ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

Risk assessment – new approaches in Austria

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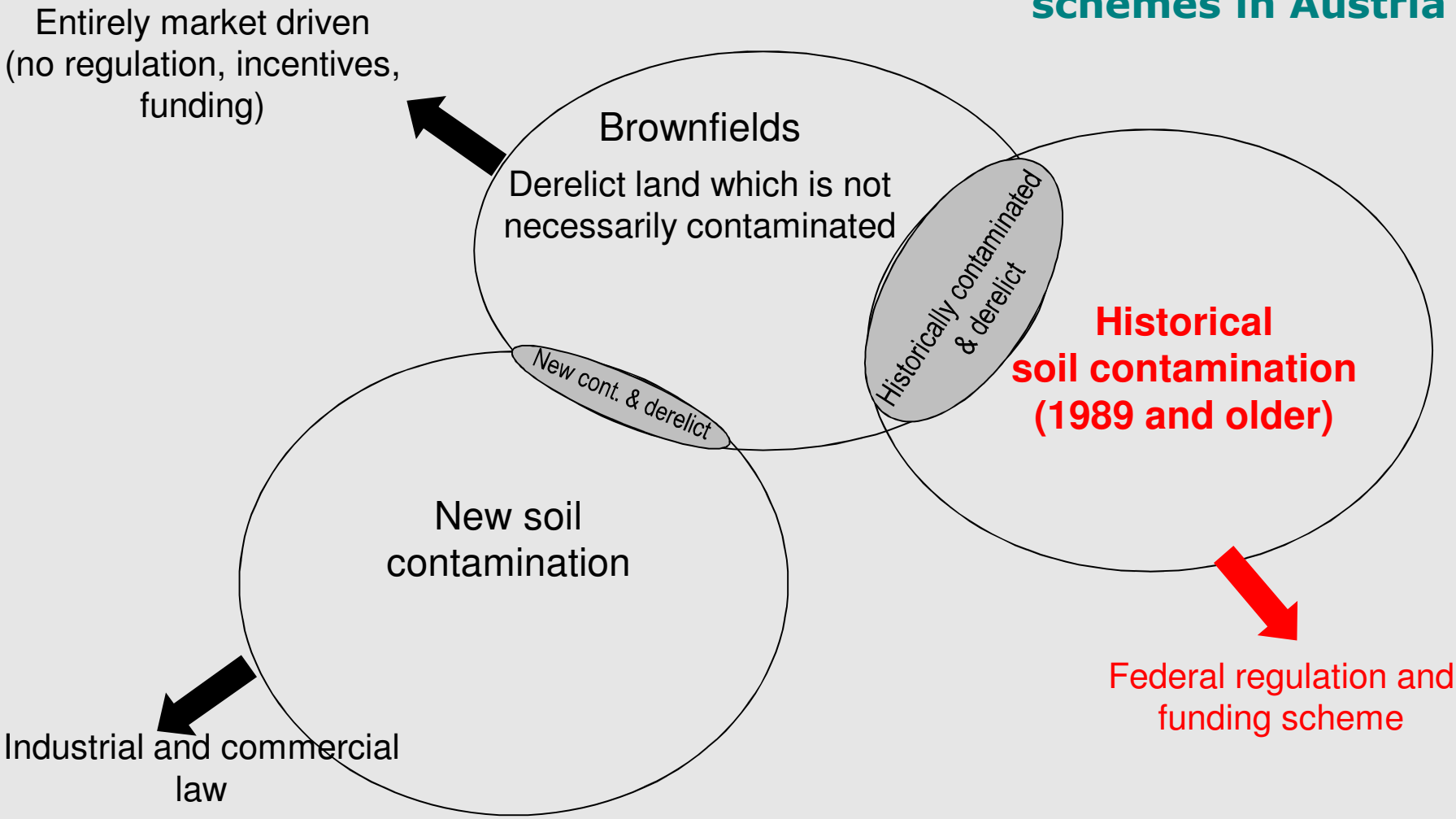
Contaminated site management – Land management schemes in Austria



Contaminated site management

Current situation in Austria

- Act on Remediation of Contaminated Sites regulates financial aspects only (used for funding remedial activities)
- Groundwater is property of land-owners
- Water Act claims that groundwater has to be of drinking water quality

➔ Intervention values and remediation goals strongly driven by groundwater protection

