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Selection of remedial solutions for legacy landfills – design risks and opportunities

SAM BUTLER – SENIOR CIVIL ENGINEER

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AGENDA

1. **Definition of legacy landfill**
2. **Objectives of the remediation works**
3. **Key identified issues**
4. **Selection Procedure**
   - Site visit, historical documentation, construction review
   - Site Investigations
   - CSM Development
   - Modelling - LFG, leachate, hydrogeological
   - Multi-Criteria Analysis of options

Legacy Landfill

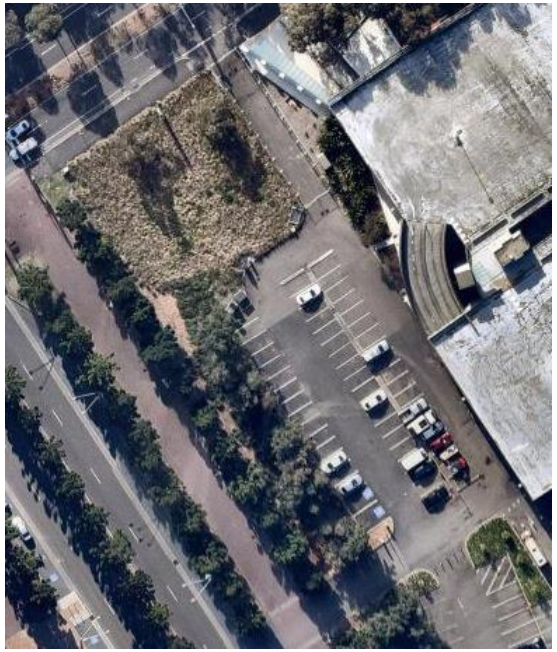
DEFINITION

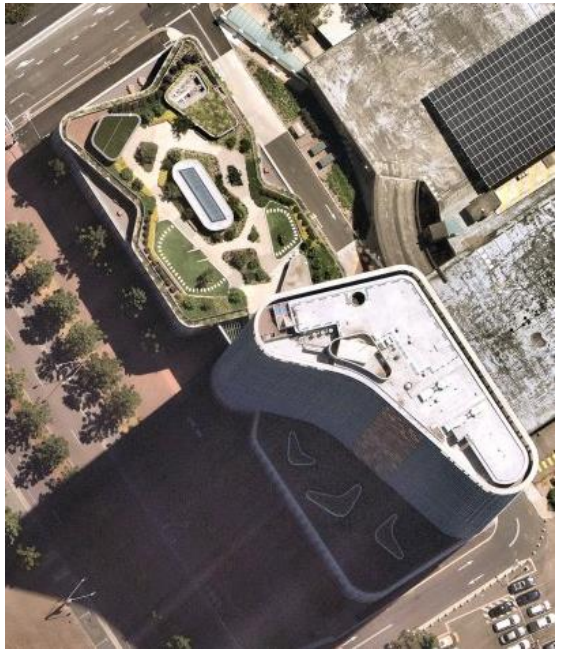
- Closed facility
- Built without any control measures such as cell lining, capping & monitoring
- Historically unregulated
- Variety of wastes disposed at the site (MSW, Hazardous, Clinical etc)

Legacy Landfill

WHY REHABILITATE?

