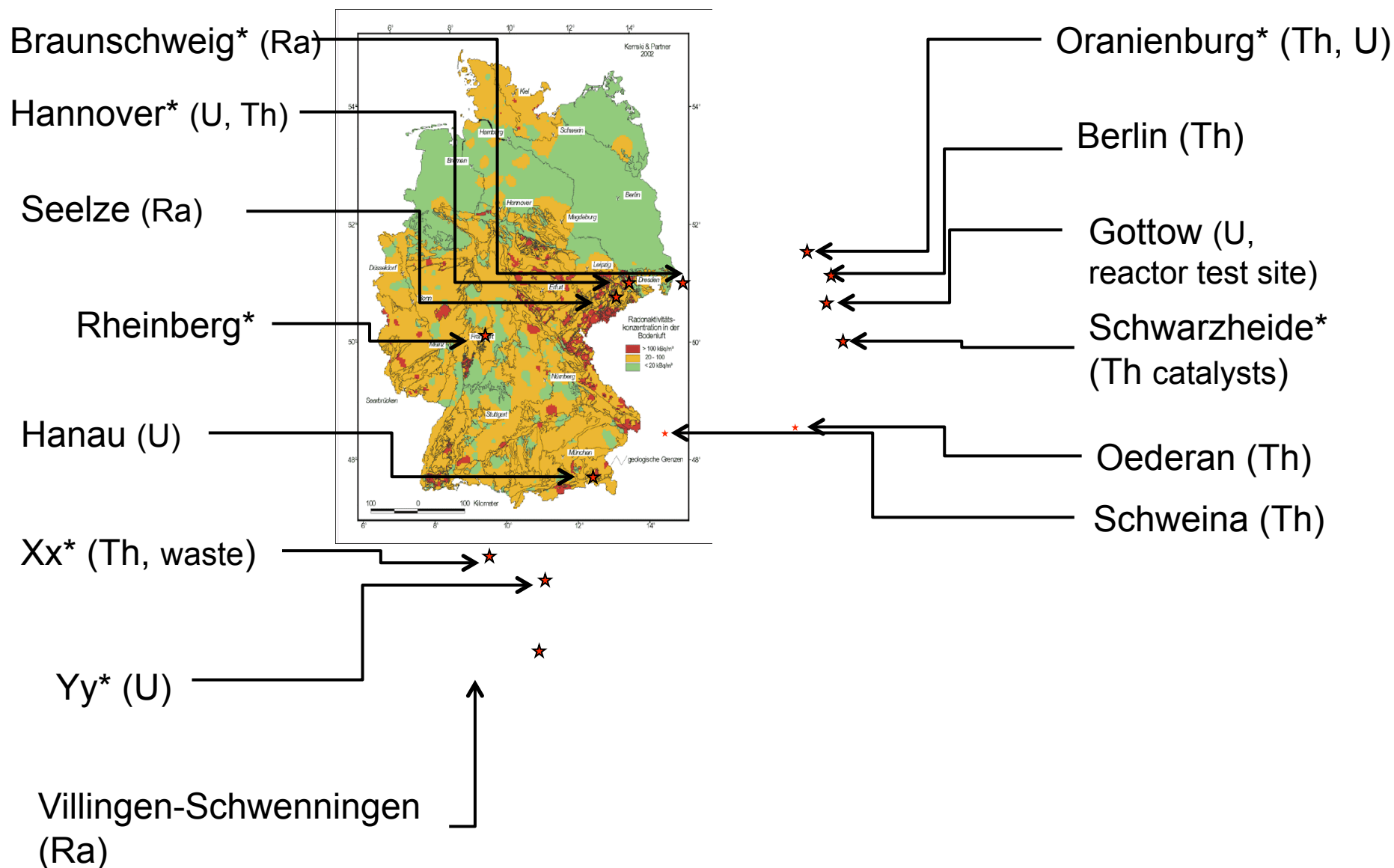


# **Radiation protection during the remediation of radioactive contaminated ground on former industrially used sites**

Rainer Gellermann  
