Long Term Planning of Leakage Reduction

Stephen Tooms – Hyder Consulting

Presented by Stuart Trow - Consultant

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Format

- Problems with leakage modelling
- The approach taken
- The two modelling techniques used
- The yield curves from leakage reduction options
- Case Study results
- Uncertainty and sensitivity
- Conclusions

Problems:

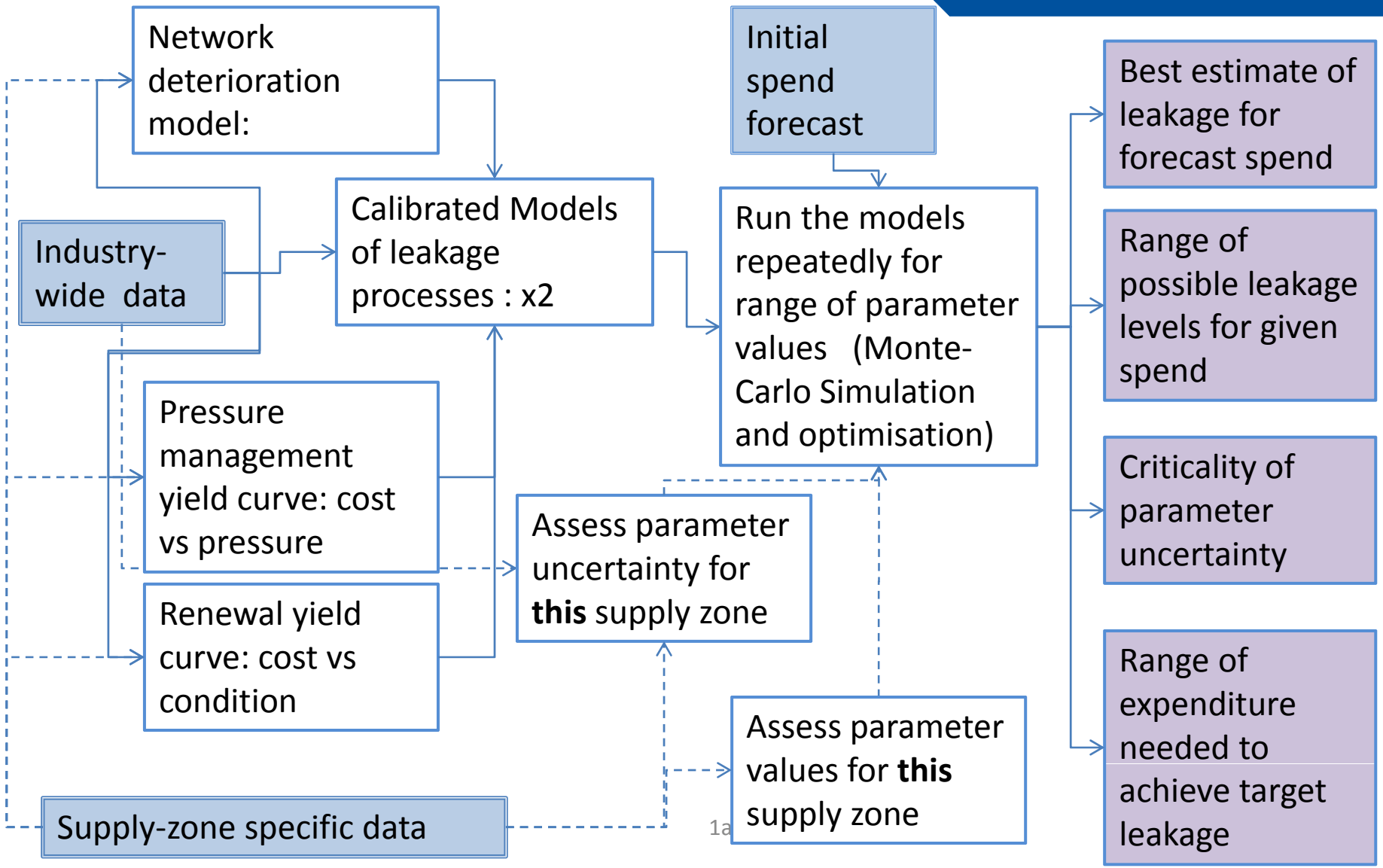
Mature water supply networks

- Water resource planning timescales in decades
- Network renewal at similar timescales and high capital cost
- Uncertainty in long term effects of alternative, lower cost, approaches
- Uncertainty in the leakage reduction that can be achieved leads to a risk of failure of water resource plans.

Leakage reduction concessions

- Minimal initial information on network performance
- Long term agreements
- Targets agreed at an early stage
- A need by all parties to understand the costs and risks