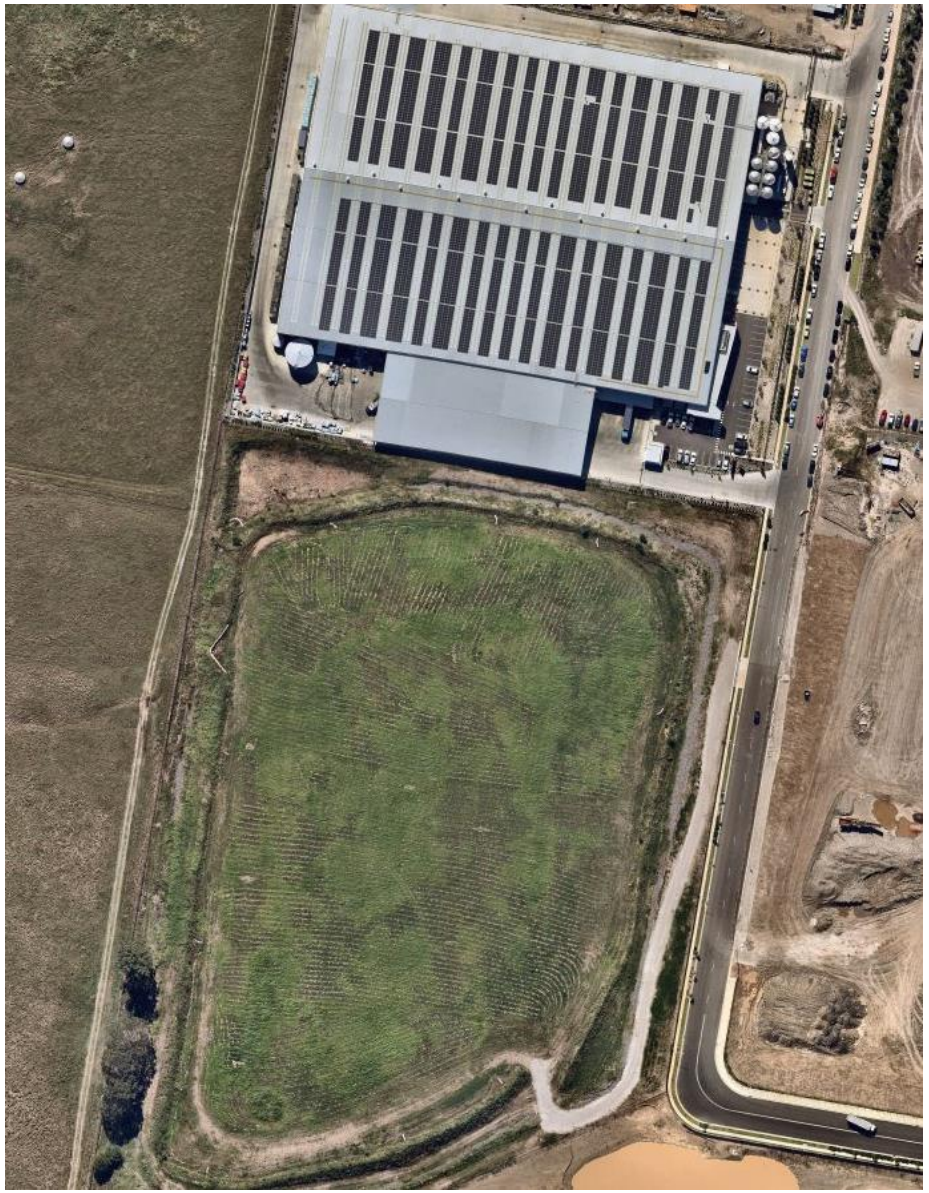
- Post-closure requirement (Environmental Protection Licence)
- Site Development
- Monitoring exceedance
- Environmental improvement program by Council





