

Evaluating Anthropogenic Cd Sources in Surface Soils Using Cd, Zn, Pb Concentrations and Stable Isotope Data

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Site Setting

- ▶ Located in Brooklyn, NY, used for industrial purposes beginning in early 1900s
- ▶ Previous uses include steel manufacturing, lumberyard, marine canvas supply, iron works, vinyl stabilizers, plastic additives
- ▶ Surrounding area created through historical filling of waterfront in the late 1800s/early 1900s
- ▶ Heavily industrialized area, multiple remediation sites in the vicinity



Photo circa 1937, obtained from NYC Municipal Archives Collection

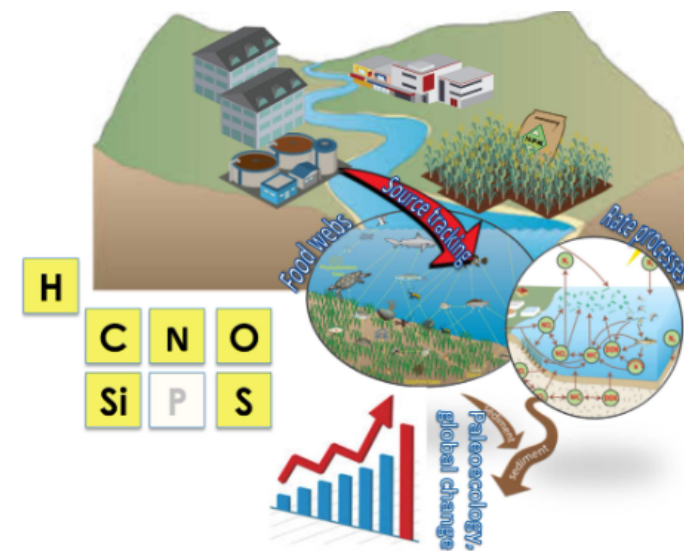
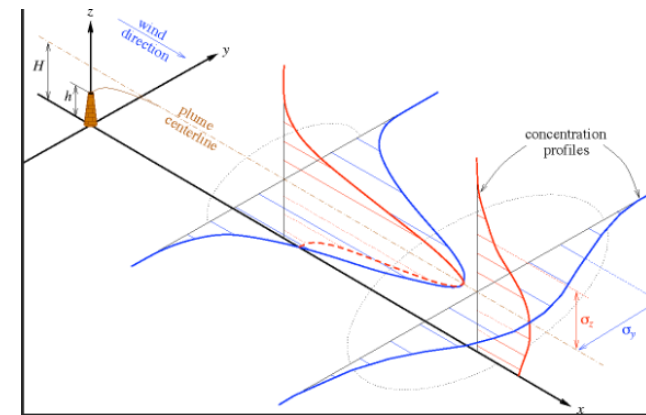
Site Introduction & Background

- Cd exceedances in shallow soils in AOC-Aerial Deposition (AOC-AD)
- Two potential sources of atmospheric Cd at the site
 - Lead Smelter 1925 – 1938
 - Plastics Plant - Cd oxidizer unit 1959 – 1999
- Cd contamination Initially attributed to Cd oxidizer stack adjacent to the AOC-AD
- Presentation focus is on data from the AOC-AD and the on-site AOC to the south.



Approach to Evaluating Cd Sources to AOC-AD

- ▶ Model atmospheric dispersion/deposition of Cd oxidizer unit emission using the AERMOD model
 - EPA recommends for near field air quality modeling
 - Simulates transport, dispersion and deposition of COCs
- ▶ Evaluate stable isotope ratios for Cd, Pb, Zn
 - Focus is on single or multiple sources indicated



