Preliminary Investigation of Potential for Modified Pervious Paving Biofilters to Vent Ground Gas and Prevent Groundwater Contamination in Historic Landfills

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watef Conference 2016 Coventry

Pervious Pavements

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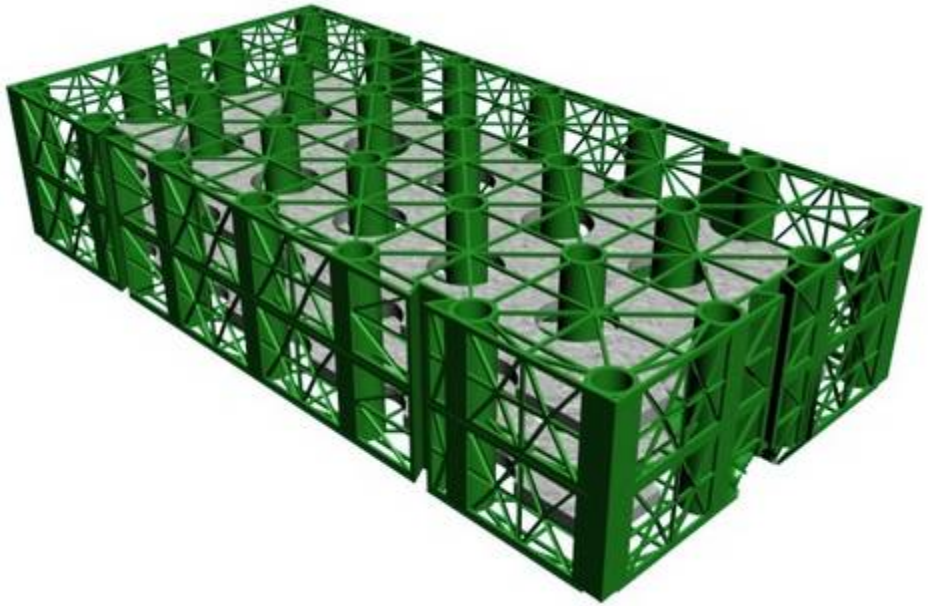
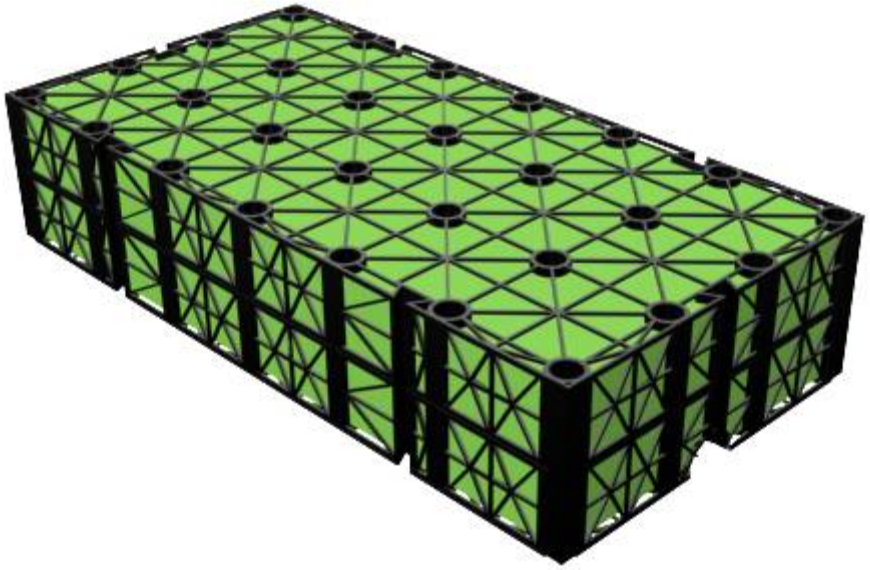
Stone Aggregate
PPS

Pavements Using Plastic Subbase Replacements

Can we put useful materials into the box ?





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Global Warming Potential of Methane

- 20 year time horizon - 86
- 100 year time horizon -34

- Source: **2013 IPCC AR5**
- **Best – oxidise with energy recovery**
- **Good – oxidise without supplementary fuel**
- **Not so good – oxidise with supplementary fuel**
- **Bad – Release methane from landfill or other ground gas source**

Ground Gas - Very High Methane Concentration

IMAGE REMOVED FOR COPYRIGHT REASONS

http://www.waste360.com/sites/waste360.com/files/wte-200904.gif

Needs around 35% methane and reasonable gas generation rate

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Traditionally if the gas contains about 20% methane it can easily be flared without supplementary fuel

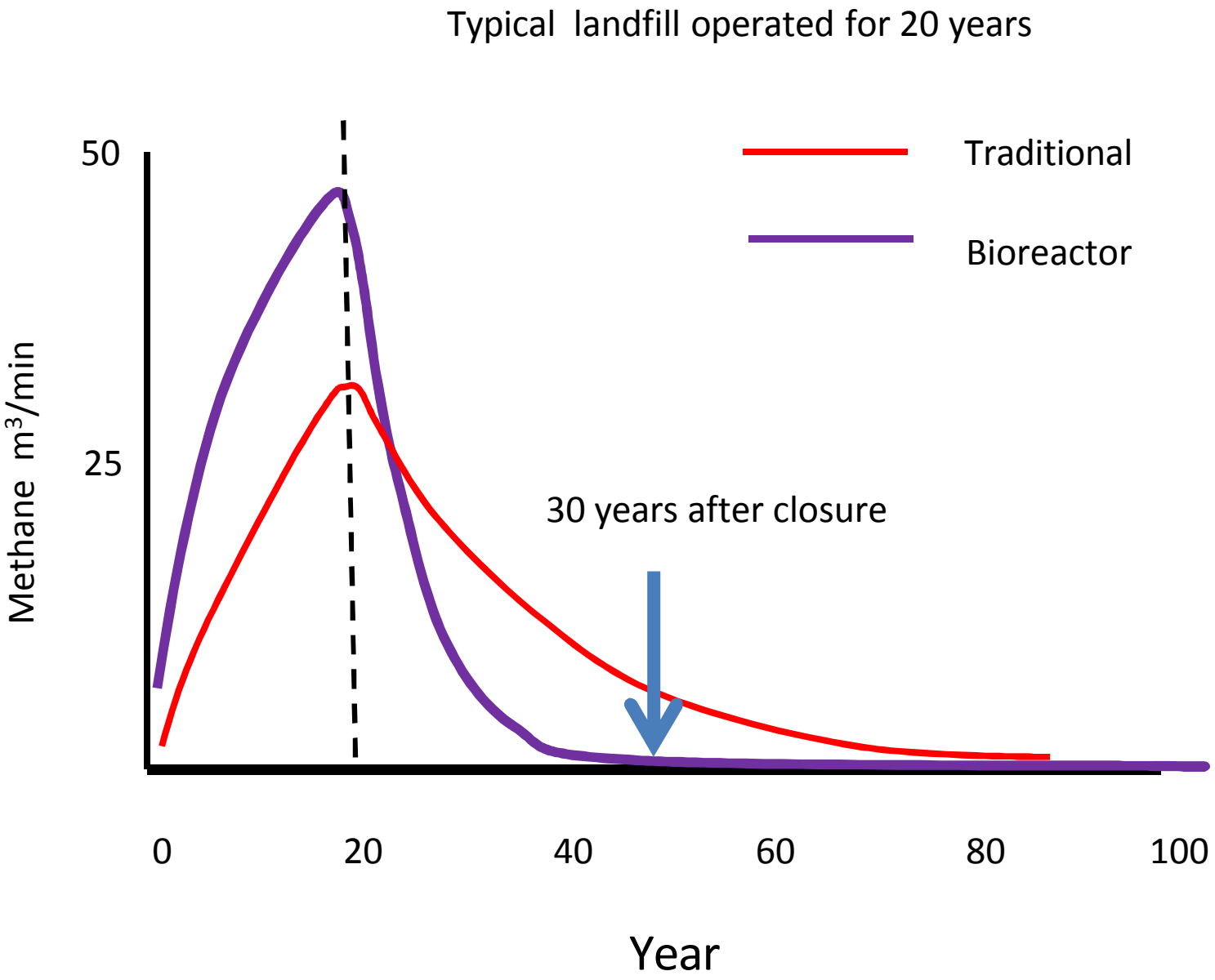
Typical landfill operated for 20 years
50
25
Methane m3/min
Traditional
Bioreactor
30 years after closure
0
20
40
60
80
100
Year

