Use of Wetlands for Leachate Treatment at Closed Landfills

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Structure of the presentation

- Waffley introduction
- Opportunities to use wetlands
- Wetland types and designs
- Case studies
- Conclusions and recommendations

A number of today's speakers have recently been experiencing signs of ageing.

However, they all continue to be extremely busy with work associated with the management of leachates from landfill sites.

Possibly surprisingly to some, this work looks likely to continue until long after we are all retired……

"A landfill is not just for Christmas etc."

Most people now acknowledge that aftercare periods for landfill sites which we close today, will be measured in decades at the very least, and are very likely to extend into centuries.

Long after the last cubic metre of useable landfill gas has been used, leachate will continue to be generated, as decomposition products keep being leached out of the wastes.

That leachate will need to be managed and disposed of safely, back into the environment.

Costs of tanker transport, or of disposal into the public sewer system, are almost certain to rise much faster than general inflation, and so on-site treatment to surface water discharge standards will be come increasingly attractive and competitive: especially in later stages of aftercare.

Vissershok LTP, Cape Town, commissioned 2011

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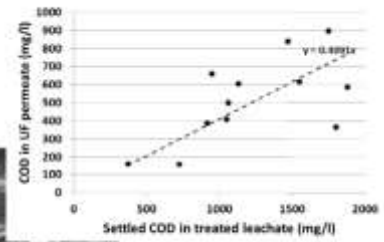
COD Removal by UF Membranes:



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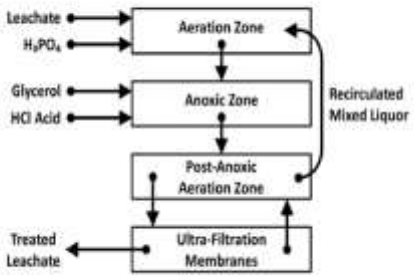
Innovative proven DeN Process Design:



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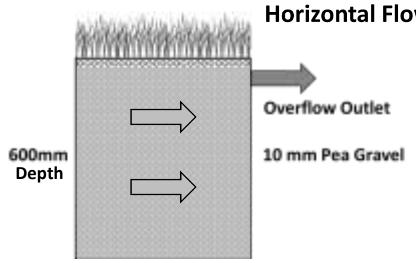
APPLICATIONS FOR REED BEDS:

Polishing of pre-treated leachates?
Treatment of raw leachates?

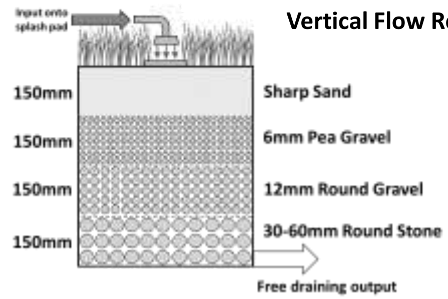
CAPACITY TO TREAT CONTAMINANTS:

Removal of dissolved methane?
Removal of suspended solids and iron ?
Removal of BOD/COD ?
Removal of dissolved methane?
Removal of ammoniacal-N ?
Other contaminants ?
Other issues ??