Methods – Air Dispersion Modeling

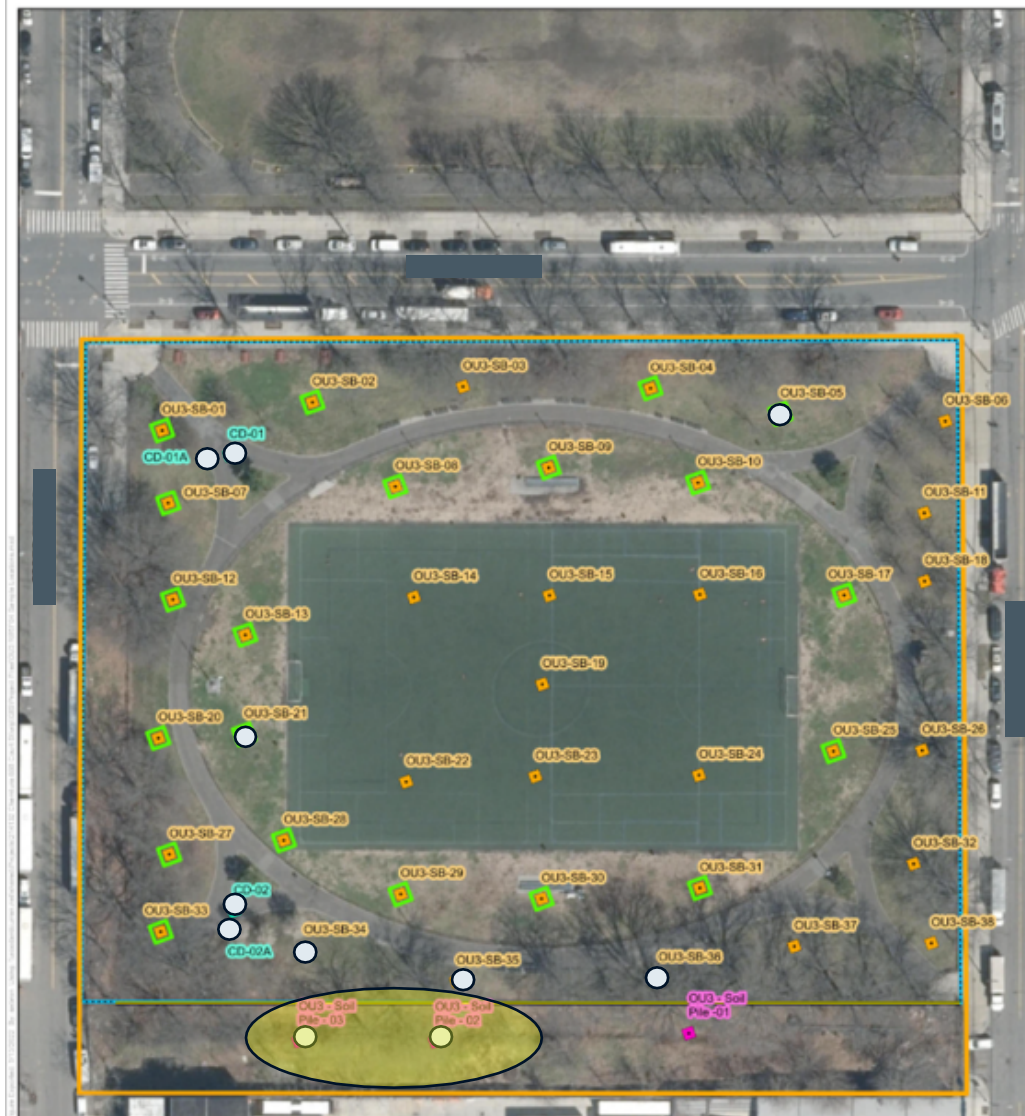
- Applied AERMOD model
- AERMAP utilized to create receptor, source and structure base elevations for each receptor location
- Stack test data from 1979 utilized to conservatively characterize emissions
- Applied an operational period of 12 hrs. per day and 5 days per week for facility activity



Methods – Field Soil Sampling

AOC-AD and AOC-On-site sampling included:

- Analysis for soil Cd, Zn, Pb concentrations:
 - 38 soil borings across AOC-AD
 - 2 soil boring within soil piles
- Stable Isotopes analyzed in 24 samples:
 - 16 samples from 12 locations and include the soil piles on the south end of the park
- 8 samples from 2 locations were sampled at on-site locations (plastics plant) adjacent and south of the soil piles.