IMAGE REMOVED FOR COPYRIGHT REASONS

See p 83

http://www.nhbc.co.uk/NHBCpublications/LiteratureLibrary/Technical/filedownload,29440,en.pdf

Extract from NHBC Traffic Light Guidance-
Concentrations of interest are well below
flaring capability

Biofilters Can deal with much lower methane concentrations

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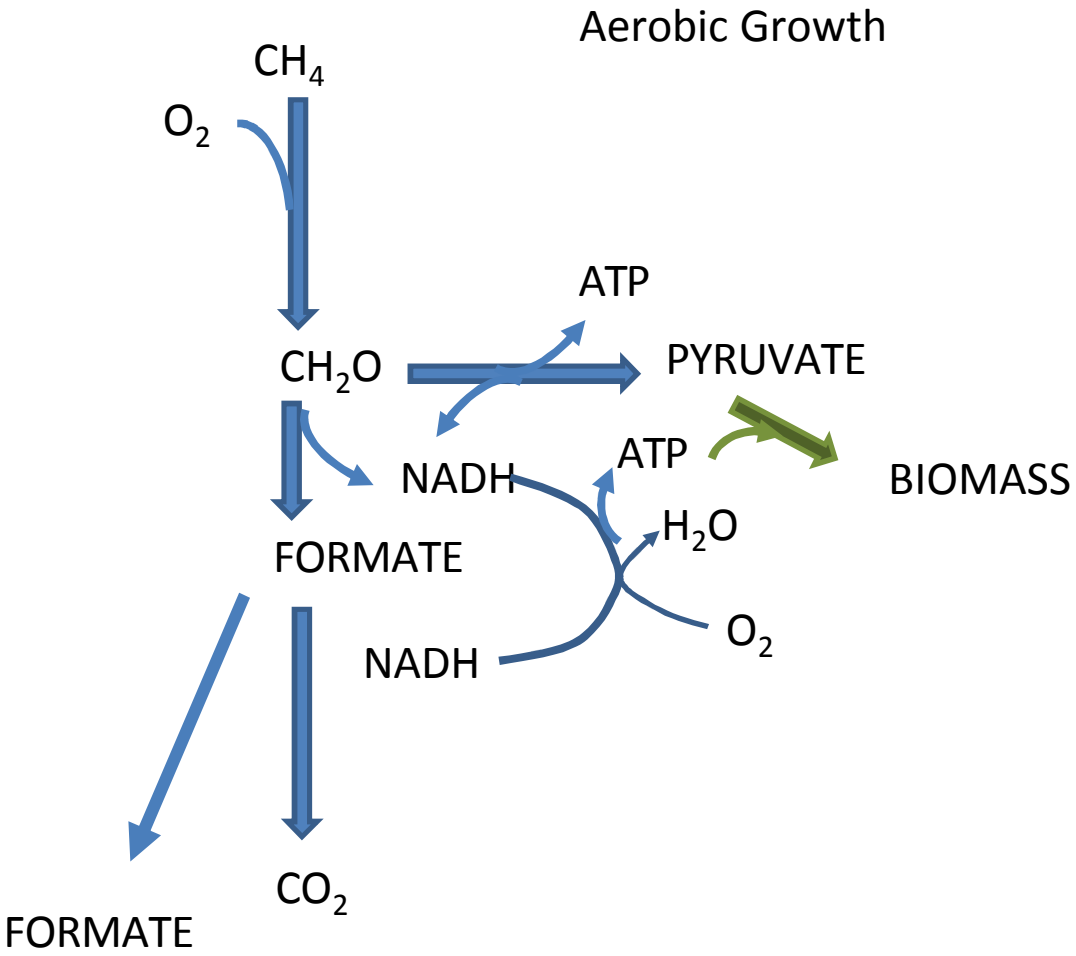
Active or Passive


Aerobic Growth
CH_4
O_2
ATP
CH_2O
PYRUVATE
NADH
ATP
BIOMASS
H_2O
FORMATE
O_2
NADH
CO_2
FORMATE

Hard Standing on Historic Landfills- can we use a PPS to oxidise methane ?

IMAGE REMOVED FOR COPYRIGHT REASONS

http://assets.inhabitat.com/wp-content/blogs.dir/1/files/2015/06/Sai-Tso-Wan-537x271.jpg

