Design considerations for steep wall liners in landfills

Simonne Eldridge

Jonathan Shamrock

Tonkin+Taylor

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Introduction

- Disused quarries, or active quarries seeking post use rehabilitation by filling, are increasingly being used for landfills as available/ acceptable greenfield options become limited
- These quarries often have steep cut slopes which require a barrier system to be installed on them
- Leakage through a barrier system is proportional to the liquid head above the barrier
- On steep quarry walls, with a leachate drainage system, very low leachate heads and leakage are thus expected

HDPE geomembrane barrier

- The HDPE geomembrane therefore becomes the critical component of the landfill barrier system
- However, MSW undergoes significant settlement (~25%) as it is loaded by subsequent waste lifts and as it degrades, resulting in considerable strain of the waste adjacent to the barrier system
- The effects of this strain are exacerbated on steep wall barrier systems
- The designer needs to ensure the barrier system can accommodate this strain

Barrier system design

- The design of the steep wall liner barrier system's components must therefore address:
  - The required puncture resistance of the protection geotextile to the leachate drainage stone above the barrier
  - The required geometry/tensile capacity of the anchor trench
  - Overall waste body stability
  - Sub-grade conditions to avoid direct stresses on the geomembrane
  - The potential stress in the barrier system components during installation, placement of waste, and as a result of ongoing waste consolidation and settlement

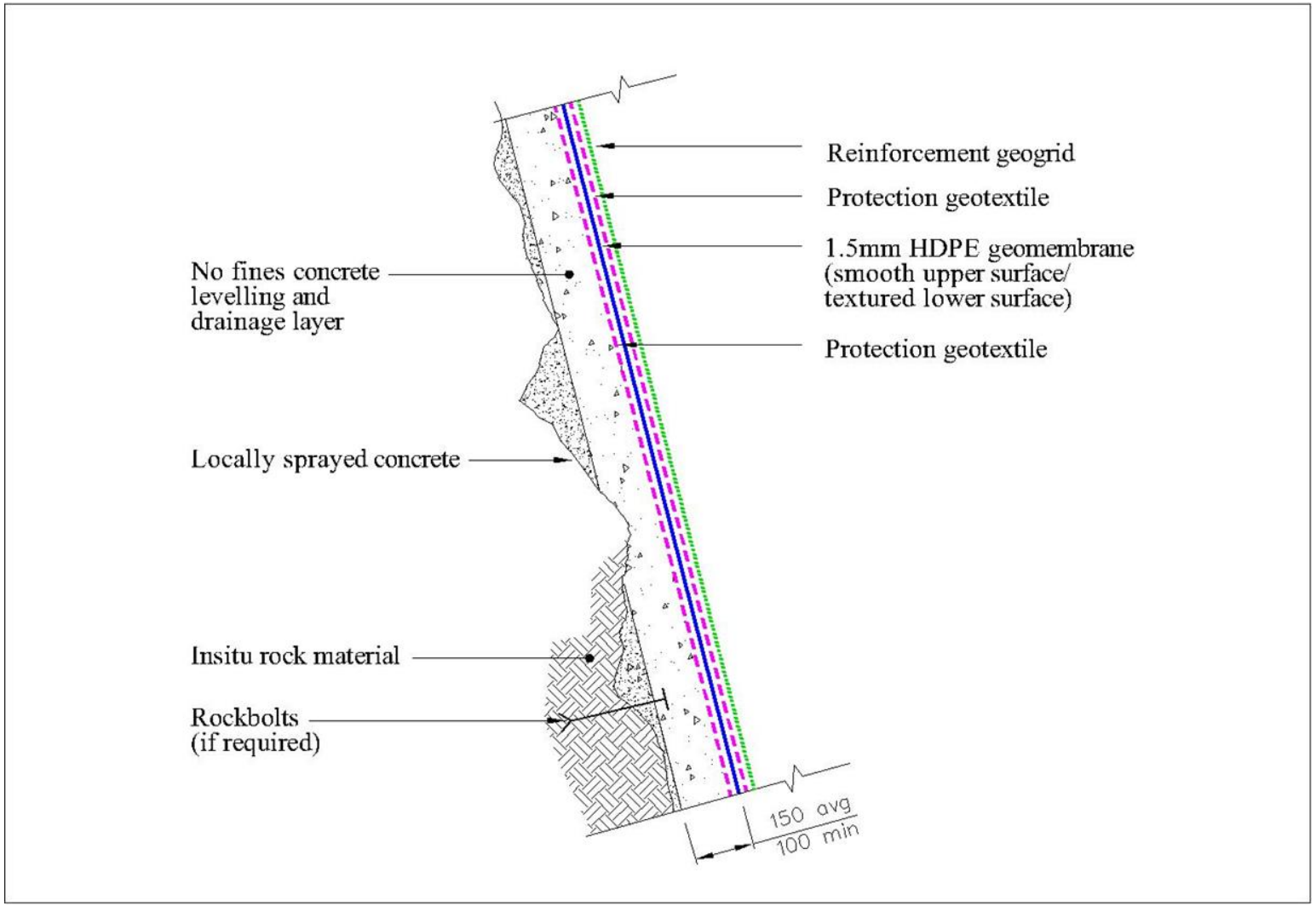
Minimising stresses from waste consolidation

