

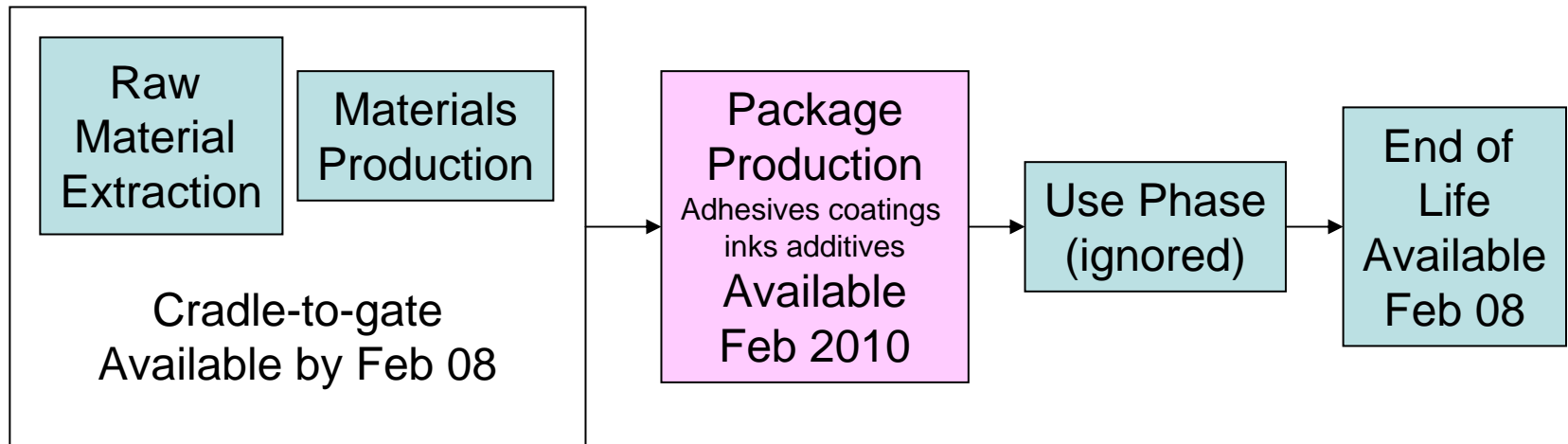
An Approach to Measuring Toxicity for the Wal-Mart Scorecard

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InLCA/LCM 2007



Packaging Health & Safety Life Cycle Approach



Process for Developing Indicator

- Health & Safety sub-committee of Steering committee for the Packaging sustainable value network
- Identified desired elements of indicator
- Reviewed available indicators
- Proposed approach at Wal-Mart SVN meeting in May (requested input from 150 attendees)
- Worked with US EPA OPPT



Toxicity Calculation

- Based on the US EPA PBT Profiler Data: ALL organics

Formula:

$$E \times L/T \times BCF = \text{toxicity}$$

Where:

E = Life cycle emissions, grams

L = Media weighted lifetime

T = lowest LC-50 or EC-50 from Eco-SARS mg/L

BCF = Bio-concentration factor

Media Weighted Lifetime

- Lifetime = $-\text{half-life} / \ln(0.5)$ (years)
- Media weighted lifetime = $\sum \text{media proportion} * \text{media lifetime}$
- Lifetime of metals = biogenic residence time



Atomic #	Element	Mean Ocean Concentration	UNIT	Residence Time, Years
1	H+	12	nmol/kg	
2	He	1.9	nmol/kg	
3	Li	25.9	μmol/kg	2,800,000
4	Be	23	pmol/kg	1,000
5	B	416	μmol/kg	9,600,000
6	C	2.248	mmol/kg	83,000
7	N2	590	μmol/kg	
7	NO3	30	μmol/kg	3,000
8	O2	175	μmol/kg	
9	F	68	μmol/kg	500,000
10	Ne	7.9	nmol/kg	
11	Na	469	mmol/kg	55,000,000
12	Mg	52.7	mmol/kg	13,000,000
13	Al	1.11	nmol/kg	200
14	Si	99.7	μmol/kg	20,000
15	PO4	2	μmol/kg	69,000
16	SO4--	28	mmol/kg	8,700,000
17	Cl-	546	mmol/kg	87,000,000
18	Ar	15.5	μmol/kg	
19	K	10.2	mmol/kg	12,000,000
20	Ca	10.27	mmol/kg	1,100,000
21	Sc	16	pmol/kg	
22	Ti	136	pmol/kg	150
23	V	39	nmol/kg	50,000
24	Cr(VI)	4	nmol/kg	8,000
25	Mn	360	pmol/kg	60
26	Fe	540	pmol/kg	500
27	Co	20	pmol/kg	340
28	Ni	8.2	nmol/kg	6,000
29	Cu	2.4	nmol/kg	5,000
30	Zn	5.4	nmol/kg	50,000
31	Ga	17	pmol/kg	500
32	Ge	75	pmol/kg	20,000
33	As	20	nmol/kg	39,000
34	Se	1.9	nmol/kg	26,000
35	Br	840	μmol/kg	130,000,000