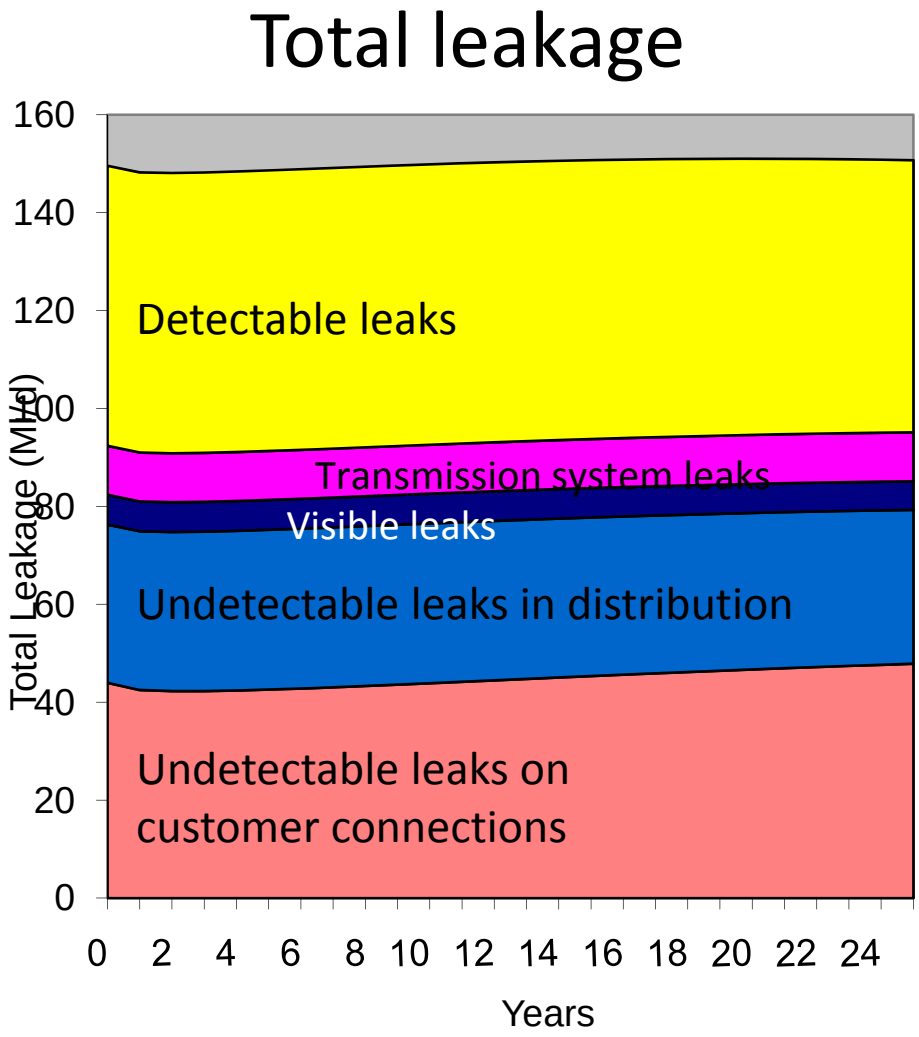
Our approach



Leakage models – model 1

Model 1- Components

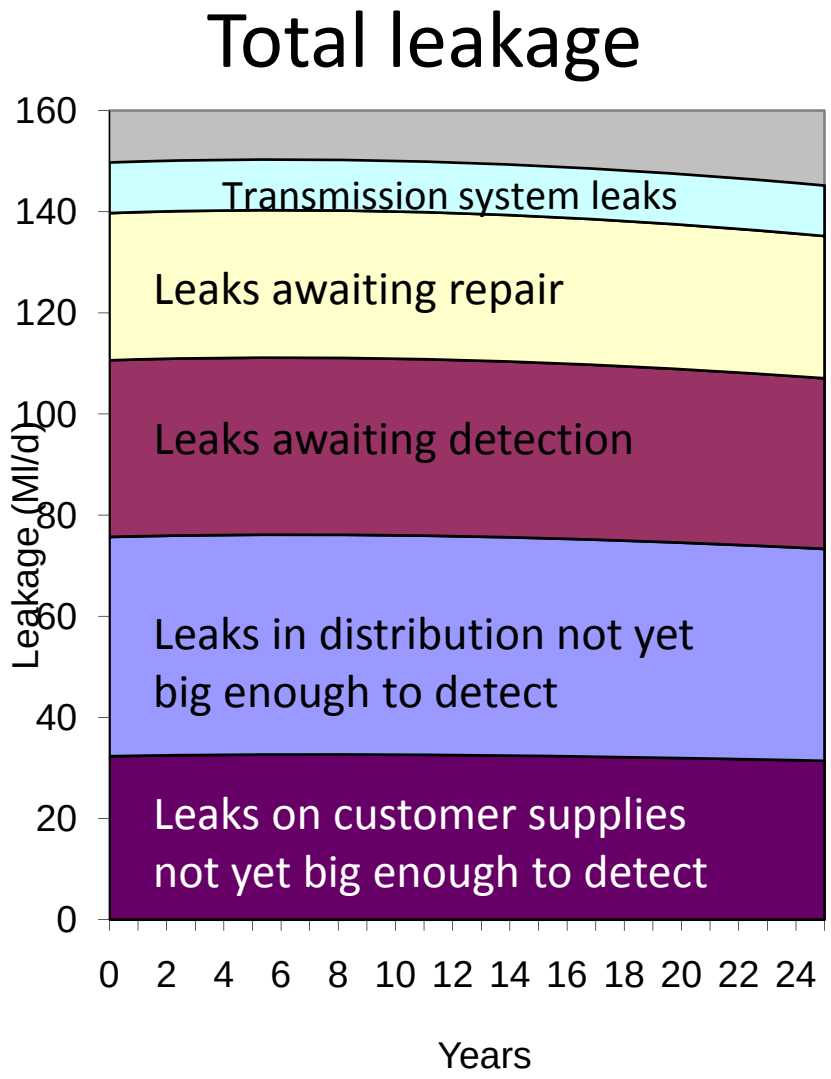
- BABE-type model
- Leaks occur and persist at full flow rate
- Leakage from detectable leaks dependent on detection expenditure
- All components are pressure dependent



