

Implementation Sustainable Aftercare of Landfills

Concepts and approach for the three pilot projects

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Outline

Introduction

Conceptual Model

Full Scale Pilot Tests

Introduction: Problem

- ▶ Heijo Scharff (LF Aftercare Forum October 2015):
 - ▶ Current Dutch Regulations require ever lasting aftercare;
 - ▶ Funding for after-care is accrued during active disposal phase;
 - ▶ Discount rates can vary;
 - ▶ Turns out the approach has considerable problems.

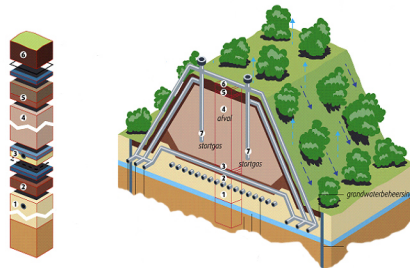


image courtesy of Attero

Introduction: Possible Solution

- ▶ Bottom liner + drainage system in place
- ▶ Actively reduce emission potential:
 - ▶ Fresh water irrigation & leachate recirculation + flushing
 - ▶ Treatment of recirculated leachate
 - ▶ Biogas collection & utilization
 - ▶ Aeration of waste body
- ▶ Approximately 10 years
- ▶ Reduction of Emission Potential
 - ▶ Leachate quality complies with regulated Emission Test Values;
 - ▶ Gas emission can be mediated by passive covers.

Project: Introduction Sustainable Landfill Management

- ▶ Ministry, Provinces and Landfill operators;
- ▶ Change regulations to allow for experimental pilots;
- ▶ Agree up-front on final criteria which define success;
- ▶ Preliminary phase finished last year;
- ▶ Now in process of starting up three pilots.

Time Line

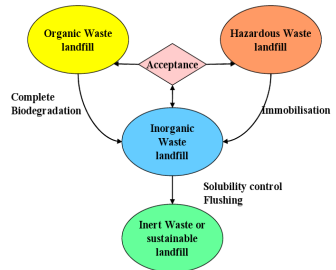


Planning projecten iDS

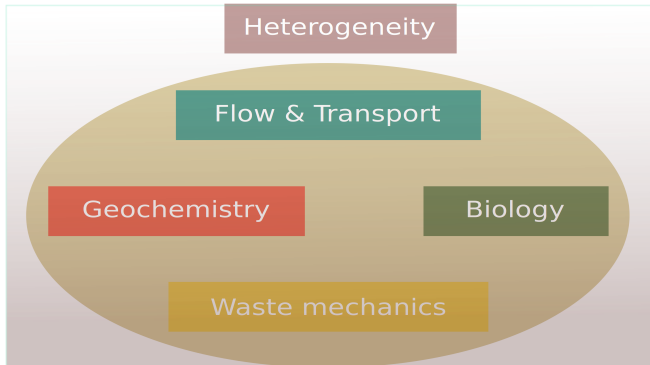


This Presentation

- ▶ Conceptual model behind the approach
 - ▶ Heterogeneity;
 - ▶ Flow of water & air
 - ▶ Transport of solutes;
 - ▶ Inorganic geochemistry of waste material;
 - ▶ Organic biochemistry of waste material;
 - ▶ Waste mechanics.
- ▶ Treatment options for the wastebodies.



