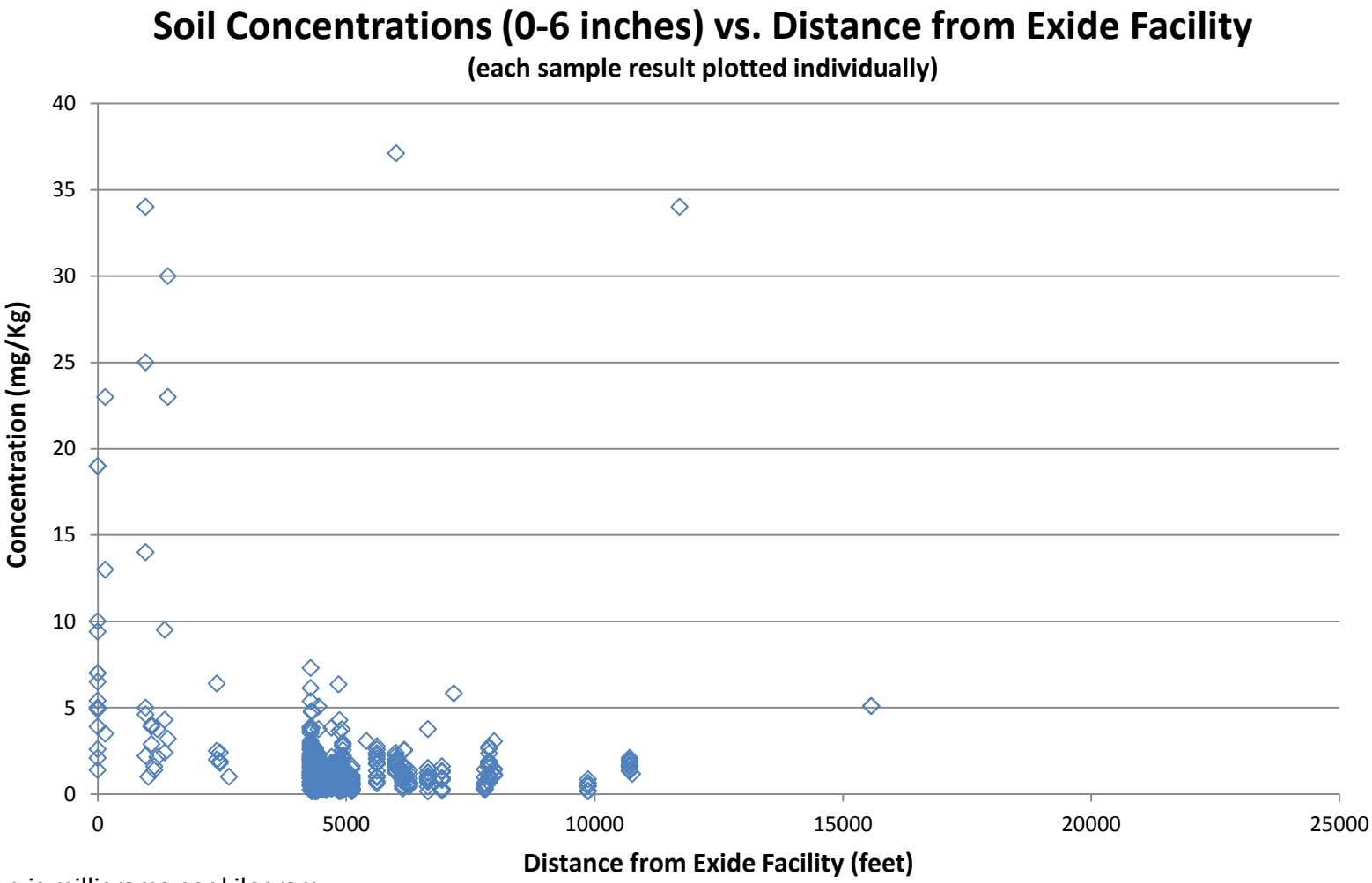


Statistic	Near	Assessment (north & south)	Expanded (north & south)
No. Samples with Detections	45	459	138
Mean (mg/kg)	7.6	1.2	1.6
Median (mg/kg)	4.3	1.0	1.2