Leakage models – model 2

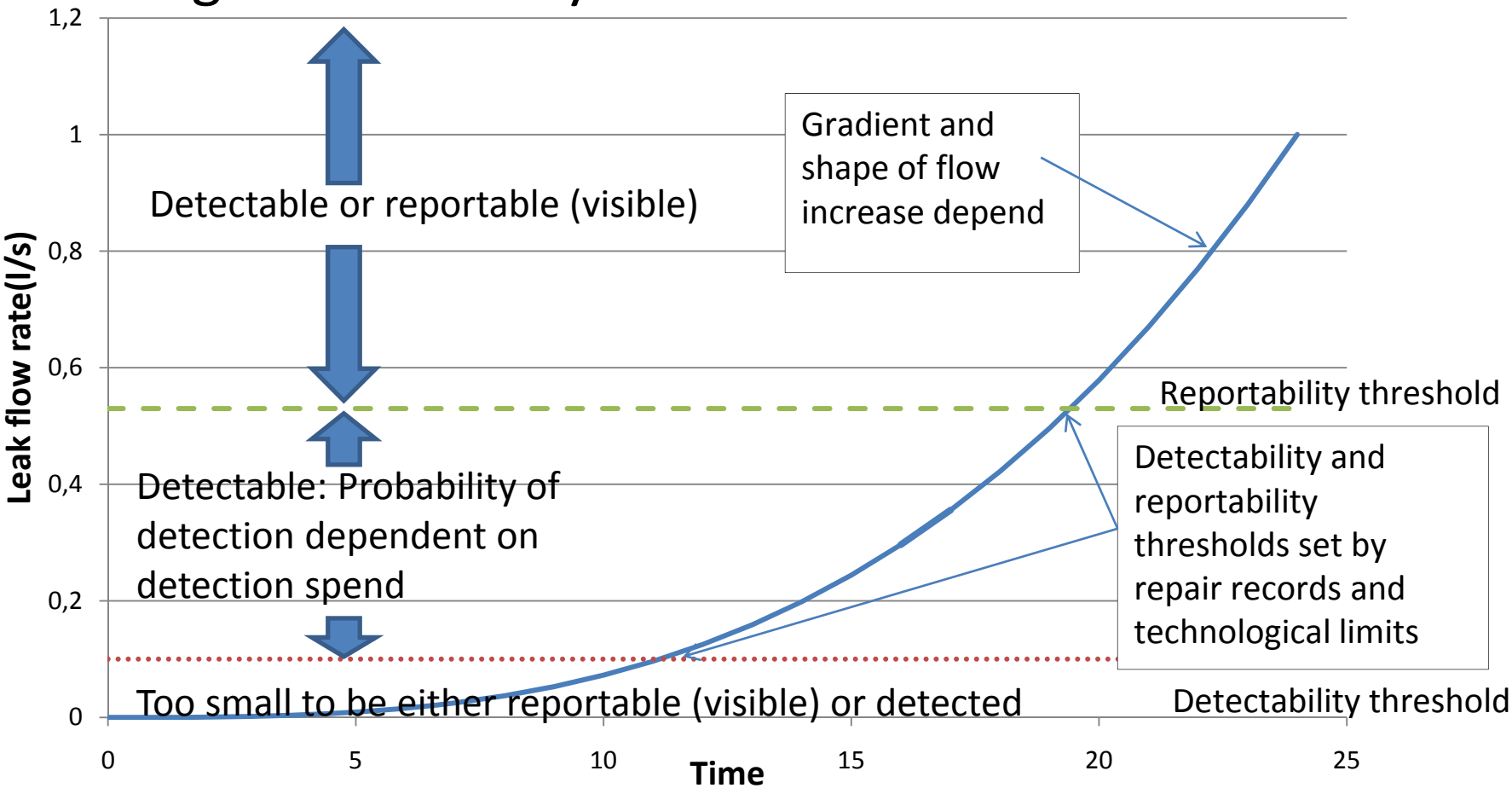
Model 2 – Leak growth

- Individual leaks grow
- Growth rate dependent on pressure
- Number of leaks dependent on network condition
- Leaks become detectable at threshold flow rate
- Probability of detection dependent on detection expenditure



