

# COMPARISON OF ALL AGES LEAD MODEL VERSION 4 WITH LEADSPREAD 8 IN EVALUATION OF LEAD EXPOSURE AT CALIFORNIA HAZARDOUS WASTE SITES

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## ABSTRACT

To evaluate lead exposure at California hazardous waste sites the Human and Ecological Risk Office (HERO) uses the CalEPA source-specific "benchmark change" lead criterion of 1 µg/dL (the estimated incremental increase in children's lead blood (PbB) reducing IQ by 1 point). HERO recommends use of LeadSpread 8 to evaluate lead exposure at our sites, and we are currently revising the model to use current state of the science. HERO is participating in USEPA's Beta Test Program for the All Ages Lead Model version 4 (AALMv4). We believe the AALMv4 will provide a scientifically sound base to compare with LeadSpread. HERO is testing how efficacious and flexible AALMv4 is with the range of site conditions and exposure scenarios seen at hazardous waste sites in California as compared to our LeadSpread 8 Model. At Site A, the maximum lead soil concentration is 388 mg/kg, the average concentration is 88 mg/kg, and the exposure scenario is a youth, exposed 3-days per week. Under the respective models' default parameters, the AALMv4 predicted a peak PbB of 0.71 µg/dL while LeadSpread 8 predicted a PbB of 2.2 µg/dL when exposed to 388 mg/kg lead in soil. Predicted PbB values of 0.16 µg/dL by AALMv4 and of 0.5 µg/dL by LeadSpread were obtained for exposure to the average lead concentration of 88 mg/kg. At Site B, the 95% upper confidence limit on the arithmetic mean (95%UCL) is 108 mg/kg, and the exposure is 7-days a week from birth to 7-years-old. The AALMv4 predicted a peak PbB of 1.19 µg/dL while LeadSpread 8 predicted a PbB of 1.4 µg/dL. The CalEPA screening value for lead in soil for residential land use is 80 mg/kg, while the USEPA value is 400 mg/kg. When evaluating a residential exposure scenario of 7-days a week from birth to 7-years-old, the AALMv4 predicted a peak PbB of 0.89 µg/dL and 4.3 µg/dL when children are exposed to 80 mg/kg and 400 mg/kg lead in soil, respectively. LeadSpread 8 predicted a PbB of 1 µg/dL and 5.2 µg/dL under the same conditions. Given the wide differences in the way the two models are constructed, the predicted PbB results appear to be comparable.

## Introduction

- Lead is a common contaminant at hazardous waste sites in California.
- Current sources of lead include batteries, ammunition, paint, glass and ceramic products, casting metals, wheel balancers, fishing weights, stabilizer in PVC, sheet lead and nuclear radiation shielding.
- Former uses of lead such as gasoline additive, household paints and pesticides also contribute to the contamination found at hazardous waste sites in California.
- Health Effects of Lead (ATSDR, 2007)
  - Children considered most sensitive population
  - Effects on many organs and systems
  - Primary targets - nervous system, kidney, hematological and cardiovascular systems
  - Can cause tumors in laboratory animals
- Selected Models Available to Evaluate Effect of Lead on Human Health:
  - DTSC/HERO: LeadSpread 8
    - Evaluates a source-specific exposure to lead in soil/dust assuming the following exposure routes: ingestion, dermal contact, and dust inhalation.
    - Does not consider background exposures and other media (e.g. water, air).
    - Blood lead level of concern is 1 µg/dL (2007 Cal/EPA OEHHA benchmark incremental change criterion for lead).
    - Recommends using the 90<sup>th</sup> percentile of the distribution to determine potential effect from lead found in soil and calculating lead soil risk based concentration.
  - USEPA: beta All Ages Lead Model version 4.0 (AALMv4)
    - The AALMv4 predicts blood and tissue lead masses (µg) and concentrations (µg/g).
    - Evaluates exposures to lead in air, drinking water, surface dust, food, or miscellaneous ingestion pathways.
    - Able to simulate multi-pathway exposures that are constant or that vary in time increments as small as one day; and that occur at any age from birth to 90 years.

## Methods

- Ran both models using the their respective default parameters.
- Ran two different exposures
  - Youth (3-days a week from age 5 to 14-years old)
  - Childhood (7-days a week from birth to age 7)
- Output
  - AALMv4 – Peak & Average Pb Levels
  - LeadSpread 8 – 90<sup>th</sup> percentile

Select Model Input Parameters		
	AALMv4	LeadSpread 8
Soil Ingestion (g/day)	0.6 (Birth) to 0.1 (10 yrs)	0.1
Bioavailability	0.60	0.44
Blood Lead Level of Concern (µg/dL)	No set level	Set at 1