- Construct uniform formation and slope heights
- Ensure stresses are taken out above the liner system, by introducing a slip surface, typically using a monotextured geomembrane, textured below, smooth above
- Manage tensile forces in protection geotextile on slip surface, impact of differential settlement, inclusion of geogrid layer

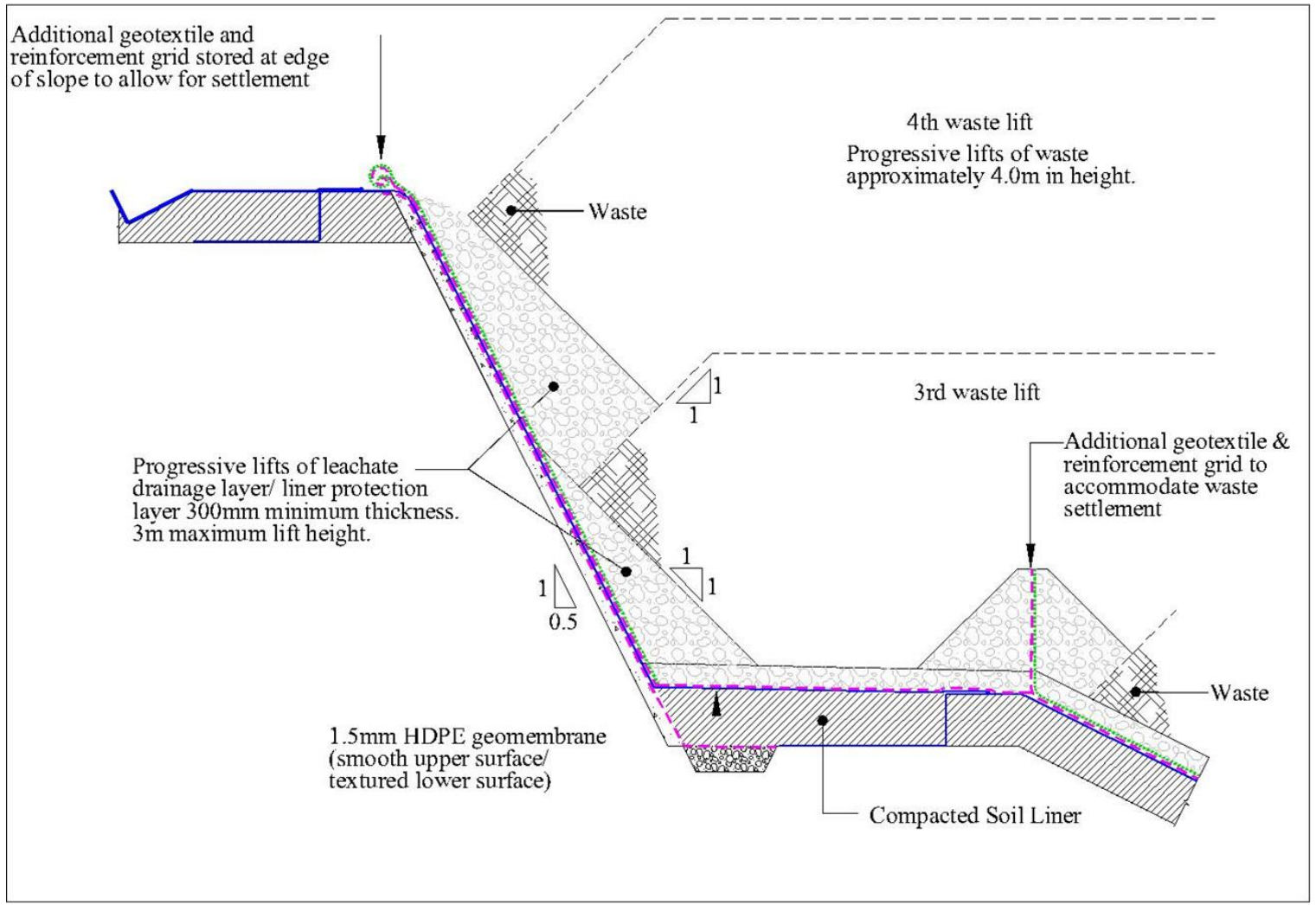
Groundwater drainage

- In a fractured rockmass, groundwater can compromise the stability of the barrier system if it is not adequately addressed
- A solution that has been successfully used in Hong Kong and New Zealand, is to include a no-fines concrete layer which has a twofold function:
  - Provides a smooth surface for supporting the HDPE geomembrane which eliminates stress concentrations from a potentially uneven subgrade
  - Ensures adequate drainage beneath the geomembrane

