- Overview -

Mercury Releases from Dental Amalgam to the Environment

Peter Maxson
Concorde East/West Sprl

"Dental Sector as a Source of Mercury Contamination"

Workshop organised by:
European Environmental Bureau - EEB
Health & Environment Alliance - HEAL
Zero Mercury Working Group

Goethe Institute, Brussels -- 25 May 2007

Aaaaaaaaaaaaaaaah!!

Dental mercury study*

- Summarize key problems
- Scope – focus on environmental releases
- Mercury pathways to the environment
- EU-27 dental mercury mass balance
- Conversion to methylmercury (bioavailability)
- Benefits vs. cost of phase-out
- Observations

* Ref. ”Mercury in Dental Use,” Maxson, 2007.

Dental mercury amalgam – apparent problems

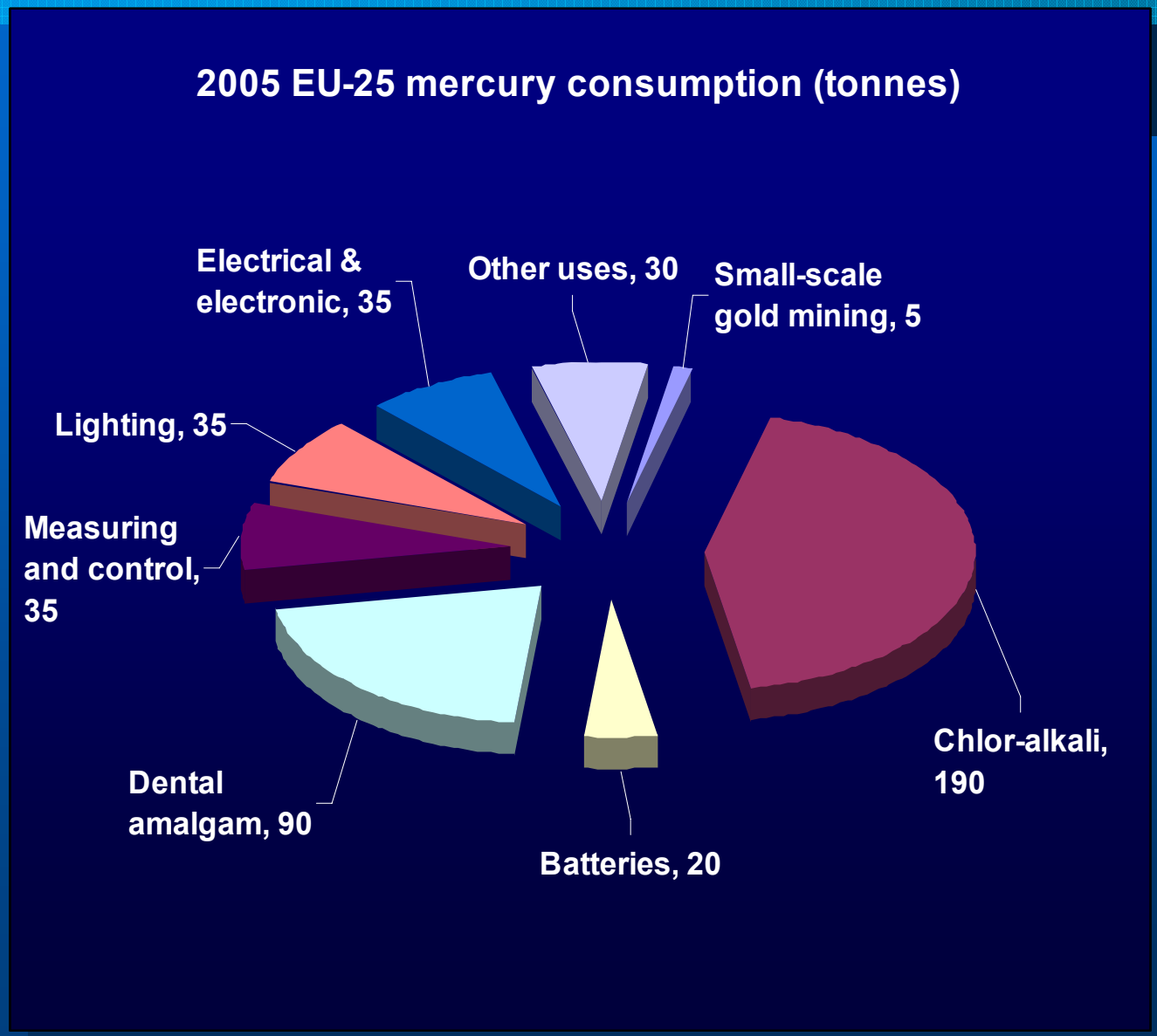
- Annual mercury use is significant
- Eventually most mercury is lost to the environment, and releases are very diffuse
- Controlling releases is costly
- Transformation to methylmercury
- Member states have very different policies with regard to dental mercury use
- Good candidate for Hg use reduction?