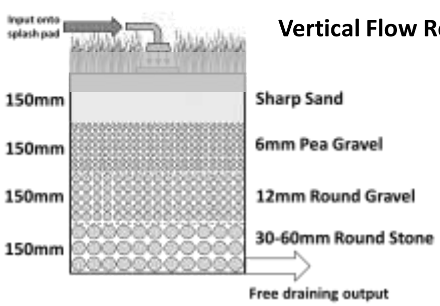
Horizontal Flow Reed Bed



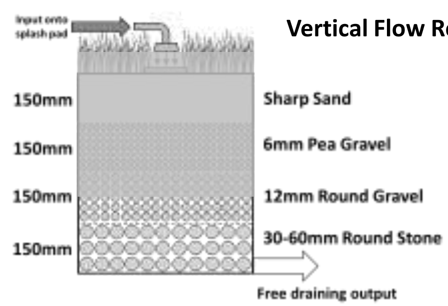
Vertical Flow Reed Bed



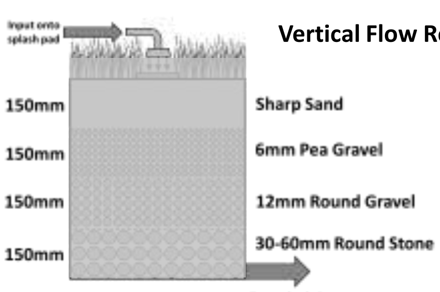
Vertical Flow Reed Bed



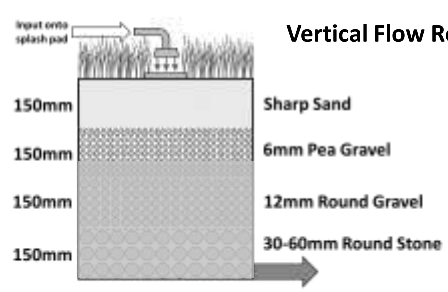
Vertical Flow Reed Bed

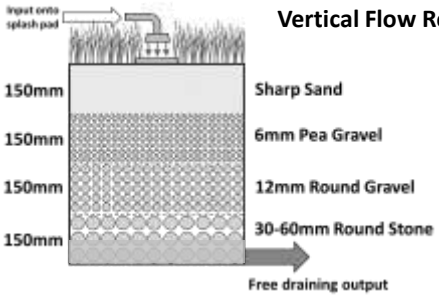


Vertical Flow Reed Bed



Vertical Flow Reed Bed





Vertical Flow Reed Bed

Dissolved methane in leachates

- Methane is twice as soluble as oxygen,
- Typically, 25mg/l can dissolve in water,
- Landfill gases contain about 60% methane by volume, so 60% of this value is typically found dissolved in leachates, that is, 15mg/l.

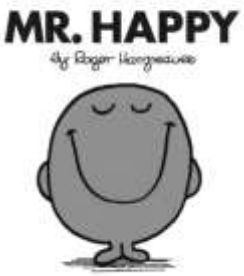
(law of partial pressures)

Dissolved methane in leachates

- At a concentration of 1.4mg/l of dissolved methane in leachate, an explosive headspace can exist.
- A factor of safety of ten is usually applied for discharges of leachate to sewer, which must therefore contain < 0.14mg/l of methane.
- Pre-treatment therefore requires removal of more than 99 per cent of dissolved methane, for safe discharge to sewer.

Reed beds for methane removal?

There is huge potential to use reed beds for removal of dissolved methane from weak leachates from old landfills, to allow their safe disposal into the public sewerage system.



Shirley Landfill, West Midlands.

Removal of dissolved methane

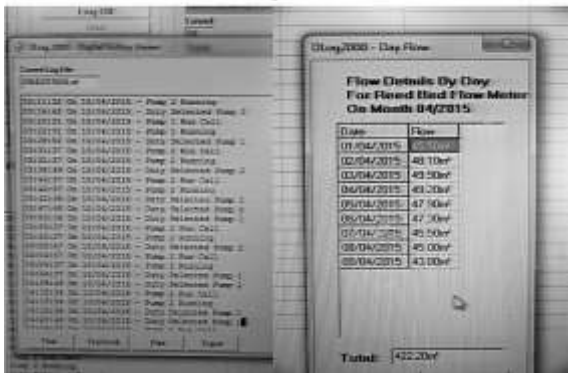
Shirley Landfill Statistics

- Area 15 hectares.
- Depth from 3 to 12m (mean 8m).
- Leachate flow 24 to 78m³/d, mean 50m³/d, (based on 4 years' data).
- ammoniacal-N from 10 to 20mg/l.
- Dissolved methane up to 2mg/l.
- Consent, less than 0.14mg/l methane.

Reed bed design

- 50m long x 7m wide x 0.6m gravel depth.
- New leachate pumping chamber, d/s,
- Pre-cast concrete header tank, 5m³, to encourage retention of iron precipitate.
- Hydraulic volume of 84m³,
- Gives HRT of 1 to 3 days at design flow,
- Simple SCADA system,
- Effluent to sewer,
- Reed bed system commissioned mid 2013.

