(Hydrogeological) Impact of Landfill Surcharging

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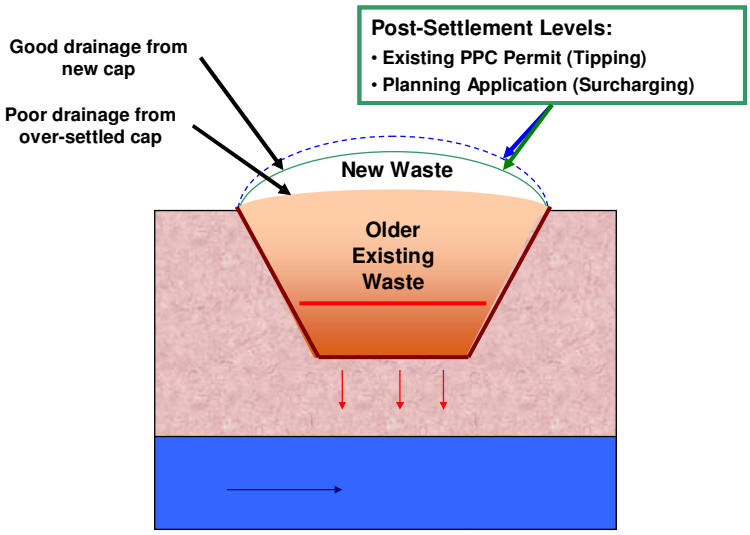
Surcharging / Tipping – What do I Mean



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Terminology / Drivers for Surcharging

- **Tipping (to meet PPC permitted levels)**
  - greater settlement than expected
  - improve cap drainage profile
- **Surcharging (new Planning App. / Permit Mod.)**
  - improve cap drainage compared to existing permitted pre-settlement levels
  - take additional waste at existing site with engineering and infrastructure compared to a new site
- ***Piggybacking (new Planning & Permit App)***
  - *bring old waste into a new improved landform*

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Impacts Considered

- **Leachate levels increase***
- **Leachate volumes to extract^**
- **Leachate extraction infrastructure ^**
- **Leachate quality deterioration***
- **Waste stabilisation takes longer***

- **These affect the HRA**
- **These affect the confidence the Agency may have in the practicality of a scheme**

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Experience

- Work in Support of Planning Applications
- Review of Leachate Management Plans
- Review of Hydrogeological Risk Assessments

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- ASIDE – Depth Dependent Waste Properties

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Depth Dependent Waste Properties

Change in Waste Properties with Depth

Average Vertical Stress	Equivalent Depth of Waste [a]	Drainable Porosity	Saturated Hydraulic Conductivity	
(kPa)	(m)	(%)	Max (m/s)	Min (m/s)
0	1	20[b]		
34.1	3.4	14.7	1.50E-04	3.40E-05
64.9	6.5	12.5	8.20E-05	1.90E-05
120	12.0	6.5	2.80E-05	3.10E-06
241	24.1	~2	8.90E-06	4.40E-07
463	46.3	~1.5	2.70E-07	3.70E-08

Powrie W and Beaven R P, 1999 Hydraulic Properties of Household Waste and Implications for Landfills. Proceedings of the Institute of Civil Engineers; Geotechnical Engineering, October 1999, pp235-247.