Kristin Nickstadt

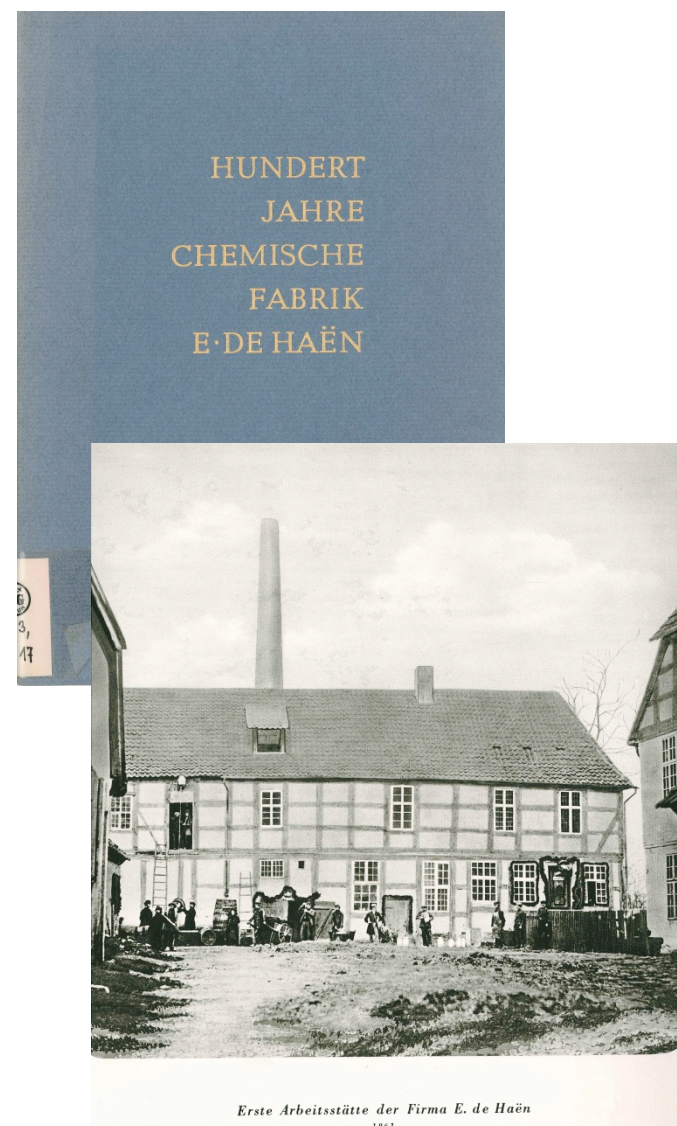
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# “Existing situations” in Germany