Simple SCADA system



Record rainfall levels in January to April 2014

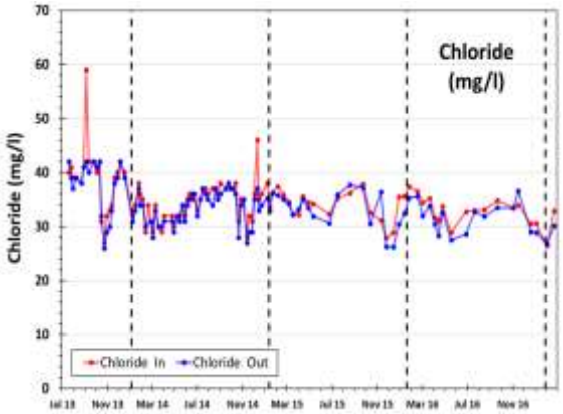
Record leachate flows in January to April 2014.


September 2014


September 2014

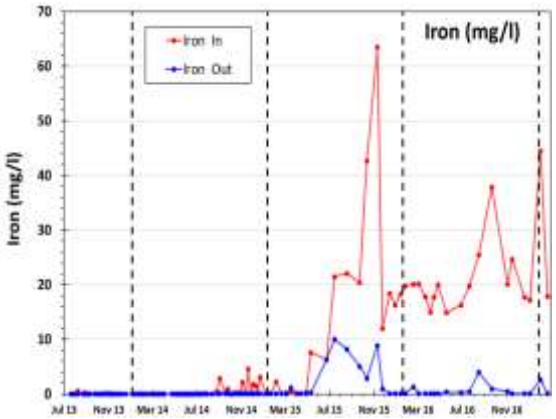

Summer 2016

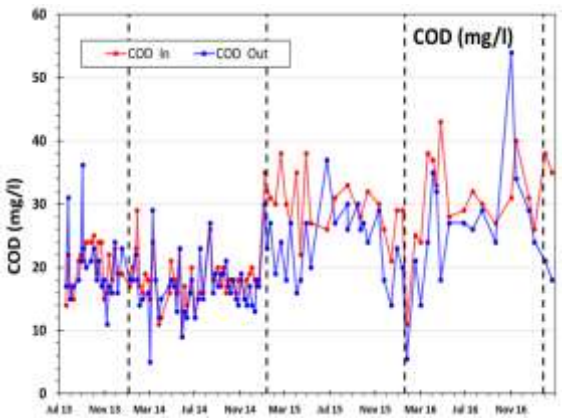

Sodium (mg/l)
Sodium (mg/l)
40
35
30
25
20
15
10
5
0
Sodium In
Sodium Out
Jul 13
Nov 13
Mar 14
Jul 14
Nov 14
Mar 15
Jul 15
Nov 15
Mar 16
Jul 16
Nov 16