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- Impact on Leachate Levels

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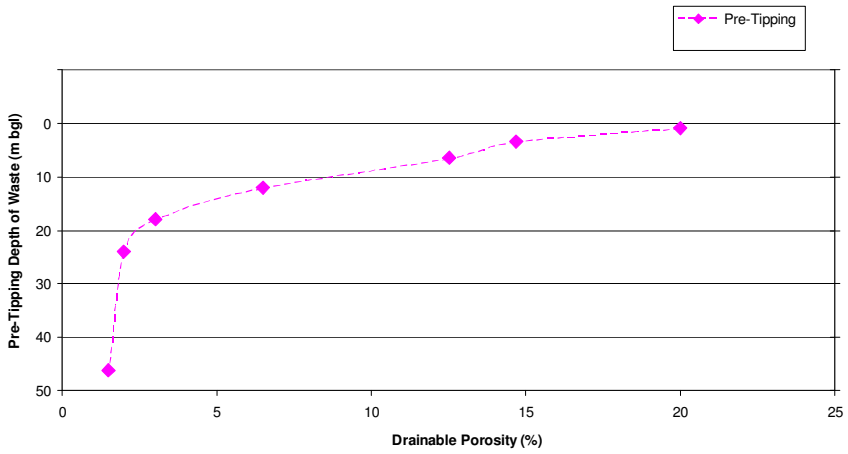
Impact on Leachate Levels



Drainable porosity decreases with depth

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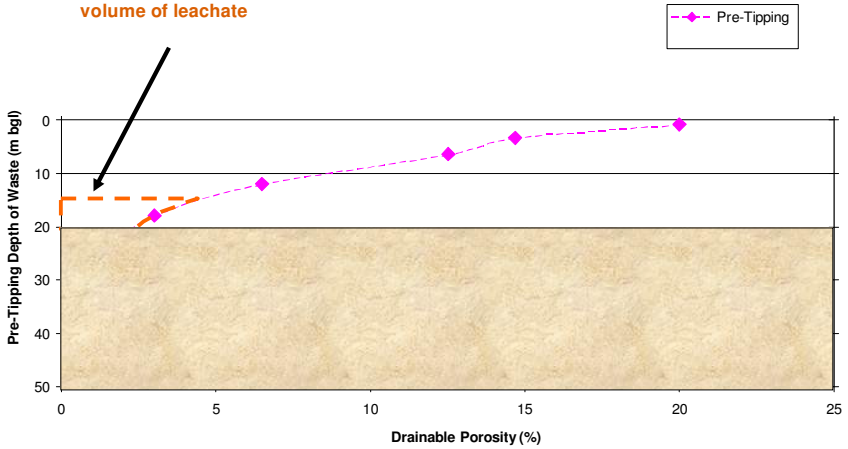
Impact on Leachate Levels

Saturated waste equates to a volume of leachate



Consider saturated waste pre-tipping

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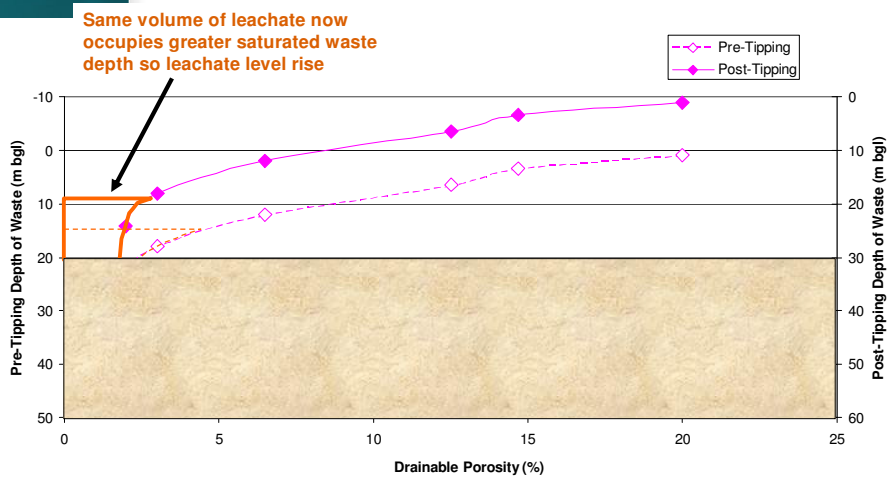
Impact on Leachate Levels



Tipping causes leachate level rise

(unless leachate goes to basal drainage)

