Brownfields to Community Gardens- Can it be done?

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Background

What is a brownfields?

Vacant, abandoned property, the reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant

Brownfield examples

- Vacant residential lots
- Abandoned residential properties next to industrial facilities
- Abandoned properties next to rail lines
- Former school buildings
- Abandoned gas stations
- Abandoned grain elevators
- Former manufacturing facilities

Small Scale Food Production Trends

- 6.8% increase in farmers markets between 2006 and 2008 (USDA)
- More than 18,000 community gardens in the U.S. and Canada (ACGA)
- In 2008, there were appr. 4,600 farmers markets in the U.S. (USDA)

From Brownfields to Community Gardens: Benefits

- Nutrition and food security
- Exercise- a preferred form of exercise across age, gender, and ethnicity
- Mental health- Working with plants and in the outdoors
- Community Health: Building Safe, Healthy, and Green Environments
- Social Life in Urban Neighborhoods- trust, civic engagement, the development of community leaders, and the sharing of goods, services, and information

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K-State Project: Gardening Initiatives at Brownfields sites

Work with select community–based gardening initiatives to evaluate uptake of heavy metals and other contaminants by food crops

Develop recommendations for soil preparation and corrective/protective actions to address potential risk of soil contaminants

Site Selection Criteria

- Brownfields site
- About 2,000 ft^2
- Intended for community gardening activities

Process

- Establish site history
- Screening and collect soil samples
- Best management practices (adding soil amendments, raised beds)
- Continuous monitoring: soil and produce
- Training and technical assistance to participating community organizations (sample collection, site evaluation, etc.) throughout

Project Goals

- Enhance the capabilities of gardening/farming initiatives to produce crops locally without potentially adverse health effects to the grower or the end consumer

- Contribute to the meaningful revitalization of brownfields sites in a sustainable manner

Project Goals (cont.)

- Increase confidence in urban food production quality
- Provide resources for producers, urban land managers, local and state government, and extension agents to implement proposed BMPs for the detection and mitigation of potentially harmful substances in soils on brownfields sites

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Washington Wheatley
Kansas City, MO

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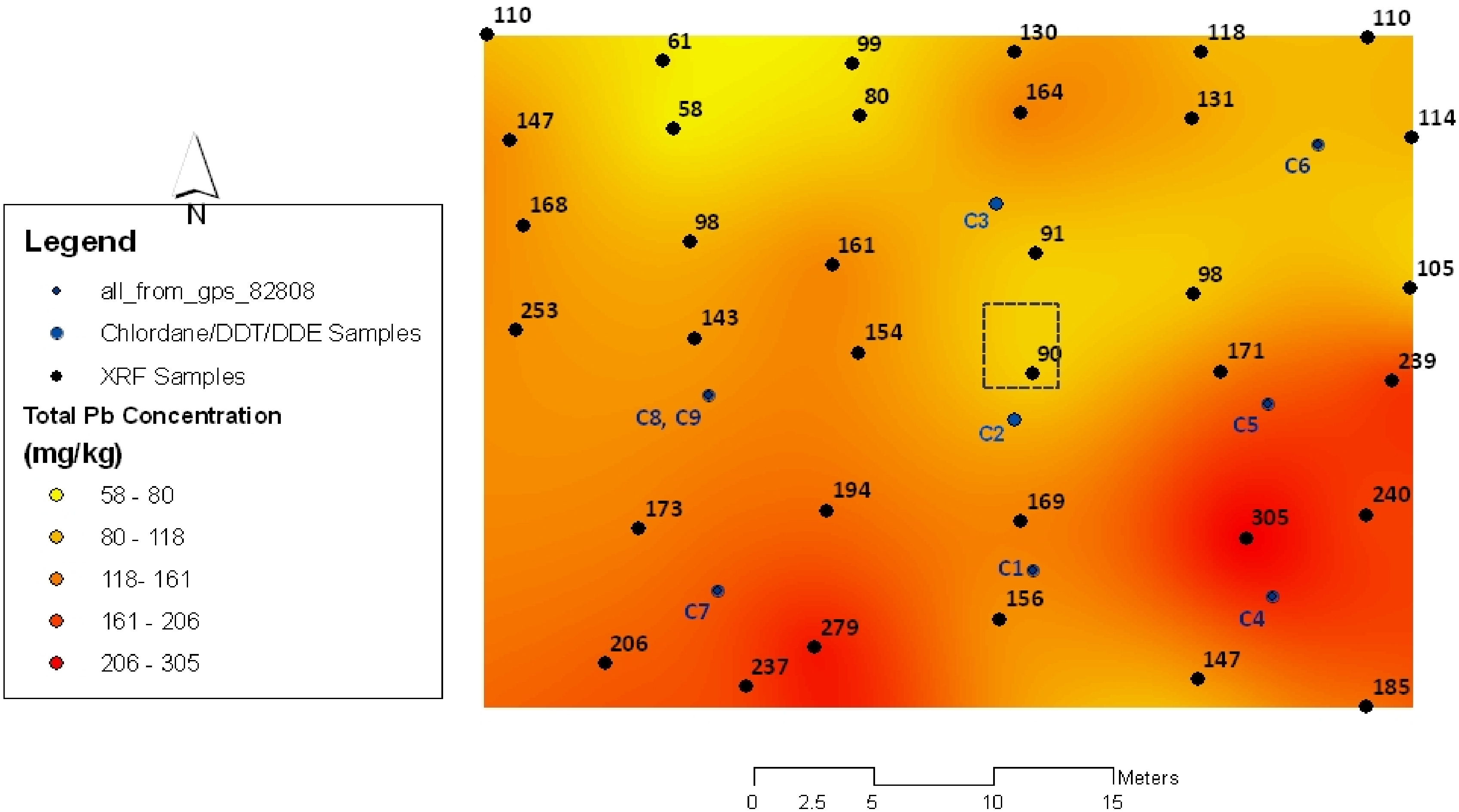
Initial Steps at Washington Wheatley