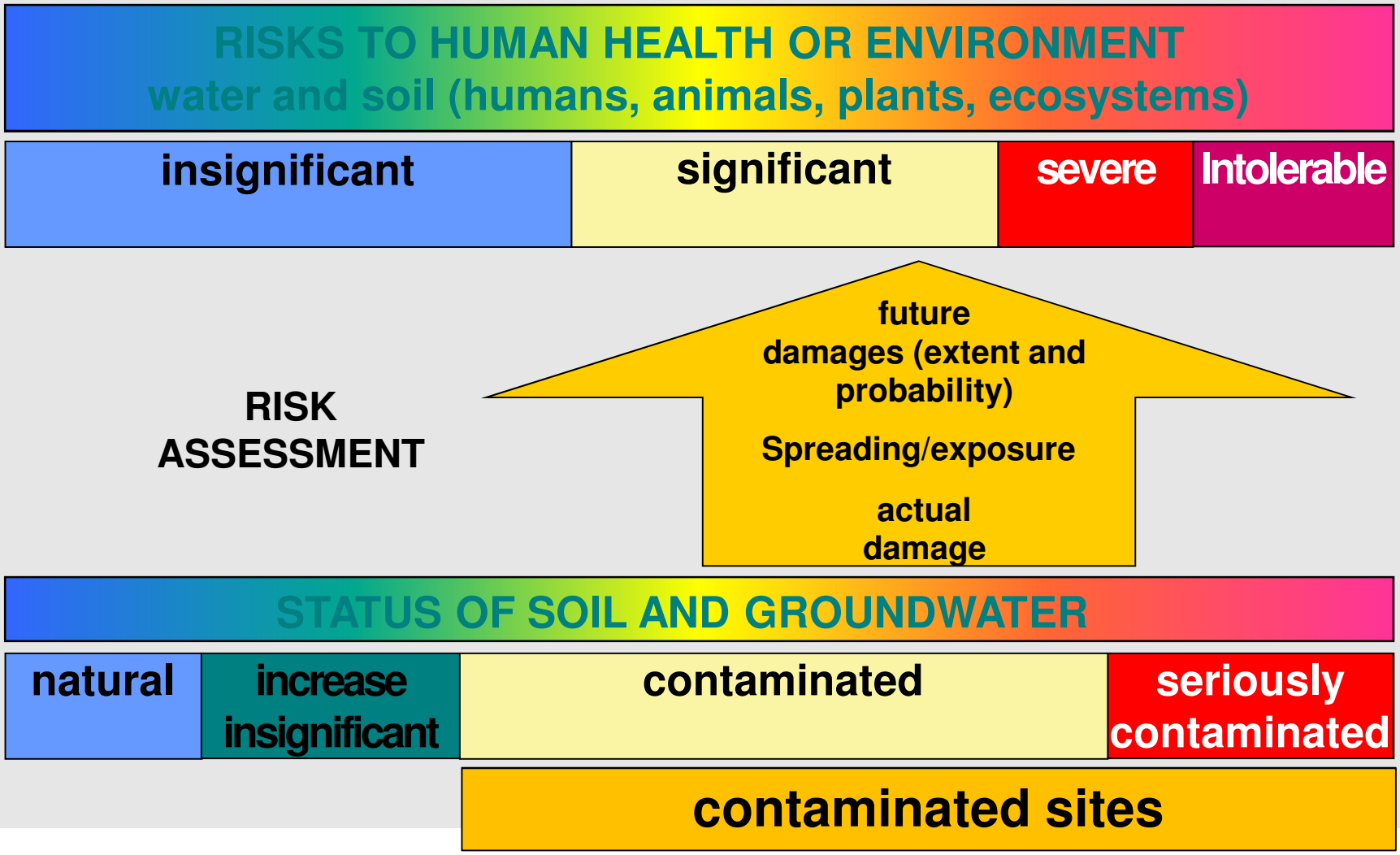
➔ Revision of legal framework currently under work ➔ new law tentatively will become effective in 2017/2018 (“site specific and land-use related approach”)

Revision of legislation on cont. sites

Main principles

- Acceleration of site investigation and remediation
- Risk assessment and remedial actions: site-specific and use-related
- Legal/financial incentives for brownfield recycling

From contamination to risk



"Serious contamination"

- Source of pollution
- Generic values for typical substance groups (see annex/manual)
  - Intensity
    - Total, leachate and soil gas concentrations
    - Substance loads in soil gas and groundwater
  - Extent
    - [m³] soil or [m²] NAPL
- If exceeded

➔ at least monitoring

➔ non-tolerable risk?