## Residential Soil Lead Screening Levels Used by Other States

[Pb] (mg/kg)	Number of States	Blood Lead (µg/dL)
500	2	
400	26	10.0
340	1	
300	1	
260	1	
200	3	5.0
153	1	
75	1	

## Residential Lead Screening Levels

Source	Lead Concentration (mg/kg)	Blood Lead (µg/dL)
USEPA	400	10
California	80	1.0
CDC		5.0

## Blood Lead Levels

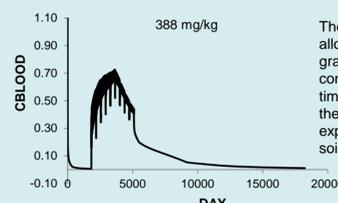
### Childhood Exposure

[Pb] (mg/kg)	AALMv4 PbB (µg/dL)		LeadSpread 8 PbB (µg/dL)
	Peak	Average	90 <sup>th</sup> Percentile
400	4.3	3.4	5.2
300	3.2	2.5	3.9
200	2.2	1.7	2.6
153	1.7	1.3	2.0
80	0.89	0.69	1.0

## CASE STUDIES

### Site A

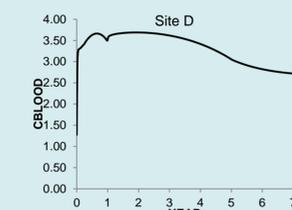
- Former Central California Firing Range.
- Currently under redevelopment - Fire road behind proposed residential housing.
- Exposure Scenario Evaluated:
  - Youth: 3-days a week from age of 5 to 14-years.
- Concentrations of Lead in Soil
  - 388 mg/kg (max concentration)
  - 88 mg/kg (average concentration)



Blood Lead Levels			
Pb Soil Concentration (mg/kg)	Youth Exposure		LeadSpread 8 PbB (µg/dL)
	AALMv4 PbB (µg/dL)	Peak	Average
388	0.71	0.55	2.2
88	0.16	0.12	0.5

### Sites C and D

- Former Northern California Surplus Housing.
- Proposed Future Development – Residential Housing.
- Exposure Scenario Evaluated:
  - Childhood: 7-days a week from birth to 7-years of age.
- For the AALMv4 model, we assumed 100% exposure from the patio until age 1, then decreased patio time exposure by 10% for each year of age. By age 7, the exposure ratio was 30% of dust from ingestion from the patio and 70% from the yard.
- Concentrations of Lead:
  - Site C
    - Patio – 460 mg/kg (sample weighted avg)
    - Back Yard – 370 mg/kg (sample weighted avg)
  - Site D
    - Patio – 340 mg/kg (sample weighted avg)
    - Front Yard – 590 mg/kg (sample weighted avg)



### Site C – Blood Lead Levels

Pb Soil Concentration (mg/kg)	Childhood Exposure		
	AALMv4 PbB (µg/dL)	LeadSpread 8 PbB (µg/dL)	90 <sup>th</sup> Percentile
Patio - 460	5.26	4.97	6.0
Back Yard - 370	---	3.73	4.8

\*No peak was detected.

### Site D – Blood Lead Levels

Pb Soil Concentration (mg/kg)	Childhood Exposure		
	AALMv4 PbB (µg/dL)	LeadSpread 8 PbB (µg/dL)	90 <sup>th</sup> Percentile
Patio – 340	3.66	3.47	4.4
Front Yard - 590	3.68	3.29	7.4

## DISCUSSION and SUMMARY

- Several models are available to evaluate lead exposure.
- We evaluated two of these models, the DTSC LeadSpread 8 and the most recent beta version of the All Ages Lead Model version 4 (AALMv4).
- The AALMv4 provides user with more flexibility than LeadSpread 8. This is particularly significant if the user is interested in a specific time range or exposure to different lead concentrations over specific time periods. This flexibility is important to DTSC since we evaluate a wide range of sites and exposure scenarios.
- In general, LeadSpread 8 predicted slightly higher PbB levels than AALMv4 for each scenario we evaluated.
- The greatest variability between LeadSpread 8 and AALMv4 occurs when evaluating a short time exposure over a defined period of time, as shown at Site A.
- The predicted PbB levels from AALMv4 model and LeadSpread 8 are similar when evaluating a child exposed to 80, 153, 200, and 300 mg/kg lead in soil 7-days a week from birth to 7-years old.
- The AALMv4 model can also predict kidney, liver, cortical bone Pb concentrations, total body, respiratory tract, blood, plasma, urine, and fecal Pb amount, and total Pb intake from ingestion and inhalation.
- The use of LeadSpread 8 at DTSC sites is health protective.

## REFERENCES

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The US Environmental Protection Agency's All Ages Lead Model version 4 (AALMv4) is a beta test model, and is not being used for any EPA regulatory activities at this time. Furthermore, EPA does not sanction or in any way endorse or support the use of the AALMv4 model for any non-EPA regulatory activities