Mean Oceanic Residence Time Known for Almost all elements

Simple biogenic sedimentation model:

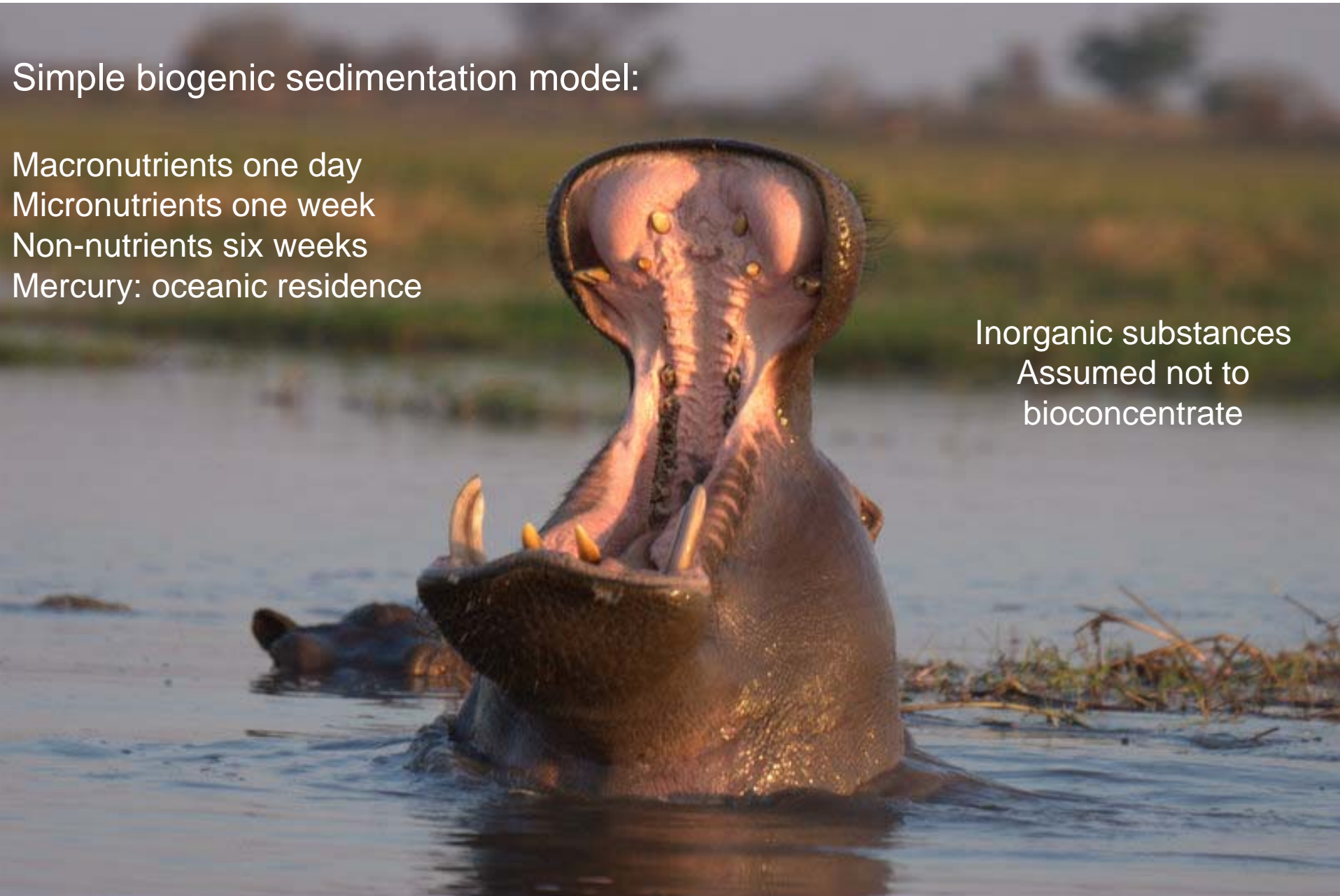
Macronutrients one day

Micronutrients one week

Non-nutrients six weeks

Mercury: oceanic residence

Inorganic substances
Assumed not to
bioconcentrate



Inorganic List

	CAS Number	EPA Standard, mg/L	Biogenic Time, Yrs
Aluminum	7429905	0.087	0.164
Ammonia-Nitrogen	7664417	0.0009	0.003
Antimony	7440360	0.006	0.164
Arsenic	7440382	0.036	0.164
Barium	7440393	2	0.164
Beryllium	7440417	0.0053	0.164
Boron	7440428	750	0.019