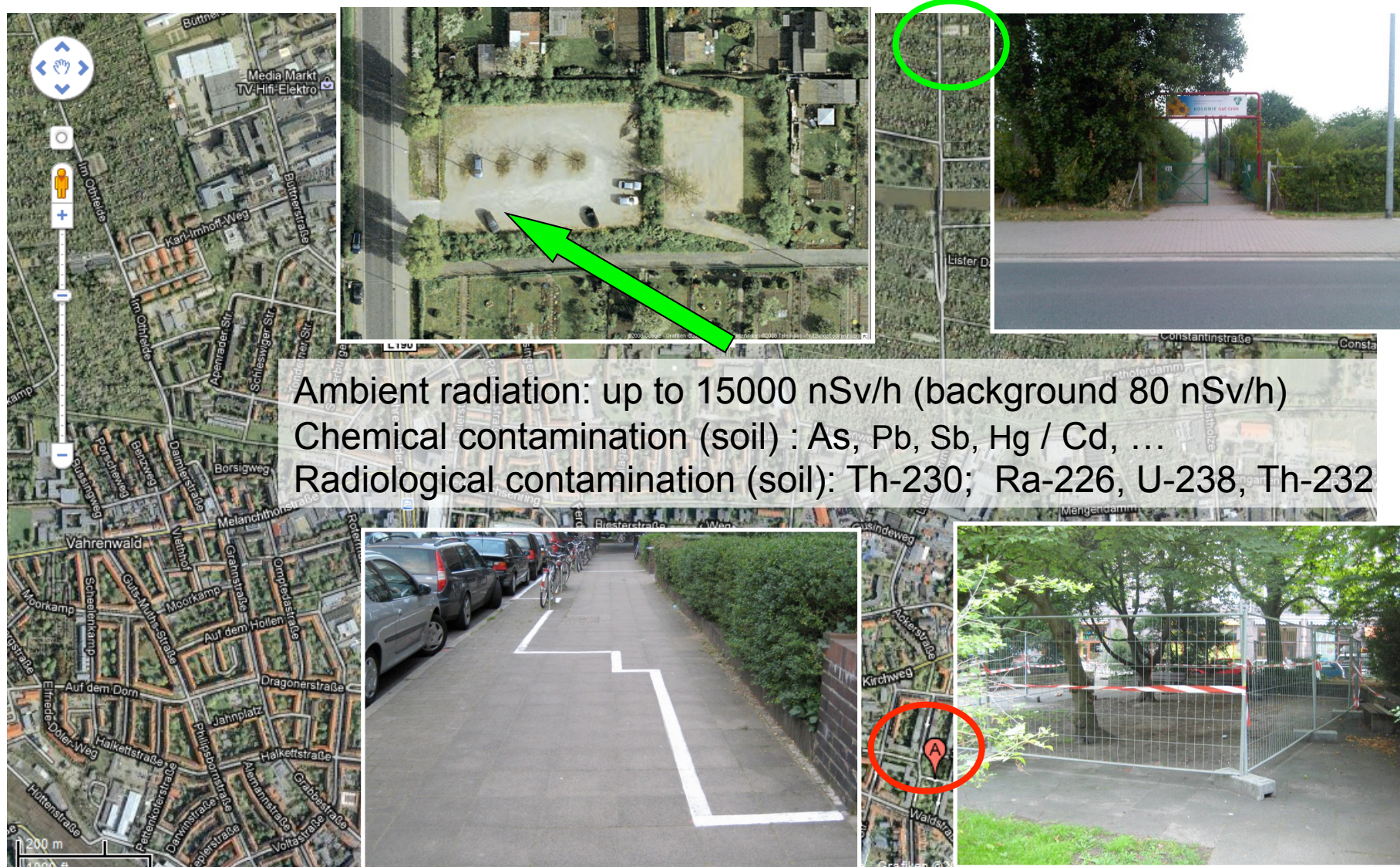
## Example: Hanover-List

- 1862: Foundation of the „Chemical Plant E. De Haen“ in the village List near Hanover.
- 1865-68: At the site of the current contaminated ground a larger plant was built. Production of inorganic chemicals.
- 1902: Company moved to Seelze near Hanover.
- Residues were transferred to a site northward and disposed of. The disposal site was later developed to an allotment garden area.
- 2008: Discovery of an “existing situation” in the residential area around the “De-Haen-Platz” in Hanover-List (only by chance!).





# Situation in 2008 (\*)



(\*) Contaminated sites on ground owned by "State Capital Hanover"

# Assessment of exposure situation

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- No specific radiation protection regulations for radioactive soil contaminations → Assessments based on German Soil Protection Law/ Ordinance. “Bridge”: radionuclides are carcinogenic substances.
- First step (preliminary hazard assessment):  
Risk level  $5 \cdot 10^{-5}$  (1 mSv) per lifetime(!) → hazardous contamination level  
 $\text{U-238sec} + \text{Th-232sec} = 0.4 \text{ Bq/g}$
- Second step (final hazard assessment):  
Dose calculation according to German “Calculation Guide Mining”. If “hazardous dose level” 1 mSv/a is exceeded → remediation.