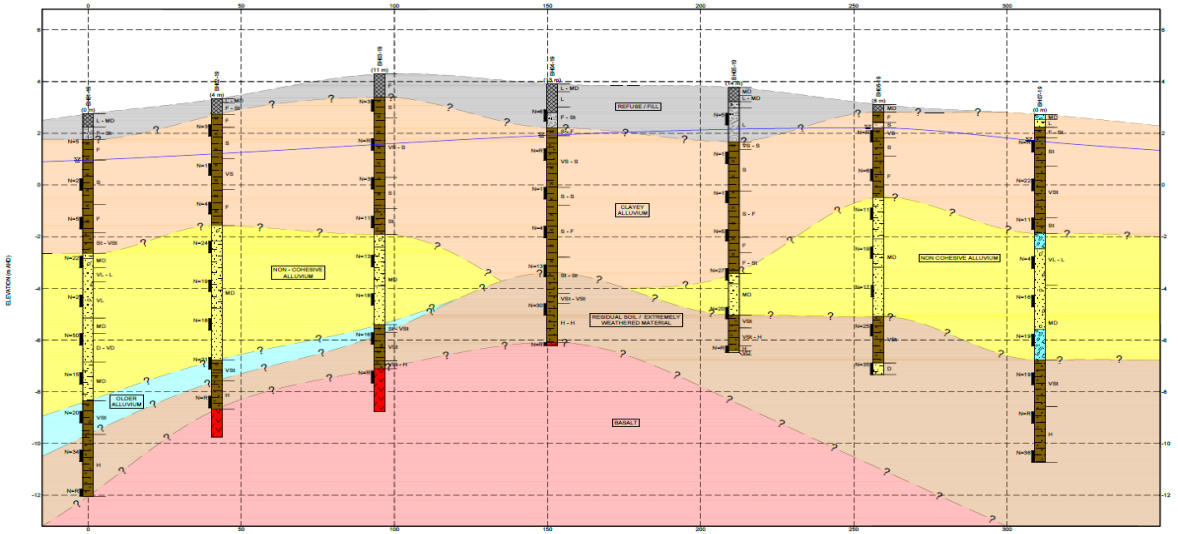
Legacy Landfill Issues

- On-going contamination to the surrounding environment from leachate (surface water, groundwater)
- Near-by sensitive receptors – odour, landfill gas migration, exposure to waste
- Stability & on-going settlement
- Erosion and sediment issues



Design Preliminaries

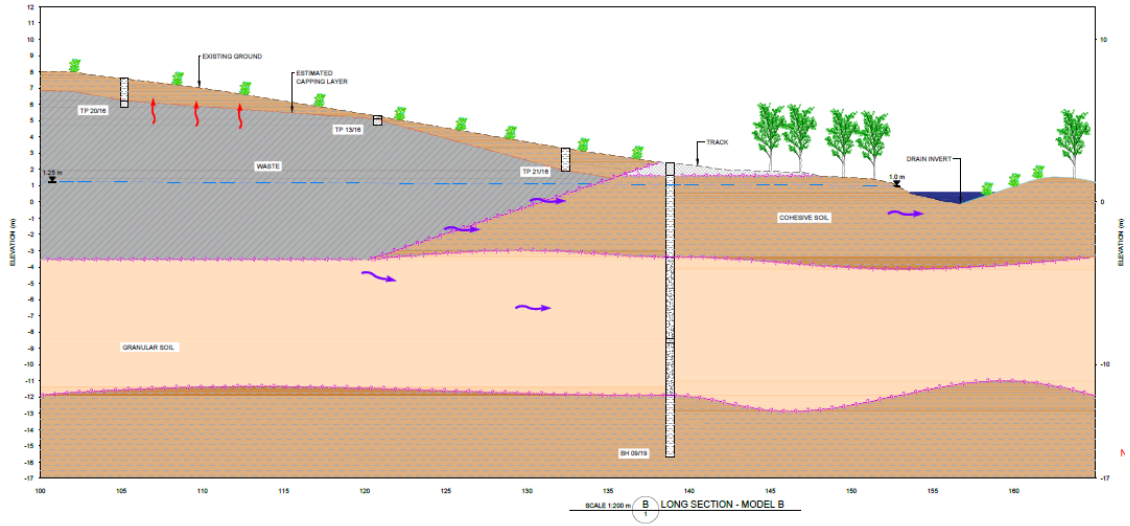
- Site visit, historical documentation review (if any)
- Preliminary Risk Assessment
- Preliminary Site Investigations
- Development of CSM