- Soil screening (in-situ)
  - Using handheld X-ray fluorescence (XRF)

- Soil sampling for laboratory verification

Washington Wheatley Total Lead and Chlordane 2009



Soil Test Results:
General soil parameters

Sample collection date: April 9, 2009

Sample ID	pH	Mehlich 3 P	K	NH_4-N	NO_3-N	OM
		---------------------- mg/kg	----------------------			%
9S	6.6	130	624	53.6	73.2	3.9
9D	6.6	93	455	9.6	35.1	3.4
21S	7.2	116	417	11.8	22.7	3.0
21D	7.2	123	221	9.3	15.0	3.1
26S	7.8	57	255	8.3	4.3	1.5
26D	7.6	80	260	8.2	2.2	1.1
39S	6.9	154	488	15.0	24.2	4.7
39D	6.9	149	334	9.6	13.3	3.3

S = shallow, 0-15 cm
D = deep, 15-30 cm

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Soil Test Results

Trace Element Concentration

Sample collection date: April 9, 2009

Sample ID	Cu†	Mo†	Cd‡	Co†	Pb†	Zn†	Ni†	As†
	……………………………… mg/kg							
21 S	27	<1	0.070	<10	117	459	15	n.d.
21D	33	<1	0.070	<10	129	459	15	n.d.
9S	31	<1	0.068	<10	243	483	14	n.d.
9D	29	<1	0.075	<10	352	409	13	n.d.
26S	20	<1	0.082	<10	80	280	16	n.d.
26D	17	<1	0.080	<10	60	203	15	n.d.
39S	38	<1	0.079	<10	237	424	15	n.d.
39D	41	<1	0.081	<10	207	435	15	n.d.