Hiriva Park – Tel Aviv

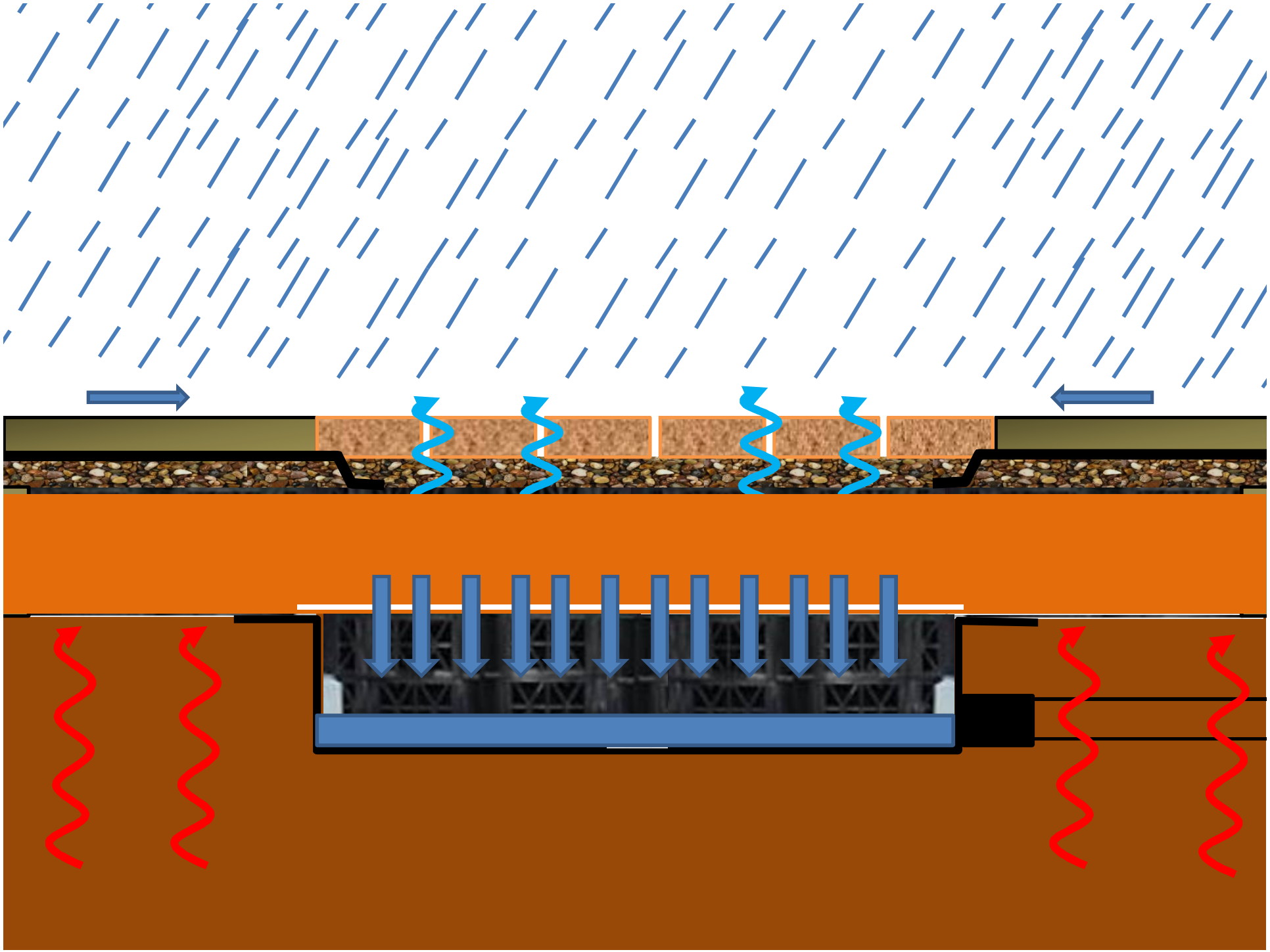
Requirements

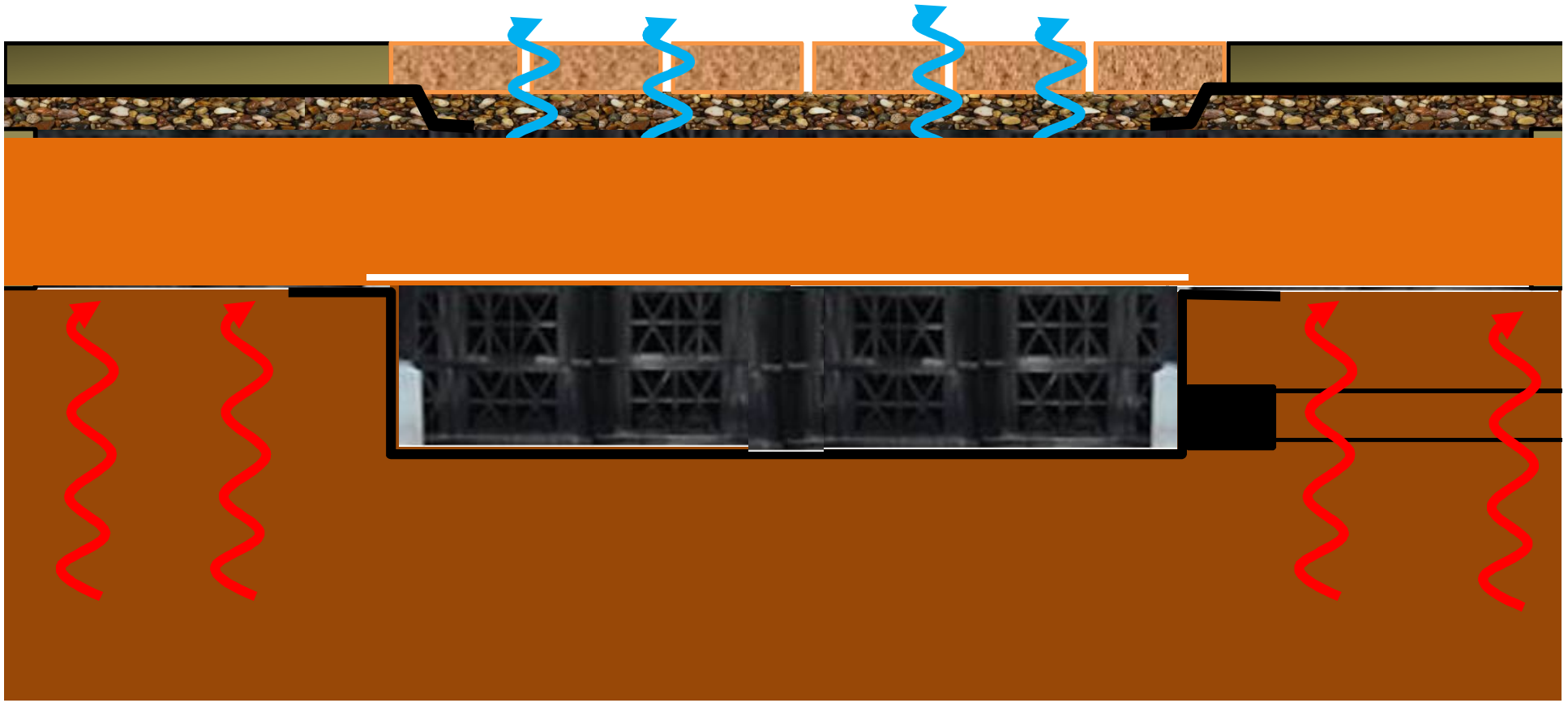
- Water needs to enter the ground – ideally passing through the compost which keeps it damp and pollutants can be adsorbed.
- Percolation into contaminated soil must be minimised
- Gas needs to have a route to surface.

Proposal

- Use plastic load bearing boxes as a support for compost to prevent compaction under load.
- Utilise sorptive properties of compost to clean stormwater percolating down.
- Utilise biodegradation in the compost to oxidise methane on its way to the surface.