mg/kg is milligrams per kilogram

Preliminary

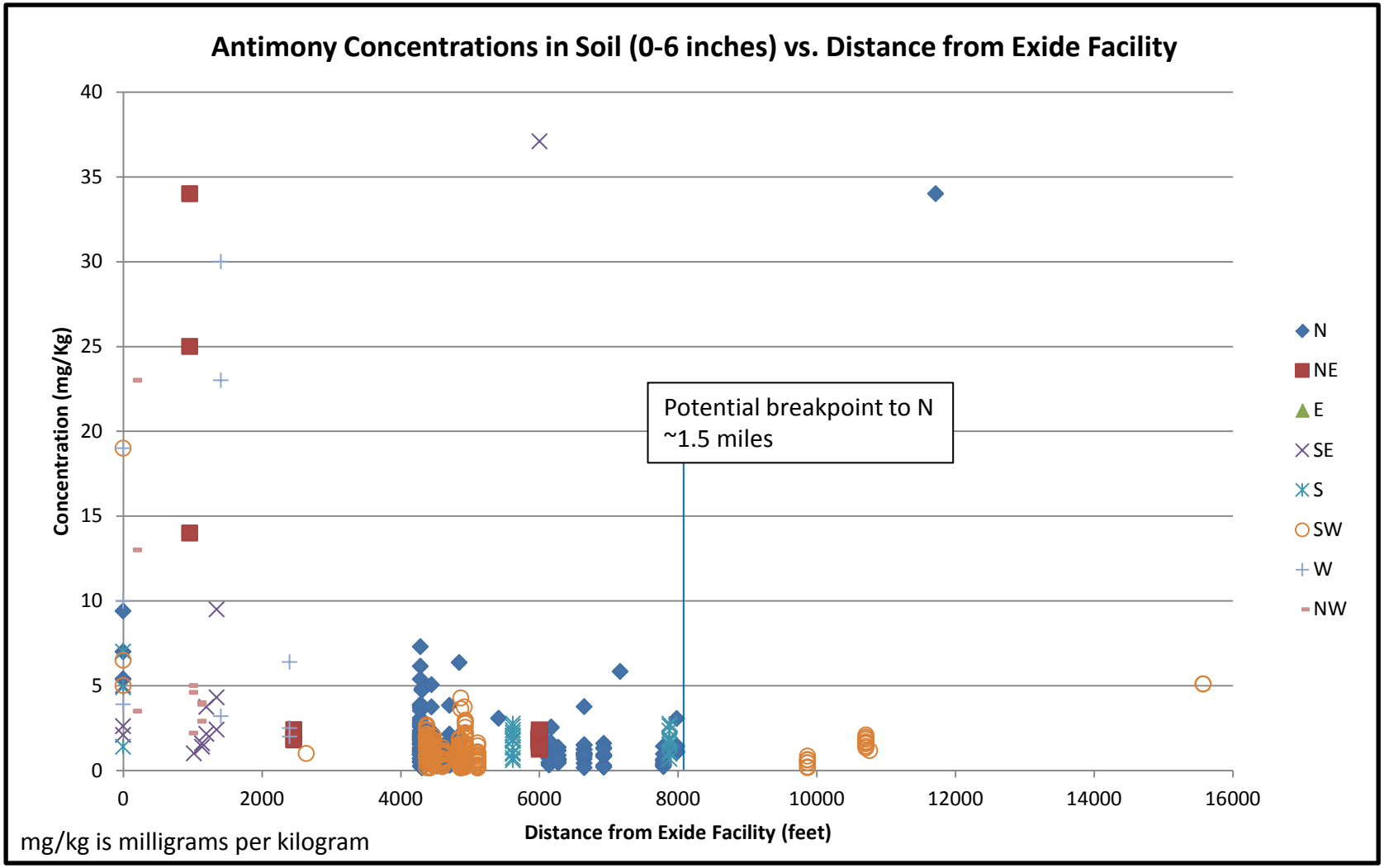
Distribution of Antimony Concentrations in Soil