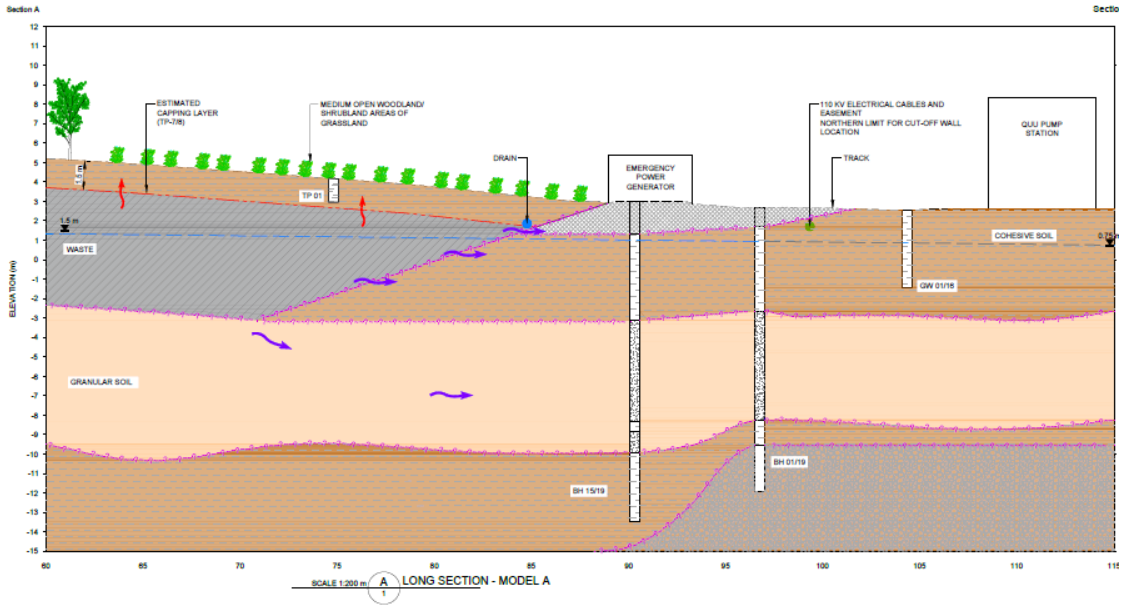


Design Considerations

REMEDIAL MEASURE SELECTION

- Informed by the CSM identified pathways
  - Leachate, Stormwater
  - LFG
  - Sensitive receptors
- Monitoring Records – Groundwater, surface water, LFG
- Regulatory & Client requirements
- Long-term Performance
- Constructability considerations