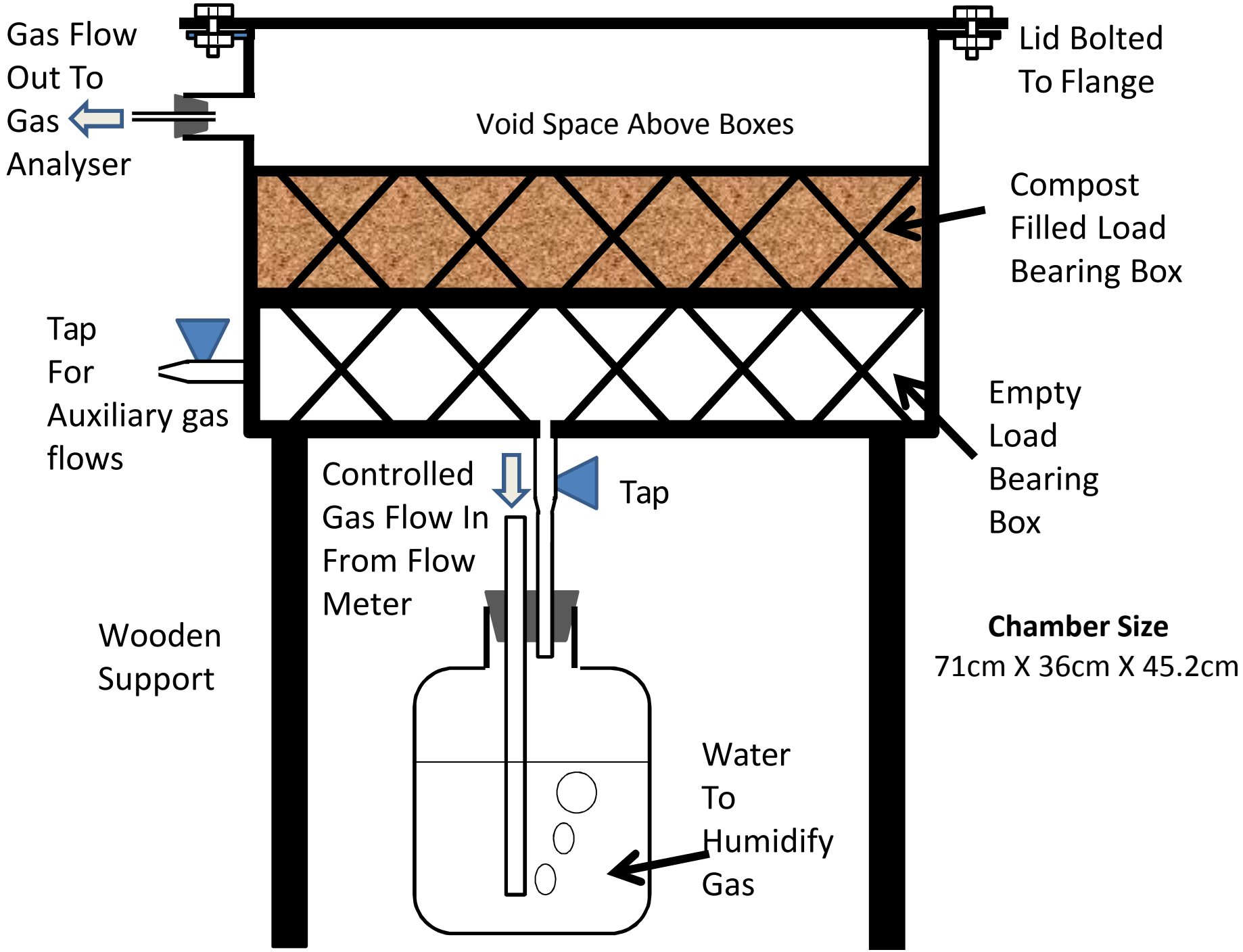
- We can achieve this with alternating permeable and impermeable surfaces. Water will largely fall down under gravity but ground gas will move along pressure gradients



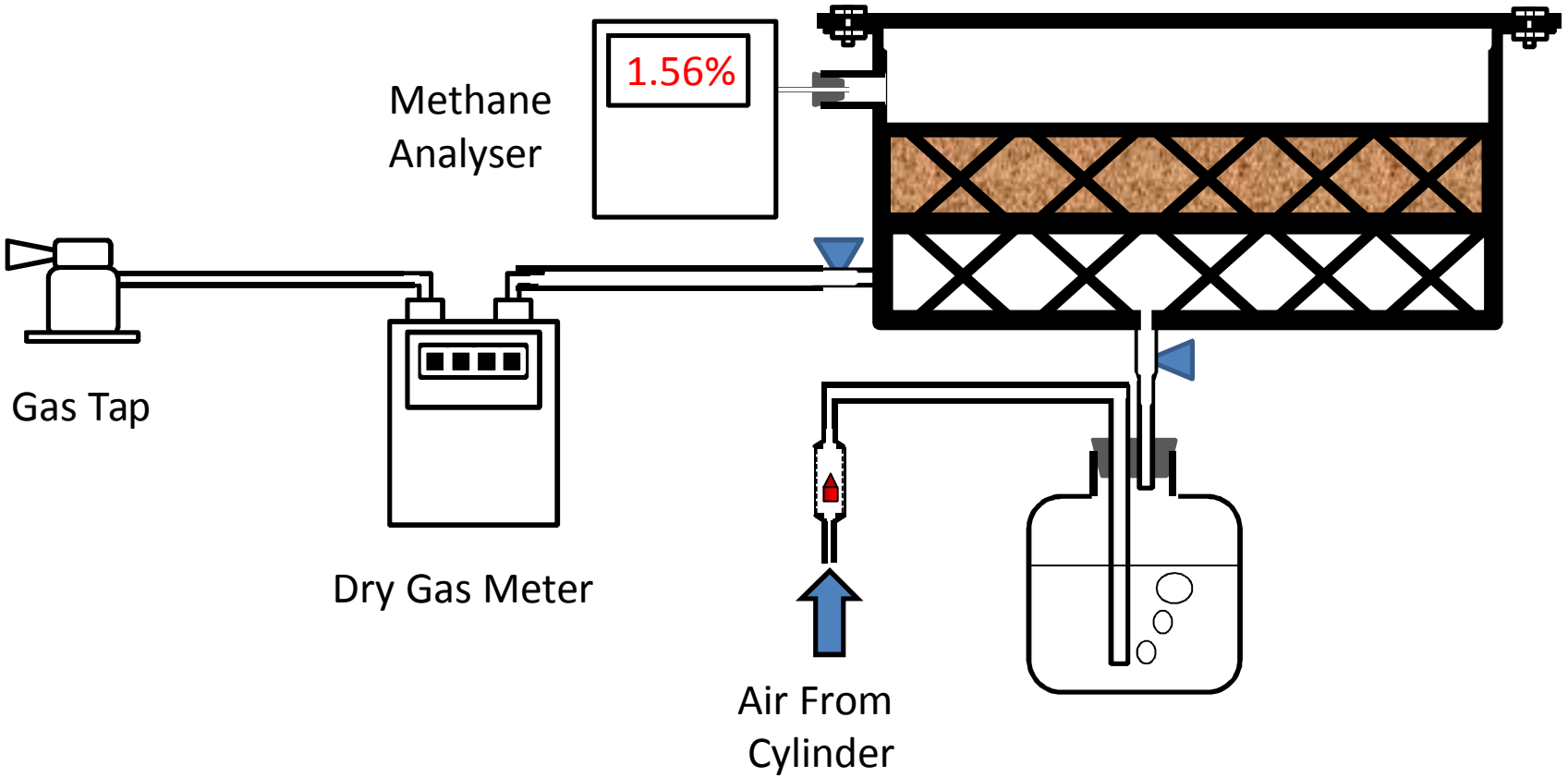


Experiments

- The main aim was to establish if a useful amount of methane degradation can be achieved