Risk assessment: criteria

- Criteria for “serious contamination”

In addition:

- Migration/spreading of contaminants
- Impacts on soil and (ground)water and their use
- Probability of contaminant uptake by humans

Migration/spreading of contaminants

- Migration of flammable or suffocating gases
  - Probability of migration/impact
  - Composition of gas
  - Potential radius of impact
- Spreading of contaminants in (ground)water
  - Substance loads in leachate and groundwater
  - Extension of plume
  - Trend of plume (probability of increase in length)

Impacts on soil and (ground)water

- Use restrictions compared to current use (and legally permitted use in future)
- Restrictions in plant production and use of plants as feedstuff or food
- Uptake by humans (see next)
- Probability of mobilisation or further spreading

Threats to human health

- Based on current land-use (and legally permitted use in future)
- Relevant human activities
- Potential exposure pathways
- Type of uptake (oral, inhalative, dermal)

Non-tolerable risks

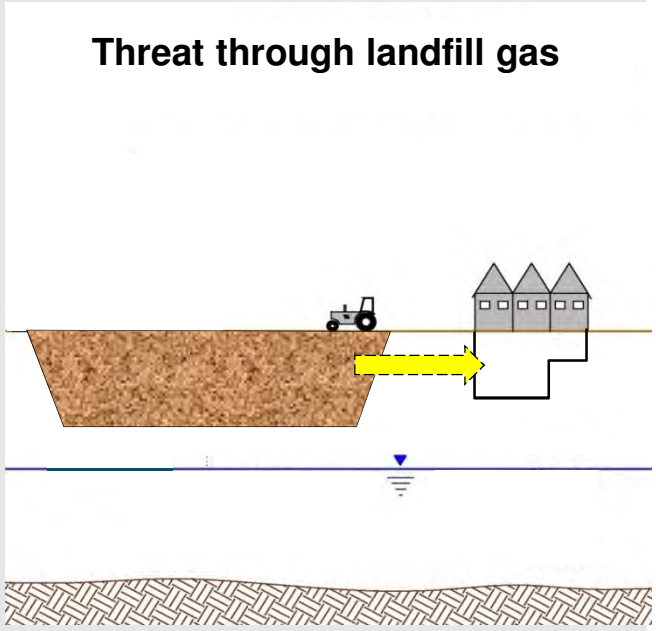
- Potential threat to human health through migration of flammable or suffocating gases
- Potential threat to human health through uptake of contaminants
- Potential restrictions in plant production or use of plants as feedstuff (food)
- (Further) spreading of contaminants in groundwater (increase in plume length)
- Potential threat to groundwater use

Flammable/suffocating gases

- Generic guidance values (CO_2/CH_4) for different POCs:
  - Source (landfill)
  - Pathway (soil in between landfill-cellar)
  - Receptor (ambient air in cellar)

- If exceeded (S/P): Characterisation of
  - Pathways (soil and underground installations)
  - Position/type/use of buildings/cellars

  ➔ Assessment of extent + probability of impact



Uptake by humans/plants

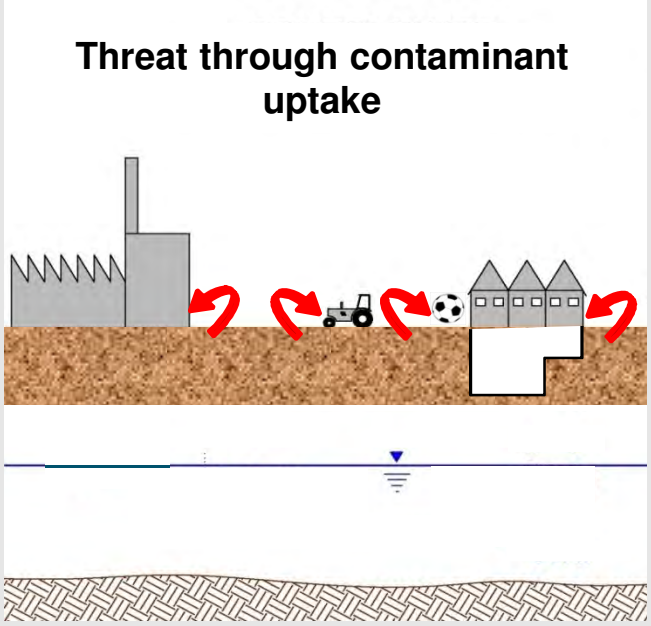
- Generic guidance values (metals, organics) for different land-use:
  - Playgrounds (oral uptake)
  - Activity "gardening" (inhalative uptake)
  - Plant production

- If exceeded (or non-existing value)