Chlorine	7782505	230	0.003
Copper	7440508	0.0031	0.019
Hexavalent Chromium	18540299	0.011	0.019
Fluorine	7782414	4	0.019
Iron	7439896	1	0.003
Lead	1439921	0.0025	0.164
Manganese	7439965	0.05	0.019
Mercury	7439976	0.0014	350.000
Nickel	7440020	0.0082	0.019
Nitrite-Nitrogen	7632000	1	0.003
Nitrate-nitrogen	7631994	10	0.003
Selenium	7782492	0.035	0.019
Silver	7440224	0.0019	0.164
Thallium	7440280	0.013	0.164
Total-Phosphorus	7601549	0.025	0.003
Zinc	7440666	0.081	0.019

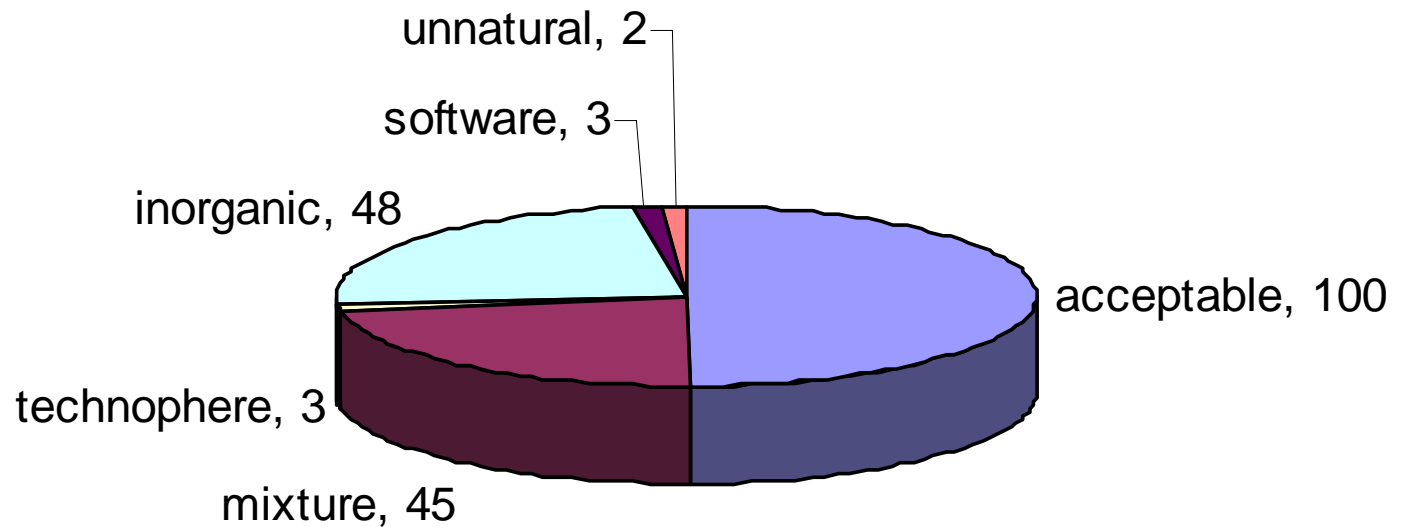
If there is no ambient
water standard we
cannot characterize
the flow

