Treatment and longevity in Norwegian soil treatment units

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Outline:

- Wastewater soil treatment systems in Norway
- Construction of wastewater soil treatment systems, Norwegian procedures
- Treatment and longevity of soil treatment systems
- Use of geophysical methods to analyse the lifespan and hydraulic properties of old systems in field

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Wastewater soil treatment systems in Norway:

- 111 000 wastewater soil treatment systems
- Considered the best on-site wastewater treatment:
  - Purification efficiency
  - Costs of operation
- Constructed by standarized procedures:
  - Purification
  - Disposal

  } of wastewater
- Old systems: unknown status

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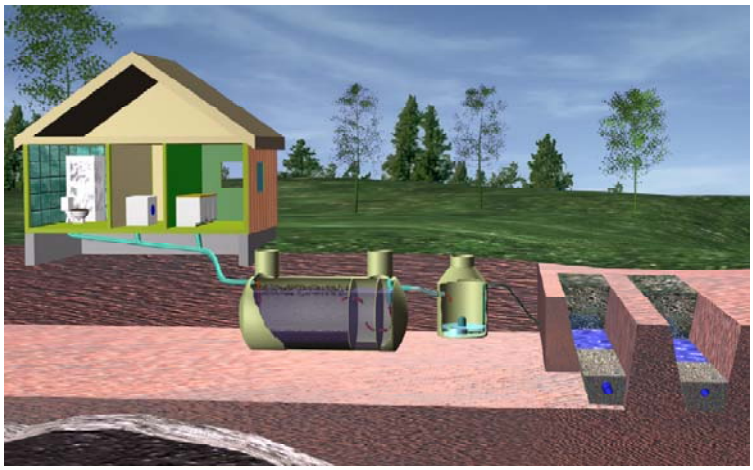
Construction of wastewater soil treatment systems, Norwegian procedures



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Construction of wastewater soil treatment systems, Norwegian procedures

Based on hydraulic criteria:

- *Hydraulic conductivity (m/day):* Grain size distribution and the shear strenght of the soil are important factors determining the soils hydraulic conductivity
- *Infiltration capacity (L/m² and day):* The amount of wastewater that can be infiltrated in a specific soil type. The soils capacity to recieve wastewater is based on the soils grain size distribution and permeability of water
- *Hydraulic load(m³/day):* The theoretical load of wastewater from the house that needs to be infilrated.
- *Thickness and distribution of unsaturated soil (m):* The thickness and extent of the unsaturated soil which can be used as a treatment filter is crucial for how the soil treatment system is constructed.

⇨ **Determined through a site evaluation**

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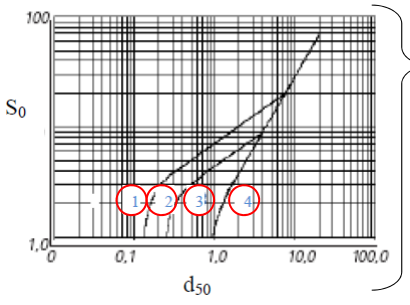
Construction of wastewater soil treatment systems, Norwegian procedures

$S_0 = d_{60}/d_{10}$

Infiltration diagram



4 soil classes :

1. Fine grained soil
2. Sand
3. Coarse sand
4. Gravel and sand

Class 4: the sand is too coarse, ɔn need for filtersand between the soil and the distribution layer. y

K: 2-5 m/d → k = 10 L/m² and day
K: 1-2 m/d → k = 6 L/m² and day
K: 0.5-1 m/d → k = very small

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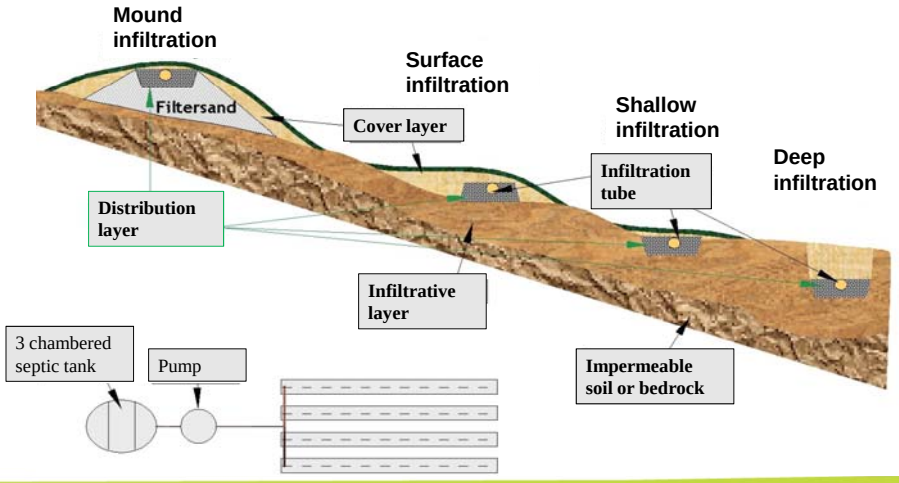
Construction of wastewater soil treatment systems, Norwegian procedures