Gas Flow Out To Gas Analyser
Lid Bolted To Flange
Void Space Above Boxes
Compost Filled Load Bearing Box
Tap For Auxiliary gas flows
Empty Load Bearing Box
Controlled Gas Flow In From Flow Meter
Tap
Wooden Support
Chamber Size
71cm X 36cm X 45.2cm
Water To Humidify Gas

Establishing & Maintaining Methanotrophic Organisms

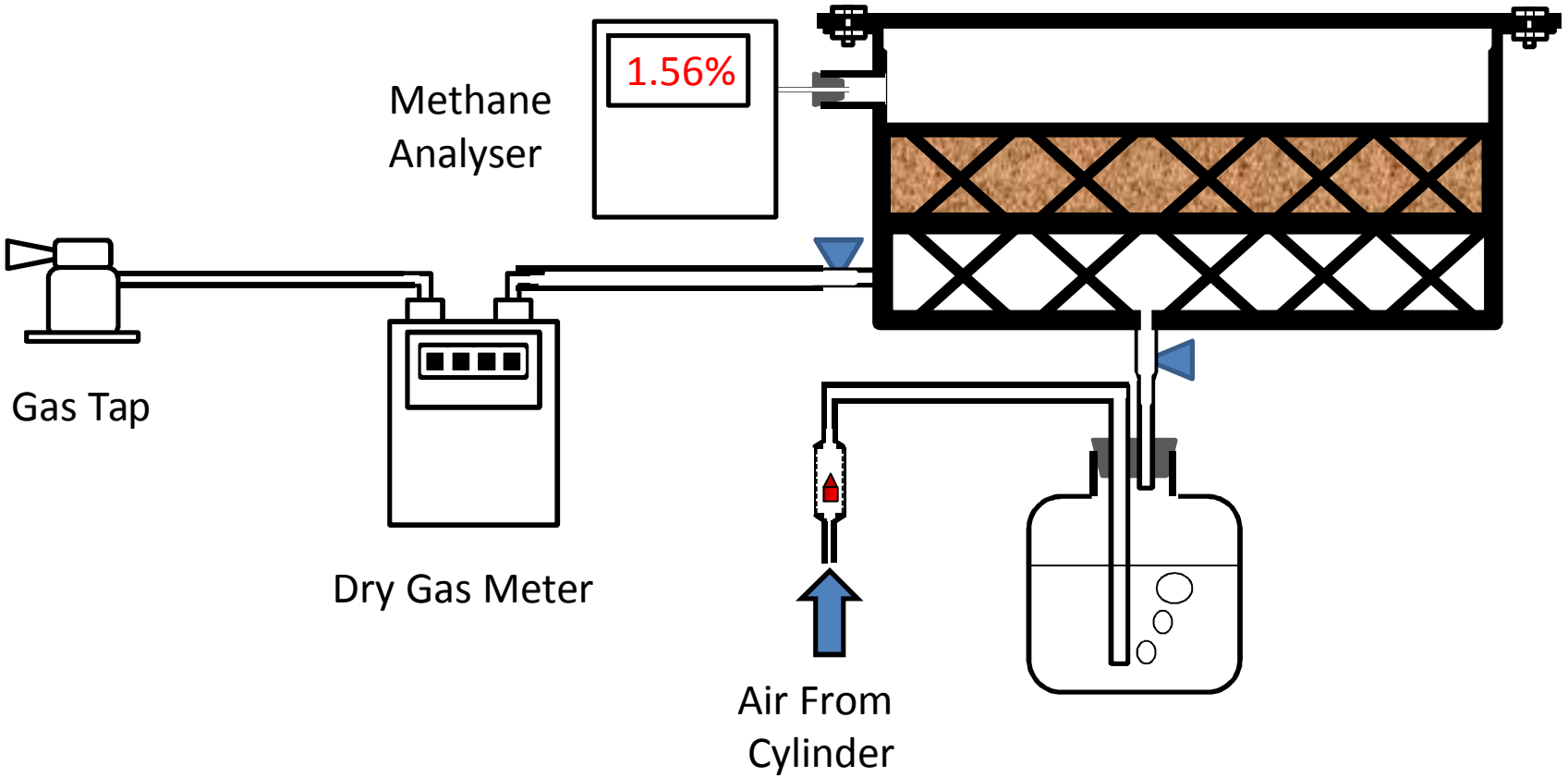


Establishing & Maintaining Methanotrophic Organisms

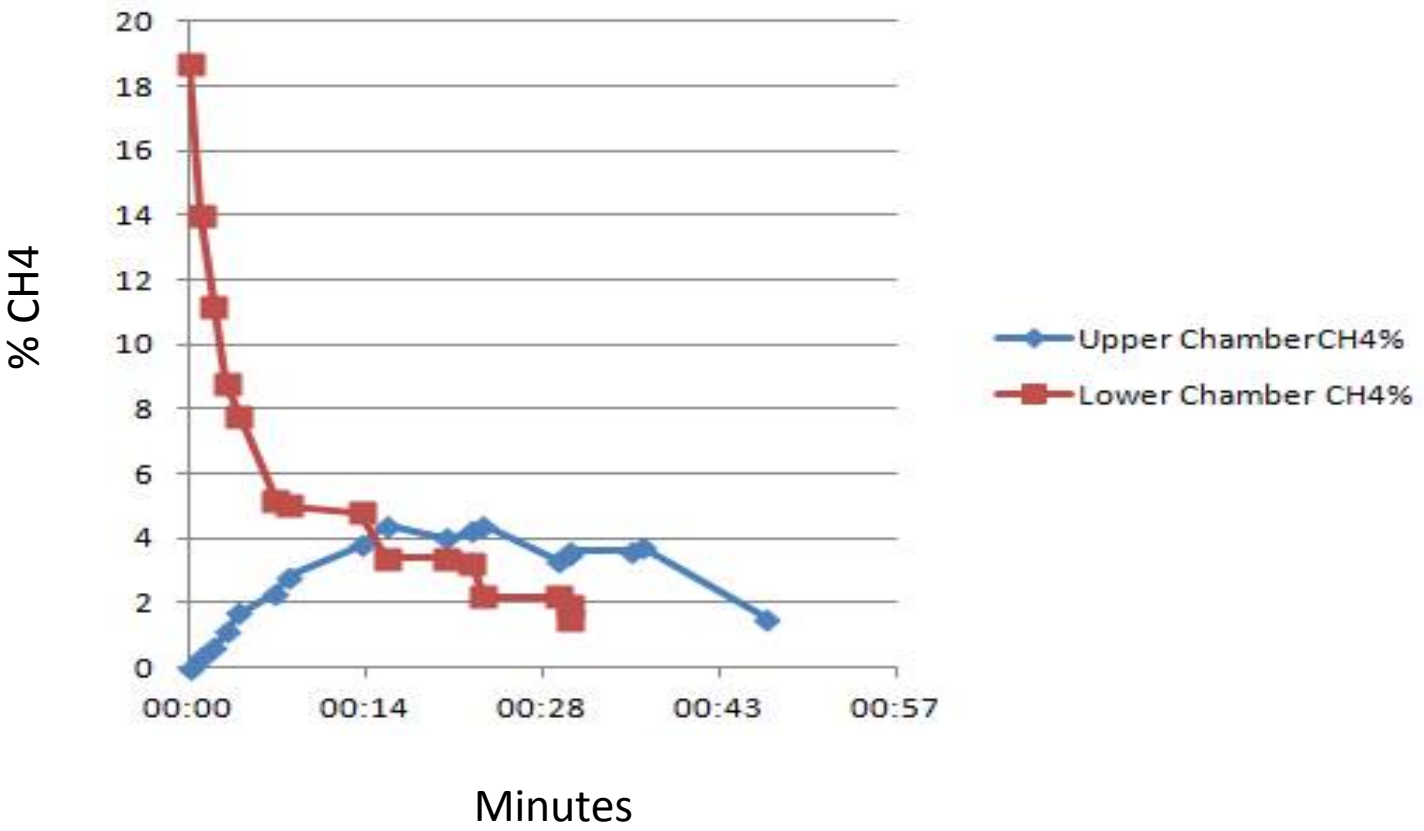
- A slug of 5litres of methane (from the gas main) was introduced into the box
- Air was pumped into the box (exiting through a port in the upper chamber)
- Aim-whilst containing a significant methane concentration in both upper and lower chambers it needed to be safe to leave the box in the lab overnight without having to leave the fume cupboard running .