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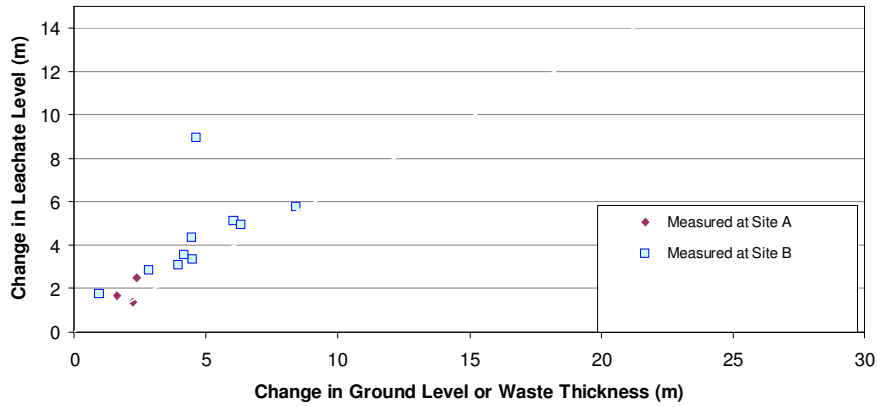
Impact on Leachate Levels



What changes are measured ?

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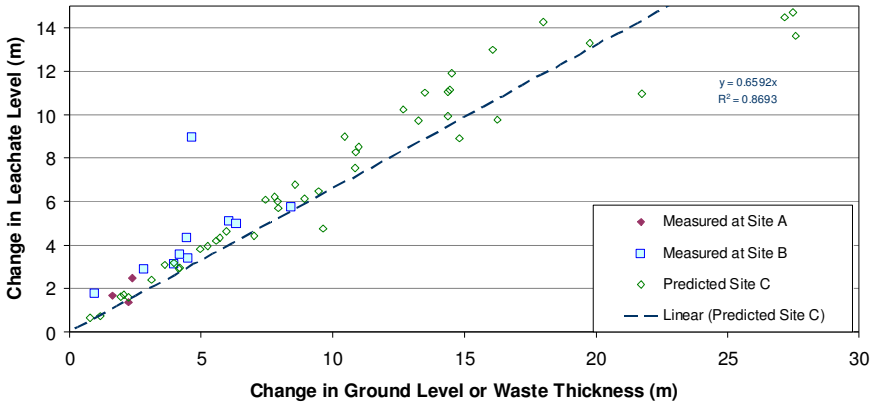
Impact on Leachate Levels



Predictions using Entec Spreadsheet

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Impacts on Leachate Levels

Leachate Level Increase Depends on:

- Thickness of saturated waste pre-tipping
- Depth of leachate level pre-tipping
- Thickness of new waste to be added

So Mitigation by:

- Reducing leachate levels pre-tipping

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- **Impact on Leachate Balance**

  (Can be quantified in spreadsheets)

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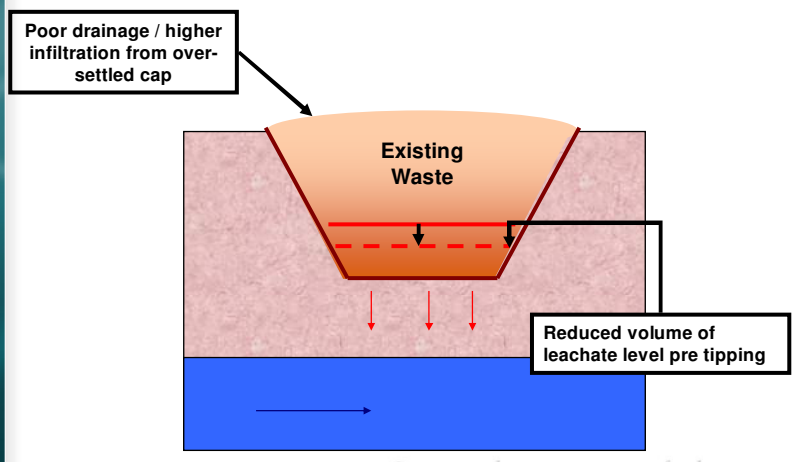
Leachate Balance – Pre-Tipping