Conceptual Model

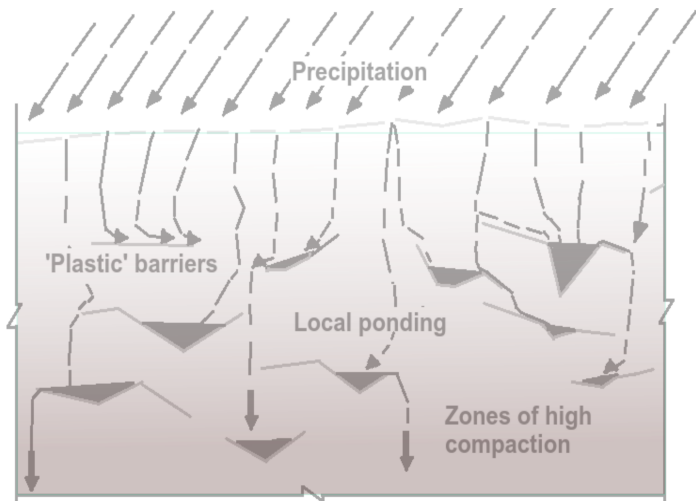


Heterogeneity in a Wastebody

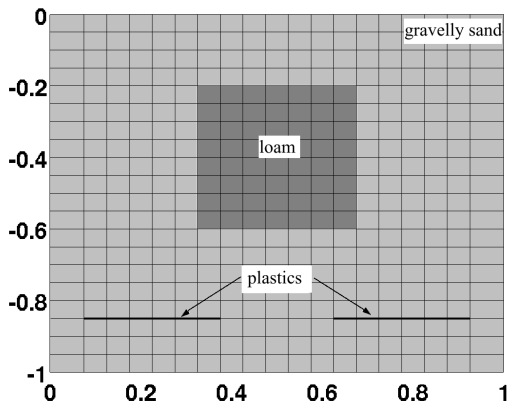


Waste is not an unsaturated soil!

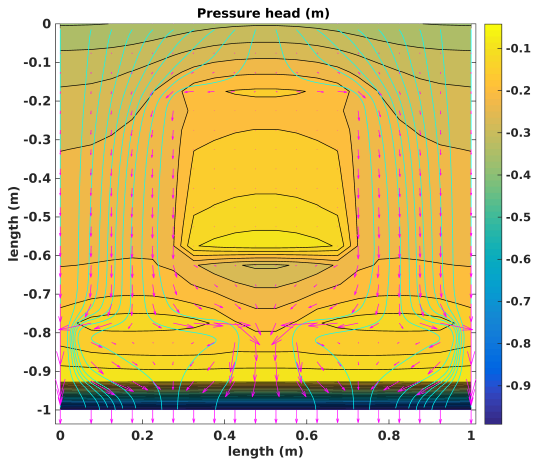
Heterogeneity Leads to Preferential Flow



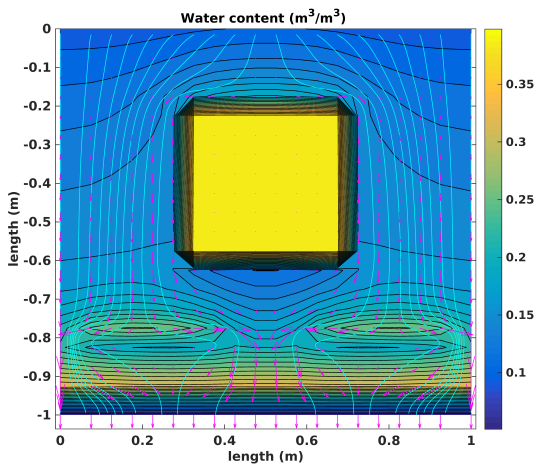
Heterogeneity and the Origin of Preferential Flow



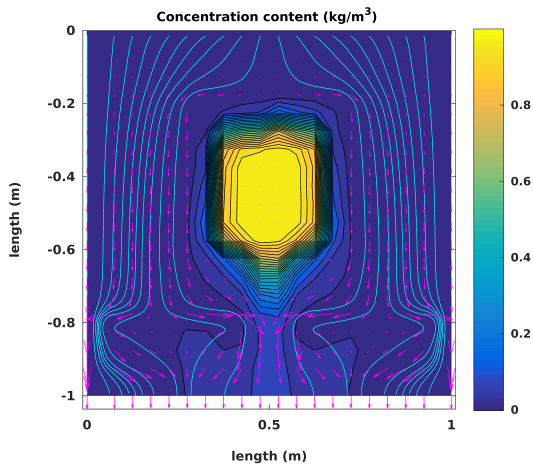
Pressure Head



Water Content

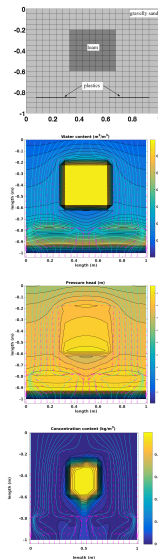


Solute Content

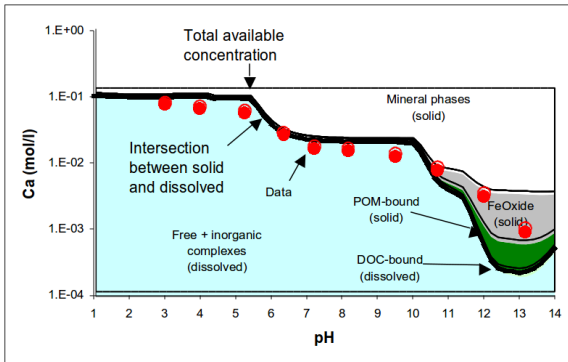
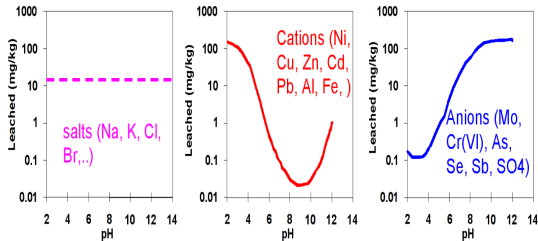


