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Towards best practice final cover systems

A BATT-based assessment for hazardous waste landfills

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Abstract

Towards Best Practice Final Cover Systems for Hazardous Waste Landfills: A BATT-Based Assessment

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Victoria's *Best Practice Environmental Management: Siting, Design, Operation and Rehabilitation of Landfills* (BPEM Publication 788.3) does not prescribe specific final cover requirements for Type 1 (hazardous waste) landfills. Consequently, final cover systems must be developed on a project-specific basis using a risk-based approach that considers site conditions, waste characteristics, regulatory expectations, and long-term environmental protection objectives.

This paper presents the methodology adopted for the design of a proposed Type 1 landfill final cover system that was subsequently approved by EPA Victoria. The assessment framework incorporated: (1) evaluation of the performance of existing final cover systems on adjacent landfill cells; (2) assessment of relevant Victorian reference projects; (3) review of EPA Victoria guidance and regulatory requirements; (4) comparison with landfill guidance from other Australian jurisdictions; and (5) a comprehensive international Best Available Techniques and Technologies (BATT) review.

The BATT framework was developed to systematically evaluate alternative cap configurations against technical, environmental, constructability, and economic criteria. Key assessment considerations included infiltration control, long-term environmental risk, impacts on surface water management, veneer stability, constructability, ease of installation, maintenance and repair requirements, compliance with relevant BPEM performance objectives, and whole-of-life value. Particular emphasis was placed on achieving an optimal balance between containment performance, long-term reliability, and the preservation of valuable landfill airspace through efficient cap design. A multiple-lines-of-evidence approach was adopted to identify technologies capable of delivering robust long-term containment performance.

The international review considered hazardous waste landfill closure requirements and practices in the United States (USEPA Subtitle C), the European Union (Directive 1999/31/EC), Germany (Class III landfills under the German Landfill Ordinance), and South Africa. The findings identify key design features associated with successful long-term containment and demonstrate how a structured BATT-based approach can support regulatory approval and the selection of robust final cover systems for hazardous waste landfills.

Presenter Bio:

Simonne Eldridge is a Chartered Environmental Engineer and Technical Director at Tonkin + Taylor with over 35 years' experience in waste management, landfill engineering and environmental regulation. She has led landfill projects throughout their lifecycle, from planning and consenting through to closure and aftercare, and is recognised for developing practical, risk-based solutions for complex waste and environmental challenges.

What does “best” actually mean?

A familiar word, but not always a clearly defined engineering test

The newest available technique?

The most conservative design?

The most technically elaborate solution?

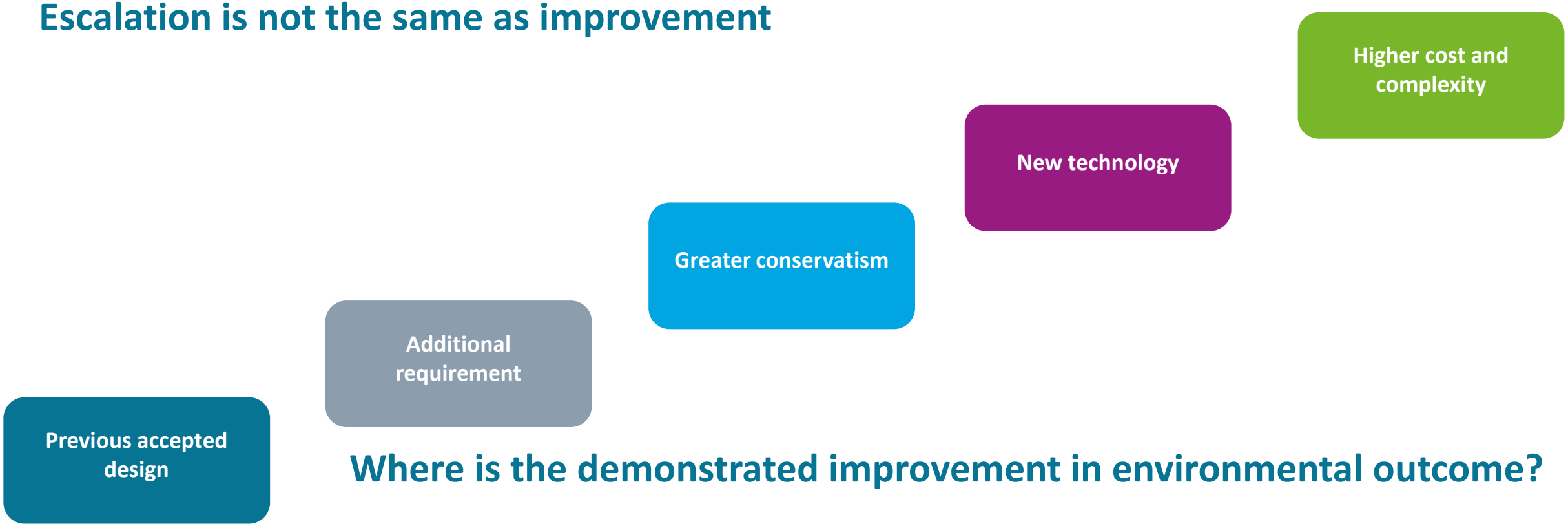
Or the solution that delivers the best justified outcome for the risk, cost and context?