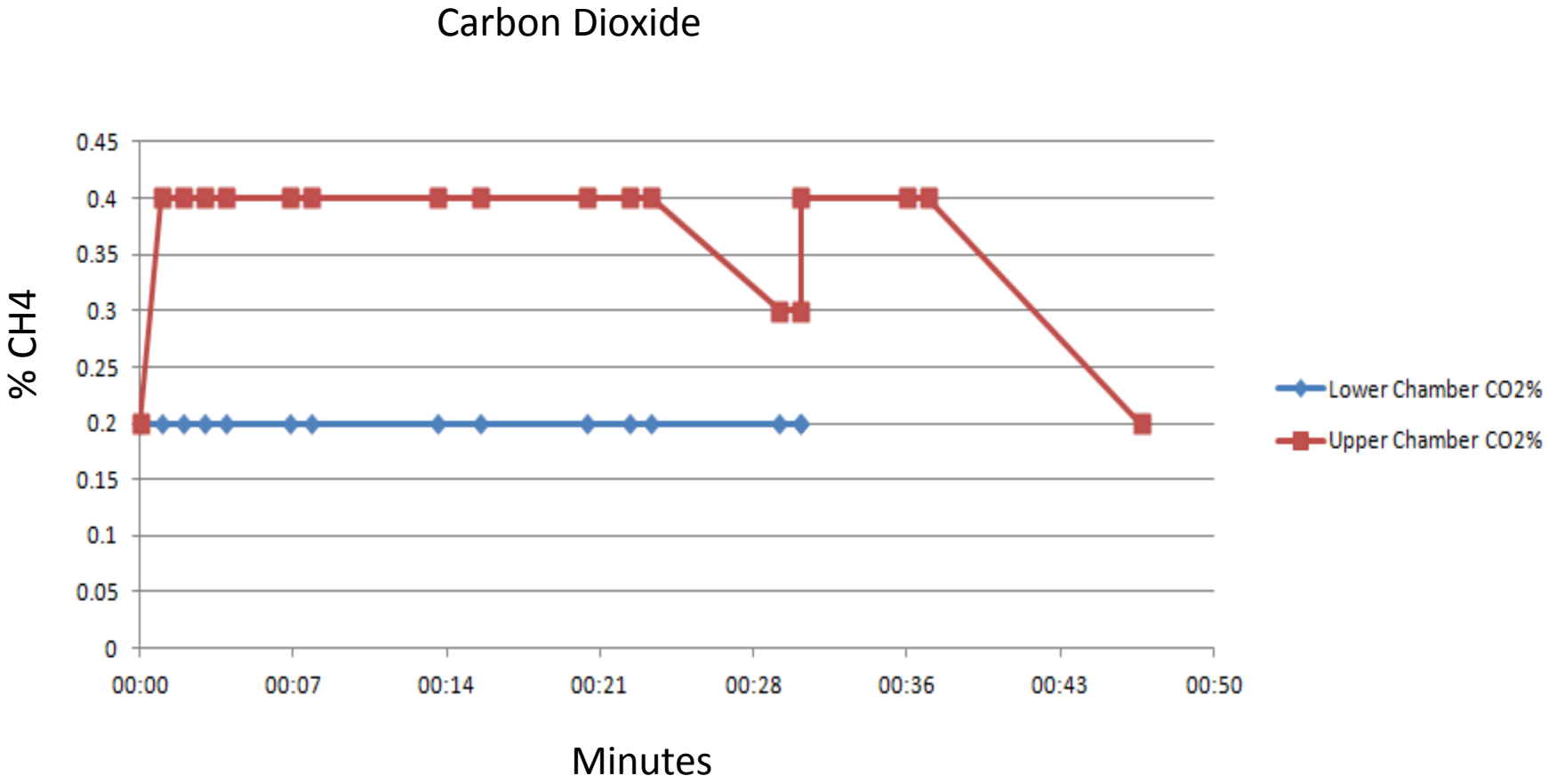
- Typically the box methane concentrations would be around 30%LEL (but no attempt was made to obtain consistent concentrations).
- Thus the compost was exposed to relatively high concentrations of both methane and oxygen.
- 3 times per week for a period of 3 weeks before commencement of the tests.

