

# **Water Balance and the Influence of Temporal Factors on Final Covers for Landfill Closure**

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# Abstract

Final covers for landfill have consisted of engineered barriers to prevent contact with the underlying waste, limit the generation of leachate and emission of landfill gas. The theory for cover design has predominantly relied on attempting to prevent moisture from draining into the waste by placing an impermeable or low conductivity barrier, often as compacted clay or more recently as geotextile or geocomposite layers (GCL). However, studies overseas over the last 10 – 15 years have shown that these barrier layers, particularly compacted clay barriers, may not perform as expected. Increasingly, interest has been focussed on designing covers that maximise evapotranspiration as this release to the atmosphere does not have other detrimental implications.

In 2006, the Waste Management Association of Australia and the Australian Research Council co-funded collaborative research between 5 Australian Universities to research the performance of compacted clay barriers and the emerging technology of phytocaps (also known as ET (evapotranspiration), alternate or store-and-release covers). This PhD is part of this collaborative research and aimed to: quantify drainage from phytocaps and conventional caps; compare water balance performance of conventional caps, including a compacted clay barrier, and phytocaps under a range of climatic, soil and vegetation conditions; and assess the temporal changes in the covers.

The trial methodology was based on field-scale lysimetry with phytocaps trialled in 5 Australian States. All test sections were constructed on previously landfilled cells and included a 10 m x 20 m lysimeter instrumented to measure weather, runoff, lateral flow (compacted clay sections only), drainage and soil moisture content. An adjacent control section without a liner to bound the area was also instrumented to provide an assessment of the impact of the lysimeter liner on the water balance. At 3 trial sites, the research included side-by-side comparison of a conventional compacted clay barrier cap and a phytocap. Data collection at the sites has been undertaken for 3 – 4 years.

The climate at the trial sites varies from summer-dominant rainfall in a tropical climate to sub-tropical and temperate climates with all-year rainfall and to temperate climates with hot, dry summers. The soil varied from alluvial loam and basaltic-derived clayey loam to coarse loamy sand. At one site, municipal waste compost was added to the available sandy loam. The vegetation has also varied between the sites from dominantly tree-based vegetation to only native grasses.

The research has found that phytocaps have the potential to reduce drainage to the same extent as conventional caps. Also, the short term data collected indicate that phytocaps are likely to be more sustainable in the longer term as the changes in the soil moisture content range over the trial timeframe tended to be beneficial in the phytocap, with increased soil storage as the plant roots developed, and detrimental in the conventional cap, with cracking and preferential flow paths developed in the compacted clay barrier. The phytocap also has greater potential for its performance to be easily improved (e.g. increasing plant density, changing plant species, adding soil ameliorants) when compared with compacted clay barriers. The drainage measured in both the phytocap and conventional caps was strongly influenced by the seasonal precipitation and the seasonality of precipitation. Long-term research is needed to confirm the findings herein and provide a better understanding of the impact of structural changes in the phytocap and improve the prediction of phytocaps in a wider range of Australian climates.

# Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to Melissa Salt and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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*“Only a person who risks is truly free”*