mg/kg is milligrams per kilogram

Preliminary

Distribution of Antimony Concentrations in Soil



mg/kg is milligrams per kilogram

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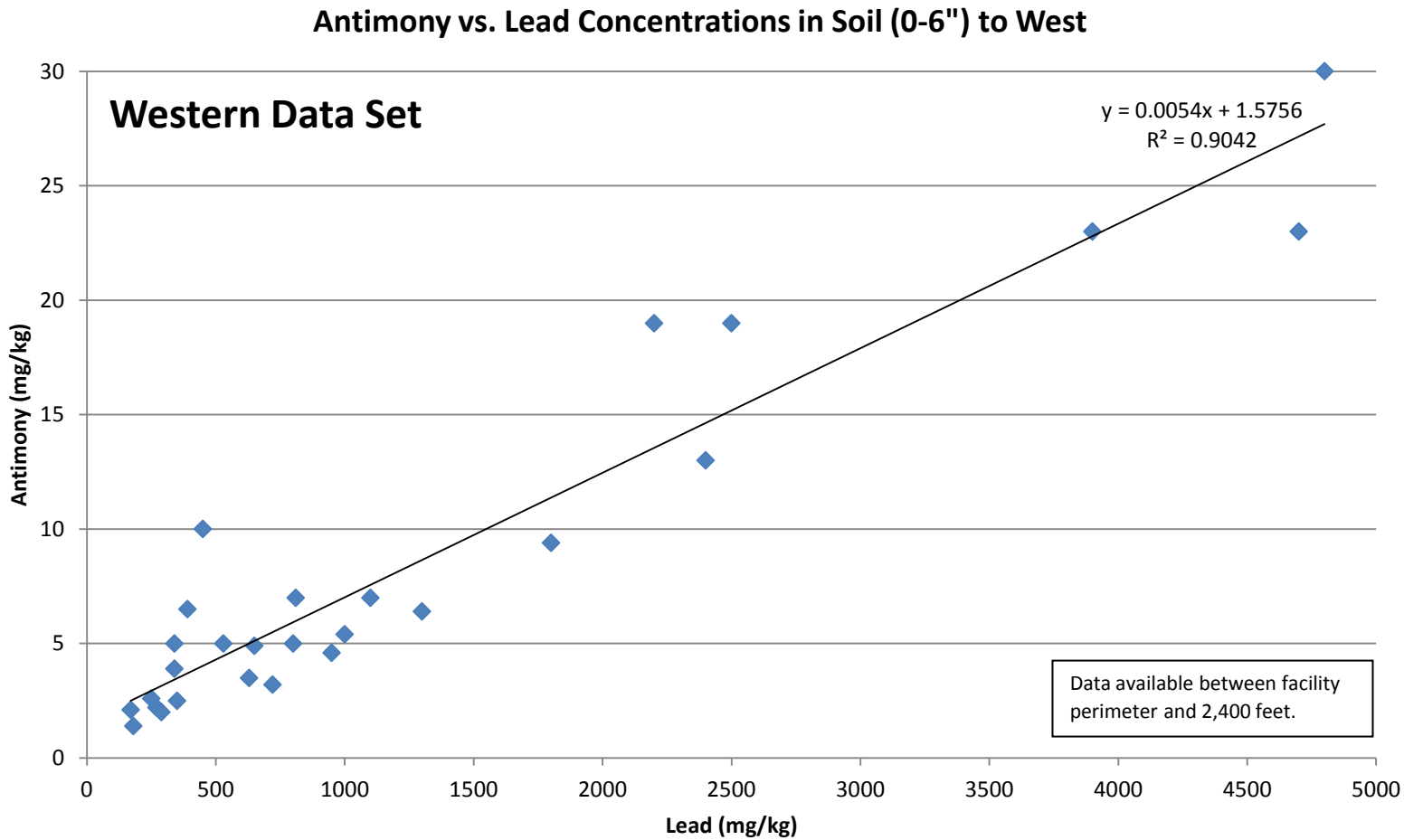
Literature Methods

- Correlation of metal to lead concentration in given sample. High degree of correlation as possible indicator of smelter emissions.
- Ratio of metal to lead concentration in given sample. Potential signature of smelter emissions.
- Initial stages of analysis. More work to be done.