Global mercury used in dental sector

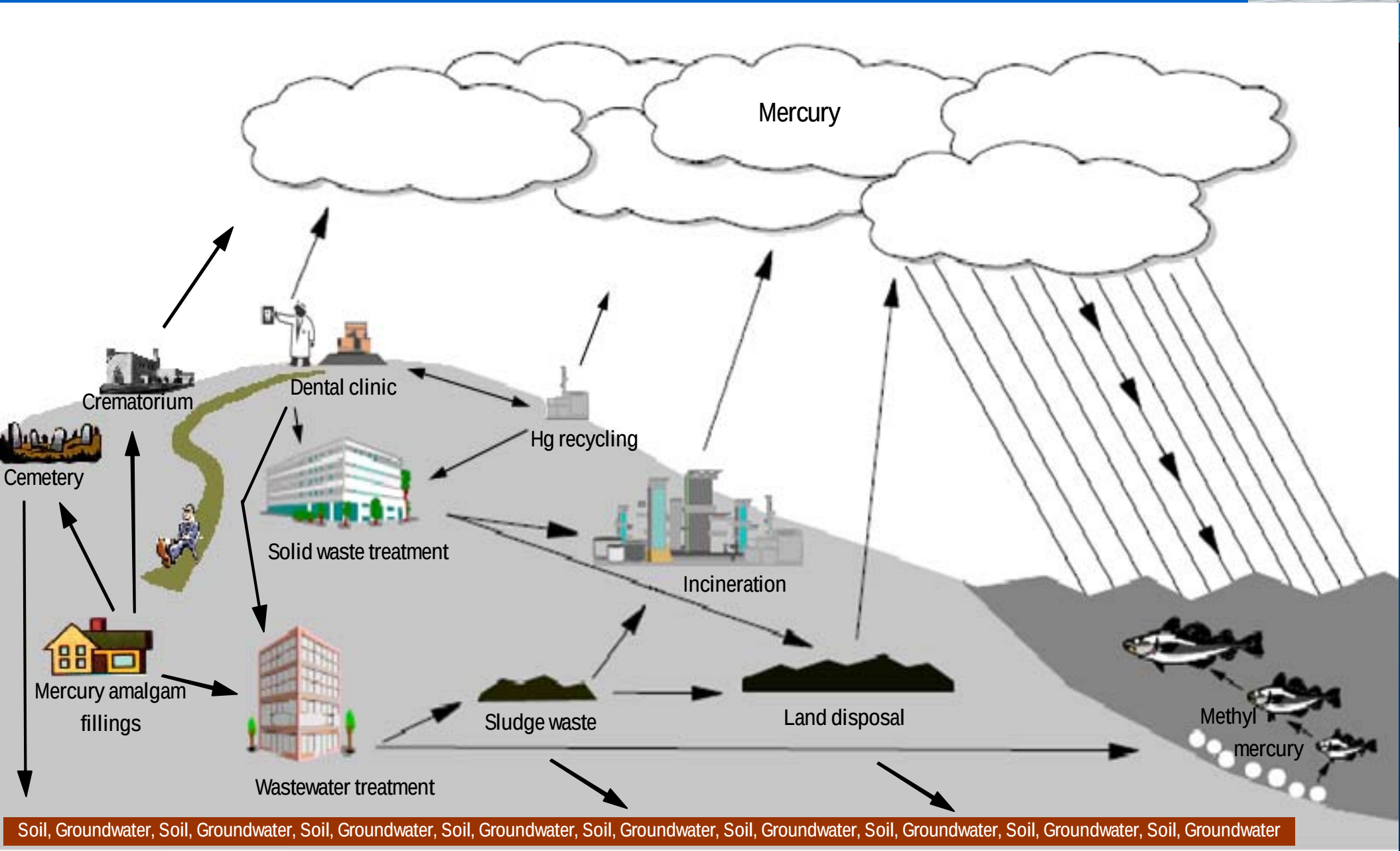
Global mercury demand (2005)	Metric tonnes
Small-scale/artisanal gold mining	650-1,000
Vinyl chloride monomer (VCM) production	600-800
Chlor-alkali production	550-650
Batteries	300-600
Dental use	**240-300**
Measuring and control devices	150-350
Lighting	100-150
Electrical and electronic devices	150-350
Other (paints, laboratory, pharmaceutical, cultural/traditional uses, etc.)	30-60
Total	**3,000-3,900**