Preferential Flow

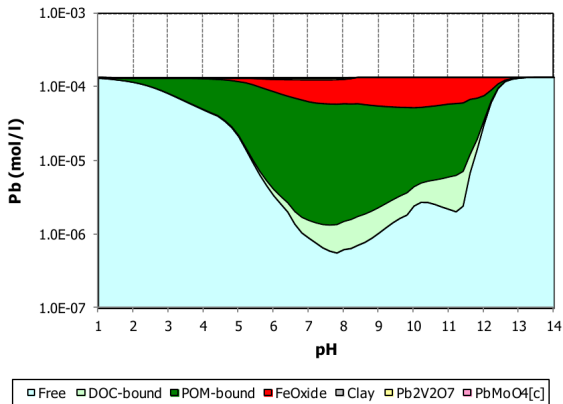
- ▶ Heterogeneous nature of waste body;
- ▶ Waste bodies in the Netherlands are unsaturated porous media;
- ▶ Impermeable materials lead to divergence from vertical flow only;
- ▶ Low permeable materials lead to very slow flow;
- ▶ Broad distribution of residence time of water in waste body.



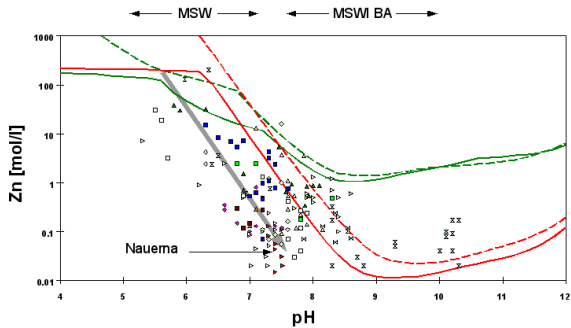
Geochemical Controls on Leachate



Speciation Across Phases Present

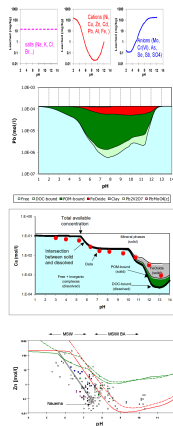


Interpretation of Leaching Tests

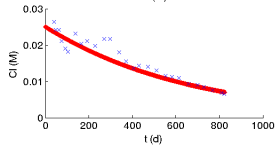
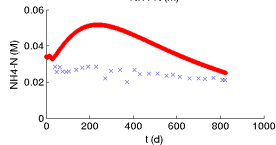
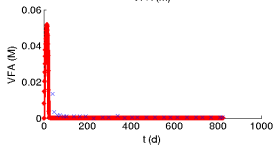
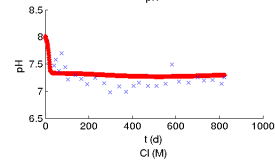
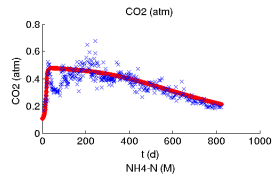
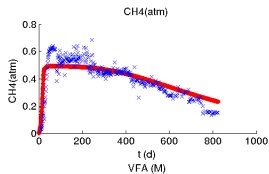
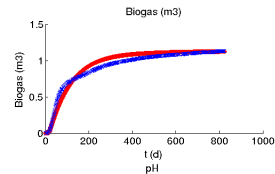