Barrier system – no fines concrete support



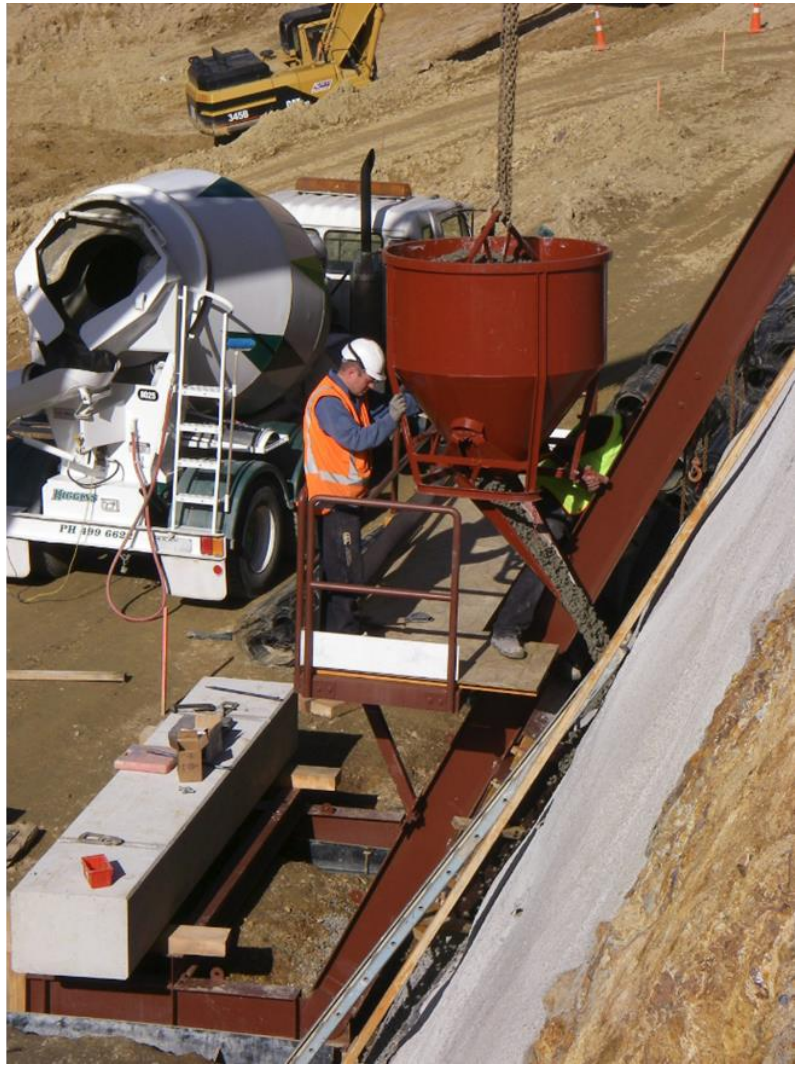
Leachate drainage



Case study 1: No fines support

- Steep rock slopes are on 1V in 0.5H with a 6 m inter-bench height
- The greywacke rock quality varies from fresh rock through to fractured and slightly weathered