# Remediation planning

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## Goals:

- Reduction of health risks to a long-lasting acceptable level (according to criteria of soil protection regulations! → 500 nSv/h / 300 nSv/h).
- Area must be usable.
- Preferred use: waste container parking lot (for garden waste)
- The measures have to be restricted to the essentials.

## Technical solution:

- Partial excavation of contaminated soil (only to the necessary extent!)
- Disposal of the excavated materials on landfills.
- Covering of remaining contaminations by uncontaminated construction materials.

# Technical execution

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## Organisation

- Responsible owner: State Capital Hanover
- Contractor 1: technical contractor
- Contractor 2: construction supervision and management
- **Contractor 3: radiological supervision and waste management**
- Contractor 4: bomb disposal service (partly)

Authorities (RP Authority – Trade Supervisory Office)

## Issues of radiological supervision and waste management

1. Determine the necessary extend of excavation (reduce waste amount but ensure compliance with remediation targets).
2. Estimate the doses of workers.
3. Manage waste materials (→ ensure low doses of workers at the disposal site, assign waste to activity classes, in particular the ADR Class 7)

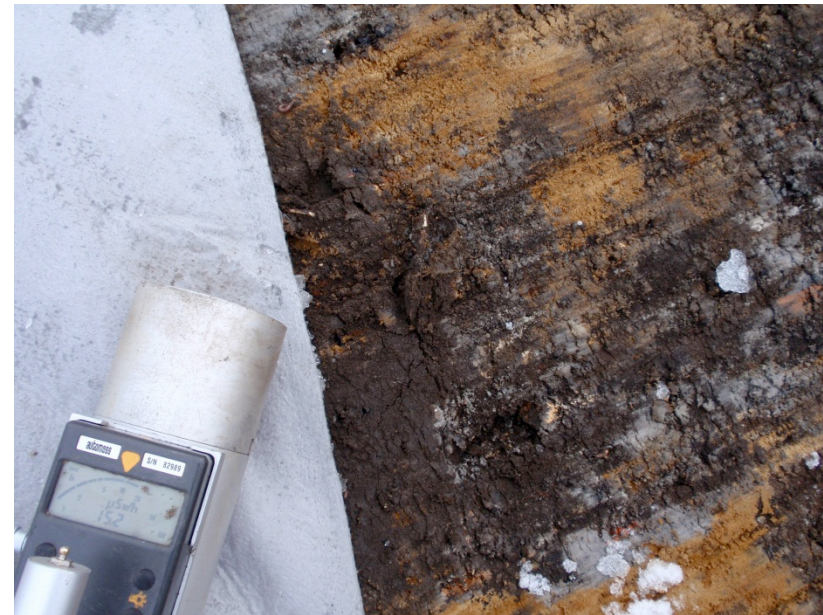
## Challenge

- Do not hinder the execution of the construction: “be fast, but not furious”.

## Task 1 Determine the necessary extend of excavation

- Dose at the surface has to be lower than 300 nSv/h
- Assessment of shielding of covering → depth of excavation
- Measurements of dose rates directly over the ground
- Apply a nomogram for decision making

Aushubtiefe		ODL (aufgesetzt) Baugrubensohle
0,0 m u. GOK	—	0,3 $\mu\text{Sv/h}$
0,1 m u. GOK	—	0,6 $\mu\text{Sv/h}$
0,2 m u. GOK	—	1,2 $\mu\text{Sv/h}$
0,3 m u. GOK	—	2,4 $\mu\text{Sv/h}$
0,35 m u. GOK	—	3,6 $\mu\text{Sv/h}$
0,4 m u. GOK	—	4,8 $\mu\text{Sv/h}$
0,5 m u. GOK	—	9,6 $\mu\text{Sv/h}$