Arrangement for Slug Test

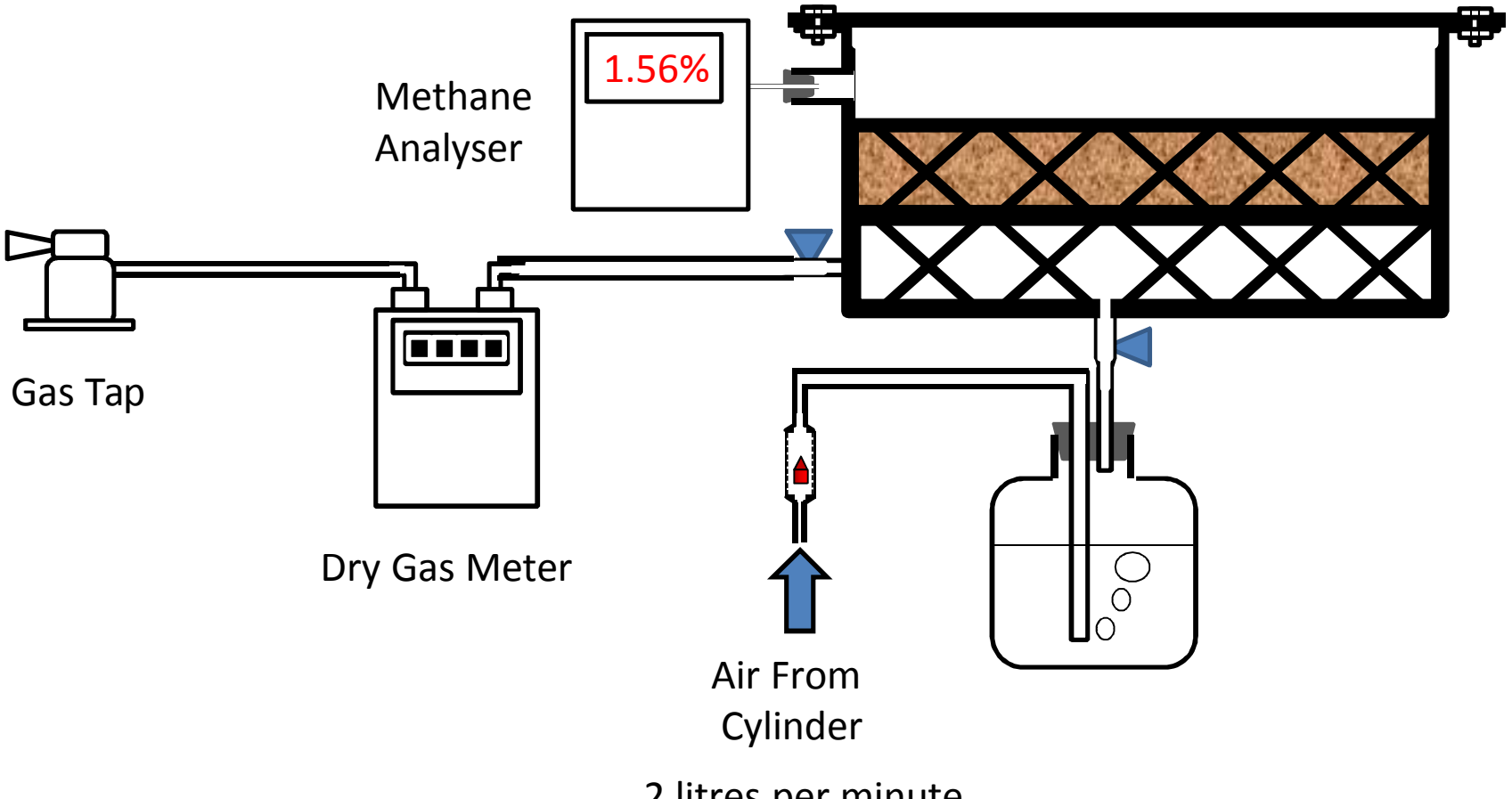


Methane Results




Carbon Dioxide
% CH4
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
00:00
00:07
00:14
00:21
00:28
00:36
00:43
00:50
Minutes
Lower Chamber CO2%
Upper Chamber CO2%

Arrangement for Longer Term Static Tests



Large Scale Static Tests

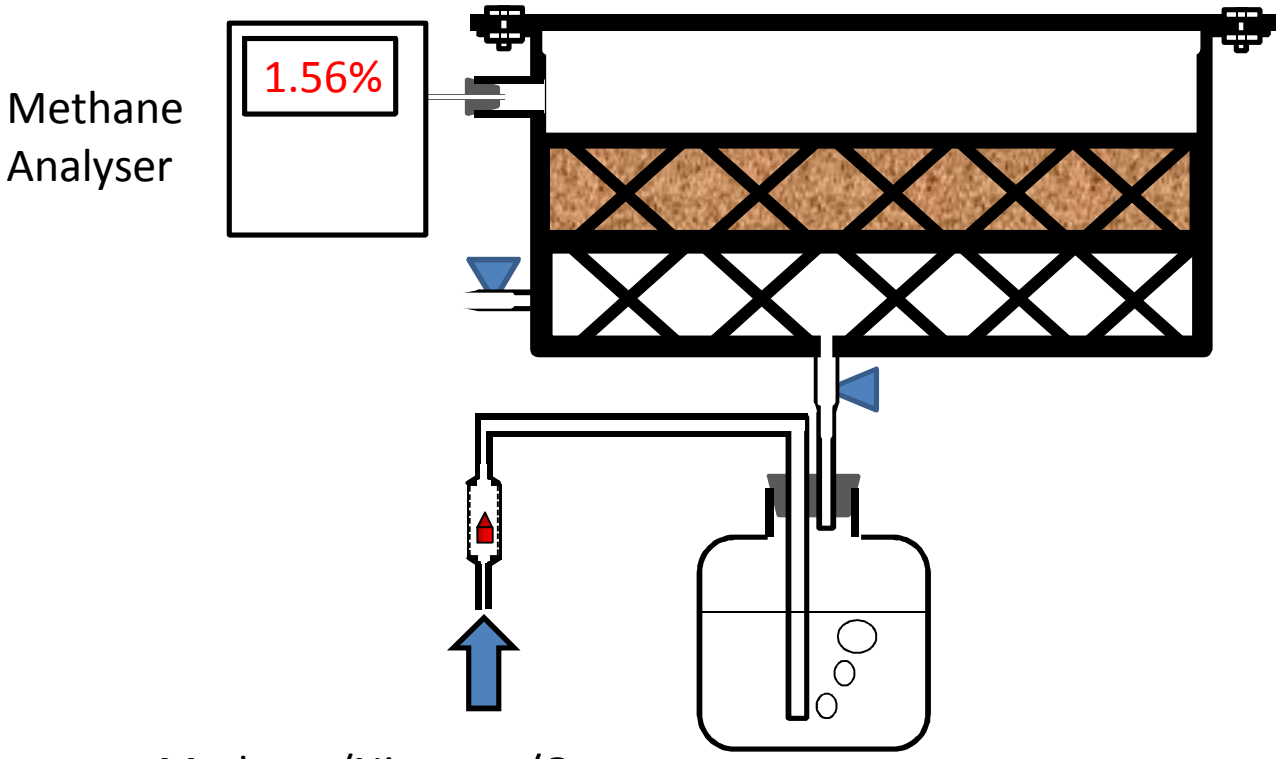
- These tests were carried out on 5 occasions with a range of starting methane concentrations.
- The system was pulsed with 5 to 10 litres of methane and air flow was applied until a methane concentration of between 30 and 60% LEL was present in both boxes.
- The boxes were then sealed and re-analysed after the exposure period.
- The first experiment was carried out over a weekend with all other experiments being carried out overnight