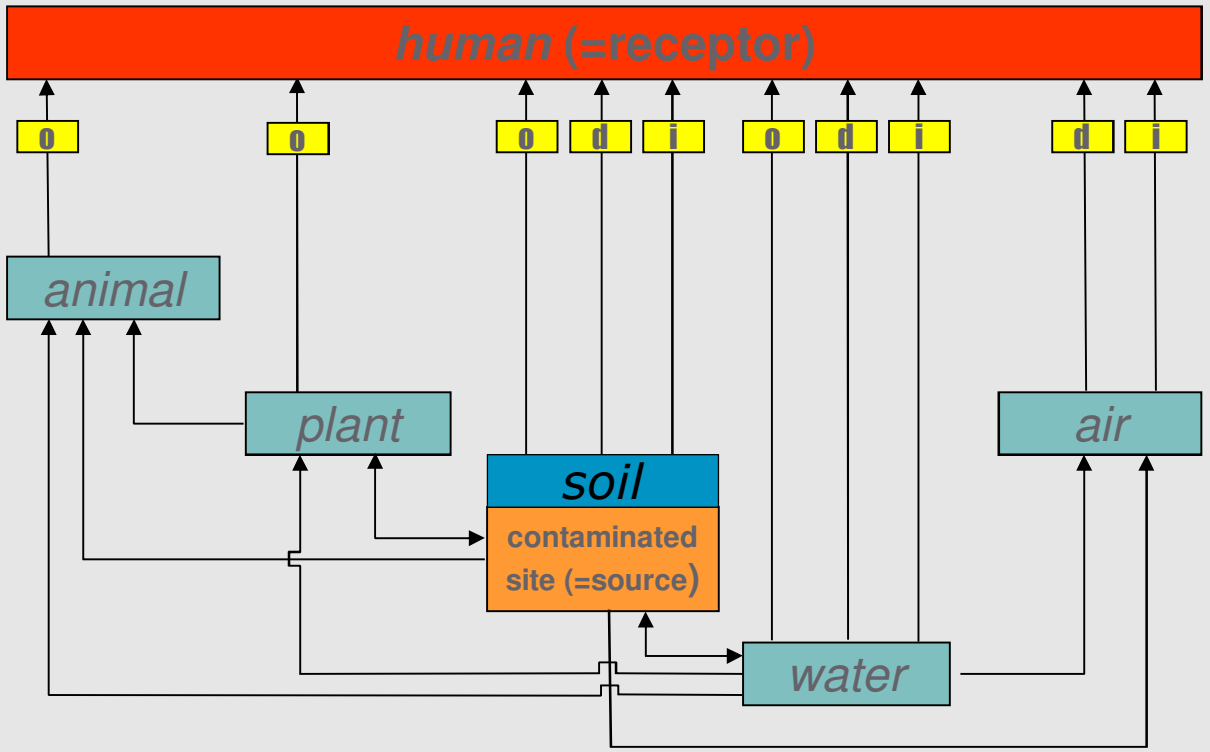
➔Assessment of exposure and risks

➔guidance document

http://www.umweltbundesamt.at/fileadmin/site/publikationen/REP0351.pdf



Potential pathways of exposure...