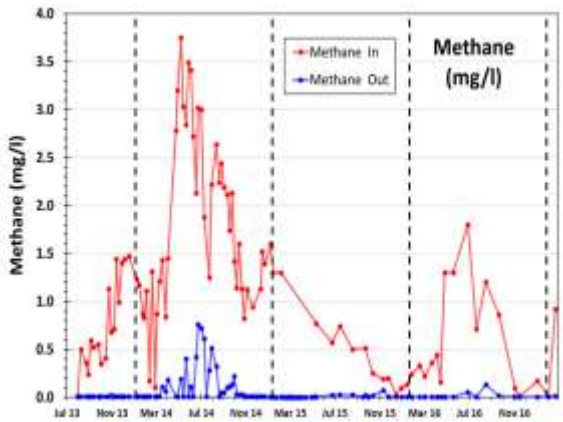


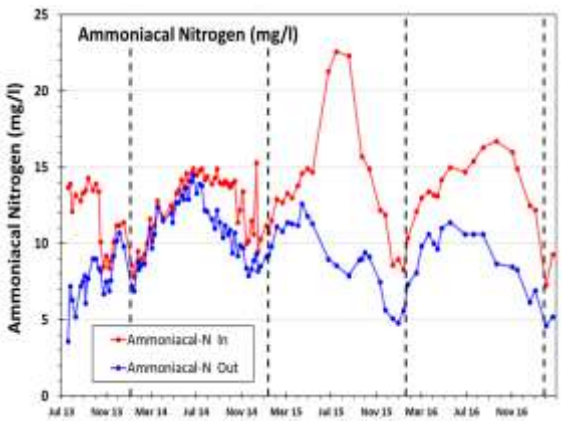
Conclusions

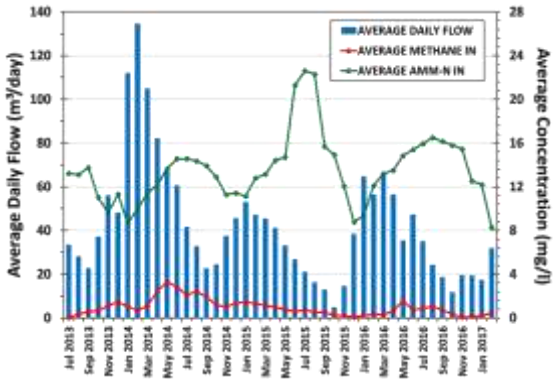
- Reed bed performed well for complete methane removal, within design limits,
- Extreme weather (flows were > double maximum design values , and methane concentrations also reached double the design values used).
- This caused some breakthrough of methane at highest loading rates, but
- Removal rates were typically up to 0.6 to 0.7g methane per m^2 bed per day – not apparently affected by season.

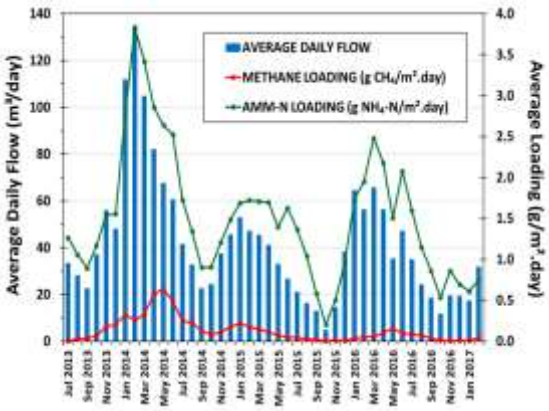












Shirley Reed Bed:
Typical removal rates

ammoniacal-N:

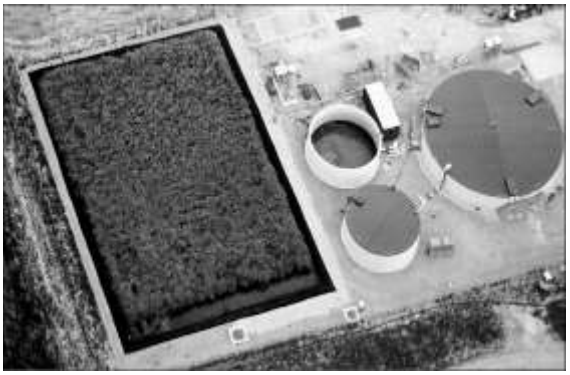
- **SUMMER: 0.9 to 1.0 gN/m^2.day**
- **WINTER: 0.4 to 0.5 gN/m^2.day**

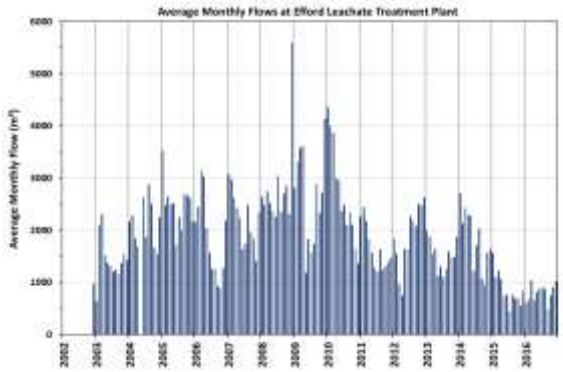
Methane:

