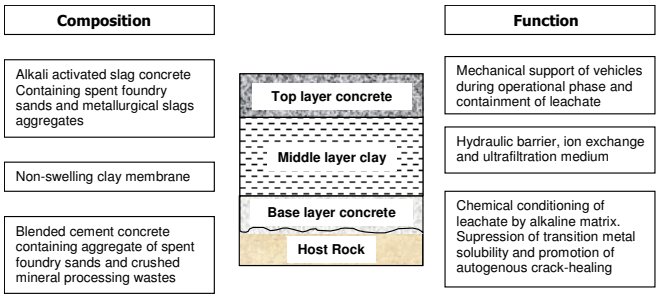
On Target for 50% Cost Savings on Landfill Liners

Scientists and engineers from two UK Universities have developed new materials for use as landfill liners, which offer large potential savings in material and construction costs. The project is undertaken jointly by Imperial College, London and Coventry University and uses waste materials to contain waste, producing strong, low permeability materials which protect the environment from contamination by landfill leachates. Through the recently introduced Landfill Tax Credit Scheme, research of environmental benefit may be supported using revenue collected as a tax on waste disposal. This is one of a number of projects approved by ENTRUST, the company established by the government to ensure that such revenue is put to the best use. This particular study is supported by Biffa, a major waste management operator in the UK and the Minerals Industry Research Organisation (MIRO) whose members are keen to see their waste products put to good use.

Conventional landfill liners employ a membrane made from high-density polyethylene sheets, which are welded together to form a continuous barrier. To protect the membrane from puncture, it is normally protected by a sand-bentonite layer, which is itself covered with a geotextile (and often also, gravel) drainage blanket. This thick layer of protection is further aided by emplacing a layer of graded waste on top of the drainage layer. This is waste from which sharp objects have been removed, to ensure nothing is likely to puncture the membrane when the waste consolidates under its own weight.

The newly developed system employs technology transfer from areas of the waste industry concerned with more hazardous wastes, where long term performance of waste containment systems are of the highest concern. Protecting the environment from such wastes often relies on an active barrier, which is in part sacrificial. Cement and concrete react with the pollutants ensuring that heavy metals (for example) remain as solid hydroxides, rather than dissolving in the leachate and potentially contaminating local groundwater. The design of the new liner uses a similar approach in which cements chemically condition solutions in their pores, limiting the solubility of heavy metals. The Liner consists of a concrete-clay-concrete layer structure, which is physically strong enough to support the weight of a refuse vehicle and is not vulnerable to puncturing by sharp objects. This removes the need for waste sorting, as vehicles may be driven directly to the point of disposal. In addition to cost saving, an obvious advantage of limiting the amount of waste handling in this way, is that wind dispersal of the waste is also limited. In the newly developed system, a membrane can be placed below the upper layer of concrete where it is fully protected at all stages of the landfill operation.



The design concept is to provide a multi-layer barrier comprising concrete-clay-concrete layers, using waste materials that would otherwise be disposed of to landfill. The role of the base layer is to provide a strong foundation which will support the hydraulic barrier but will also contribute to the chemical conditioning of leachate which will percolate through the structure in the late stages of the post-closure period. The middle layer consists of locally won non-swelling clay, compacted to provide a hydraulic barrier which will prevent leachate

migration for some hundreds of years. In addition to its role as a hydraulic barrier, the clay will serve as an ion-exchange medium (retaining dissolved metal ions) and an ultra-filtration blanket (mediating transport of large organic species). On top of this, lies an upper layer of concrete which fulfils two functions; in the operational phase of the landfill, it will support vehicles allowing them to drive directly on to the liner but after closure, will contribute to the physical containment of the leachate. Moreover, late in the post-closure period, it will provide a reserve of alkalinity, which will chemically condition the leachate, neutralising organic acids and precipitating heavy metals.

This approach offers distinct operational and environmental advantages over current liner technology:

- **Economic advantages-** Mineral barriers are relatively inexpensive; offering an estimated saving up to 50% of construction costs in comparison with conventional liner systems.

- **Environmental advantages-** The mineral barrier could be made thinner than conventional liner systems, as it does not require the protection of a sand-bentonite layer. Consequently, more air space is available for waste containment, allowing more waste to be emplaced per unit area of land surface.

- **Operational advantages-** Removing the need for a graded waste layer above the liner limits the amount of waste handling necessary at the disposal site. In addition, as the mineral barrier is physically strong, refuse vehicles may be unloaded at the point of disposal. This reduction in waste handling offers potential time and cost savings to the operator whilst minimising the likelihood of waste dispersal by wind and vermin.

Waste materials used in the project include spent foundry sands (from the casting industry) and metals processing slags (such as ferrosilicates and chrome-alumina) as concrete aggregates. The cement that binds them together also contains waste materials. Portland cement is largely replaced by pulverised fuel ash (a waste product from coal-burning power stations) or cementitious slag (a by-product of iron production). To make these cementitious binders hydrate, they are mixed with solutions of waste alkalis, which are recycled from non-ferrous metal refining. During field trials of the materials, Pioneer Concrete Ltd, who are experts in speciality concrete production, made the concretes from materials originating in the metals refining or casting industries and found that they were relatively easy to produce and emplace. The liners produced in this way have proved to be both physically strong and of very low permeability and are regularly monitored at a licensed landfill site.

The research team seeks to use their materials in a full-scale operational cell at a commercial landfill and are currently in negotiations with waste producers, operators and regulators. Although laboratory studies and field experiments in demonstration cells suggest these materials perform very well indeed, the conservative nature of both the construction and waste management industries will need to see these liners prove themselves at the largest scale. Perhaps involvement of the regulators in the next phase of the work will go some way to alleviating the fears of the operators, encouraging them to use recycled materials in liner construction.

Alan Gibbon, research co-ordinator for MIRO sees this as a valuable route to extending the useful life of industrial by products. At a recent meeting of MIRO member companies, he said, "The economic potential of this type of re-cycling is enormous. British industry

produces a wide range of metalliferous wastes, which are uneconomic to refine further. Using them to contain other wastes satisfies many needs; the materials serve a useful purpose in producing new materials which, at lower cost, perform at least as well as existing technologies."… [and] "the environmental impact of waste disposal is reduced as more volume is available for waste containment."

The use of cement in waste management will be discussed at a conference in London (April 26th) organised by the Society of Chemical Industry, at which results of this work will be presented. It is to be hoped that in our 'throw away society', more though will be given to using waste to contain waste.