Note: In each of these sectors some mercury recycling takes place, involving the recovery of mercury from products or wastes. Therefore, “net consumption” of mercury in any of these sectors may be significantly lower than “gross consumption” indicated here.

EU-25 (+2) mercury used in dental sector



Where does dental mercury go?



Simplified dental waste flow diagram

Hg

Waste

Separator

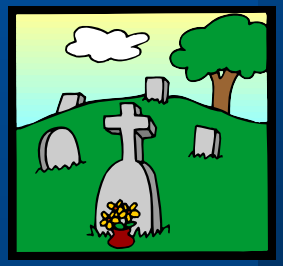
Waste

Sewer system

Incineration

Sewage sludge

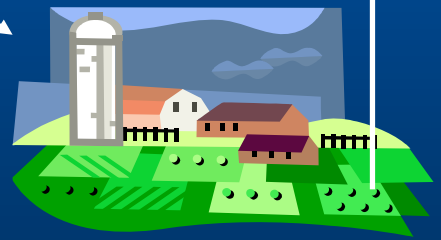
Hg



Burial

Cremation

Landfill



Land application

Courtesy of KemI – Kemikalieinspektionen – www.kemi.se

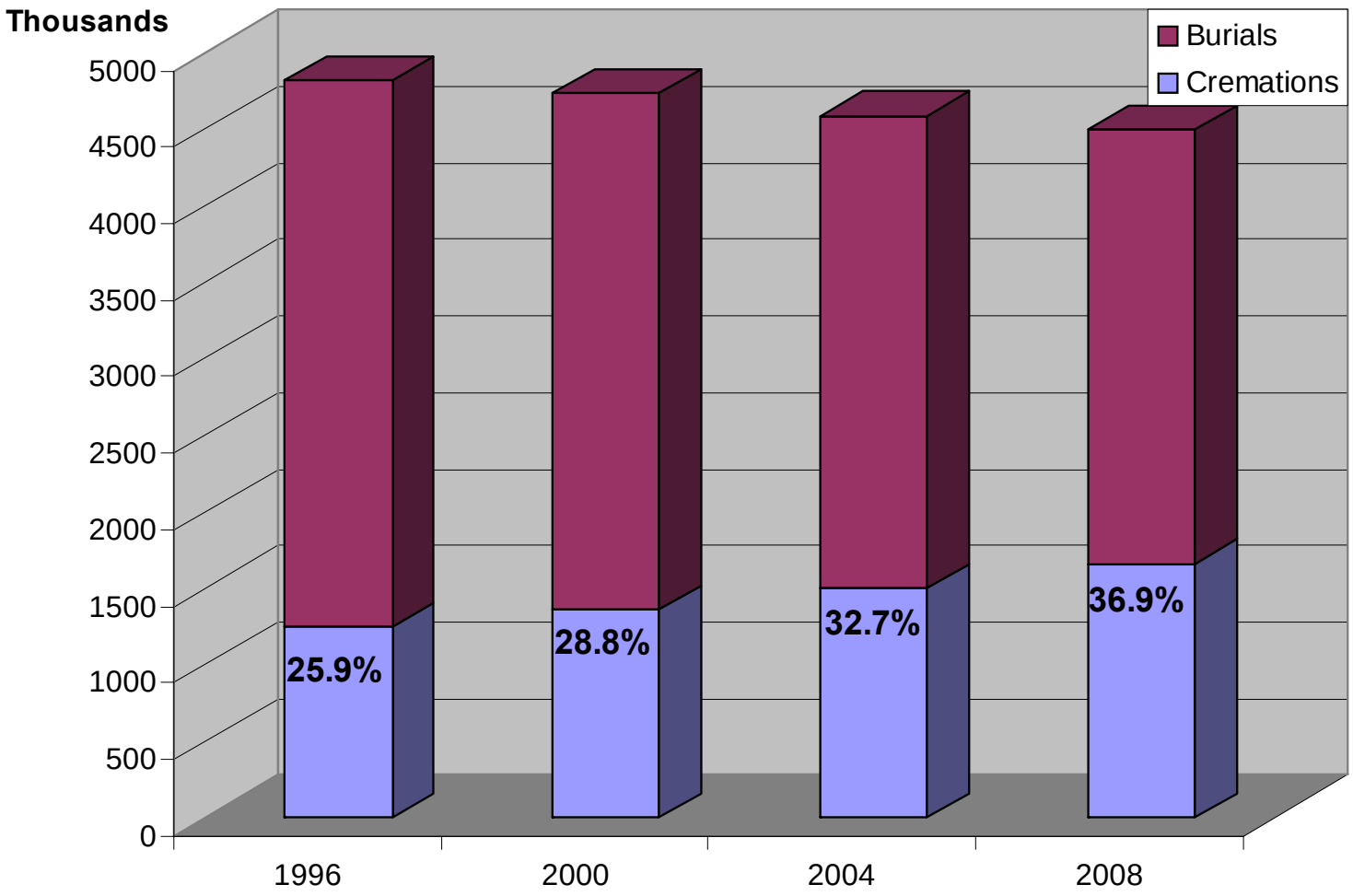
A look at the numbers for EU-27 – p1

- Approximately 500M citizens
- 50-75% of persons have fillings
- Average mouth with fillings ≈ 3-4g mercury
- Human “inventory” ≈ 1000-1200 t mercury – fairly stable

A look at the numbers for EU-27 – p2

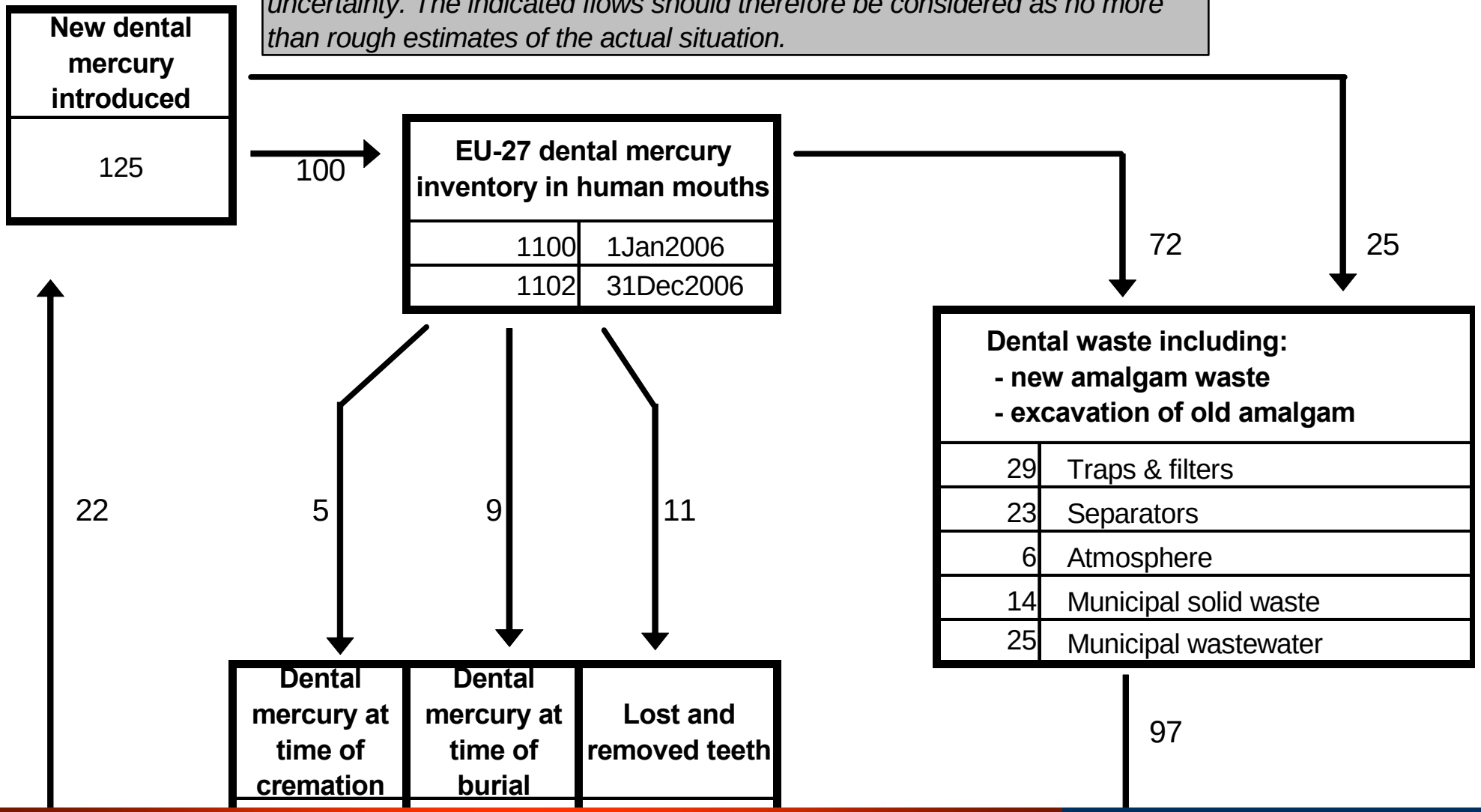
- Average filling lasts 10-12 yr
- Annual mercury placed in fillings ≈ 100 t, not including 10-30% carved away as waste ≈ 125 t total mercury demand by dental profession
- Average fillings of dead person ≈ 3g mercury – increasing
- EU cremation rate ≈ 35% – increasing