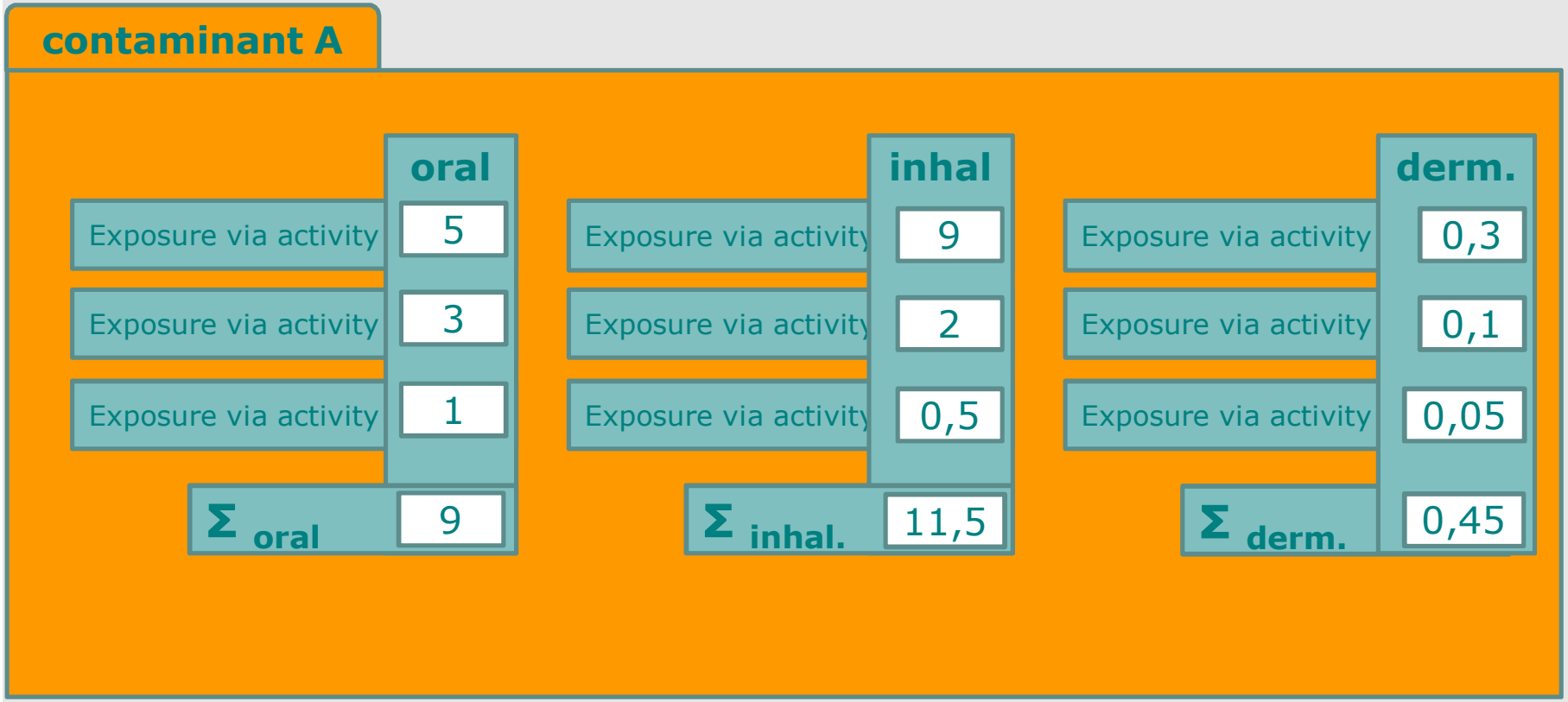


... which are relevant for my site?

„Activities“ in various land use categories

Categories of use	activities	uptake media				uptake paths		
		soil	air	water	food	*oral*	*dermal*	*inhalativ*
Residential areas	outdoor activities	•						x
			•					x
	gardening	•					x	x
	consumption of self produced food				•	x		
	drinking of groundwater			•		x		
	watering with groundwater			•			x	x
	taking showers with groundwater			•		x	x	x
Agriculture and horticulture	fiel work	•					x	x
Recreation areas	sports and recreation activities	•					x	x
Industry, business and traffic areas	indoor work	•						x
			•					x
	outdoor work	•						x
	use of traffic areas	•						x