- On completion, the total waste depth will be in the order of 100 m

No fines cast against excavated face



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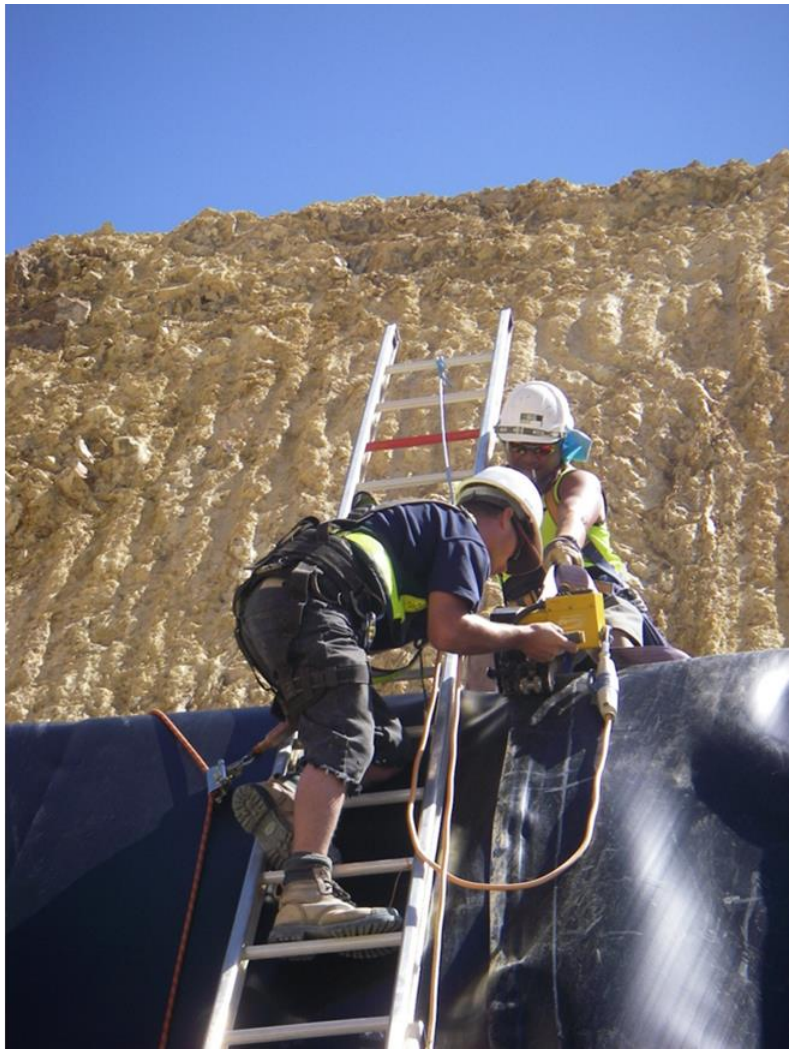
No fines completed subgrade