In engineering, “best” must be demonstrated, not assumed

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Is “best practice” becoming a one-way ratchet?

Escalation is not the same as improvement



Where is the demonstrated improvement in environmental outcome?

Without technical justification, “best” can become an escalation of specification rather than an improvement in performance

More is not necessarily better

The objective is neither minimum cost nor maximum intervention

Potential benefit

- Greater environmental protection
- Additional resilience
- Reduced consequences of defects
- Improved confidence under uncertainty

JUSTIFIED BY THE RISK?

Potential burden

- Greater cost
- Increased construction complexity
- More interfaces and failure modes
- Greater maintenance and embodied impacts

What additional risk is addressed? What additional benefit is achieved?
Is the response proportionate?

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New is not synonymous with better

Novelty is something to assess. It is not, by itself, evidence of better performance

New technology may offer

- Improved material properties
- Better installation methods
- Greater monitoring capability
- A response to known weaknesses

JUSTIFIED BY THE RISK?

But may also

- Limited long-term field evidence
- Different or poorly understood failure modes
- Greater installation sensitivity
- More difficult inspection and repair

If “new” and “more” do not necessarily mean “better”, we need a disciplined way to determine what is technically justified

BATT replacing assumption with justification

A structured way to determine what “best” means for the particular risk, site and context

1. Define performance
2. Gather evidence
3. Develop options
4. Evaluate trade-offs
5. Document the case

Traceable • risk-based • performance-driven • site-specific

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The evidence base for a final cover example

Five evidence streams, each answering a different question

1	**Existing cover performance**	What has worked, and what limitations are evident?
2	**Local reference projects**	What has recently been accepted and constructed?
3	**Local guidance**	What performance objectives and expectations apply?
4	**International BATT**	What techniques and technologies are used elsewhere?
5	**Site-specific constraints**	What must the design accommodate here?

Layering the evidence: from local to global

We started with the guidance for the Australian State where the project is located, then broadened the review to other Australian guidance, before looking internationally to inform the BATT assessment.

1 Relevant Australian State guidance

Primary reference for the project



- Regulatory framework
- Performance objectives
- Design expectations
- Approval requirements

2 Other Australian guidance

Wider national context



Other State and Territory guidance
e.g. landfill and contaminated land guidelines

Federal guidance
e.g. national environmental protection measures, technical guidance

Recent Australian reference projects
What has been accepted and constructed elsewhere?

3 International guidance and practice

Global perspectives on BATT

United States
Regulatory standards and design practice

European Union
Directive 1999/31/EC and member state practice

United Kingdom
Guidance and regulatory practice

Canada
Federal and provincial guidance

Ireland
Regulatory guidance and landfill design practice

4 Synthesis and application

From evidence to a site-specific design

- Identify convergence and differences
- Understand the reasons for different approaches (e.g. climate, risk, regulatory context)
- Apply insights to develop and justify a site-specific design

Project and local context → **National context** → **International perspective**

Multiple lines of evidence → a site-specific, defensible design

No single jurisdiction provides a definitive profile, but the combined evidence informs a technically justified solution for the site.

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What converged across the review

The strongest common signal was functional, not dimensional.



Single composite barrier

Geomembrane with a mineral or geosynthetic clay component.

Drainage and protection

Protection of the barrier and control of water above it.

Surface and growth layer

Erosion control, vegetation and afteruse compatibility.

Quality assurance

Installation quality and defect detection determine realised performance.

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Where practice differed

Understand why requirements differ before importing them

Soil cover	Drainage	Geomembrane	Gas layer	Performance basis
Thickness varied widely	Granular or geosynthetic	Material and thickness varied	Optional or site-dependent	Prescriptive and performance-based

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The project-specific constraints

The system had to work with the site, not against it

Variable slopes

Different drainage and veneer-stability demands.