Exposure assessment

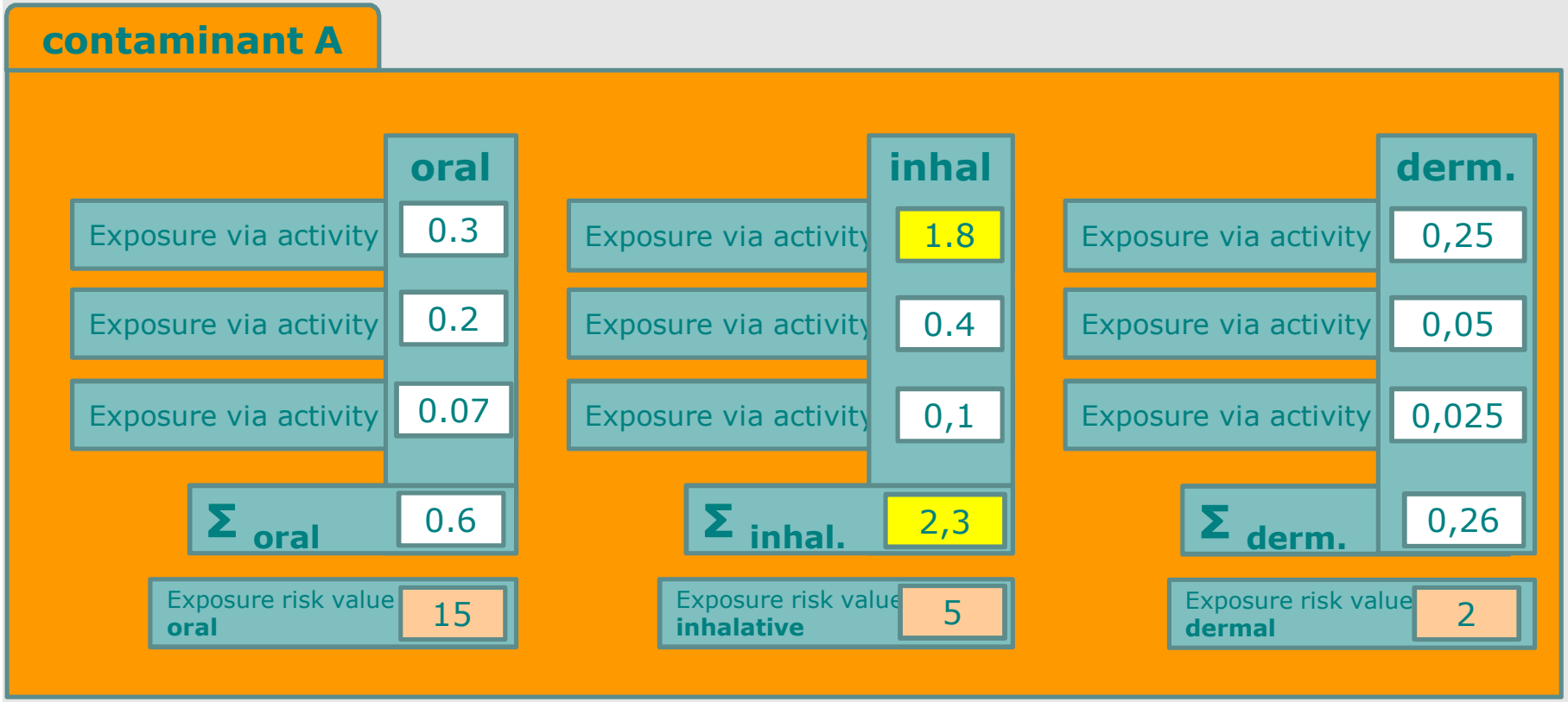


Exposure assessment – example

Exposure ($EP_{PM\text{-}inhalativ}$)	$E_{Bodenstaub\text{-}inhalativ} = \frac{AR * (C_{PM10} * f_{Massenanteil} * f_{Lunge}) * C_{Schadstoff\ im\ Bodenstaub} * (t_{exp} / 24) * ET / 365}{KG} * 10^{-6}$		
		Land-use: agricultural area	Land-use: residential area
AR	Respiratory rate [m³/d]	120[1]	68[2]
C_{PM}	Substance concentration in PM from soil [mg/kg]	measured	measured
ET	Days of exposure per year [d/a]	7	60
t_{exp}	Hours of exposure per day [h/d]	10	2
f_{Lunge}	Respirable fraction of PM	0,5[3]	
$f_{Massenanteil}$	Fraction of contaminated soil in PM	0,5[3]	
KG	Body mass [kg]	70	

[1] intense harvesting activity; [2] moderate gardening activity ; [3] i.e. 50 %

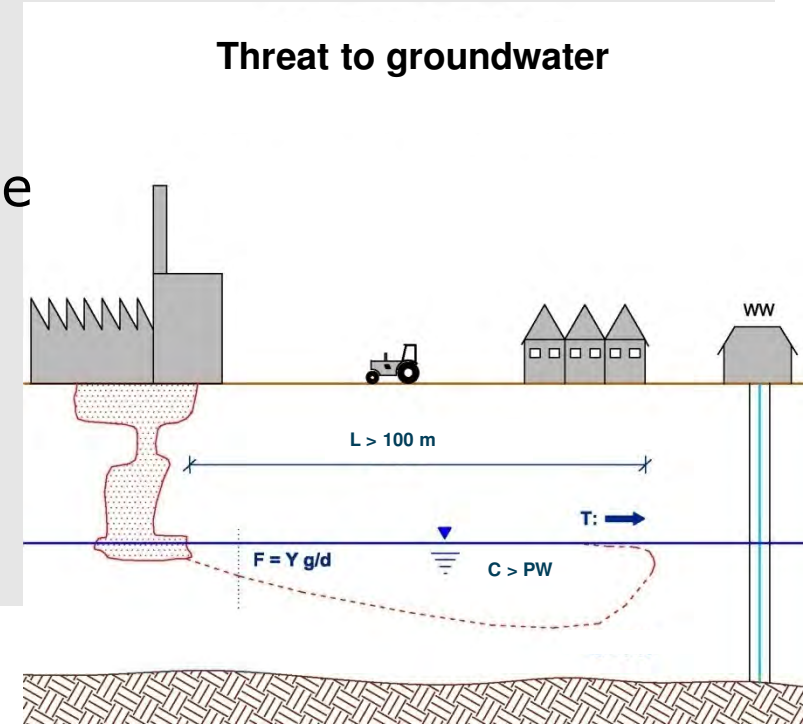
Risk characterisation



Threat to (ground)water

- Generic guidance values (substance loads): see annex
- Trend of plume: decrease/increase
- If applicable: drinking water thresholds

- If exceeded: non-tolerable risks
- Risk assessment may be applicable
  - if uptake by irrigation or
  - showering etc may be relevant



Risk assessment: Guidance in AT

- Groundwater: generic values (soil concentrations; groundwater loads) for “serious contamination”, i.e. need for measures (at least monitoring)
- Groundwater: guidelines for assessment of groundwater pollution (in preparation) and availability/leachate assessment
- Pollutant uptake by humans/plants: land-use related generic values
- Pollutant uptake by humans: guideline for risk assessment
- Landfill-gas: generic values for threats to humans

Contact & Information

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Annexes

"Serious contamination": CHC + HC

A1 Contaminations with chlorinated hydrocarbons (CHC)

(i.e. C1 or C2 substances like PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, VC etc)

	intensity/extent
	Substance load in soil gas [a] [g/d]
Sum of CHCs	50

a... Verified by a soil-gas extraction test lasting for 24 hours (only applicable to soil with kf>10-5 m/s)

Generally, a site is considered as seriously contaminated, if the guidance value for intensity/extent is exceeded.