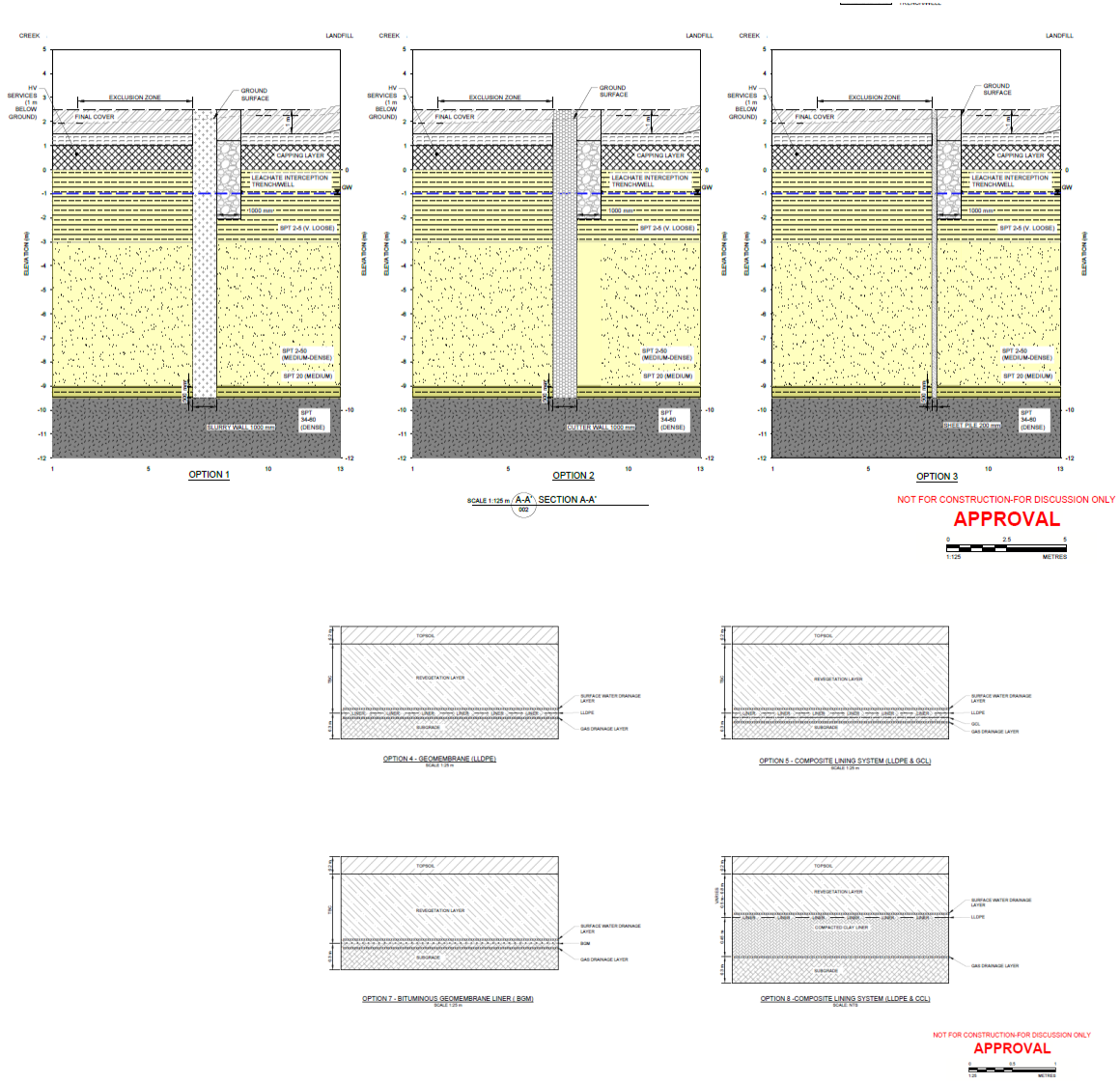




Design Considerations

TYPICAL REMEDIATION MEASURES

- Vertical barrier (lateral migration)
- Final capping (vertical migration)
- Leachate collection and extraction system
- Landfill gas treatment (lateral migration)
  - Passive ventilation system
  - Active extraction system



Multi-Criteria Analysis

MCA OPTIONS DEVELOPMENT

1. Agreement with Client for Assessment Criteria
2. Qualitative Assessment Criteria
   - Regulatory compliance
   - Constructability (experience)
   - Aesthetics / final land use requirements
3. Quantitative Assessment Criteria
   - Modelled Performance of barrier system
   - Environmental improvement
   - CAPEX & OPEX

Table 13: Weighted MCA Assessment for Vertical Barrier Options

			SCORE / 100							
Assessment category	Assessment Criteria	Weight	Option 1 - Slurry Wall & Leachate Collection Trench	Option 2 - Slurry Wall & Leachate Collection Wells	Option 3 - Cutter Soil Mix & Leachate Collection Trench	Option 4 - Cutter Soil Mix & Leachate Collection Wells	Option 5 - Sheet Pile Wall & Leachate Collection Trench	Option 6 - Sheet Pile Wall & Leachate Collection Wells	Option 7 - Slurry Wall	Option 8 - Sheet Pile Wall
1. Environmental Considerations	Long term net environmental benefit (refer to Section 4.1 for indicative improvements set out)									
	[Absence of] Potential adverse environment effects during construction									
2. Technical Considerations	Seepage interception efficiency									
	Operational / Long-term performance									
	Post-construction scalability									
	Constructability									
	Provision of surface water control structures to manage run-off from the main body of the landfill									
	Ability to be installed in the presence of sand layers underlying waste material									
	Low Waste/Spoil generation									
4. Cost	Capital Expenditure									
	Estimated Operation Expenditure									

