Ambrents Stauly, mass balance approach.  Sample data and soll was collected in the child's play areas and analyzed for the presence of the tracers used.  Tracers: Al, Ba, Min, Anaconda Study: Superfund stel in Calabrese et al (1989)  Anaconda Study: Superfund stel in Study included 4 groups of children in the hospital (1990)  Wan Wijnen et [1990]  Washington State (three cities): Soil and dust ingestion was evaluated by analyzing soil, dust, free, urine, and distinguish analysis for the tracers in soil of the control group of children in the hospital.  Washington State (three cities): Soil and dust ingestion was evaluated by analyzing soil, dust, free, urine, and individuals and on control group of children.  Davis et al. (1990)  Washington State (three cities): Soil and dust ingestion was evaluated by analyzing soil, dust, free, urine, and individuals and soil and control. 2. 1. 3 to 8 soil 0 10 20 NR (100 30 NR (100 3					Sample		Ingestion	Central Tendency p50		Study	Long term	Primary or Secondary		
Sample dust and soil was collected in the claibrese et al. (1989)  From weeks (1989)  Fro		Study/Reference	Summary	Study Methodology	Size	Age (years)	Medium	(mean)	p95 (mg/day)	Duration	extrapolation	data	Notes	EFH
Process of the tracers used.   10 of tracers and tracers and the tracers used.   10 of tracers and tra		Calabrese et al.	Sample dust and soil was collected in the child's play areas and analyzed for the		* '		soil		,,,,,,	Two weeks 5 (two 3-4 day No time periods)			unable to distinguish the contribution of soil and dust	
Anaconda Study: Superfund site in Montana. Soil ingestion was estimated using a mass balance approach.  Tracers: Al, Cs, La, Mailington State (three cities): Soil and dust ingestion was evaluated by analyzing soil, dust, fees, urine, and dust ingestion was evaluated by analyzing soil, dust, fees, urine, and dust ingestion was evaluated by analyzing soil, dust, fees, urine, and dustingestion was evaluated by analyzing balance approach.  Tracer: Al, Si 18 8 soil 30 NR (150) NR  Tracer: Aluminum 104 2 to 7 soil/dust NR (160) NR  Tracer: Aluminum 104 2 to 7 soil/du				, . , ,		1 to 4	dust		·			Primary	mediums. Negative values come from very high levels of barium and manganese (and possibly other tracers) in	Yes
Calabrese et al. (1997)  Whether and Study: included 4 groups of children: 1. that live in the inner ofty (with little soil contact), 2. living in homes with a did interest AI, 13, and Acid-instoluble 292  Washington State (three cities): Soil and dust ingestion was evaluated by analyzing soil, dust, feece, unine, and duplicate food, didensity and realized to be most stable/reliable.  Washington State (three cities): Soil and dust ingestion was evaluated by analyzing soil, dust, feece, unine, and duplicate food, delicents. Children were randomly selected.  Washington State (three cities): Soil and dust ingestion was evaluated by analyzing soil, dust, feece, unine, and duplicate food, delicents. Children were randomly selected.  Washington State (three cities): Soil and dust ingestion was evaluated by analyzing soil, dust, feece, unine, and duplicate food, delicents. Children were randomly selected.  