Example 15,2  $\mu\text{Sv/h}$  in 30 cm depth → not sufficient

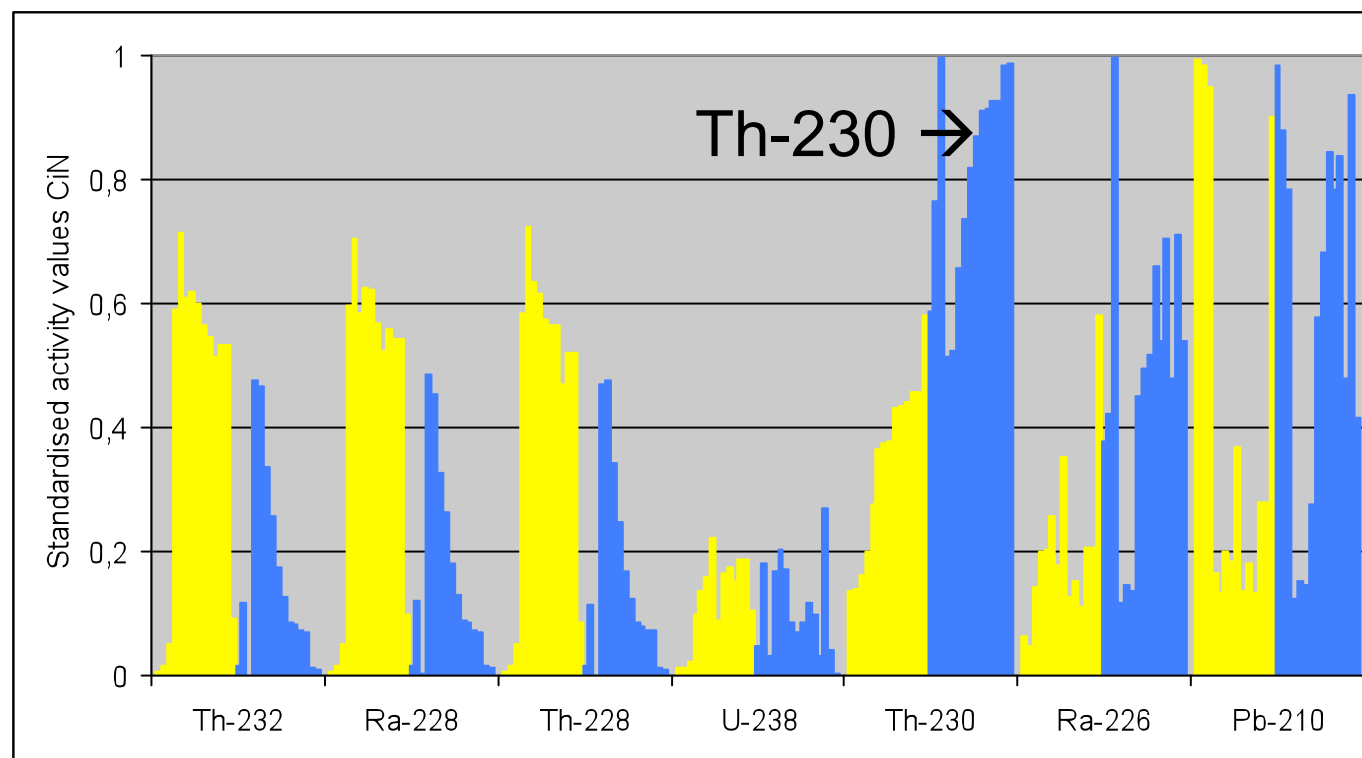


## Task 2: Estimate the doses of workers

### Planning

Pre-estimation of doses based on the specific knowledge of materials

- Planned duration of the work
- Expected activities
- Nuclide composition (standardised:  $a_{iN}/(a_{Th232max} + a_{U-238max})$ )



## Task 2: Estimate the doses of workers

	External dose	inhalation	ingestion	total dose
	mSv	mSv	mSv	mSv
Excavator driver	0,032	0,032	0,017	0,081
wheel loader driver	0,035	0,013	0,007	0,055
Supervisor (with sampling)	0,18	0,13	0,007	0,32
Remediation worker	0,45	0,032	0,017	0,50
Public	0,0022	0,0045	0,00004	0,0068

Health and Safety Plan.