Table 14: Weighted MCA Assessment for Capping Options

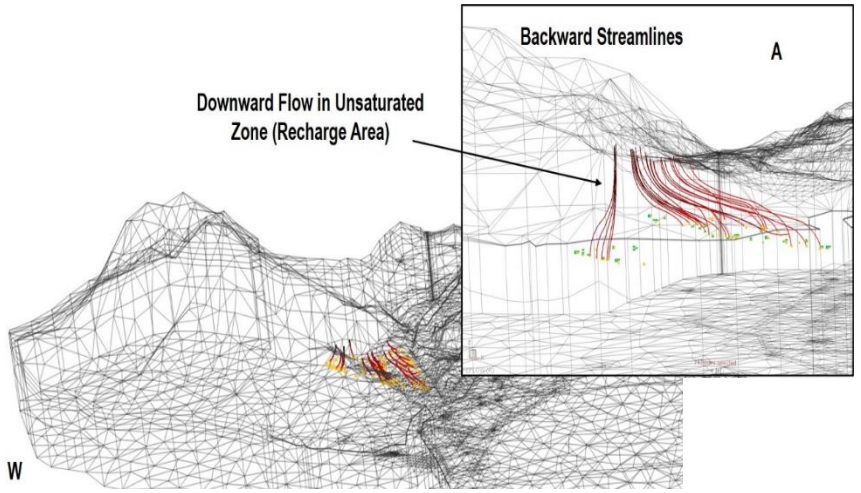
			SCORE / 100							
Assessment category	Assessment Criteria	Weight	Option A - Compacted Clay Liner (CCL)	Option B - Geosynthetic Clay Liner (GCL)	Option C - Coated GCL	Option D - Geomembrane (LLDPE)	Option E - ~~Geocomposite~~ (GCL/ LLDPE)	Option F - ~~Bentocon~~	Option G - Bituminous Geomembrane Liner (BGM)	Option H - ~~Geocomposite~~ (CCL/ LLDPE)
1. Environmental Considerations	Satisfies Regulatory Requirements									
	Ability to minimise leachate generation									
	Ability to minimise landfill gas impacts									
2. Technical Issues	Suitability for site Circumstances - (e.g. after use conditions, geotechnical stability, levels, integration with vertical barrier system)									
	Ability to execute and establish quickly									
	Suitability for future site specific requirements (Operational activities and development, etc)									
	Robust Technology for the full post closure period (understood to be 30 years)									
	Safety (Residual risks, installation)									
	Ability to withstand strong differential settlement processes									
3. Cost	Initial Capital Cost									
	Operating and Maintenance Cost (vegetation, erosion, repairs, cap perforations for landfill gas, etc.)									
	Beneficial reuse of material Cost (i.e., ability to integrate with other projects on site)									
	Dependence on imported earth fill for construction and amount of earthfill required for construction									
	Total Weighted Sum (Out of 100)									

Barrier Performance

QUANTITATIVE ASSESSMENT - NUMERICAL MODELLING

Vertical Barrier Systems

- 3D or 2D numerical modelling
  - Hydraulic conductivity of material parameters
  - Streamline collection / barrier efficiency (%)
- MCA Score (/100) for Vertical Barrier