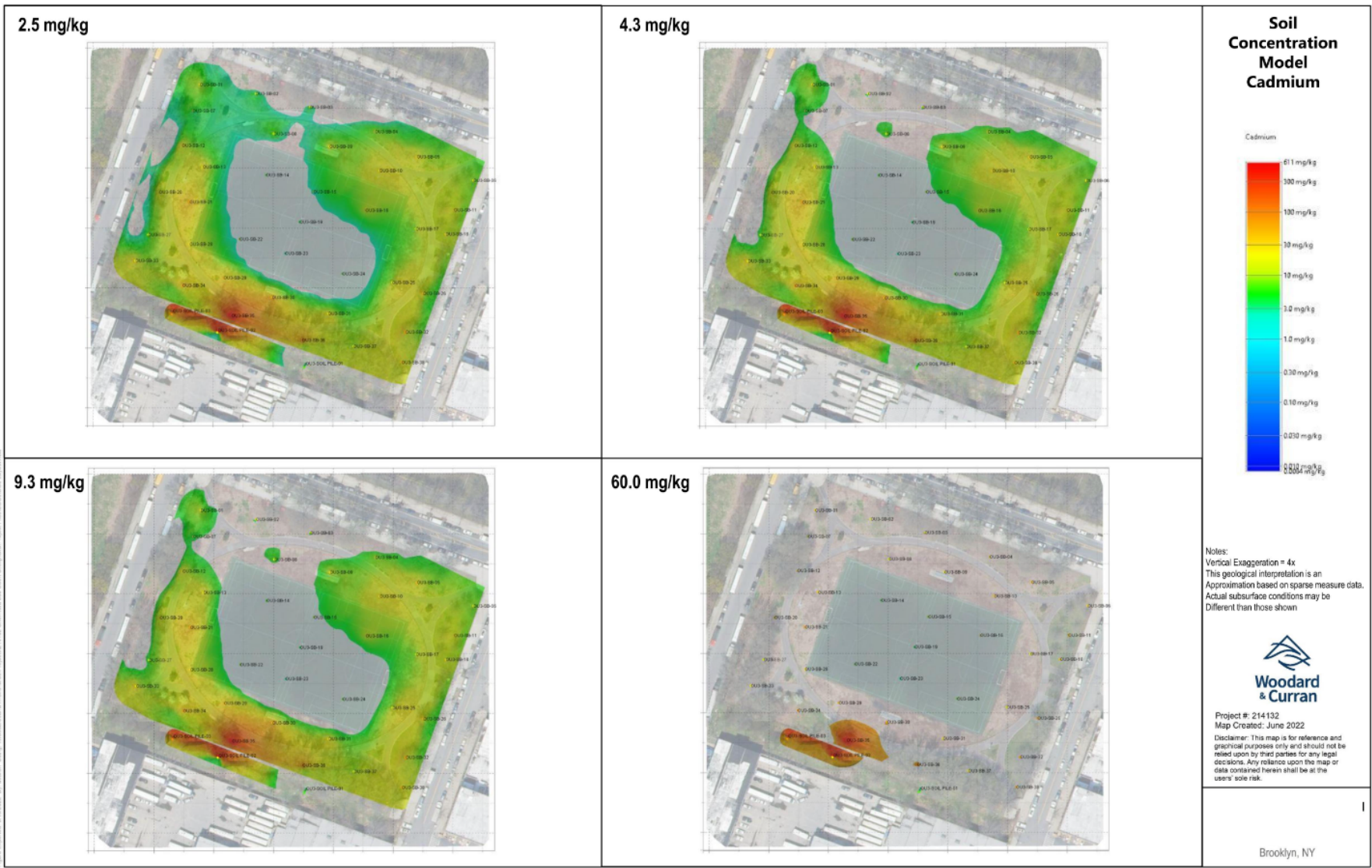


Sample Locations
FIGURE 4

Methods – Laboratory & Analytical

- Cadmium, Zinc, and Lead concentration and stable isotope analyses contracted with the University of Wisconsin. All procedures completed in the Trace Elements Clean Lab (TECL) at the Wisconsin State Laboratory of Hygiene (WSLH)
- Soil extractions for quantifying surface exchangeable metal fractions, total digestions and column purifications performed in class-1000 ultra clean sample preparation room
- All analyses were performed in a class-10,000 instrument room containing the multi-collector inductively coupled plasma mass spectrometer (MC-ICP-MS). All soil samples were freeze dried prior to processing
- Stable isotope values for Cd and Zn are expressed using delta (δ) notation where:
 - Isotope ratio: **(R) = heavy/light**
 - Expressed as: $\delta R = (R_{\text{sample}}/R_{\text{reference}} - 1) * 1000$
 - Unit is **per mil (‰)**
- Stable isotopes for Pb are expressed as atom ratios