S –Shallow, 0-15 cm
D – Deep, 15-30cm
n.d. = Non-Detectable by ICP-AES

†Analyses by ICP-AES
‡Analyses by GF-AAS

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Soil Test Results

- No detectable chlordane
- Detectable levels of DDT (0.04 to1.3 mg/kg) and DDE (0.03 and 0.04 mg/kg)
- DDE is a daughter/breakdown product of DDT
- DDT, an insecticide, was banned in the US in 1972, but is very persistent in soils (half-life of DDT ~15 yrs., DDE ~11 yrs.)
- Mildly to moderately elevated Pb levels

Potential Exposure Pathways

Direct exposure

Soil → Human

Indirect Exposure

Soil → Plant → Human

Ways to minimize Human Exposure to Pb in Soils

1. Wash hands (especially children)
2. Root vegetables should be washed and peeled before consumption
3. All other vegetables should be thoroughly washed prior to consumption
4. Apply soil amendments to reduce risk

Any other practices to minimize direct exposure to soil

Addition of soil amendments can reduce contaminant bioavailability

Bioavailability: the fraction of the chemical(s) of concern in soil that is accessible to an organism (human or plants) for absorption

Metal contaminated soils- unamended

With amendment A

With amendment B

With amendment C

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Trace elements in alfalfa

pH	Cd	Mo
	---- mg/kg ----	
6.0	0.8	193
7.7	0.4	370

Source: Pierzynski, 1985

Recommendations

To minimize absorption of Pb (and DDT/DDE) by plants:

- Maintain soil pH levels above 6.5 to 7.0. - The soil pH at the WW site was about 7; therefore, no action was required

- Lead is also less available when soil P concentrations are high. Available P concentrations at the WW site soils were very high. So P addition was not necessary for this growing season

- Add organic matter to soil to reduce Pb availability to plants

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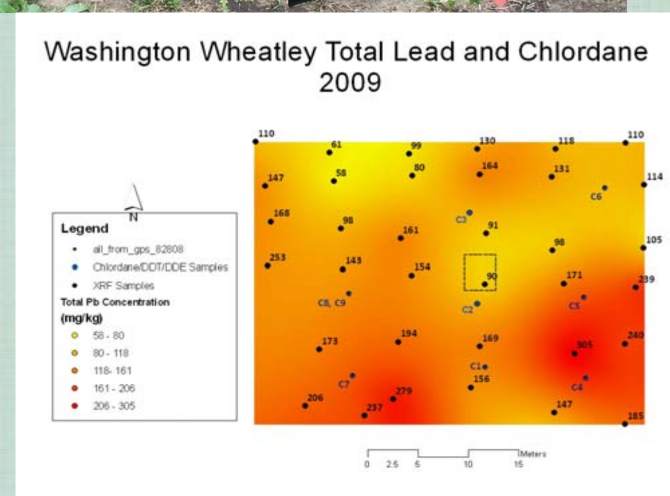
Kansas City Test Plots

Summer 2009

Experimental Design:

Completely randomized block design (RCBD) in spilt-plot arrangement

Factor	Variables
Compost	yes, no
Plant type	tomato, sweet potato, Swiss chard



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Test Plots

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Test Plots

Total Pb Concentrations (determined by 4M HNO_3 digestion) in Soil (prior to planting, June 2009)

Main plot (Compost)	Subplot (Plant type)	Soil Total Pb (mg/kg)
Yes	Swiss Chard	81.2 ± 4.2†
	Sweet Potato	101.6 ± 16.3
	Tomato	96.5 ± 10.8
No	Swiss Chard	95.3 ± 12.6
	Sweet Potato	130.3 ± 10.3
	Tomato	123.1 ± 21.1

† ±standard error of three field replicates

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Test Plots

July 2009

September 2009

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Plant uptake data

Analysis is on-going

Swiss Chard: preliminary data

Compost	Cleaning Treatment	Pb concentration (μg/kg)
Yes	Kitchen	288 ± 70[†]
	Lab	306 ±26
No	Kitchen	625 ± 199
	Lab	495 ± 212

[†] ±standard error of three field replicates

Additional Benefits

Rundown house was painted, had new windows and a new porch installed

"They now have a garden instead on a blighted piece of property next door"

WW Gardeners

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Plans for Next Year

- Move test plot at Kansas City site, larger test plots
- Add more project sites- different contaminants and/or contaminant mixtures
- Greenhouse experiments- to test effects of various amendments on contaminant uptake by plants
- Use PBET (Physiologically Based Extraction Test) to determine direct bioavailability of soil Pb to humans

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Community and Partnering Organizations

Environmental Protection Agency

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