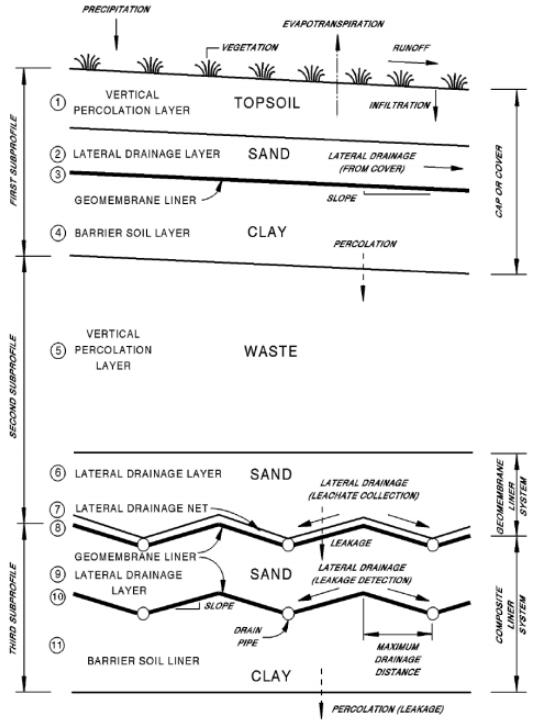


Barrier Performance

QUANTITATIVE ASSESSMENT - NUMERICAL MODELLING

Horizontal Barrier (Capping) System

- HELP Modelling
  - Quasi-two dimensional modelling
  - Specific site data required
  - Infiltration percentage (%)
  - MCA Score (/100)

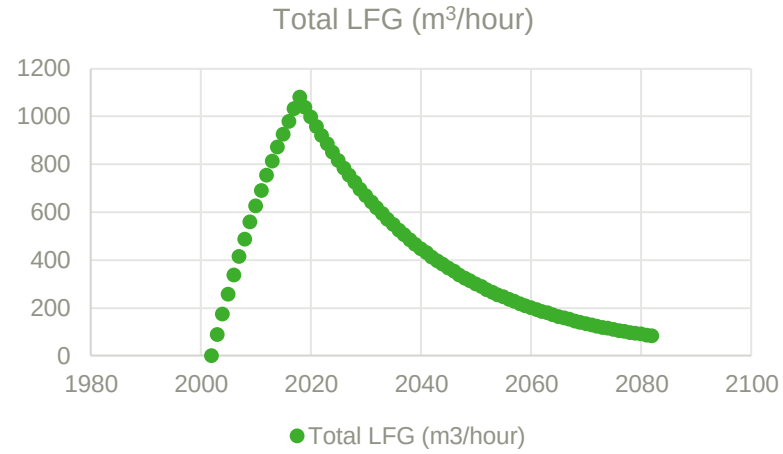


Design Considerations

NUMERICAL MODELLING

Landfill Gas

- LFG generation modelling
- Active / Passive LFG treatment
  - Biofiltration oxidation
  - Flaring
  - MCA Score (/100)



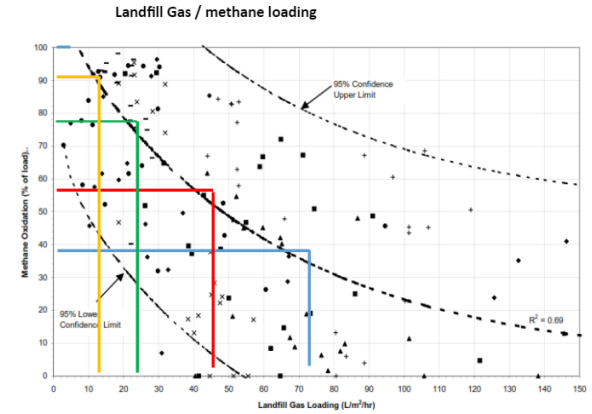


Figure 23: Effect of landfill gas loading on methane oxidation rate (% of load) of a passive biofilter operating in Sydney