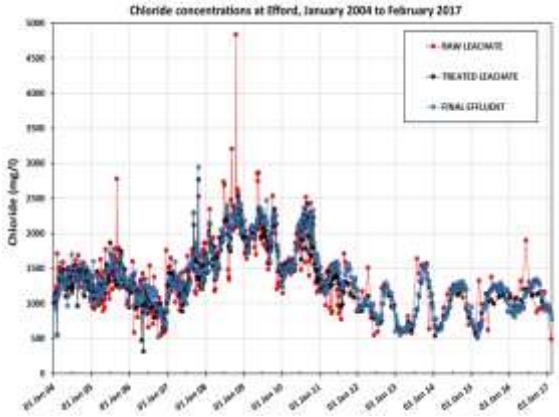
- **100% removal of dissolved methane, winter and summer, at loading rates up to 0.4 or 0.5 gCH_4/m^2.day**

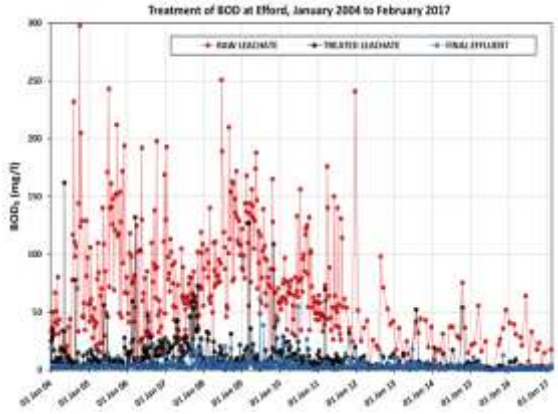
Efford Landfill, Hampshire.

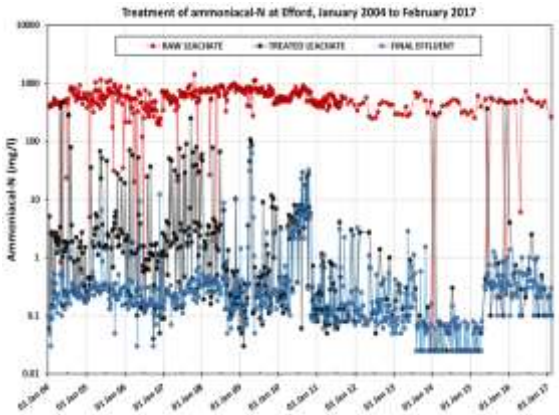
Polishing of biologically pre-treated leachate

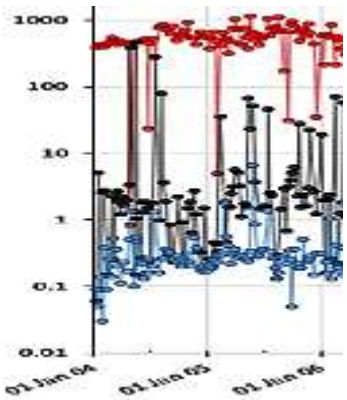






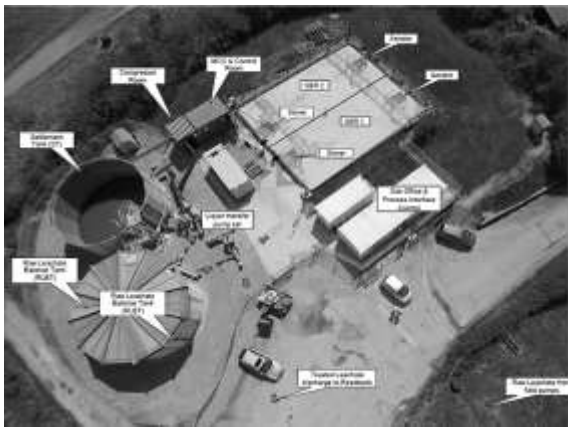




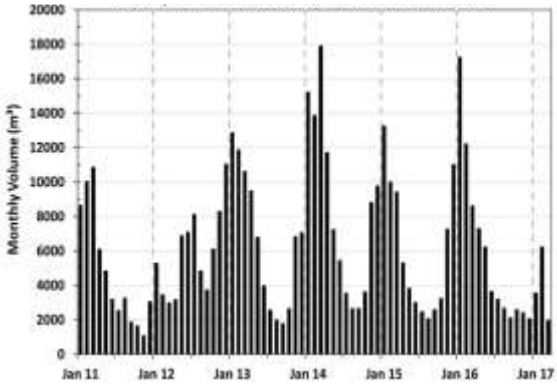


Small Dole Landfill, West Sussex.