Tracer: Aluminum 104 2 to 7 Soil/dust NR (160) NR  Tracer: Silicon Soil/dust NR (160) NR  Tracer: Silicon NR (160) NR  Tracer: Silicon NR (150) NR  NR (160) NR  Tracer: Silicon NR (160) NR  Tracer: Silicon NR (150) NR  NR (160) NR  Tracer: Silicon NR (160) NR  Tracer: Silicon NR (150) NR  NR (160) NR  Tracer: Silicon NR (160) NR  Tracer: Silicon NR (150) NR  NR (160) NR  NR (160) NR  NR (160) NR  Tracer: Silicon NR (150) NR  NR (160) NR  Tracer: Silicon NR (150) NR  NR (160) NR				Si, Vn, Y, Zi, Ti			soil + dust	-340 to +456	159 to 3,174					
No. 5), Ti, Y, Zr dust 26.8 613.6 days)  No. 5), Ti, Y, Zr dust 26.8 613.6 days)  No. 5), Ti, Y, Zr dust 26.8 613.6 days)  No. 5), Ti, Y, Zr dust 26.8 613.6 days)  No. 5), Ti, Y, Zr dust 26.8 days days decided a groups of children: 1. that live in the inner cty (with little soil contact), 2. living in homes with a damitted to a hospital (control group)  No. 5), Ti, Y, Zr dust 26.8 days days days days days days days days		Calabrese et al.	Montana. Soil ingestion was estimated	Tracers: Al Ce la	64	1 to 4	soil	20.1	282.4	(seven consecutive	No	Primary	stability and reliability of the tracers. Al, Si, Y were found	Yes
Netherland Study-included agroups of children: 1. that live in the inner city (with little soil contact), 2. living in homes with a garden, 3. from campgrounds, and 4. admitted to a hospital (control group)  Washington State (three cities): Soil and Acid-insoluble 292  Now week (1990)  Washington State (three cities): Soil and Acid-insoluble 292  Now week (1990)  Washington State (three cities): Soil and Acid-insoluble 292  Now week (1990)  Washington State (three cities): Soil and dust finestion was evaluated by analyzing soil, dust, frees, urine, and duplicate food, dietary supplement, medication and mouthwash samples for the tracer elements. Children were randomly selected.  Davis et al. (1990)  Davis and Milrick (2006)  Children and adults from same family: Soil ingestion was estimated using a mass balance approach.  Vermeer and Frate (1990)  Surveyed about geophagy (regular consumption of clay over weeks); No 229 in Soil of the same as for the read of a processor of the pr							dust	26.8	613.6					
dust ingestion was evaluated by analyzing soil, dust, feese, urine, and duplicate food, dietary supplement, medication and mouthwash samples for the tracer elements. Children were randomly selected.  Tracer: Silicon  Tracer: Si	ıry Analysis	Van Wijnen et el	children: 1. that live in the inner city (with little soil contact), 2. living in homes with a garden, 3. from campgrounds, and 4.	Tracers: Al, Ti, and Acid-insoluble	292					(two 3-4 day	No	Primary	presented represents the ingestion rate <i>after</i> correcting the ingestion rate by subtracting the ingestion rate of the	Yes
dust ingestion was evaluated by analyzing soil, dust, feese, urine, and duplicate food, dietary supplement, medication and mouthwash samples for the tracer elements. Children were randomly selected.  Tracer: Silicon  Tracer: Si	E I						Soil	NR (0 to 200a)	NR					
