Use of XRF to Characterize Pre-Hanford Orchards in the 100-OL-1 Operable Unit

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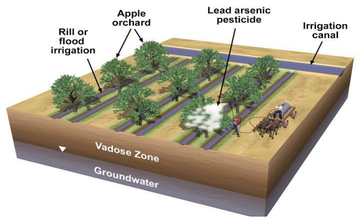
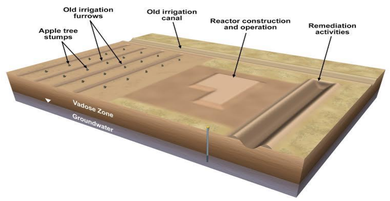
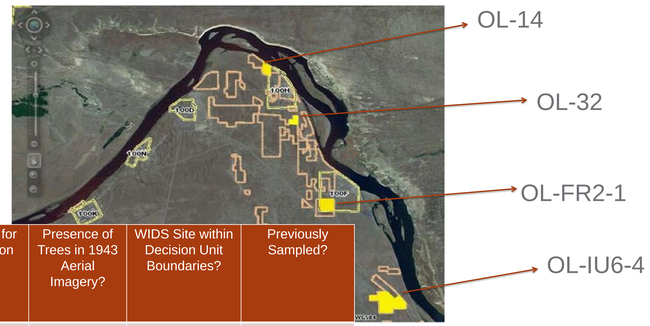
Introduction





- Prior to 1943, Hanford site included several small towns with approximately 5,000 acres of orchards; at the time lead arsenate ($PbHAsO_4$) was the most commonly used pesticide
- High concentration of lead and arsenic have been recorded where trees and stumps are still visible
- Pre-Hanford orchards have been designated as 100-OL-1 Operable Unit
- An Optimization study evaluated optimal counting time and position of the XRF from soils collected at the site
- A Pilot Study included the evaluation of a field portable x-ray fluorescence (XRF) analyzer determining if performance results meet quality assurance criteria for cleanup
- XRF has only previously been used as a screening tool

- Four Decision Units (DUs) are to be analyzed: Ol-14. OL-32. OL-IU6-4 and OL-FR2-1
- The DUs vary in size and have had distinct historic activities; such as 46.4 acres OL-14 having a military camp in the 1950s unlike OL-FR2-1 having been disturbed as it is near the F area reactor
- Together the DUs provide an adequate representation of the Operable Unit
- Screening criteria for lead (250 mg/kg) and arsenic (20 mg/kg)



Decision Unit ID	Acreage for Evaluation	Presence of Trees in 1943 Aerial Imagery?	WIDS Site within Decision Unit Boundaries?	Previously Sampled?
OL-14	46.4	Yes	Yes	Yes
OL-32	28.7	Yes	No	Yes
OL-FR2-1	48.0	No	Yes	Yes
OL-IU6-4	250.6	Yes	Yes	Yes

WIDS is Waste Information Data System

Experimental Methods

Optimization Study

Sample Collection:
Six samples were collected ranging above, at, and below the screening criteria of 250 mg/kg for Pb and 20 mg/kg for As at the Decision Units OL-14 and OL-IU6-4, and labeled respectively.

Sample Preparation:
Samples were hand sieved, homogenized and placed in sample cups. Three replicates were prepared for each sample.

Sample Analysis:
Each sample cup was analyzed 3 times for 30 sec. A Standard Reference Material (SRM) was analyzed after every 20 readings.

Time Count Determination:
Three samples were selected for 15, 30, 45, 60, 90, 120, 150 and 180 second fixed and variable analysis.

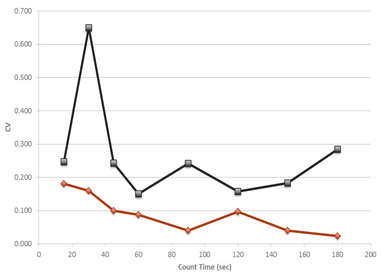
Field Variability:
Two transects at OL-14, and one at OL-IU6-4 were created by selecting locations 90° around ground zero at distances of 0.5, 1, 2, 4, 8 and 12 feet (16 ft for OL-14). Locations were scanned in triplicate for 60 seconds each.