EU-27 cremations vs. burials + trend

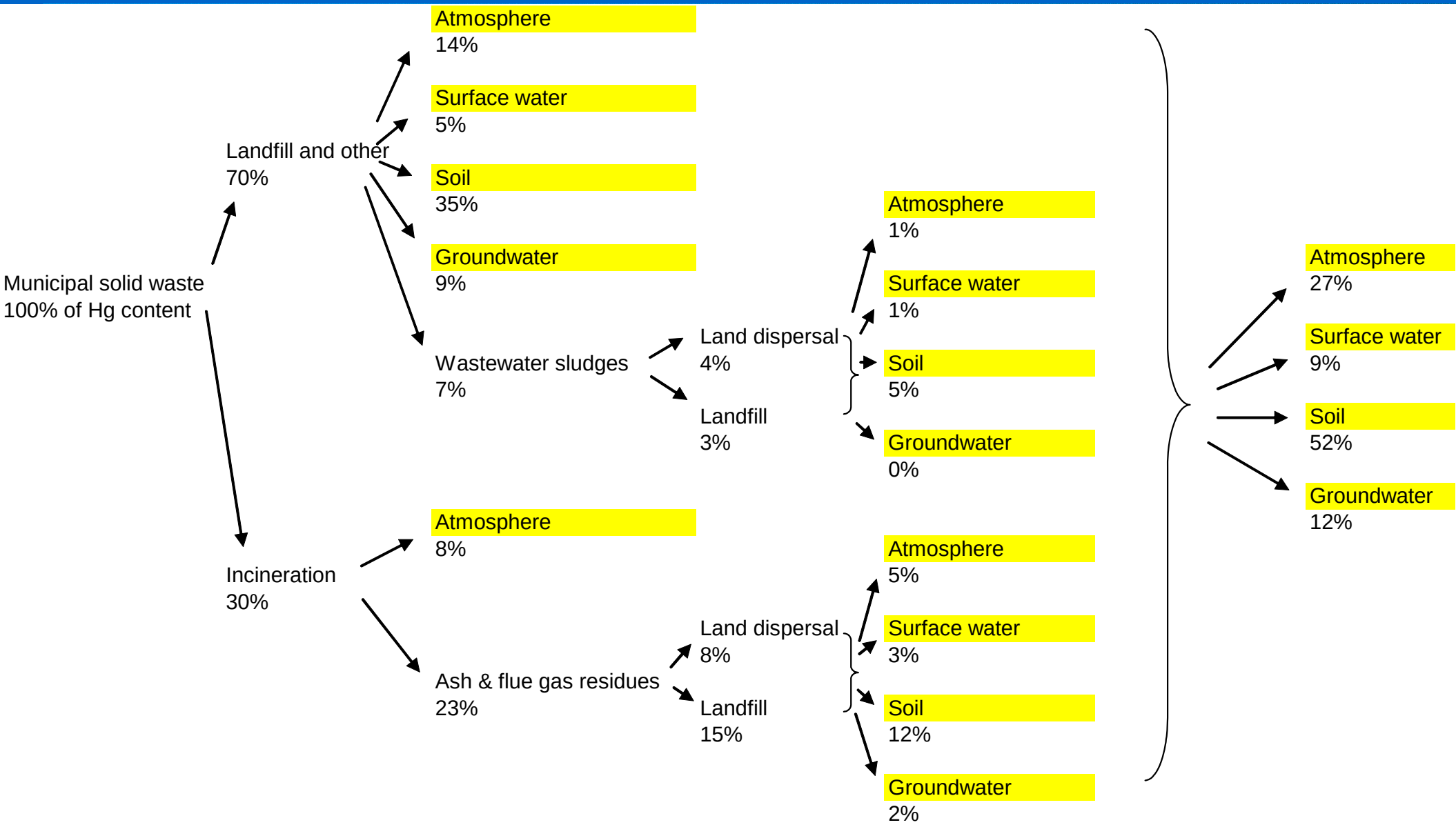


MB 1 – EU dental clinic waste mercury

N.B.: The mercury flows represented in this diagram are the outputs of a simple mass balance model based on inputs that often represent considerable uncertainty. The indicated flows should therefore be considered as no more than rough estimates of the actual situation.