Leaching of Inorganic Compounds

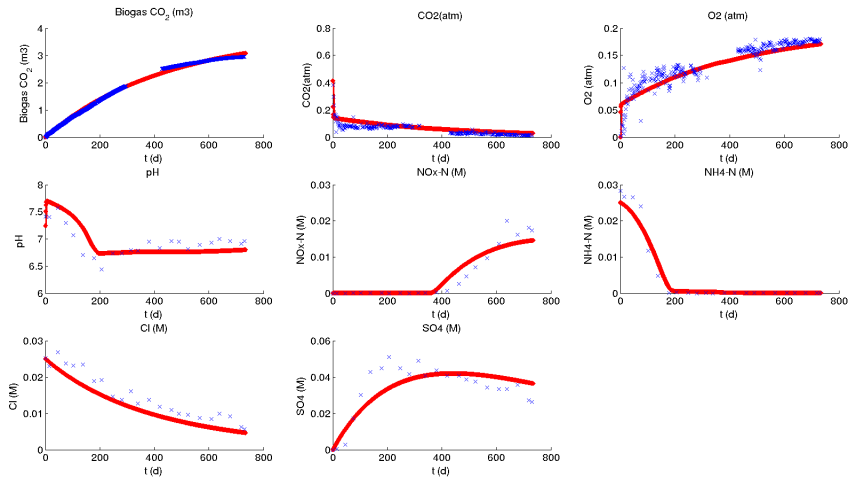
- ▶ Inorganic leaching is predictable using readily available geochemical modelling tools and databases;
- ▶ pH, DOM-complexation and redox are controlling parameters;
- ▶ Modelling gives insight in to phase distribution;
- ▶ Predictions match data from a wide range of field sites;
- ▶ DOM is the crucial parameter we need to control in order meet the ETVs.



Biochemical Reaction Modelling: Anaerobic recirculation test

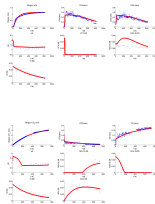


Biochemical Reaction Modelling: Aerobic recirculation test

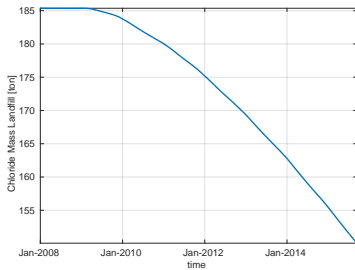
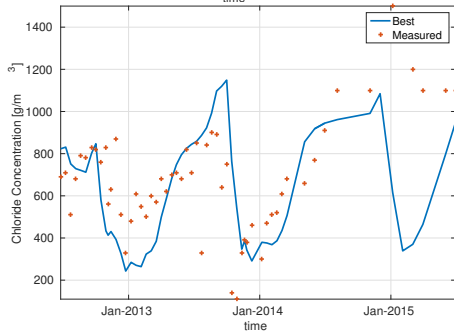
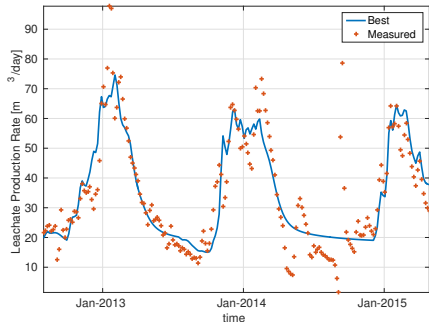


Biodegradation, Gas Production & DOM Levels

- ▶ Biodegradation is predictable using available data;
- ▶ Water content, inhibition, pH-buffering are important;
- ▶ DOM levels require further attention;
- ▶ Ammonium dynamics are challenging;
- ▶ Hydrolysis is the rate limiting parameter.



Full-scale Integrative Modelling



Emission Potential in the Context of Integrative Models

- ▶ High frequency measurements on leachate discharge and composition;
- ▶ Stochastic modelling based on conceptual model;
- ▶ Parameter estimation in a probabilistic framework;
- ▶ Quantification of the change in total Leachable Mass present in the waste body as a function of time.

Full Scale Pilot Tests on Three Landfills

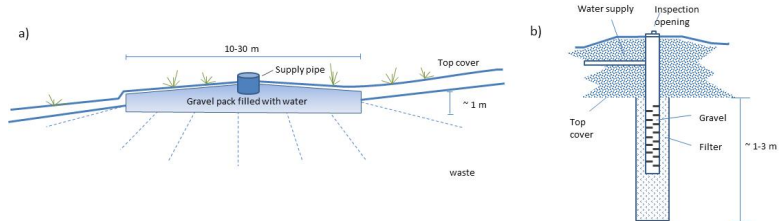


- ▶ Demonstration projects in The Netherlands
- ▶ Irrigation & leachate recirculation
- ▶ Aeration of wastebody
- ▶ Sequential application of both technologies

Leachate Recirculation (Kragge only)