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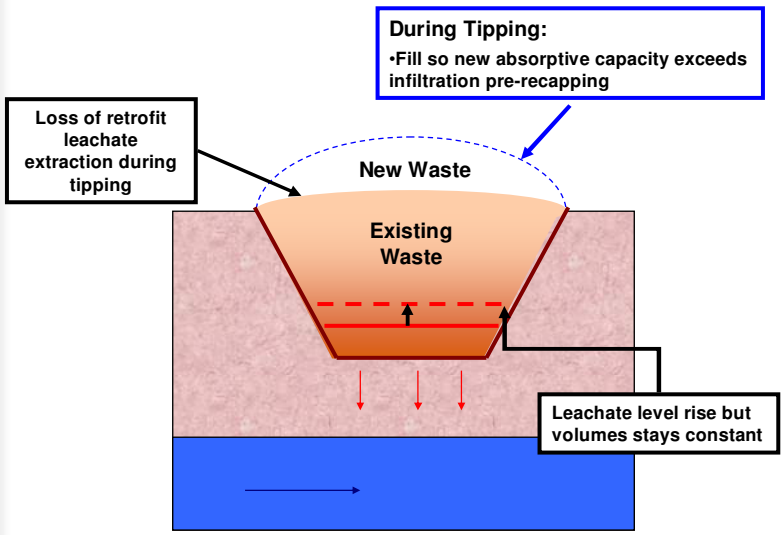
Leachate Balance – During Tipping



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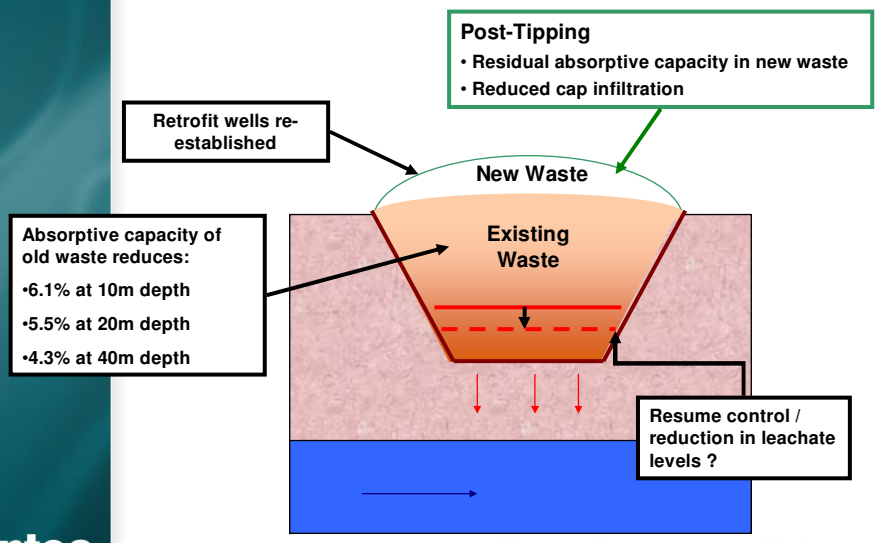
Leachate Balance Post Tipping



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- Impact on Leachate Extraction Infrastructure

