

Risk based and integrated approach for management of large contaminated sites

Case: Forest Park(land) Noorderbos

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Introduction

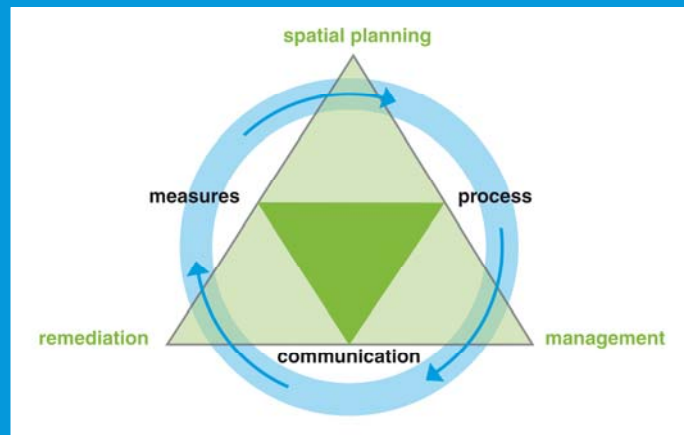
Mission:

*'Incorporating Sustainable
Approaches in Site Remediation'*

Need for alternative remediation strategies:

- (Small) hotspots → new technologies
- Large contaminated sites → **risk based** and **integrated** site management

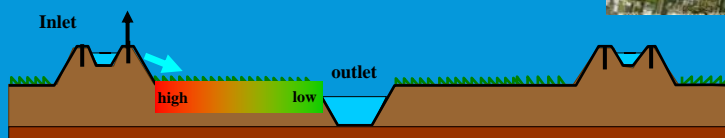
Sustainable approach for management of large contaminated sites



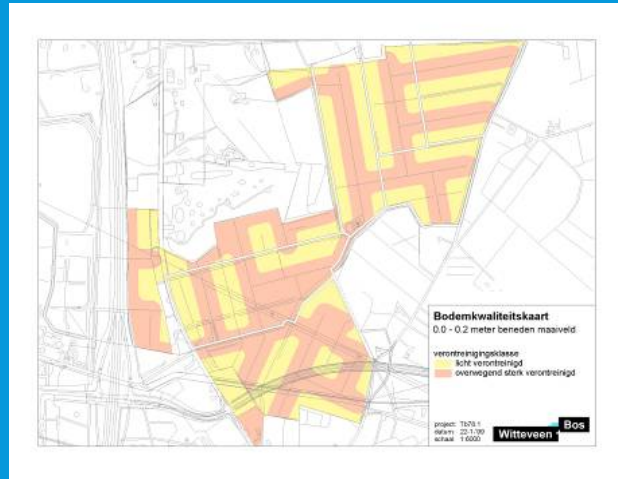
Redevelopment of Former Sewage Farm

Sewage farm 'De Zandleij' of City of Tilburg:

- an area of 100 hectare
- start 1919 till 1980
- used for spreading and purification of domestic and industrial sewage water (leather industry)
- the topsoil (0-0,4) contaminated:
 - major components Cr and As
 - minor Cd, Zn, Cu, Pb



Soil quality map



Redevelopment into forest parkland

- City of Tilburg planned to turn this area into a forest parkland (**'Noorderbos'**) offering:
 - extensive recreational opportunities (walking, cycling and horse riding)
 - form an 'ecological corridor' between two nature areas.
- Conventional remediation too expensive + high impact on environment
(excavation and landfilling 500.000 m³ = 50 million gulden)
- In late 90's an alternative approach was chosen;
'controlling risks by integrated land and forest management'



Site Management Plan

1999 Site Management Plan:

- risk based landscape design
 - procedures for ground work
 - a (provisional) monitoring plan
 - measures to reduce the risks (e.g. liming)
-
- Risk evaluation had indicated that development of the forest:
 - acidification of the soil
 - increase of availability and mobility of metals
 - ecological effects and leaching?

2000 Study was started because uncertainties about ecological risks:

→ update and optimise Site Management Plan

Risk based landscape design



Landscape design:

- paths for walking, cycling horse riding
- elements of 'industrial' heritage
- various tree species (oak, beech, robinia)

To prevent human risks:

- walking paths (mainly) on slightly contaminated zones
- tree density: high on heavily contaminated zones