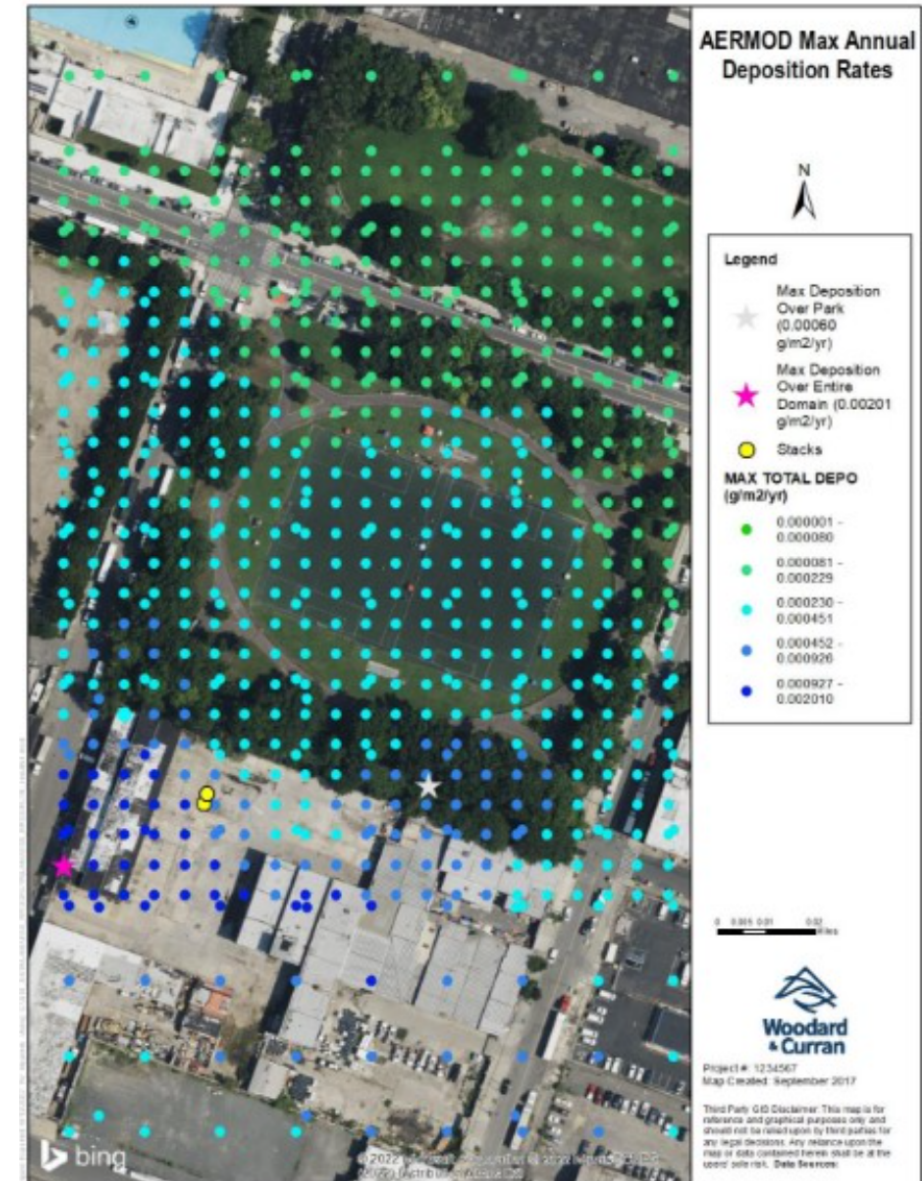
Results - Cd Distribution in Shallow Soils in AOC-AD