Protection geotextile installation

Geomembrane installation

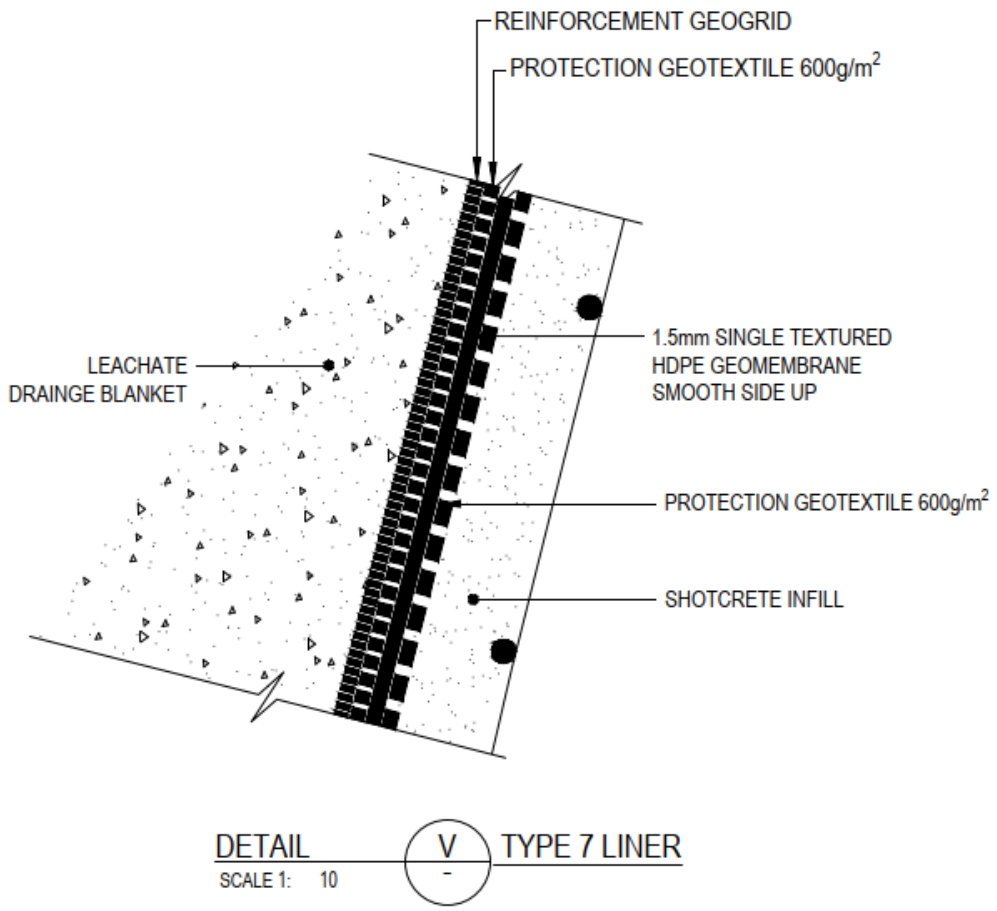
Geomembrane welding



Case study 2: Spray concrete support

- Steep rock slopes are on 1V in 0.25H with a 10 m inter-bench height
- The greywacke rock quality varies from fresh rock through to fractured and slightly weathered
- On completion, the total waste depth will be in the order of 60 m
- Groundwater drainage accommodated by strip drains installed at 45 degrees to the rock face

Spray concrete support



Quarry stabilisation

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Quarry excavation surface preparation

Hook bolts, strip drains, supporting mesh, screed rails

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Panel installation between screed rails

Completed shotcrete subgrade

Geomembrane installation

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Protection and leachate drainage layer installation

Filling

Staged construction as waste filling progresses

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Case study 3: Soft rock excavation

- Steep excavated soft rock slopes are on 1V in 0.5H with a 10 m inter-bench height, 5 m wide benches
- First bench in excavated soft fine grained rock
- Upper lifts, in more blocky weathered material, to have steep compacted clay liner installed

Excavation into in-situ weathered siltstone

Subgrade preparation fine grained soft rock

Composite GCL/HDPE installation

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Protection geotextile and geogrid

Thank you

Simonne Eldridge – seldridge@tonkintaylor.co.nz

Jonathan Shamrock – jshamrock@tonkintaylor.co.nz

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