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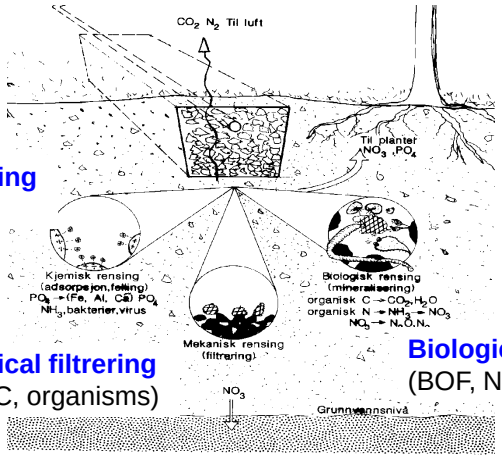
Treatment and longevity



Chemical binding
(P, NH_4, OM)

Mechanical filtrering
(SS, TOC, organisms)

Biological degradation
(BOF, N, organisms)

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Treatment and longevity

	Average	Upper part	Treatment efficiency(%)
BOF (mg/L)	5	<10	90 – 99
Suspended solids (mg/L)	2	<5	>95
Phosphorus (mg/L)	1	<5	90 - 99
Nitrogen (mg/L)	10	<20	>50
TCB (pr/100 mL)	10	<200	>log3
Infiltration trough 4 – 5 m unsaturated sandy soil, application rate: 5 – 40 cm/d (USEPA 1981)			
Parasites			High
Virus			Variable
Organic toxics			High
Heavy metals			High

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Treatment and longevity

Expected lifetime of a wastewater soil treatment unit:

- Based on purification properties and hydraulic properties of the soil media
  - P-sorption capacity
  - Clogging of the soil infiltrative surface

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Treatment and longevity: P sorption

Phosphorus in wastewater exists mainly as PO_4

- Fast reversible sorption: Fe. Al, Ca
- Slower irreversible sorption: diffusion into micropores, precipitation of phosphorus minerals.

A soil's phosphorus sorption capacity is dependent on:

- Soil mineralogy
- Texture
- Wastewater retention time
- Wastewater composition

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Treatment and longevity: P sorption

Batch experiments have been used to assess the phosphorus sorption capacity of a soil.

Estimated lifespan: > 20 years

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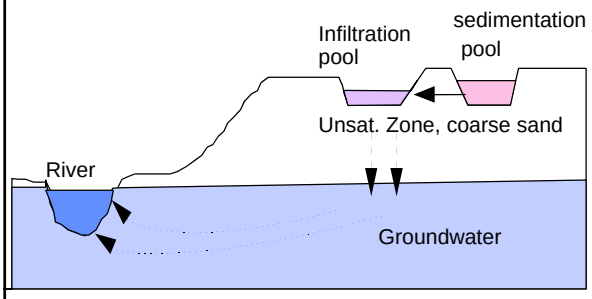
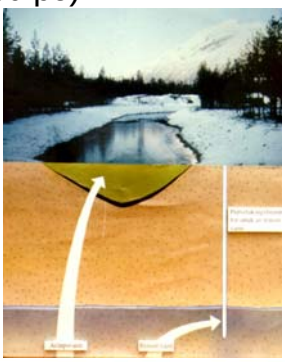
Treatment and longevity: P sorption

Analysis of a 15 year old infiltration system in Norway: Setermoen soil treatment system (8000 pe)





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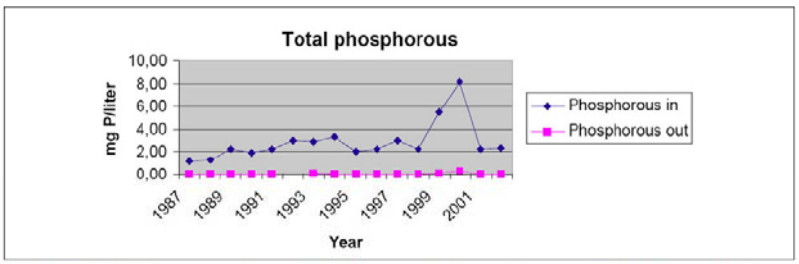
Treatment and longevity: P sorption

Analysis of an old infiltration system in Norway: Setermoen soil treatment system (8000 pe)



Figur 3-27 . Totalfosfor i avløpsvann og i renset vann/grunnvann ved Setermoen infiltrasjonsanlegg i perioden 1987–2002. Hvert punkt representerer årsgjennomsnitt (fra Einarsen 2004).