Pilot Study

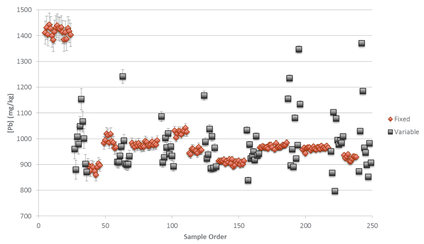
Preparation:
4 Decision Units spanning roughly 370 acres were chosen to represent 100-OL-1 Operable Unit.
40 locations within each DU were selected using Visual Sample Plan (VSP) with a random start and systematic grid pattern

Field Work:
Each location would be analyzed with 3 replicates and a 60 second count time. The Standard Reference Material (SRM) and blank are analyzed after every 20 counts to ensure accuracy.

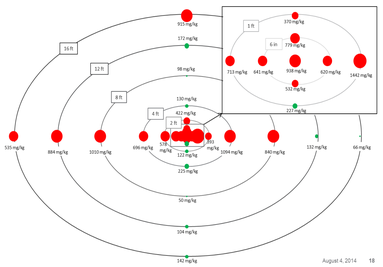
Analysis:
Data is extracted from XRF to be implemented in GIS for visual representation of site with 1943 and 2013 aerial imagery.



Arsenic coefficient of variability



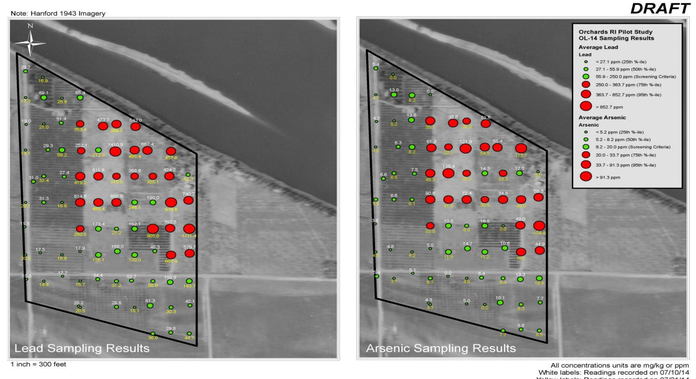
Fixed and variable XRF sensitivity OL-IU6-4-M

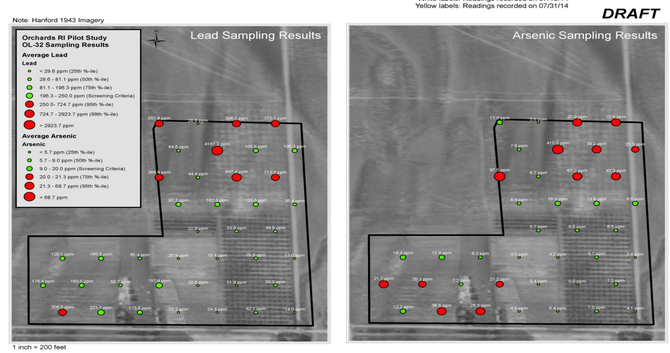


Field variability transect at OL-14

XRF side and front view

Preliminary Results





Discussion/Conclusion

- XRF provided a good indication of precision and accuracy relative to ICP with a linear correlation R^2 value higher than anticipated at .9735
- MDL proved the detection limit is significantly lower than the screening criteria,
- When comparing results from the first 40 locations of OL-14 to the total 80 locations of OL-14, the same variability was seen
- We expect high concentrations of Pb and As to be where past orchards are present though this does not occur as all sites

Significance

- XRF is competent for decision making as values fall within ±20% ICP data
- The highest concentrations are not where expected, which may be an issue for sites outside of Hanford that have had more development
- The size of the DU does not affect the number of samples measured

Future Work

- Verification and validation of the XRF Data (QA/QC)
- Revise conceptual site model
- Statistical evaluations to investigate: Estimation of variability in surface soils, appropriate size for DU, and sample size per DU
- Coordinating sample results through CORE
- Displaying sample results in PHOENIX (GIS tool)

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