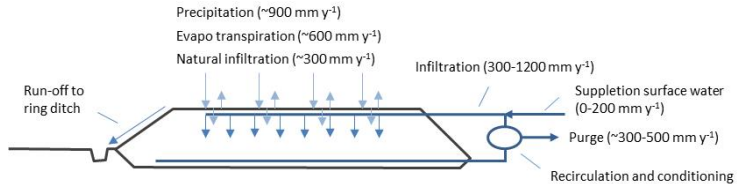


Proposed Techniques

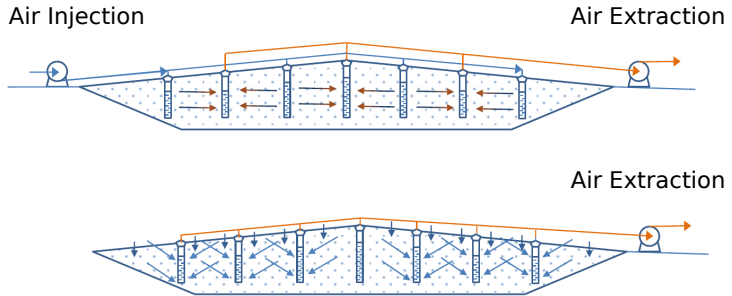


- ▶ Attero has chosen for a strategy based on drains in gravel trenches.

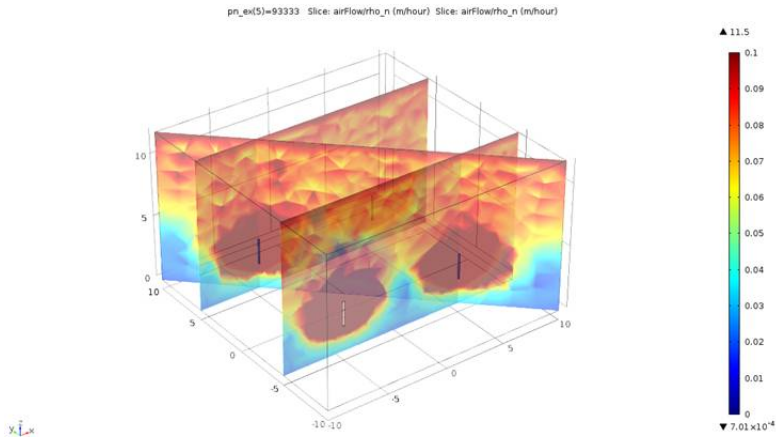
Leachate Recirculation Quantities



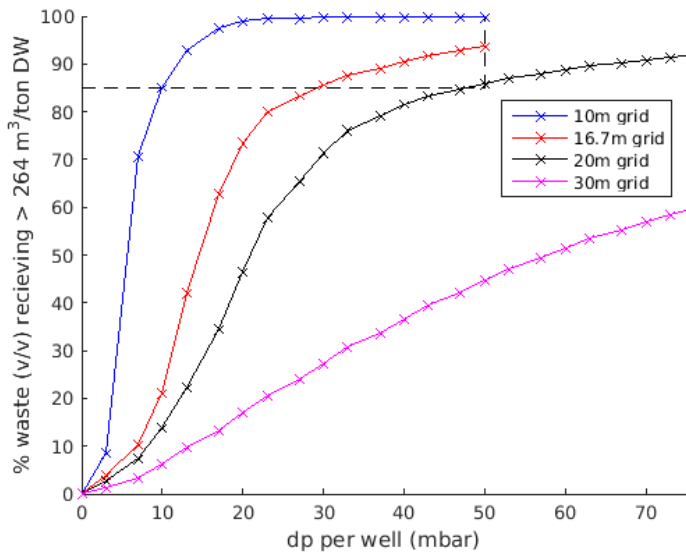
Aeration (all three landfills, starting with Braambergen and Wieringermeer)



Aeration Scenario Modelling



Volumes of Waste Influenced by Aeration



Aeration

- ▶ Deep filters due to landfill properties;
- ▶ Large number of wells in order to reach a sufficient volume of water;
- ▶ Test drilling shows that approach will be a challenge;
- ▶ Large amounts of perched water encountered during test drilling.

Final Remarks

- ▶ We are going to try to stabilize 3 cells on different landfills;
- ▶ We have some ideas what should happen;
- ▶ We face a large number of unknowns;
- ▶ We invite interested parties to join our effort;
- ▶ There is really no other (sustainable) option!

Thank You!



- ▶ Afvalzorg
- ▶ Attero
- ▶ Deltares
- ▶ Royal Haskoning
- ▶ Oonkay!
- ▶ Stichting Duurzaam Storten
- ▶ ECN
- ▶ STW