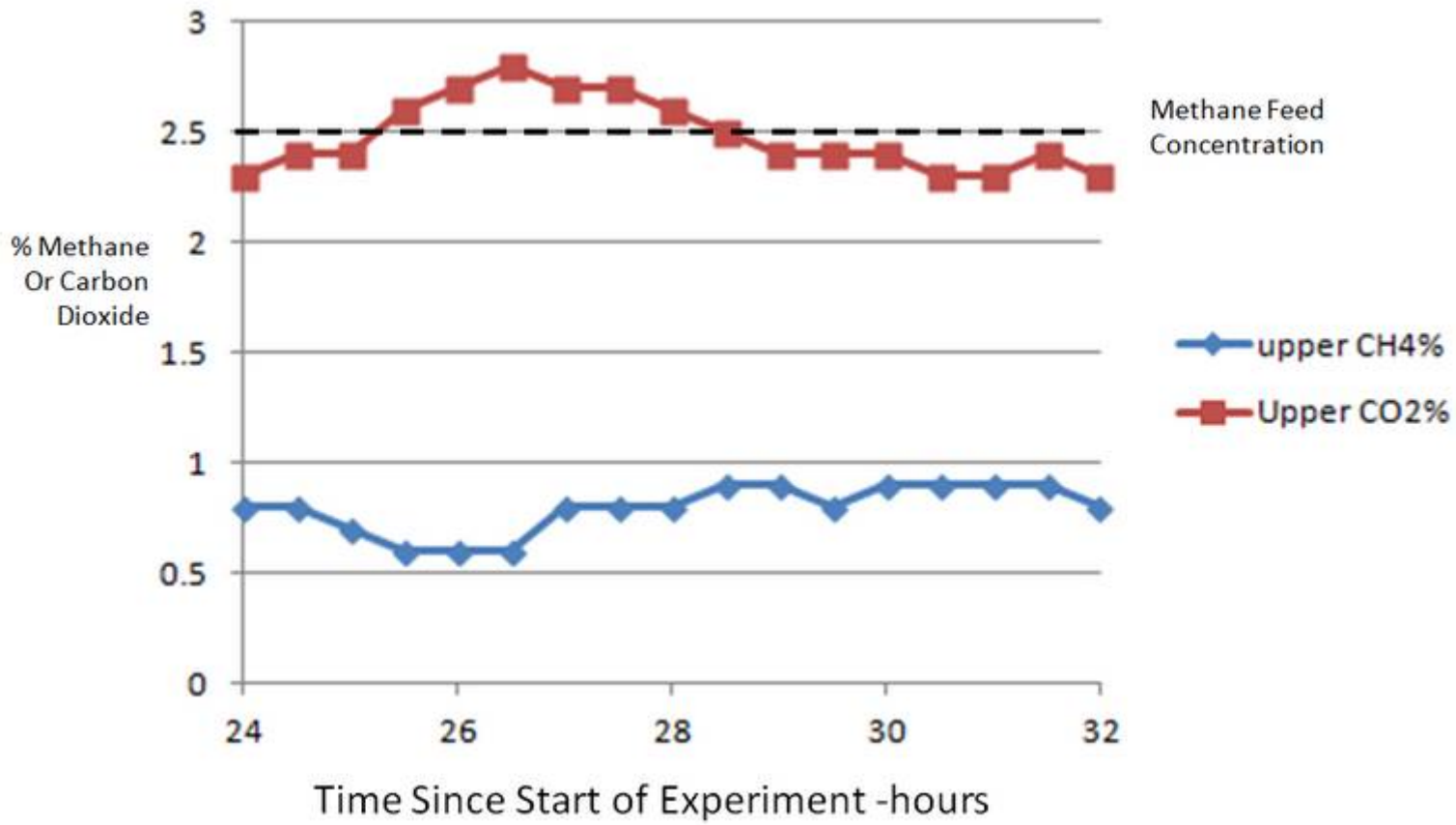
Results Static Tests

- In all cases the methane concentration at the end of the tests was less than the limit of detection with carbon dioxide concentrations around 4%
- Significantly higher than the typical resting concentrations for carbon dioxide (between 0.9% and 7%)

Dynamic Tests

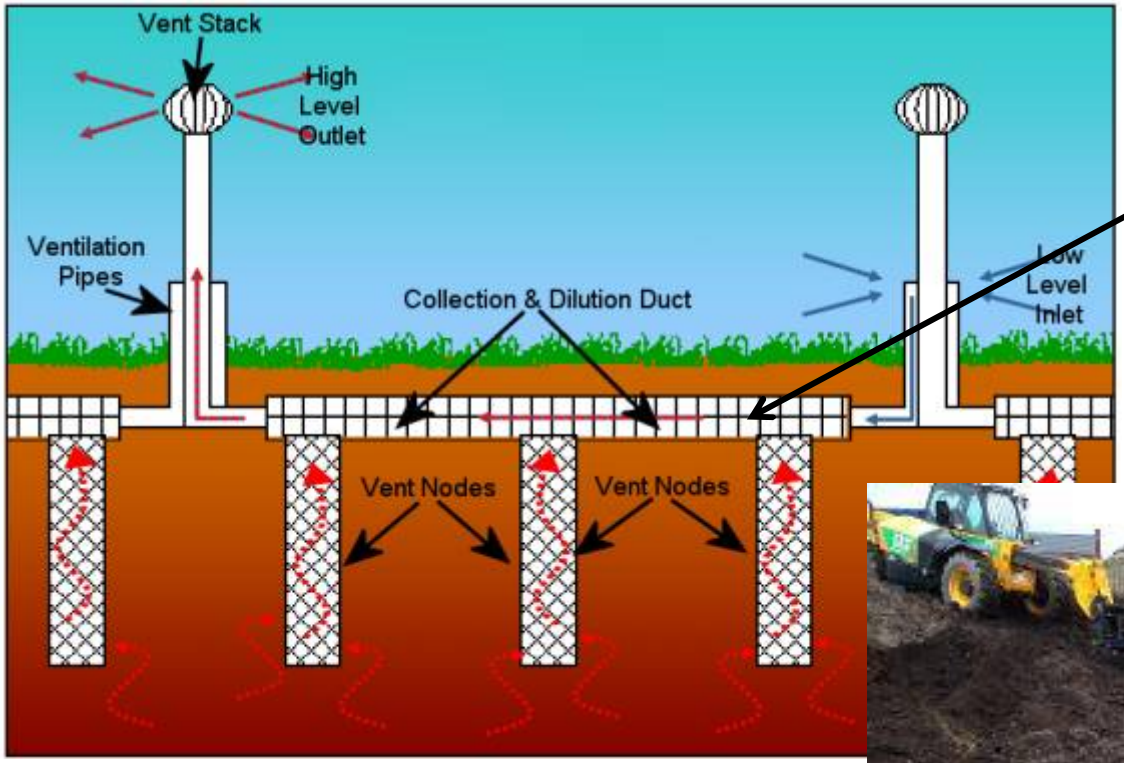
Dynamic Tests





100ml/min Experiment 2. Feed concentration : 2.5% Methane

Alternative Application



This duct is a chain of Permavoid units

Virtual Curtain

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Conclusion

- Promising results but desperately in need of field trials!

Acknowledgements

- Environmental Protection Group Ltd funded this work.
- SEL Environmental constructed the test rigs

Information

- The concept of using compost within a load bearing box to oxidise methane is protected by patent application held by the Environmental Protection Group Ltd