Airspace

Additional thickness consumes disposal capacity.

Settlement

A barrier able to tolerate long-term movement.

Afteruse and aftercare

Drainage, vegetation, monitoring and repair remain part of performance.

Interfaces

Tie-ins to existing covers and infrastructure.

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Turning evidence into options

Credible configurations were assessed against common criteria

01 Infiltration performance

02 Environmental risk

03 Constructability

04 Surface-water effects

05 Veneer stability

06 Repair and maintenance

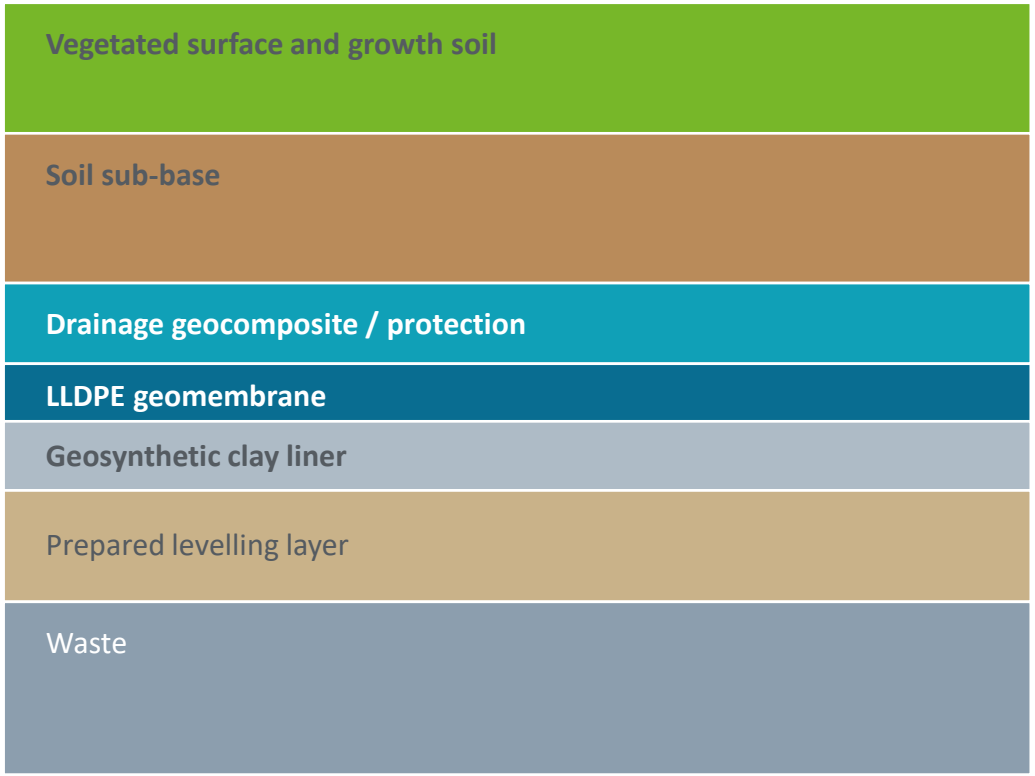
07 Whole-of-life value

08 Guidance alignment

09 Approval pathway

Why the preferred concept emerged

A flexible composite barrier with stronger installation assurance



Flexible containment

LLDPE and GCL accommodate settlement.

Constructability

Geosynthetics reduce thick compacted layers on steep slopes.

Installation assurance

CQA and electrical integrity testing address installation risk.

Site response

Drainage and slope detailing can vary by zone.

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What the review process improved

Independent review strengthened the basis and audit trail

Primary sources

Regulations and technical guidance replaced secondary summaries.

Terminology

Assessment aligned with recognised BATT nomenclature.

Comparative clarity

Reference profiles and the concept were directly compared.

Site performance

Existing performance and monitoring limitations were addressed.

Aftercare

Afteruse, maintenance and water management were linked.

Verification

Integrity surveying, CQA and commitments were explicit.

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Key lessons for applying BATT elsewhere

1	**Start with performance**	Define what the cover must achieve before debating thickness.
2	**Use multiple lines of evidence**	No single precedent, guideline or model is sufficient.
3	**Explain divergence**	Show why an alternative to a reference profile is suitable.
4	**Design for construction**	Installed quality matters as much as nominal properties.
5	**Keep the lifecycle visible**	Afteruse, inspection, maintenance and repair belong in the decision.

A defensible final cover is not simply the thickest or most complicated system

It is the system that delivers long-term containment for the site, can be constructed reliably, and can be maintained throughout the aftercare period

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