A2 Mineral oil contaminations

	Intensity		Extent	
	Total content [mg/kg]	Soil gas [mg/m³]	Volume [m³]	Area of LNAPL [m²]
Hydrocarbon-index (GC)	500-2.000[a]	-	5.000	500
VOC (C_5 - C_{10})[d]	-	100[c]	5.000	500
BTEX	25[b]	50[c]	5.000	500
Benzene	5[b]	10[c]	5.000	500

a... value depends on mobility (chain length) of contaminants

< C22: 500 mg/kg

> 80 % of contaminants > C30: 2.000 mg/kg

b... total content BTEX and benzene only applicable to soil with kf<10-5 m/s

c... soil gas concentrations only applicable to soil with kf>10-5 m/s

d... sum of aliphatic (n-, iso- and cyclo-alkanes, alkenes) and aromatic (C6-C10) hydrocarbons

Generally, a site is considered as seriously contaminated, if

- **guidance values for intensity AND extent are exceeded OR**
- **guidance value for area of LNAPL is exceeded.**

"Serious contamination": PAH, metals

A3 Tar oil contaminations

	Intensity	Extent	
	Total content [mg/kg]	Volume [m³]	Area of LNAPL or DNAPL [m²]
Sum of PAH-15[a]	100	5.000	500
Naphthalene	25	5.000	500
Phenol-index	10[b]	-	-
Sum of phenol and alkyl-phenols	25	5.000	500

a...Sum PAH-16 according to US EPA without naphthalene

b...if guidance value of phenole-index is exceeded, total content of phenol and alkyl-phenols (cresols, di- and tri-methyl-phenols) have to be analysed.

c...LNAPL/DNAPL has to be considered independently of position (unsaturated zone, water table, top of aquiclude)

Generally, a site is considered as seriously contaminated, if

- **guidance values for intensity AND extent are exceeded OR**
- **guidance value for area of LNAPL/DNAPL is exceeded.**

A4 Metal contaminations

	Intensity		Extent
	Total content [mg/kg]	Leachate[a] [mg/kg]	Volume [m³]
Arsenic	-	1,0	5.000
Cadmium	-	0,5	5.000
Chromium	-	5	5.000
Copper	-	10	5.000
Mercury	10	0,02	5.000
Nickel	-	5	5.000
Lead	-	1,0	5.000
Zinc	-	-	-

a...Leachate with a solid/liquid-ratio of 2:1 according to DIN 19529

Generally, a site is considered as seriously contaminated, if guidance values for intensity AND extent are exceeded.

"Serious contamination": landfills

A5 Landfills with gas production potential

	Intensity [Vol.-%] [a]	Extent
		Volume [m³]
Less reactive parts	Methane > 5 % and carbon-dioxide > 15 %	100.000
Reactive core	Sum of Methane and carbon-dioxide > 40 %	25.000

Generally, a landfill is considered as seriously contaminated, if guidance values for intensity AND extent are exceeded.

When assessing the landfill gas potential, the results of landfill gas measurements have to be checked regarding their plausibility by considering following issues:

- Surface liner: type, construction details and date of construction
- Liquid/solid-ratio of landfill
- Organoleptic assessment and water content of landfilled waste
- DOC in leachate (L/S=10:1; < 100 mg/l ➔ low potential; > 1.000 mg/l ➔ high potential)

"Serious contamination": loads

Table B: Guidance values for substance loads in groundwater

		Guidance value
Sum of CHCs	g/d	15
Tetrachloroethene	g/d	5
Trichloroethene	g/d	5
Vinylchloride	g/d	0,2
Hydrocarbon-Index (GC)	g/d	50
BTEX	g/d	25
Benzene	g/d	0,5
Sum of PAH-15[a]	g/d	0,5
Naphthalene	g/d	1,0
Sum of phenol and alkyl-phenols	g/d	25
Arsenic	g/d	5
Cadmium	g/d	2,5
Chromium	g/d	25
Copper	g/d	50
Mercury	g/d	0,5
Nickel	g/d	10
Lead	g/d	5
Zinc	g/d	2.500
Ammonia	g/d	1.000
Boron	g/d	500

a...Sum of PAH-16 according to US EPA without naphthalene

Generally, a site is considered as seriously contaminated, if the guidance value downstream the site is exceeded.