Preliminary

Example Antimony to Lead Correlation



mg/kg is milligrams per kilogram

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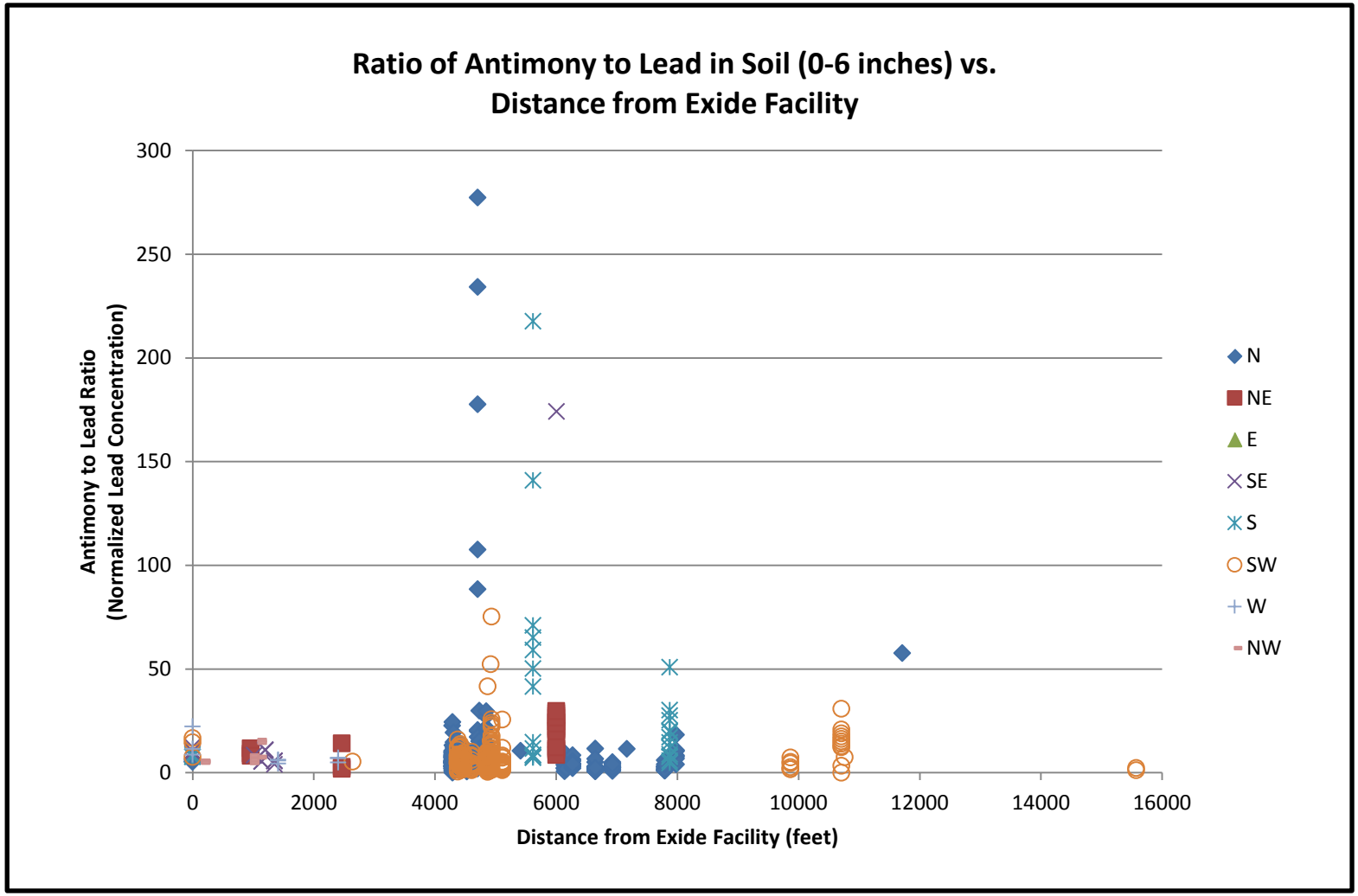
Antimony to Lead Ratio



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Summary of Findings for Other Metals

Metal	Associated with secondary smelters?	Common to other sources?	Concentration pattern with distance (Fits conceptual site model of Exide emissions?)	Near facility data?	Strength as indicator of Exide distribution
Antimony	Yes, "antimonial lead"	No	Strong decreasing trend	Yes	Very strong
Arsenic	Yes	Yes	Limited variation with distance	Yes	Weak
Cadmium	Yes	Yes	Strong decreasing trend	Yes	Strong
Copper	Yes	Yes	Apparent decreasing trend (variability in data)	No	May be strong (additional data needed)
Nickel	Yes	Yes	Limited variation with distance	No	Weak
Zinc	Yes	Yes	Apparent decreasing trend (variability in data)	No	May be strong (additional data needed)

This table summarizes the characteristics that make a given metal useful as an indicator of Exide's distribution.

Preliminary

Summary

- Findings support conceptual site model of:
  (1) decreasing concentrations with increasing distance and (2) lead concentrations that merge with urban lead levels

- Based on data evaluation approach presented, preliminary estimates of distribution of Exide's emissions:

Line of Evidence	N	NE / E	S / SW	W / NW
Lead	~1.3-1.7 miles	~1.4-1.7 miles	~1.5-1.8 miles	--
Antimony	~1.5 miles	--	--	>0.5 miles

Preliminary

Next Steps

- Continue evaluating lead distribution
- Address data gaps
  - more data near facility (upcoming industrial sampling effort)
  - more data near estimated extent
- Summary report (in development) will be shared for external scientific peer review