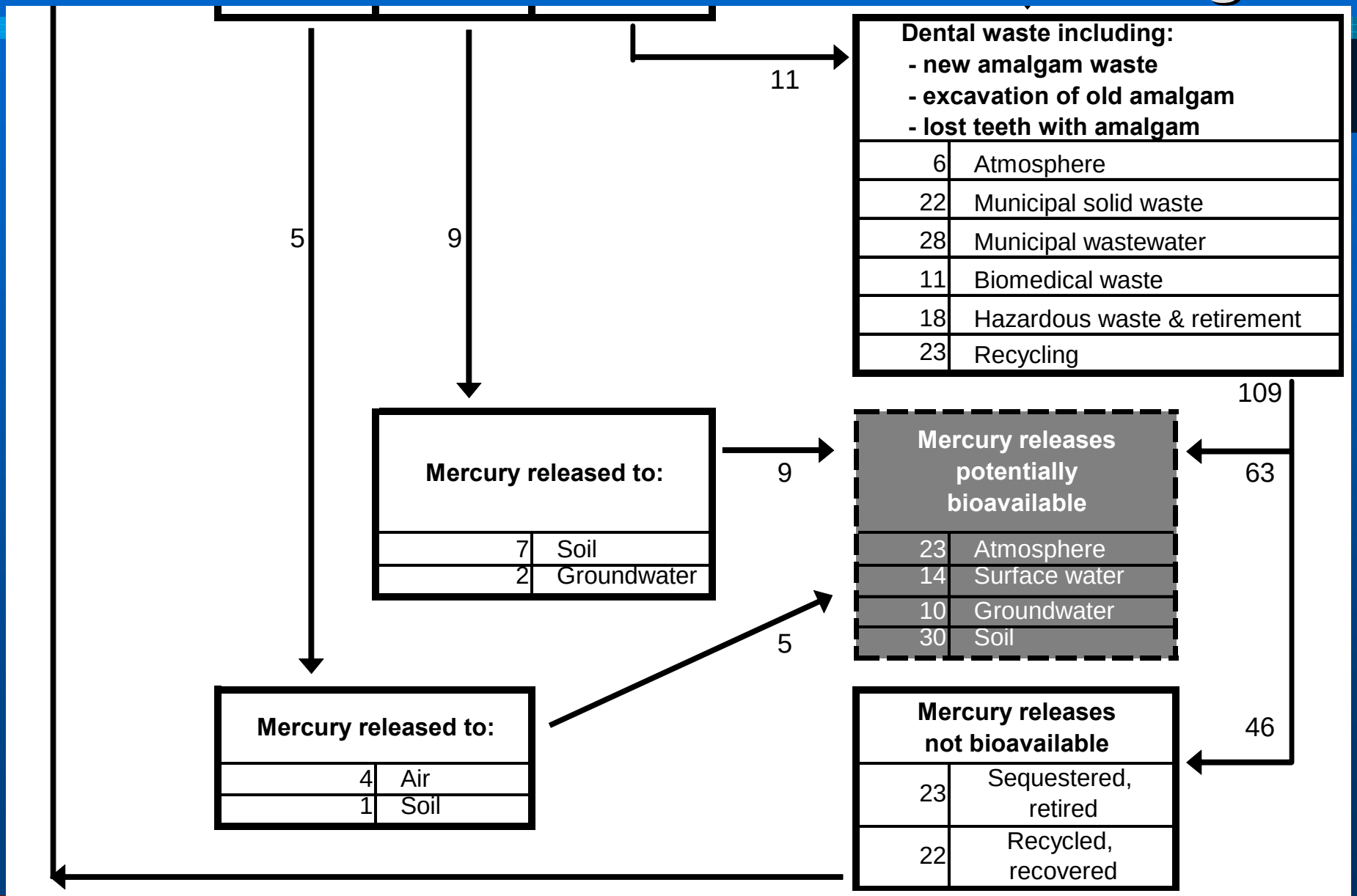
MB 2 – dental mercury in EU MSW



MB 3 – EU disposal/environmental media matrix for dental Hg

	Clinic wastewater to air	Municipal solid waste	Municipal wastewater system	Biomedical waste	Hazardous waste & retirement	Recycling	Burial	Cremation
Atmosphere	100%	30%	10%	25%	2%	2%	0%	80%
Surfacewater	0%	10%	40%	5%	0%	0%	0%	0%
Groundwater	0%	10%	20%	5%	0%	0%	20%	0%
Soil	0%	50%	30%	15%	0%	2%	80%	20%
Recycled, retired, not bioavailable	0%	0%	0%	50%	98%	96%	0%	0%

MB 4 – environ. destinations of EU dental Hg



Dental mercury and bioavailability

- Ekroth (1978) demonstrated that Hg from dental amalgam in water was taken up by fish
- Heintze *et al.* (1983) found that oral bacteria are able to methylate Hg from dental amalgams
- Leistevuo *et al.* (2001) found a correlation between the total amalgam surfaces and organic mercury in saliva
- Leistevuo *et al.* (2002) showed that the concentration of total mercury in saliva (and Hg to municipal wastewater) increased with the number of fillings
- Kennedy (2003) confirmed concentrations of mercury in fish increased by 200+ times in the presence of dental amalgam in the water
- Stone *et al.* (2005) observed environmentally important levels of methylmercury in dental-unit wastewater at concentrations that are orders of magnitude higher than in nature

Cost of controlling dental mercury releases

Activity	Place and year	Cost[a] (US$ kg^{-1} Hg)	Reduction potential	Reference
Increase recycling of mercury captured by chairside traps in dentistry	Minnesota, estimated 1999	240	Medium	Jackson *et al.* 2000