Size of Biofilter	Oxidation Rate
1200m2	35%
2000 m2	55%
3850 m2	75%
7000 m2	90%

Multi-Criteria Analysis

OPTIONS DEVELOPMENT

1. Assignment of Scoring (/100) based upon Qualitative and Quantitative data assessment
2. Development of weighting with Client
3. Selection of preferred option

			SCORE / 100							
Assessment category	Assessment Criteria	Weight	Option 1 - Slurry Wall & Leachate Collection Trench	Option 2 - Slurry Wall & Leachate Collection Wells	Option 3 - Cutter Soil Mix & Leachate Collection Trench	Option 4 - Cutter Soil Mix & Leachate Collection Wells	Option 5 - Sheet Pile Wall & Leachate Collection Trench	Option 6 - Sheet Pile Wall & Leachate Collection Wells	Option 7 - Slurry Wall	Option 8 - Sheet Pile Wall
1. Environmental Considerations	Long term net environmental benefit (refer to Section 4.1 for indicative improvements set out)	8%	100	100	100	100	100	100	20	20
	[Absence of] Potential adverse environment effects during construction	12%	30	40	60	70	70	80	20	20
2. Technical Considerations	Seepage interception efficiency	15%	90	80	90	80	90	80	40	40
	Operational / Long-term performance	9%	80	70	80	70	80	70	20	20
	Post-construction scalability	6%	90	90	90	90	90	90	90	90
	Constructability	12%	40	40	70	70	90	90	40	90
	Provision of surface water control structures to manage run-off from the main body of the landfill	3%	20	20	80	80	80	80	20	80
	Ability to be installed in the presence of sand layers underlying waste material	6%	30	30	60	60	80	80	30	80
	Low Waste/Spoil generation	9%	20	20	60	60	90	90	20	90
4. Cost	Capital Expenditure	12%	60	70	60	70	80	80	70	90
	Estimated Operation Expenditure	8%	60	50	60	50	60	50	80	80
Total Weighted Sum (Out of 100)			56.3	56.7	70.7	71.1	83	81	39.8	61.7

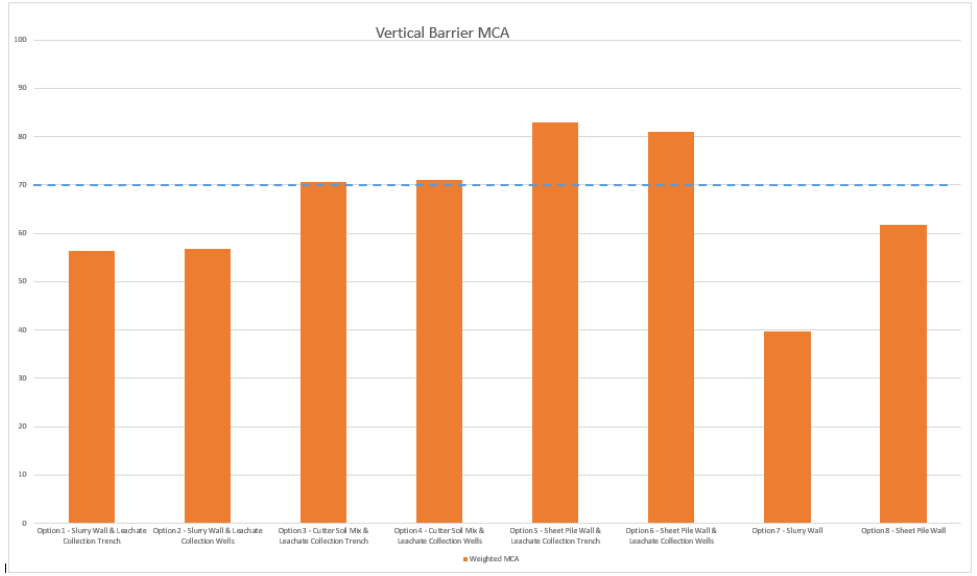


Figure 3: Weighted MCA Assessment for Vertical Barrier Options

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Thank you