Study of chemical and ecological effects

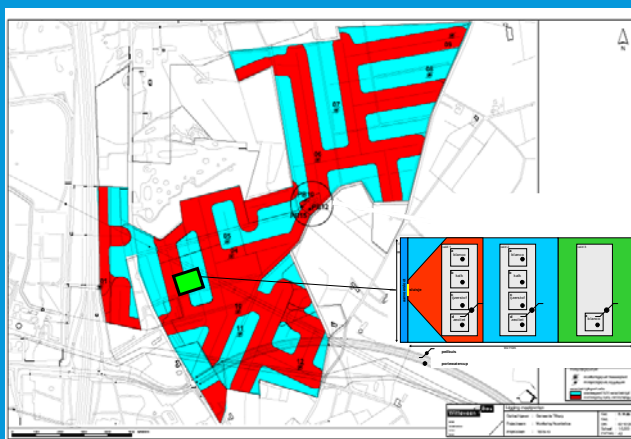
Based on TRIAD approach



The investigation focussed on:

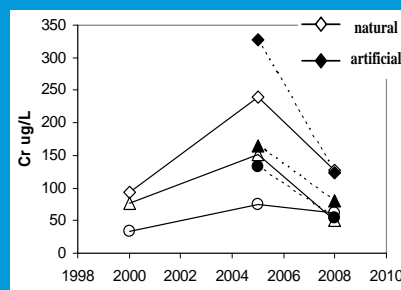
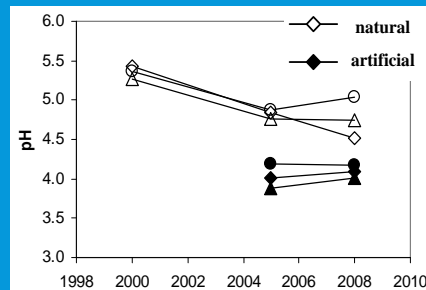
- testing usefulness of various tests for risks assessment:
 - **bioassays** (Microtox, Biomet and earthworms)
 - **ecological tests** (bacteria, fungi, springtails, nematodes)
 - **chemical analyses** (HNO_3 , CaCl_2 , DMT)
- speciation of metals (particularly chromium)
- effect of different measures (liming, metallic iron, zeolite)
- effects of extreme (artificial) **acidification** ($\text{pH} = 4$)
- **critical limits** at which point action must be taken

Monitoring 2000, 2005 and 2008



- Soil-total
- Soil-available
- Groundwater
- Ecology
- Field test (plot):
 - acidification
 - amendments

pH and metal availability in topsoil



- Since the tree planting in 2000 the pH of the soil has dropped by half a pH unit
- 2000-2005 increase metals in solution
- 2005-2008 decrease
- low concentrations of inorganic Cr(III) + Cr(VI)

Ecological effects and migration

Untreated plots:

- **no** significant effects

Artificial acidified plots:

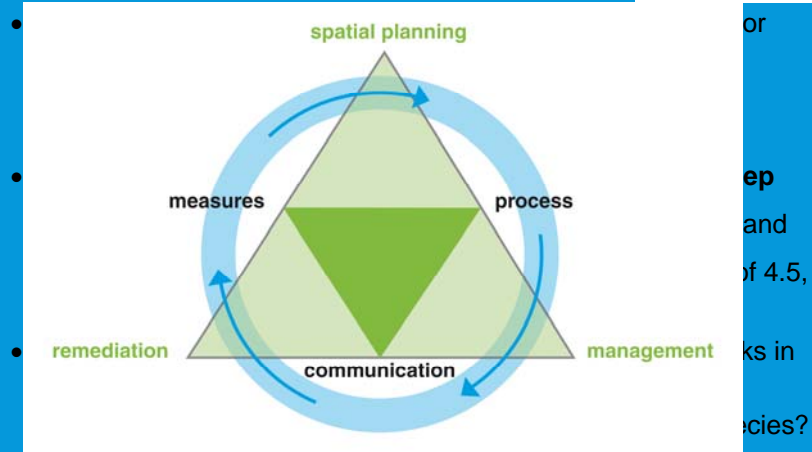
- 2005 negative effects
- 2008 **no** effects

- **No** leaching of metals into the 1st aquifer
- **No** accumulation of metals in ditch and stream beds in Noorderbos
- Increase of metal concentrations in future
- More information is needed about migration of metals to surface water

Noorderbos 2009



Update Site Management Plan



Closing

- With sound site management: 100 hectares of contaminated soil became:
 - a natural habitat
 - valuable recreational function
 - CO₂ fixation 100 ha forest: **~50.000 ton CO₂ per 50 yr**
= emission of **100 households** in 50 y
- This case showed that (re)forestation can be a **cost effective** and **environmental friendly** alternative for the management of large contaminated sites
- This concept also gives opportunities for:
 - parkland or temporarily land use
 - **phytoremediation** and/or **phytostabilisation**
 - short rotation plantation for **production of bioenergy**

Tilburg Noorderbos; the example of **green remediation!**

- City of Tilburg
Sustainable City 2005, 2006, 2007, 2008
www.tilburg.nl
- Witteveen+Bos Consulting Engineers
www.witteveenbos.nl
- Alterra Wageningen University and Research Centre
www.alterra.wur.nl