Polishing of biologically pre-treated leachate

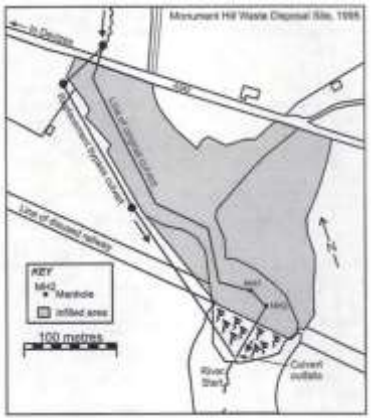

Compressor Room
Generator
Generator
Generator

Monthly volumes of leachate treated at Small Dole: 2011 to 2017.



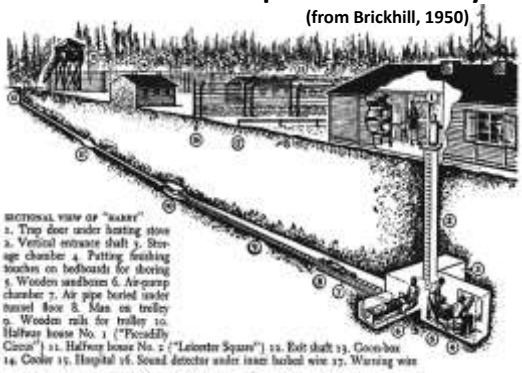
Monument Hill Landfill, Wiltshire.

Removal of suspended solids and iron from raw leachate



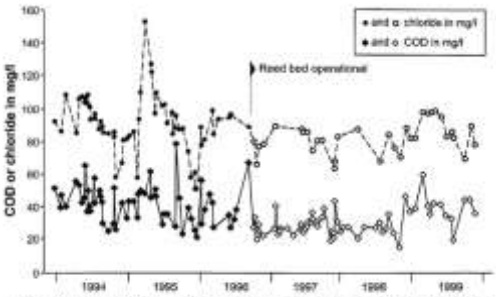
Detail of Great Escape "Tunnel Harry".

(from Brickhill, 1950)



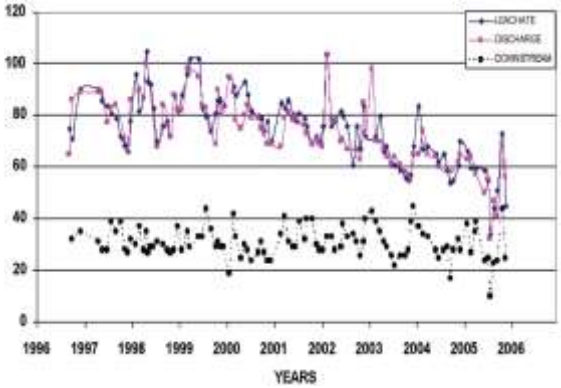
SECTIONAL VIEW OF "HARRY"
1. Trap door under heating stove 2. Vertical entrance shaft 3. Storage chamber 4. Putting finishing touches on bedboards for shoring 5. Wooden sandboxes 6. Air-pump chamber 7. Air pipe buried under tunnel floor 8. Man on trolley 9. Wooden rails for trolley 10. Halfway house No. 1 ("Piccadilly Circus") 11. Halfway house No. 2 ("Leicester Square") 12. Exit shaft 13. Goon-box 14. Cooler 15. Hospital 16. Sound detector under inner barbed wire 17. Warning wire

Routine desludging of iron precipitation from header tank

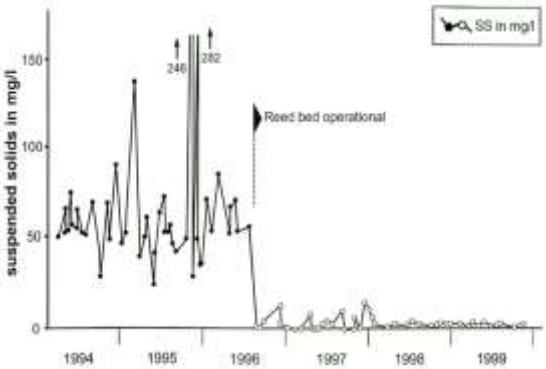


Concentrations of chloride, and COD values, in the discharge to the Stert Watercourse, December 1993 to December 1999.