- Radioactive **and** other toxic substances (Hg, Pb, Sb, Cd, ...)
- Radioactivity should be considered as a toxic substance like others!  
ALARA is applicable for chemical contaminants, too.

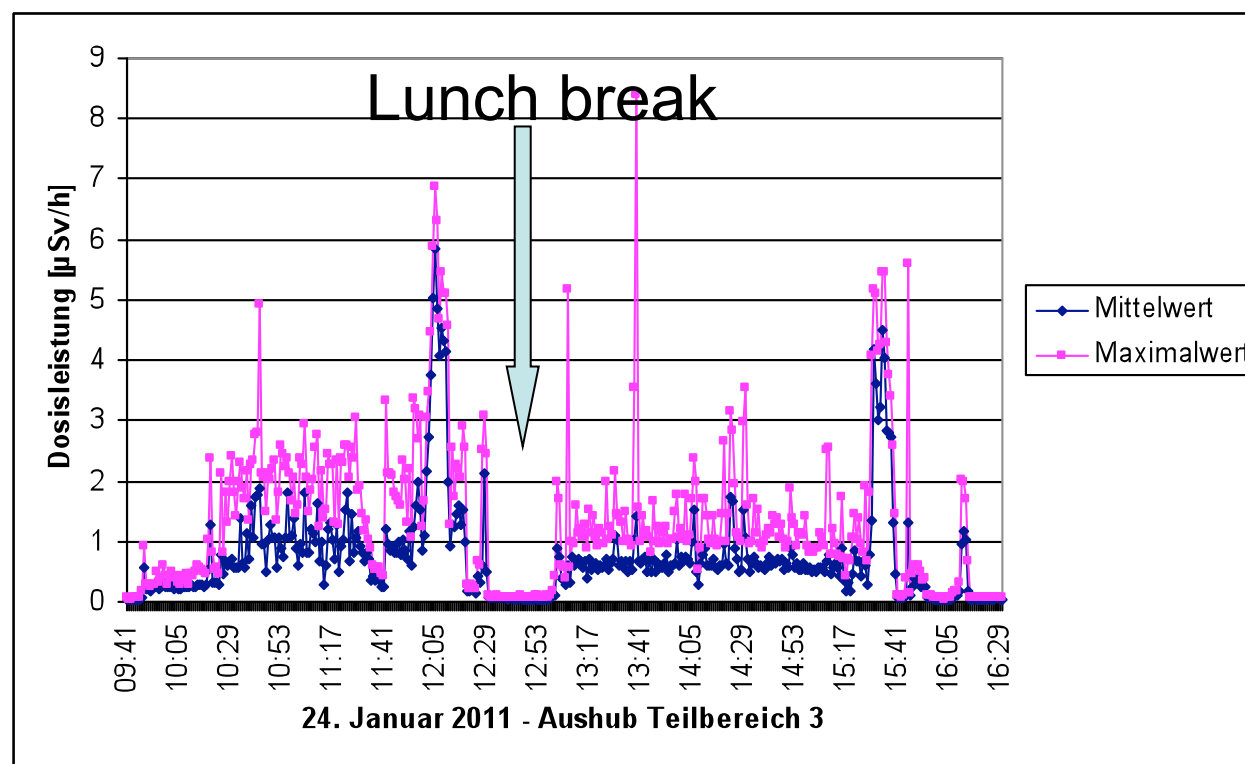
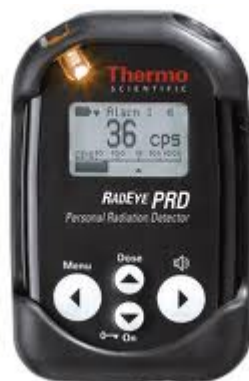
## Task 2: Estimate the doses of workers

### Execution phase

Dose surveillance was NOT necessary (estimated doses lower 1 mSv)