Children and adults from same family: Soil and Mirick (2006)  Davis and Mirick (2006)  Children and adults from same family: Soil ingestion was estimated using a mass  Davis and Mirick (2006)  Davis and Mirick (2006)  Surveyed about geophagy (regular consumption of clay over weeks); N= 229 in 50 sousholds; 56 women, 33 men, 140 children or adolescents.  Questionaire/  Primary Titanium was shown to be reliable and stable in children, but not in adults (Calabrese and Stanek 1995)  NR  11  Consecutive No Primary Yes  Also, only 2 children over the age of 4 practiced geophagia. Yes  No geophagia was reported among men or adolescents.  Also, only 2 children over the age of 4 practiced geophagia. Yes  Collected	Studies of	Davis et al. (1990)	dust ingestion was evaluated by analyzing soil, dust, feces, urine, and duplicate food, dietary supplement, medication and mouthwash samples for the tracer	Tracer: Aluminum	104	2 to 7				one week	No	Primary	the tracer concentration in yard soil and house dust based on proportion of time spent indoors and outdoors (assuming ingestion of soil was the same as ingestion of	Yes
Davis and Mirick (2006)  NR  Surveyed about geophagy (regular consumption of clay over weeks); N= 229 in 50 bouseholds; 56 women, 33 men, 140 children or adolescents.  Questionaire/  Davis and Mirick (2006)  NR  Davis and Mirick (2006)  NR  Davis and Mirick (2006)  NR  NN  Davis and Mirick (2006)  NR  NN  No geophagia was reported among men or adolescents.  Also, only 2 children over the age of 4 practiced geophagia.  Yes  Collected  Yes	ž			Tracer: Silicon			soil/dust	NR (160)	NR					
Davis and Mirick (2006)  Reconsecutive No Primary  Yes  No geophagia was reported among men or adolescents.  No geophagia was reported among men or adolescents.  On Surveyed about geophagi was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  No geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.  On Surveyed about geophagia was reported among men or adolescents.		Davis and Mirick (2006)	ingestion was estimated using a mass		12	3 to 8	soil	30		consecutive No				
(2006)  12 3 to 8 soil 45 NR days  38 adults soil 200 to 260 NR  Vermeer and Frate (1979)  Softward of the consumption of clay over weeks); N= 229 in 500 to 260 NR					38	adults	soil	soil 0 to 20	NR		No	Primary		Yes
Vermeer and Frate (1979)  Surveyed about geophagy (regular  consumption of clay over weeks); N= 229 in 50 households; 56 women, 33 men, 140 children or adolescents.  Questionaire/  Female  No geophagia was reported among men or adolescents.  Data not Also, only 2 children over the age of 4 practiced peophagia.  Yes Collected					12	3 to 8	soil	45	NR					
Vermeer and Frate (1979)  Consumption of clay over weeks); N= 229 in Solution of clay					38	adults	soil	200 to 260	NR					
Questionarcy		Vermeer and Frate	consumption of clay over weeks); N= 229 in 50 households; 56 women, 33 men, 140		115		Soil	NR	NR	NA	No	empirically	Also, only 2 children over the age of 4 practiced	Yes
Survey 56 Adults Soil NR NR			children or adolescents.		56		Soil	NR	NR			conected		