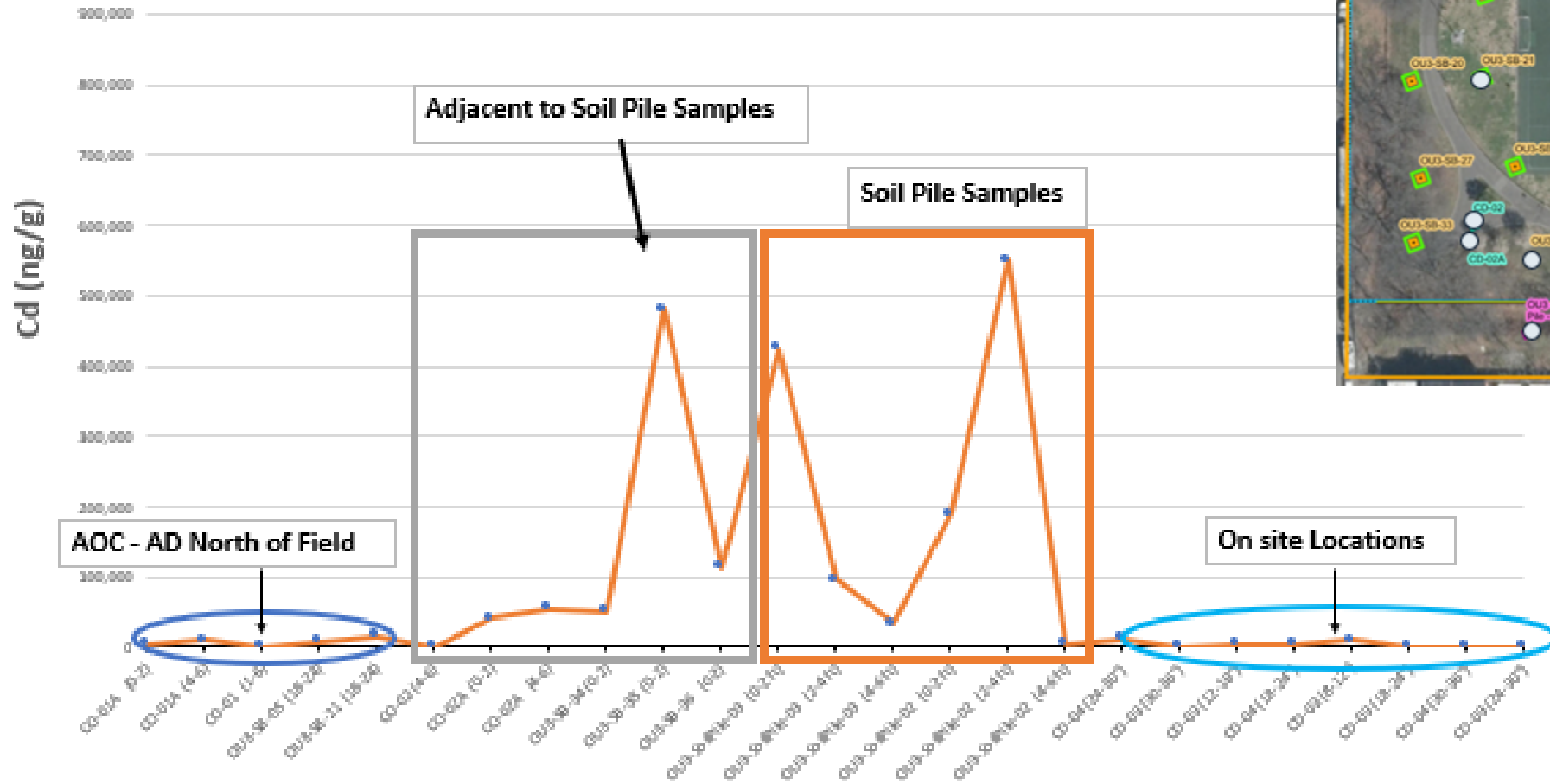
Results – Air Deposition Rates for Cd

Table 4: Maximum Modeled Deposition Rates Compared to Sampled Soil Concentrations

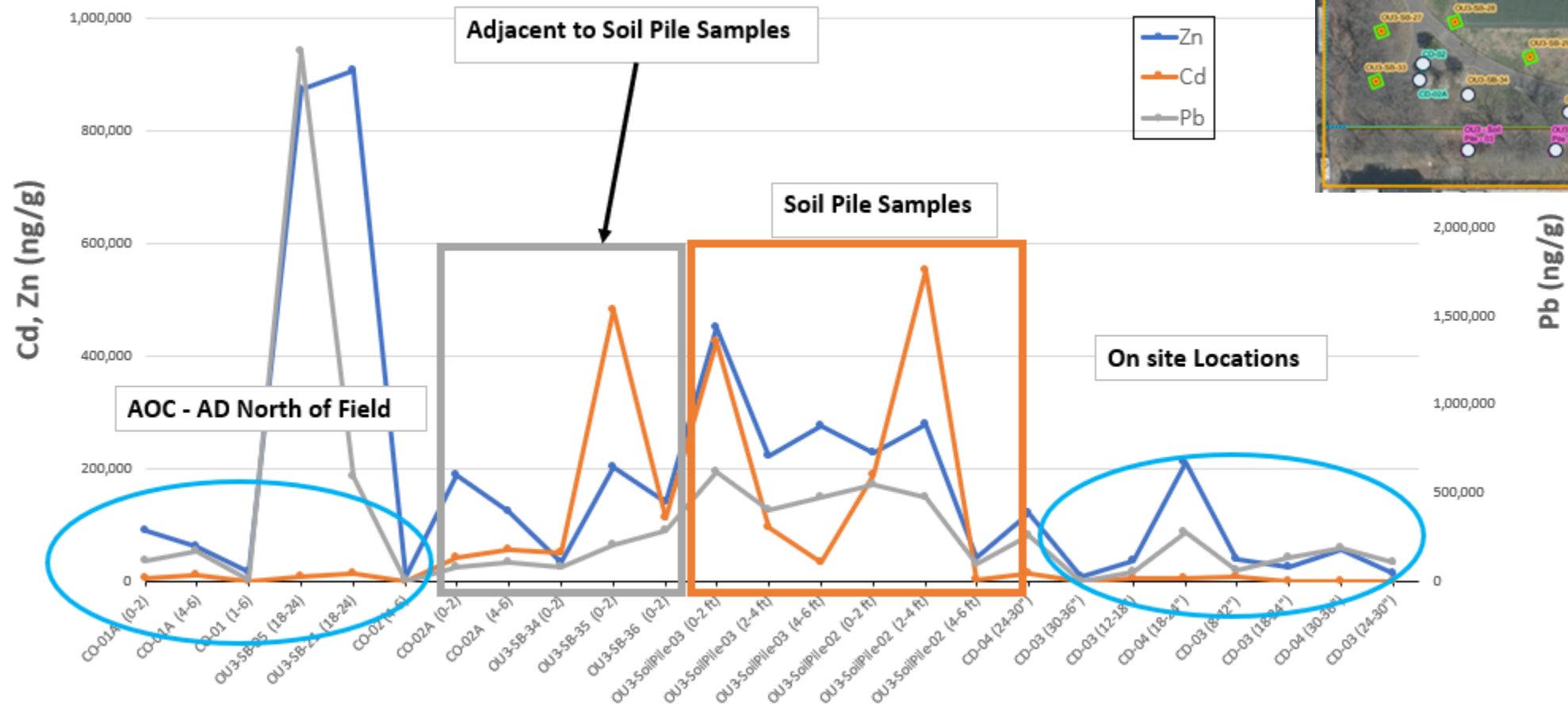
Receptors	Maximum 1-yr Annual Average Deposition Rate (g/m ² /yr)	Soil Concentration (mg/kg)				Years Needed for Max Modeled Rate to Develop Sampled Concentration
		Max Model	Sample	Sample Basis	Fraction of Model to Sample	
Over Entire Model Domain	0.00201	1.82	611	Sample MAX	0.30%	13,406
			85.20	AVG of Sample MAXs	2.14%	1,869
			5.64	20-th %tile of Sample MAXs	32.32%	124
Over All Sample Locations in the Park to the North of the Facility	0.00060	0.54	611	Sample MAX	0.09%	45,996
			85.20	AVG of Sample MAXs	0.64%	6,414
			5.64	20-th %tile of Sample MAXs	9.61%	425