Use amalgam separators at dental practices	USA, estimated 2002	2 000 to 4 000	Medium/ Large	Derived from Bender 2002
Remove amalgam fillings before burial or cremation	Sweden, estimated 2004	400	Large	Hylander and Goodsite 2006
Remove mercury from crematoria gases (warm start furnace)	OSPAR estimate	25 000 to 37 000	Medium/ Large	Derived from OSPAR 2003a
Scrub flue gases of medical waste incinerators	USA estimated 1996	4 400 to 8 800	Medium/ Large	US EPA 1997
Use carbon injection in flue gases of waste incinerators	USA, estimated 1996	465 to 1 900	Medium/ Large	US EPA 1997
Use combined technologies on waste incinerators	Uppsala, Sweden, 2004	40 000	Large	Hylander and Goodsite 2006

Sources: Minor adaptation of Hylander and Goodsite (2006)

Observations – p1

Uncertainty in quantities of dental mercury moving through the EU waste stream must be noted, but important conclusions may be drawn:

- **Annual EU-27 mercury use is significant and higher than we thought**
- **Eventually most dental mercury is released to the environment:**
  - **>20 t to the atmosphere?**
  - **10-20 t to surface waters**
  - **30-50 t to groundwater and soil**

Observations – p2

- Mercury releases are very diffuse – difficult and expensive to adequately control
- Transformation of (how much?) dental mercury to methylmercury, which may enter the food chain, especially via fish consumption
- Low level of awareness among many dental staff members of mercury hazards in the workplace

Observations – p3

- Alternatives to amalgam exist – less than 5% of fillings placed in Sweden are Hg amalgam
- The ONLY viable (and cost-effective) response to all of these challenges is the phase-out of mercury use in dentistry