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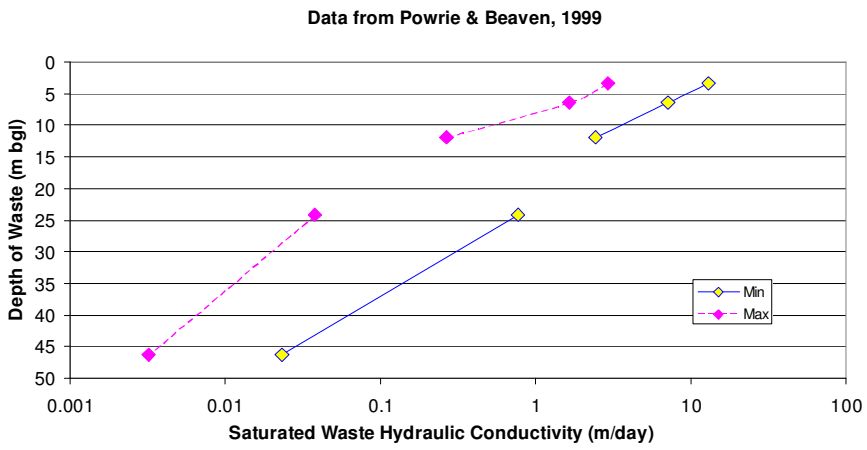
Impact on Leachate Well Performance



Note: Waste permeability reduces with depth

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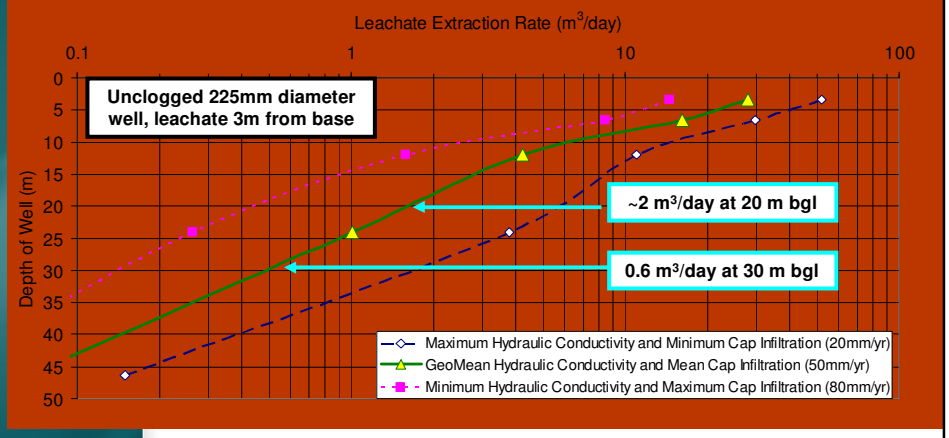
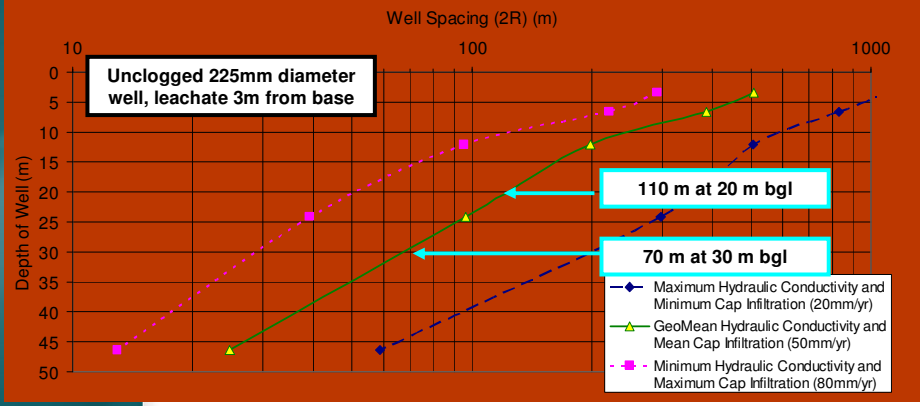
Impact on Leachate Well Performance



Well performance reduces with depth

Rowe and Nadarah (1996), Estimating leachate drawdown due to pumping wells in landfills, (Canadian Geotechnical Journal, 33, pp1-10 (1996))

Impact on Leachate Well Spacing



Need more wells after addition of new waste

Rowe and Nadarah (1996), Estimating leachate drawdown due to pumping wells in landfills, (Canadian Geotechnical Journal, 33, pp1-10 (1996))