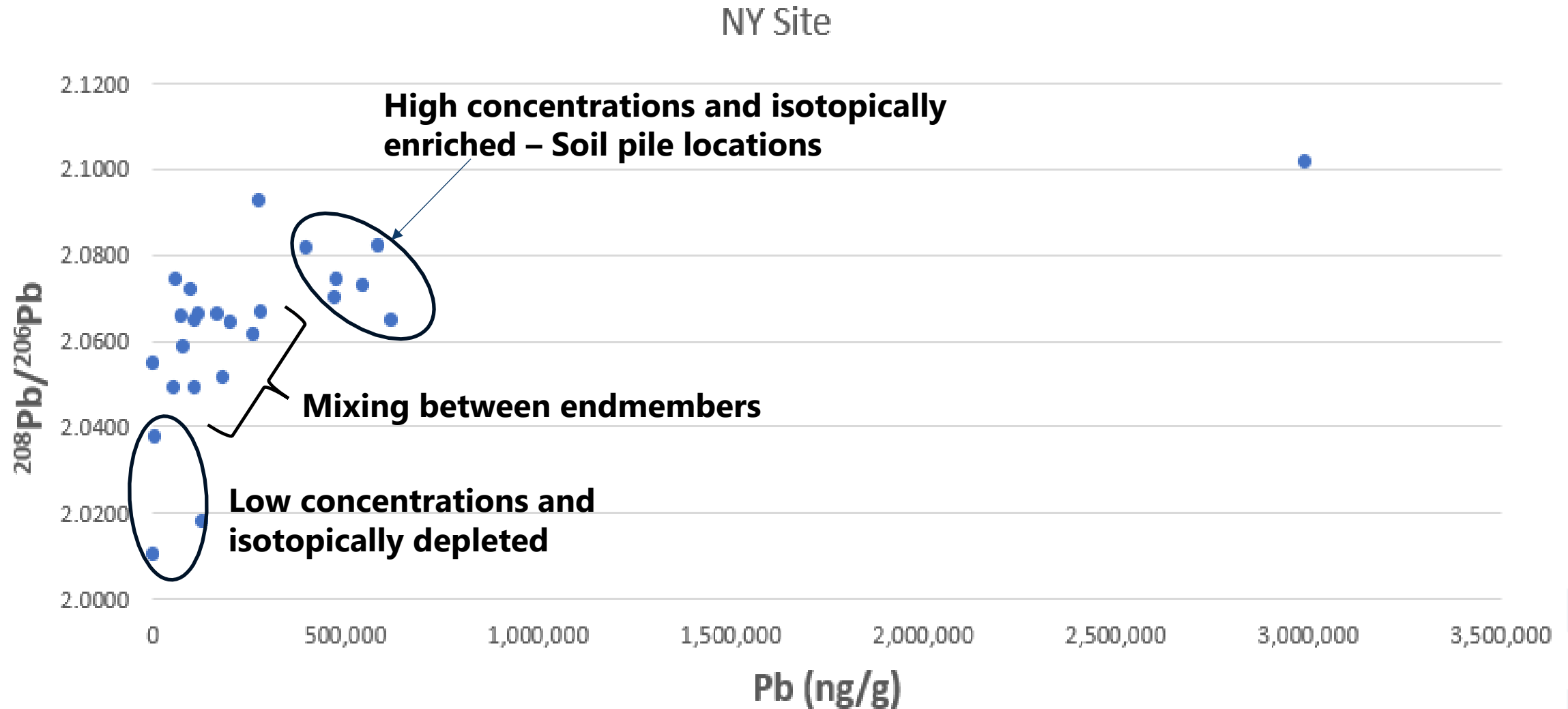
Results – Cd Concentration in Soils



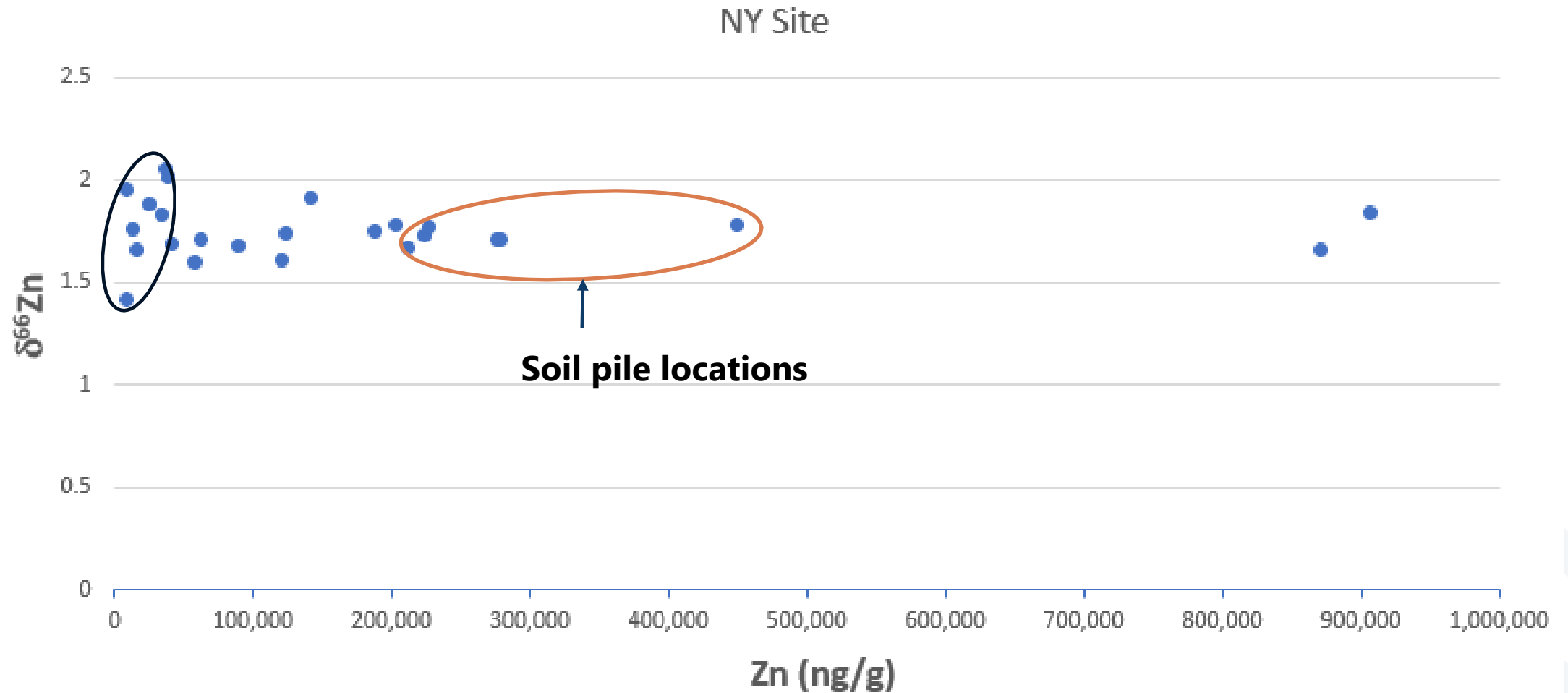
Results – Cd, Pb, Zn Concentrations in Soils