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Treatment and longevity: Clogging

As the soil recieves wastewater a biofilm developes on the soil infiltrative surface

$K_{biofilm} <<< K_{soil}$ → redused infiltration capacity

Estimated lifespan with today's dimension criteria: 30-40 years.

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Treatment and longevity: Clogging

Some degree of clogging is po

- Increased retention tim purification

But too extensive clogging ma

- Hydraulic failure

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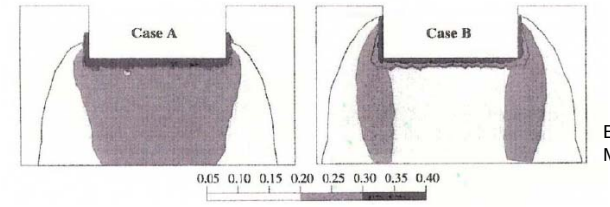
Treatment and longevity: Clogging

Little is known about the long term change of soil physical properties due to constant load of wastewater.



Beach and McCray (2003)

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Treatment and longevity: Clogging

- > 50 % of the infiltration systems in operation in Norway today are more than 20 years
- Little is known about their treatment efficiency
- Outdated systems with respect to phosphorus binding capacity may still have aceptable treatment due to long distance to recipient.

There is a need for more research regarding the lifespan of infiltration systems

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Use of geophysical methods to analyse the lifespan and hydraulic properties of old systems in field

Geophysical methods have been used for analyses of subsurface flow properties:

- Characterize waste landfill structure
- Study contaminant of groundwater by leachate from landfills
- Map contaminant plume geometry, and monitor plume movements
- Evaluate spatial and temporal variation in subsurface water content

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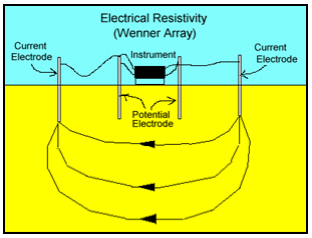
Geophysical methods

Electrical resisivity (ER): measurements performed at the surface or by electrodes in boreholes



The measured ER depends on the porosity, water content, water salinity and soil structure

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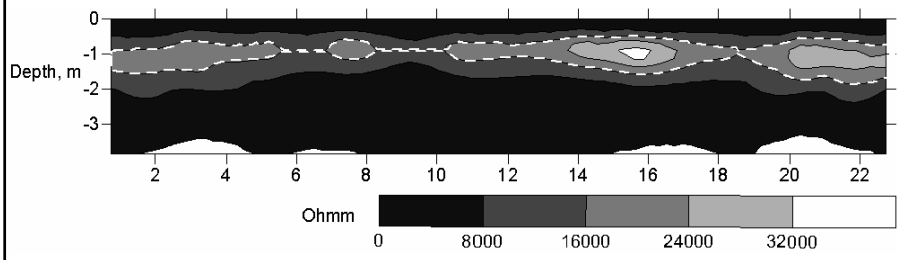
Geophysical methods

ER measurements conducted at Åbogen infiltration system (300 pe):



(French et al., 2006)

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Geophysical methods

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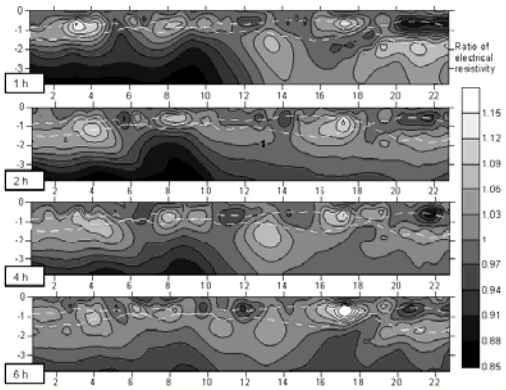

(French et al., 2006)

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Geophysical methods: Conclusion

- GM may give interesting information of the hydraulics of old systems
- May be used for assessing the change of soil physical properties due to constant load of wastewater
- May be used to give better estimate of the service life of wastewater soil treatment systems
- Possible tool for evaluation of the performance of older systems.

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