Impact on Leachate Extraction Infrastructure

- Loss of retrofit wells due to tipping
- New wells have lower yields
- Need more wells for same leachate level control
- Potential loss of new retrofits due to settlement of new waste
- Far less of an issue where there is basal drainage blanket

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- Impact on Leachate Quality

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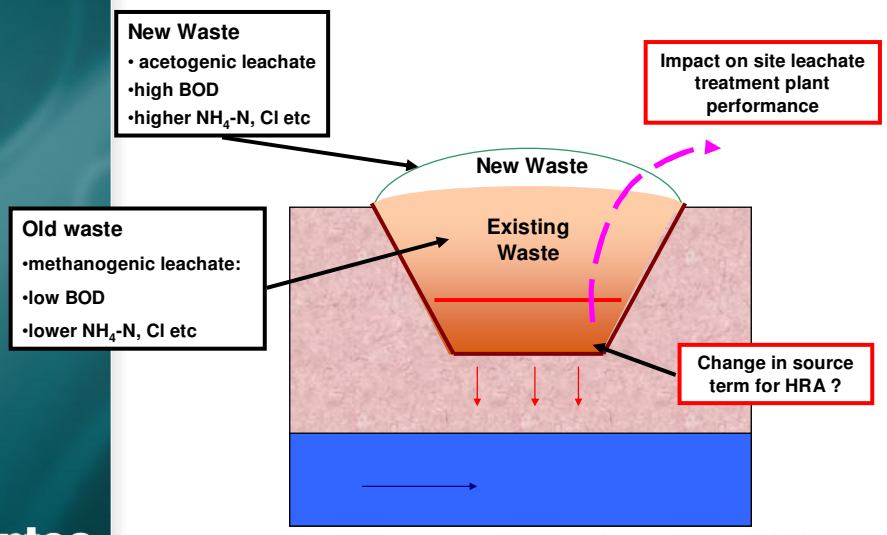
Impact on Leachate Quality



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Impact on Leachate Quality

Will depend on

- Quality and volume of existing leachate
- Relative thicknesses of old and new waste
- New cap infiltration
- Less of an issue where leachate is tankered off site

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- Impact on Waste Stabilisation

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Impact on Waste Stabilisation

LandSim v2.02

$$t = \frac{Wt.Wn}{HER}.\ln\left(\frac{C_0}{C_t}\right)$$

LandSim v2.5

$$t = \frac{Wt.\rho}{HER.\kappa}.\ln\left(\frac{C_0}{C_t}\right)$$

t = time to achieve acceptable leachate quality
Wt = waste thickness

- **So extra tipping leads to longer period for waste stabilisation**
- **Unless we recirculate or add additional water…..**
- **More leachate to extract and treat**

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- Summary and Conclusions

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Summary

Impact	Can it be Modelled?	Can it be Mitigated Against ?
Leachate level rise	Yes Spreadsheets taking account of drainable porosity and changes in waste thicknesses	Yes Reducing leachate levels before tipping (to calculated pre-tipping target levels)
Leachate volumes	Yes Spreadsheets calculating volumes to be removed before, during and after tipping	Yes Change leachate extraction schedule and export and / or treat more leachate. Overall more leachate to extract (=£)
Extraction infrastructure	Yes Spreadsheets	Yes Additional wells or improved well design / servicing (=£)
Leachate quality	Yes? Spreadsheets?	Yes Modify treatment plant, increase tankering (=£)
Waste stabilisation	Yes LandSim or spreadsheets	? Recirculation, addition of water = more leachate to extract (=£)

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Conclusions

- **So there are impacts from surcharging:**
  - can be modelled / quantified
  - quantifying demonstrates feasibility / risks to Agency
  - can largely be mitigated
- **Residual impact(s) are on site operation costs in short and long term**
- **Waste contractors should factor these impacts into their cost-benefit assessment of schemes**

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