Guidance values Playgrounds

Tabelle 1 — Richtwerte für die Nutzungsklasse Kinderspielplatz (orale Aufnahme von verunreinigtem Boden bei regelmäßiger und häufiger Nutzung durch Kleinkinder; Probenahmetiefe: 0 cm bis 10 cm)

Parameter	Einheit	Prüfwert[a]
Antimon	mg/kg TM	5
Arsen	mg/kg TM	20
Blei	mg/kg TM	100
Cadmium	mg/kg TM	2
Chrom	mg/kg TM	100
Kupfer	mg/kg TM	100
Nickel	mg/kg TM	70
Quecksilber	mg/kg TM	1
Cyanid gesamt[b]	mg/kg TM	5
Kohlenwasserstoff-Index (GC)	mg/kg TM	50
PCDD/F[c]	ng TE/kg TM	50
PCB[d]	mg/kg TM	0,2
PAK 16[e]	mg/kg TM	4
Benz(a)pyren	mg/kg TM	0,1

[a] Die Werte wurden auf Basis einer Expositionsgleichung für die orale Aufnahme von Boden durch spielende Kinder (siehe Anhang B) und im Vergleich mit Boden-Referenzwerten abgeleitet.

[b] Bei der Überschreitung des Prüfwertes sind der Ursprung der Verunreinigungen sowie die chemische Verbindung (Spezies) zu ermitteln.

[c] Toxizitätsäquivalente I-TEF

[d] Summe von 7 Einzelsubstanzen gemäß ÖNORM EN 16167, siehe auch ÖLMB [4]

[e] Summe von 16 Einzelsubstanzen nach US-EPA 550 [1]

Guidance values "Gardening"

Tabelle 2 — Richtwerte für die Aktivität Gartenarbeit in der Nutzungsklasse „Wohnen"

Parameter	Einheit	Prüfwert[a]
Antimon	mg/kg TM	60
Arsen	mg/kg TM	50[e]
Blei	mg/kg TM	500
Cadmium	mg/kg TM	2[e]
Chrom	mg/kg TM	75[e]
Kupfer	mg/kg TM	500
Quecksilber	mg/kg TM	10
PCDD/F[b]	ng TE/kg TM	600
PCB[c]	mg/kg TM	2
PAK 16[d]	mg/kg TM	10
Benz(a)pyren	mg/kg TM	0,5

[a] Die Werte wurden im Allgemeinen auf Basis der Expositionsgleichung für inhalative Aufnahme von Bodenstaub (siehe Anhang B) durch Erwachsene bei der Gartenarbeit und im Vergleich mit Boden-Referenzwerten abgeleitet. Die Prüfwerte für die Parameter PCDD/F und Benz(a)pyren wurden für eine dermale Aufnahme ermittelt.

[b] Toxizitätsäquivalente I-TEF

[c] Summe von 7 Einzelsubstanzen gemäß ÖNORM EN 16167, siehe auch ÖLMB [4]

[d] Summe von 16 Einzelsubstanzen nach US-EPA 550 [1]

[e] In Abhängigkeit der chemischen Verbindung (Spezies) sind kanzerogene Wirkungen möglich und gesondert zu prüfen.

Guidance values agricultural soil - plant uptake

Tabelle 3 — Richtwerte für Schadstoffgehalte im Boden (0 cm bis 20 cm) bei der Pflanzenproduktion in der Nutzungsklasse Landwirtschaft und Gartenbau

Parameter	Einheit	Prüfwert[a]
Antimon	mg/kg TM	2
Arsen	mg/kg TM	20
Blei	mg/kg TM	100
Cadmium	mg/kg TM	0,5
Chrom	mg/kg TM	100
Cobalt	mg/kg TM	50
Kupfer	mg/kg TM	100
Molybdän	mg/kg TM	2,5
Nickel	mg/kg TM	100
Quecksilber	mg/kg TM	0,5
Selen	mg/kg TM	1
Thallium	mg/kg TM	1
Vanadium	mg/kg TM	100
Zink	mg/kg TM	300
Fluorid gesamt	mg/kg TM	200
Cyanid gesamt	mg/kg TM	5
Kohlenwasserstoff-Index (GC)	mg/kg TM	200
PCDD/F[b]	ng TE/kg TM	10
PCB[c]	mg/kg TM	0,1
PAK 16[d]	mg/kg TM	2

[a] Die Werte wurden in Anlehnung an ÖNORM L 1075, den Bundes-Abfallwirtschaftsplan 2011 sowie die „Verwaltungsvorschrift über Orientierungswerte für die Bearbeitung von Altlasten und Schadensfällen“ [6] zusammengestellt.

[b] Toxizitätsäquivalente I-TEF

[c] Summe von 7 Einzelsubstanzen gemäß ÖNORM EN 16167, siehe auch ÖLMB [4]

[d] Summe von 16 Einzelsubstanzen nach US-EPA 550 [1]