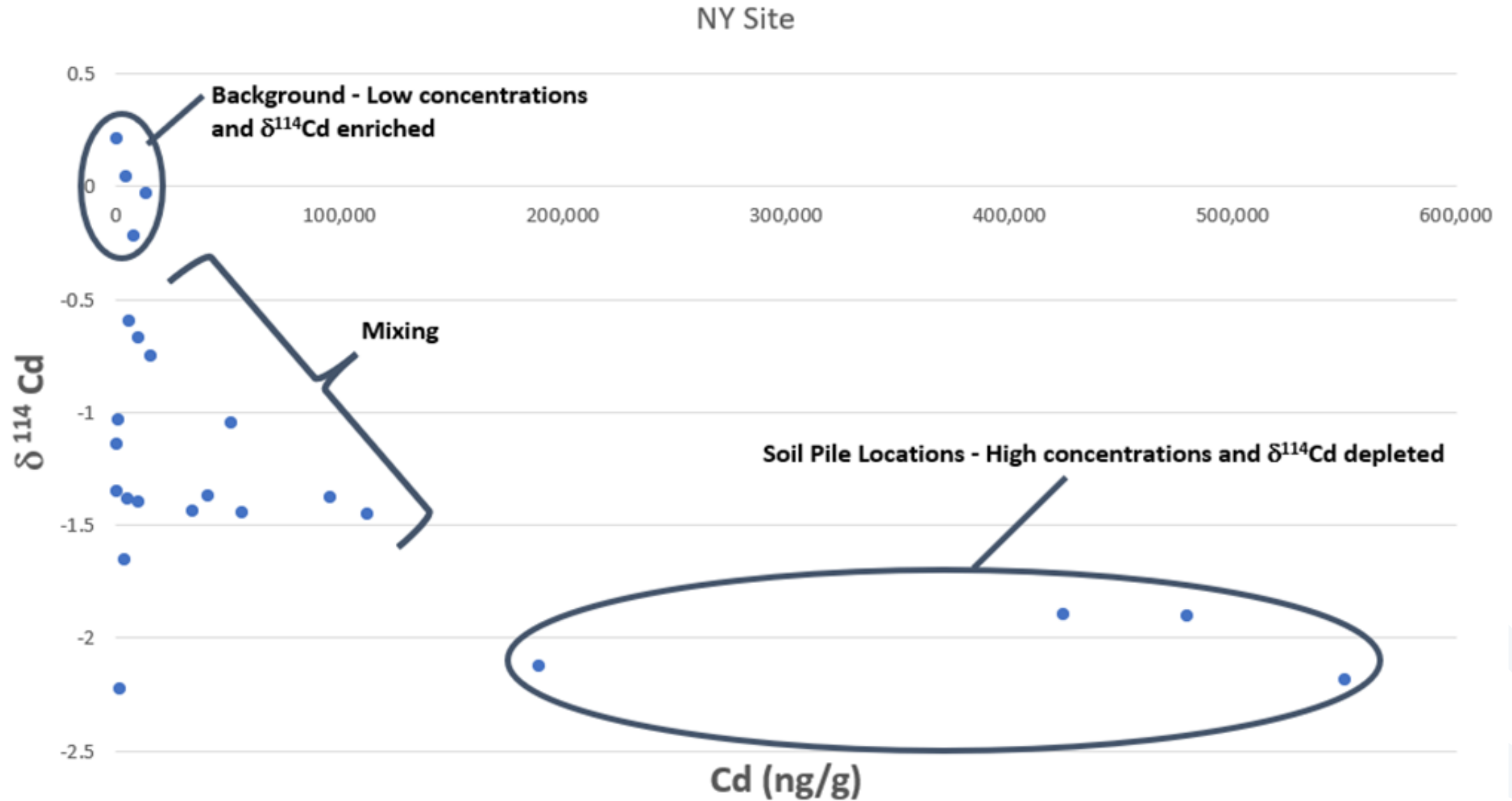
Results – Pb Concentration and Stable Isotopes in Soils



Results – Zn Concentration and Stable Isotopes in Soils



Results – Cd Concentration and Stable Isotopes in Soils



Conclusions

► Air Dispersion/Deposition Modeling

- Requires 100's to 10,000 years of operation
- Facility was in operation for approximately 40 years.

► Cd, Zn, Pb soil concentrations

- High Pb and Zn generally throughout the AOC- AD (compared to Cd) and in the soil piles and locations directly adjacent to soil piles
- High Cd was in the soil piles and adjacent sampling locations
- The lowest Cd concentrations were measured in the on-site sampling area and on northern side of AOC-AD

► Cd, Zn, Pb stable Isotopes

- One source for Cd, Pb, Zn to shallow soils
- The source is indicated to be the soil piles on the southern end of the AOC-AD

- The soil piles adjacent to and north of the former plastics plant (on-site) are the primary source of Cd, Pb, and Zn in the shallow soil samples throughout the AOC-AD area. These soils have high Cd, Pb, Zn concentrations with stable isotope signatures indicative of a single source.

Thank you!

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