More work is needed

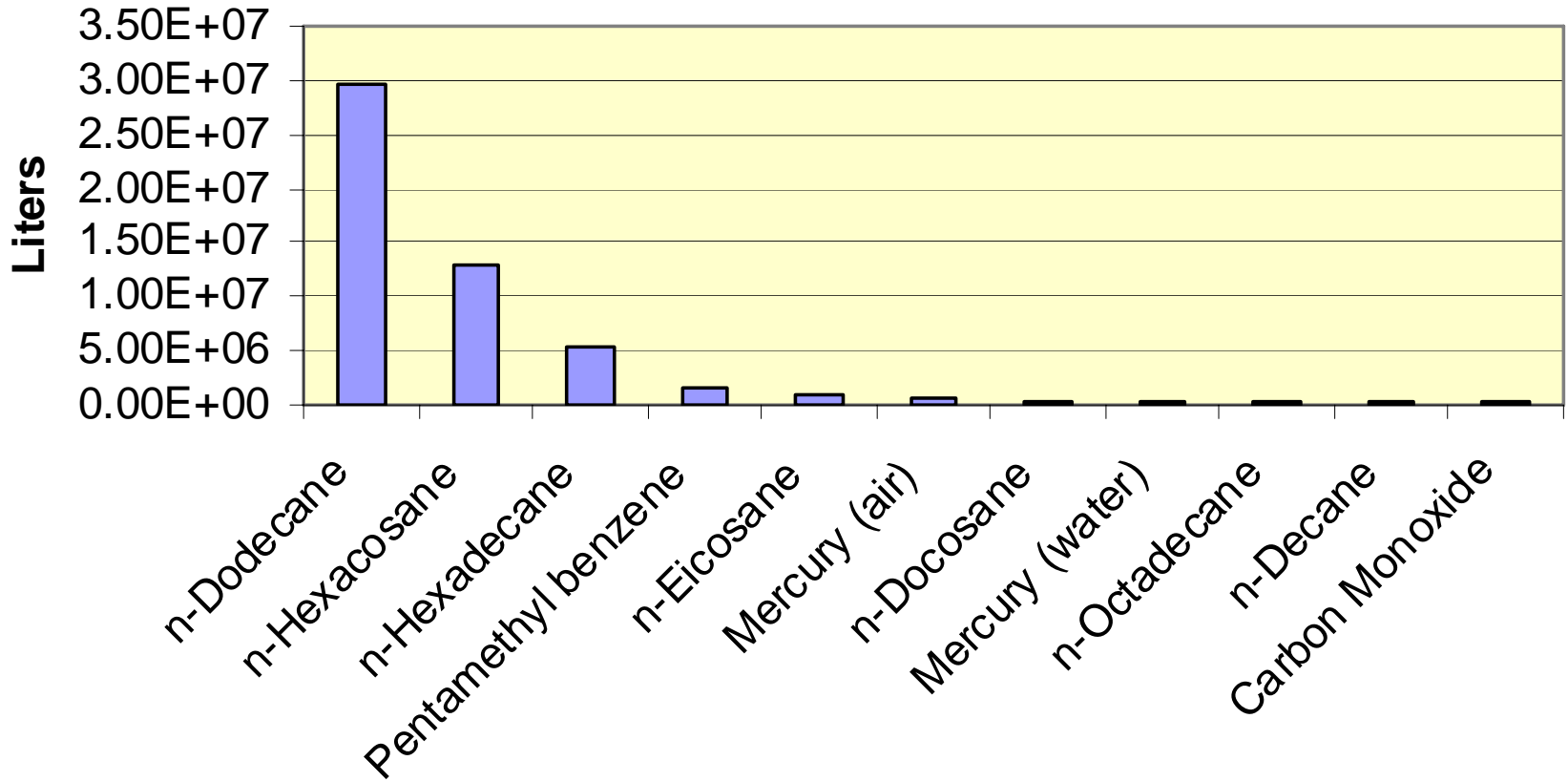


Test on Cradle-to-Resin HDPE

Characterization Status



LCA-Tox 1000 lbs HDPE



LC emissions

99% of indicator in only 10 substances: Total 5280 cubic meters



Example Indicator Calculations

Material	LCI Results Lbs/1000 lbs	LCA-tox Liters
HDPE Cradle to Resin	1,920	5.28×10^7
ABS Cradle to Resin	3,830	6.25×10^7

Based on US Life Cycle Inventory



You, too can use LCA-tox

- Beta version FREE on IERE's Website www.iere.org/LCA-tox/
- Need to have data in this format:

CAS#	mg emission	Substance Name
106-99-0	4.49E-01	1,3 Butadiene
1730-37-6	3.28E-01	1-methylfluorene
105-67-9	8.07E+01	2,4 dimethylphenol
121-14-2	3.20E-06	2,4-Dinitrotoluene
532-27-4	7.98E-05	2-Chloroacetophenone

Some Notes

- LCA-tox is an eco-tox, not a human tox model
- It is based on mortality, not other adverse endpoints
- LCA-tox is still in early days:
 - Seeking input for improvement
- Inorganic list is very incomplete
 - What about substances for which no standards exist?