				Sample		Ingestion	Central Tendency p50		Study	Long term	Primary or Secondary		
	Study/Reference	Summary	Study Methodology		Age (years)	Medium	(mean)	p95 (mg/day)	Duration	extrapolation	data	Notes	EFH
	Wong (1988); Calabrese and Stanek (1993)	Wong (1988) is a dissertation investigating the exposure to parasites. Calabrese and stanek reviewed because of its information on soil ingestion, particularly soil pica.	Tracer: Silicon	15	0.3 to 7.5	soil	NR	NR	4 months; 1 fecal sample collected per month	No	Both	5 of the 24 younger children displayed soil pica (> 1 g soil per day) on at least one occasion. Study did not use mass balance, but instead used hospitalized children as controls. Children were in government institutions waiting for foster home placement.	Yes
				28	1.8 to 14	soil	NR	NR					
	Stanek and Calabrese (2000)	Anaconda reanalysis. After correcting for tracer error, ingestion rate data was re-analyzed. Original study by Calabrese et al. 1997	Tracers: Al, Si, Ti	64	1 to 4	soil	24	91		Yes	Primary		Yes
		Amherst Study: reanalysis	Tracers: Al, Si, Ti			soil	17	106	Two weeks			Authors performed adult control study to determine reliability	
	Calabrese et al. (1989)	Amnerst Study: reanalysis	Tracer: Al, Si, Y only	64	1 to 4	Soil Dust	9 to 40 15 to 49	106 to 653 169 to 692	(two - 3 to 4 day time	No	Secondary	of tracers and found that of the eight used, only Al, Si, and Y were stable and reliable.	No
						Soil + Dust	11 to 49	159 to 653	periods)				
sis	Calabrese and Stanek	After correcting for tracer error, ingestion rate data was re-analyzed. Original study by Van Wijnen et al. 1990	Day care/campground- revisited	292	0.1 to 5	soil	111	NR		No	Secondary		Yes
a <del>/</del>			revisited			soil	160	NR					
Secondary Analysis	Calabrese and Stanek	After correcting for tracer error, ingestion rate data was re-analyzed. Original study by Binder et al. 1986.	Tracer: Al	59	1 to 3	soil	121	NR		No	Secondary	The four best tracers were used (i.e., most stable with lowest F/S ratio)	No
			Tracer: Si		1 to 3	soil	136	NR			Secondary		NO
u			Tracer: Ti			soil	618	NR					
of Seco	Calabrese and Stanek	After correcting for tracer error, ingestion rate data was re-analyzed. Original study by Davis et al., 1990	Tracer: Al	104	2 to 7	soil	25	NR	one week	No	Secondary	The four best tracers were used (i.e., most stable with lowest F/S ratio)	Yes
			Tracer: Si	104	2 10 7	soil	59	NR	OHE WEEK	NO	Secondary		103
Se			Tracer: Ti			soil	81	NR					
/ Studies	Calabrese and Stanek (1995)	After correcting for tracer error, ingestion rate data was re-analyzed. Original study by Calabrese 1989 (Amherst Study)	Tracer: Al	64	1 to 4	soil	29	NR	Two weeks (two - 3 to 4	No S	Secondary	The four best tracers were used (i.e., most stable with lowest F/S ratio)	Yes
			Tracer: Si			soil	40	NR	day time		,		
Key			Tracer: Ti			soil	55	NR	periods)				
_	Calabrese and Stanek	After correcting for tracer error, ingestion rate data was re-analyzed. Original study by Calabrese 1989	Tracers: Al, Si, Ti, Y,						Three weeks	No	Secondary	The four best tracers were used (i.e., most stable with lowest F/S ratio)	Yes
			and Zr	6	Adults	soil	87	142					
		Biokinetic model comparison methodology to								No Seconda		The study populations were in general random samples of	
		review the measured blood lead levels of children living near lead smelting communities.			0.3 to 1	soil	30	NR				children 6 months to 7 years of age. The values derived for	
				478		dust	30				Secondary	infants (i.e., <1 year) and children are EFH recommended	
					1 to 6	soil	50	NR				values for soil and/or dust central tendency ingestion rates.	
		Orbertal developed at least developed	Biokinetic Model			dust	60	NR				CON of investigation was force and 2007 from these	Yes
		Ozkaynak et al. developed soil and dust ingestion rates for children using US EPA SHEDS								Yes?	Secondary	60% of ingestion was from soil, 30% from dust on hands, and 10% from dust on objects.	
	Ozkaynak et al. (2011)	model.	Activity Pattern		3 to <6	soil/dust	37.75	224			Secondary		Yes
	Wilson et al. (2013	Revisits the activity pattern method but simplifies it to overall activities and does not distinguish between individual activities.	Activity Pattern		0.2 to adult					No	Secondary		
		•				soil	1.2 to 23	4.8 to 75					No

Notes:

Notes:
IR= ingestion rate
mg= milligrams
NR= Not reported
p50= the 50th percentile
p95= the 95th percentile

Mean= arithmetic mean unless otherwise denoted
a = geometric mean
\*\* Value is presented as Best Tracer Methodology (BTM)

Best Tracer Methodology (BTM) uses food/soil (F/S) tracer concentration ratios in order to correct for errors caused by misalignment of tracer input and outputs, ingestion of non-food sources, and non-soil sources. F/S ratio is the tracer concentration present in duplicate Food/Tracer concentration in Soil where children (or adults) spend their time®

Table 5. Calculated arithmetic mean soil ingestion rates

Age (year)	Arithmetic ± SD (p95)
1 to 5	20 ± 26 (64)
5 to 11	23 ± 32 (75)
11 to 18	1.5 ± 2.6 (5.3)