Dose measurements with personal dosimeters (film dosimeters) for some persons

Measurements of dose records of the “radiological supervisor” with RadEye PRD





## Task 2: Estimate the doses of workers

Datum	Auslesewert [μSv]	Auslesewert [h]	Bearbeiteter Teilbereich
08.12.2010	0,6	04:00	Gut Grün 31 und Teilbereich 7
13.12.2010	2,55	06:30	Gut Grün 31 und Gut Grün 32
03.01.2011	2,6	05:45	Gut Grün 32
04.01.2011	3,1	06:00	Gut Grün 32
05.01.2011	3,3	05:53	Gut Grün 32
07.01.2011	4,42	07:06	Gut Grün 32
10.01.2011	2,72	07:21	Gut Grün 32
11.01.2011	1,05	03:19	Gut Grün 32
12.01.2011	2,59	07:44	Gräben Gut Grün 31/32
13.01.2011	3,84	07:43	Gut Grün 32
14.01.2011	1,95	02:15	Gut Grün 32
18.01.2011	5,3	06:23	Teilbereich 4
19.01.2011	27,8	08:30	Teilbereich 4
20.01.2011	14,5	03:25	Teilbereich 4
21.01.2011	2,7	05:22	Teilbereich 4
24.01.2011	5,33	06:30	Teilbereich 3
25.01.2011	4,01	06:21	Teilbereich 3
26.01.2011	6,94	07:20	Teilbereich 3
27.01.2011	7,66	05:44	Teilbereich 2
31.01.2011	1,54	02:15	Teilbereich 2
01.02.2011	2,08	05:55	Hecken und Teilbereich 1
02.02.2011	5,14	08:09	Hecken und Teilbereich 1
03.02.2011	17,6	07:33	Teilbereich 1
04.02.2011	5,16	03:15	Teilbereich 1
07.02.2011	4,55	06:00	Teilbereich 1
08.02.2011	2,91	05:45	Gut Grün 1 Fischbecken u. Mulden

**SUMME: 142 μSv**

**SUMME: 0,142 mSv**

**Dose record**  
**December-February:**  
**0.14 mSv**

## Task 2: Estimate the doses of workers

Results obtained from individual dosemeters

	Oct-Nov	Dec-Feb	Prognosis
	mSv	mSv	
Excavator driver	< 0.1	0.1	0.081
wheel loader driver	<0.1	0.2	0.055
Supervisor (with sampling)	<0.1	0.2	0.32
Remediation worker	<0.1	0.3	0.5

# Task 3 Waste management



- Sampling
- Determination of dose rates (\*)
- Laboratory analysis

(\*) NaI-detector

- assign waste to activity classes
- ensure low doses of workers at the disposal site,