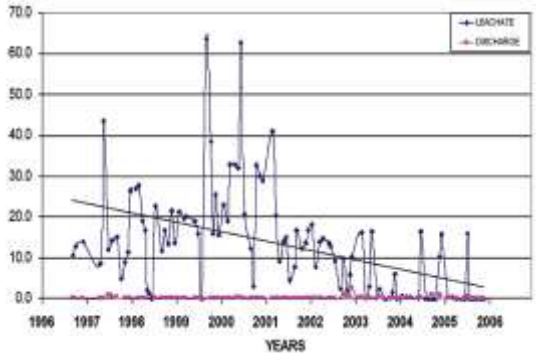
Reed bed performance: Passage of chloride through the bed

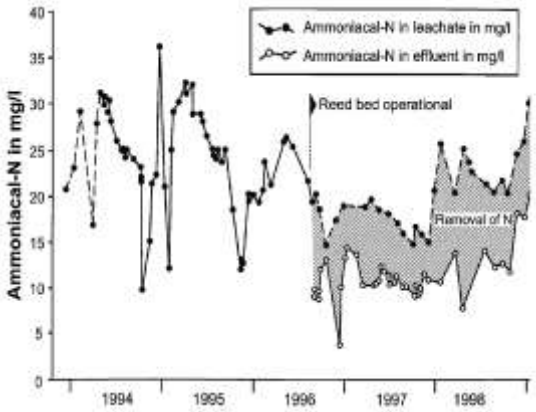


Reed bed performance: Solids removal.

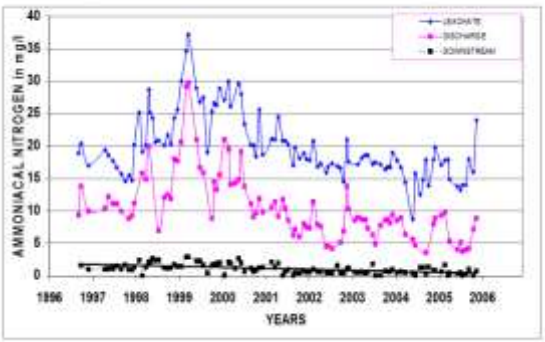


Reed bed performance: Removal of iron.





Concentrations of ammoniacal-N in raw leachate, in treated leachate, and in the downstream watercourse, 1996-2006



Monument Hill Reed Bed:
Typical removal rates for ammoniacal-N

- **SUMMER: 0.65 to 1.35 gN/m^2.day**
- **WINTER: 0.55 to 1.10 gN/m^2.day**

Reed Bed refurbishment 2010

Excavation of gravel for cleaning

Gravel removed

Replacement of cleaned gravel

Re-levelling of replaced gravel

Re-planting of reeds

Conclusions (1)

- Well-designed reed bed treatment systems are simple, elegant, and effective in treatment of leachates from closed landfill sites,
- They are ideal to provide final polishing of biologically treated leachates, before surface water discharges, and will benefit from biological effluent typically being at >20°C all year.
- For direct treatment of raw leachates, to achieve complete and year-round removal of ammoniacal-N from influent concentrations of greater than 10mg/l, will require careful design, and will probably require vertical flow systems.

Conclusions (2)

- 100% removal of dissolved methane, winter and summer, at loading rates up to 0.4 or 0.5g methane/m^2.day in horizontal flow systems,
- Summer removal rates for ammoniacal-N of between 0.65 and 1.35 g NH_4-N/m^2.day,
- Winter removal rates for ammoniacal-N of between 0.4 and 1.10 g NH_4-N/m^2.day,
- For stronger BOD leachates, dissolved oxygen inputs can readily become the limiting factor,
- Designs must be conservative, in order to ensure that treatment achieves limits 100% of the time, even though flows may vary widely.

Grateful Acknowledgements to:

- **Clients and Colleagues at Phoenix Engineering, for support.**

- **CEMEX UK, Worcestershire C.C., Wiltshire C.C., Veolia UK and Hampshire C.C. for help in providing recent data and allowing me to use these case studies in my presentation.**

Thank you for listening!