## Big-Bags

- Determination of dose rates  
(4 measuring points )
- Sampling + analysis

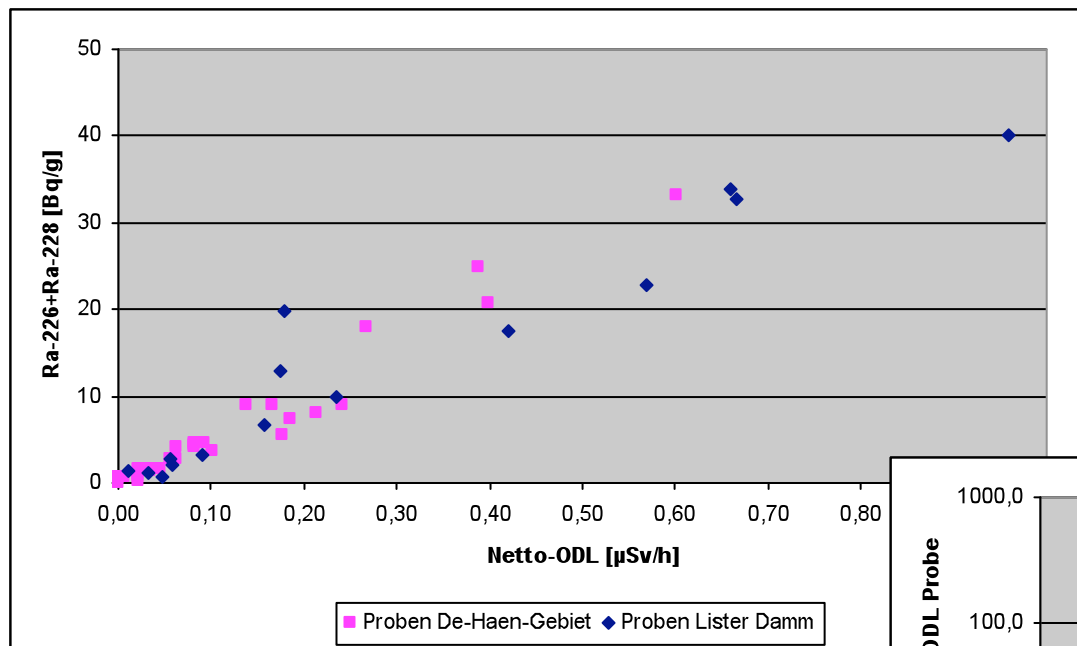
## Container

- Determination of dose rates  
(10 measuring points )
- Sampling + analysis



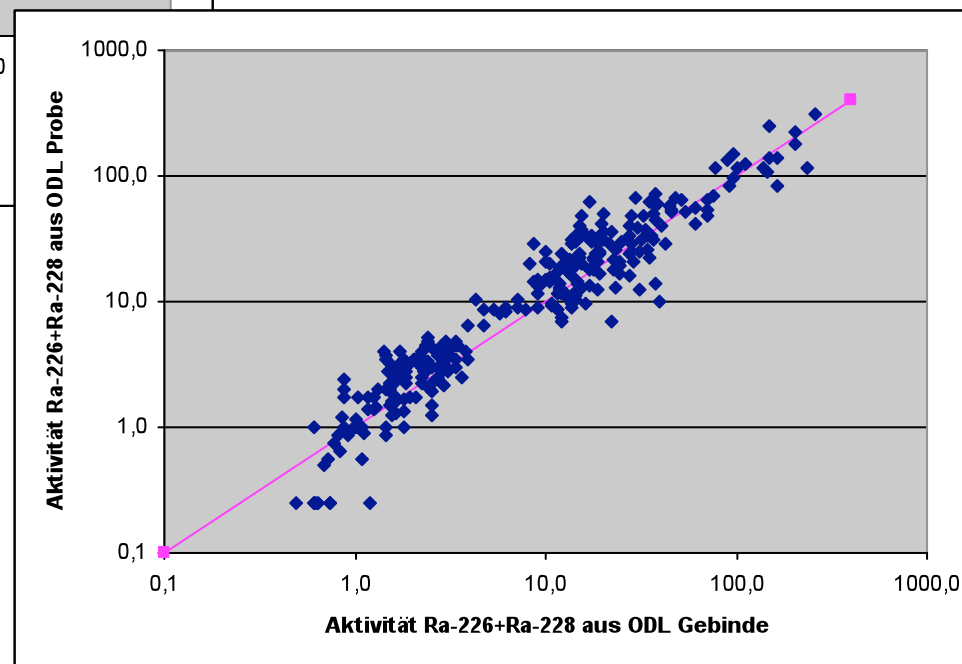


# Task 3 Waste management



Comparison of sum activities Ra-226+Ra-228 obtained from samples and from dose rate measurements at packages

## Calibration curves



## Task 3 Waste management

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### Waste classification

Class 0: radioactively not contaminated waste → waste treatment facility

Class 1: radioactively contaminated waste, exempted from ADR Class 7 → landfill 1

Class 2: radioactively contaminated waste, transport according to ADR Class 7 → landfill 2

Class 3: “radioactive waste” → federal state collecting facility for radioactive waste.



# Situation in 2010/11





# Situation in 2012





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**Thank you for attention**

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