Leakage models – model 2

Leak growth: History of an individual leak

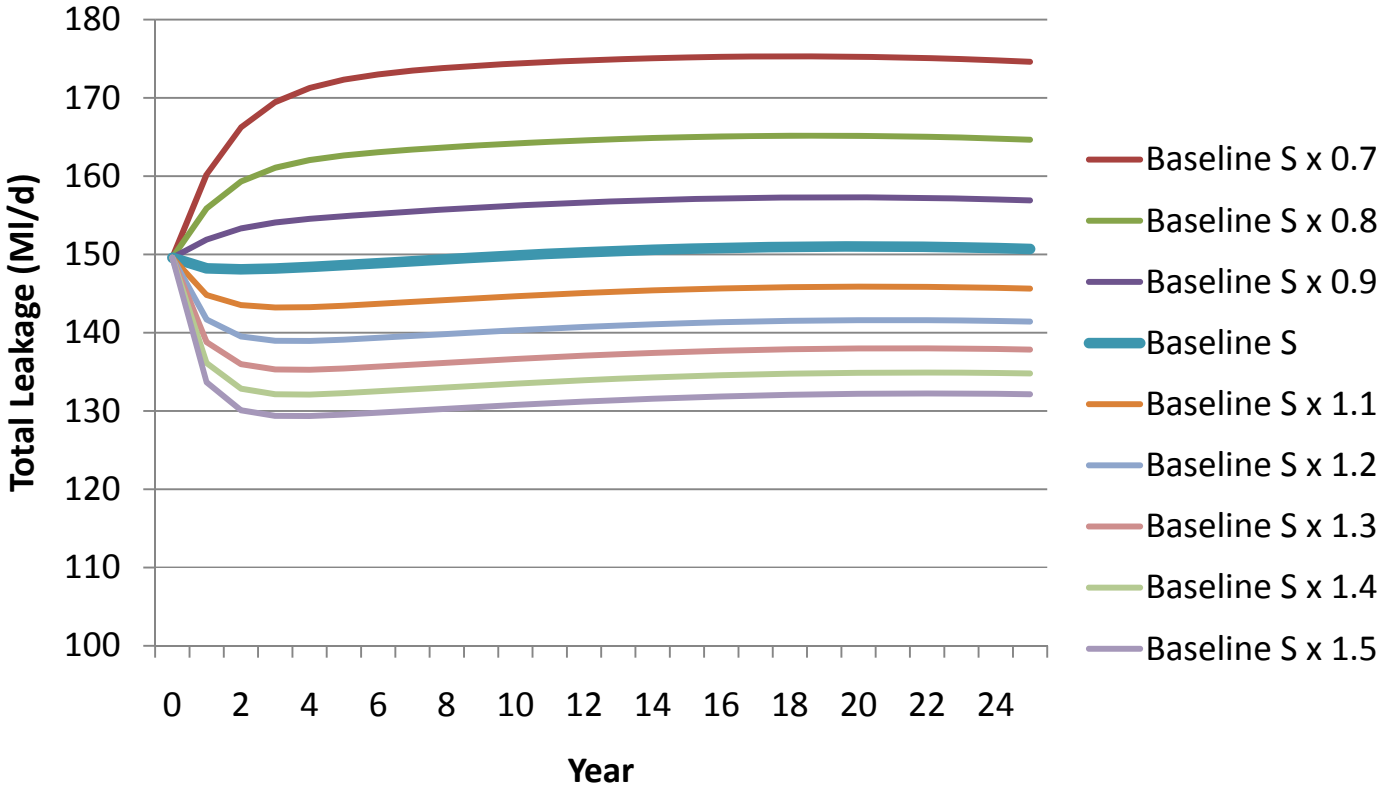


Comparison of Techniques

Model	Leak occurrence	Detection productivity	Pressure relation-ships	Impact of renewal
1-Component approach	Separate mains, connection leaks. Leaks occur at full flow rate	Inverse leak-duration vs ALC spend relationship	Leak flow rates α P Breakout rate αP^{N3}	Reduces breakout rate and background leakage
2-Leak growth approach	Leak growth with shape factor	Probabilistic dependent on flow rate	Growth rate αP Breakout rate αP^{N3}	Reduces breakout rate and background leakage

Yield assumptions-detection

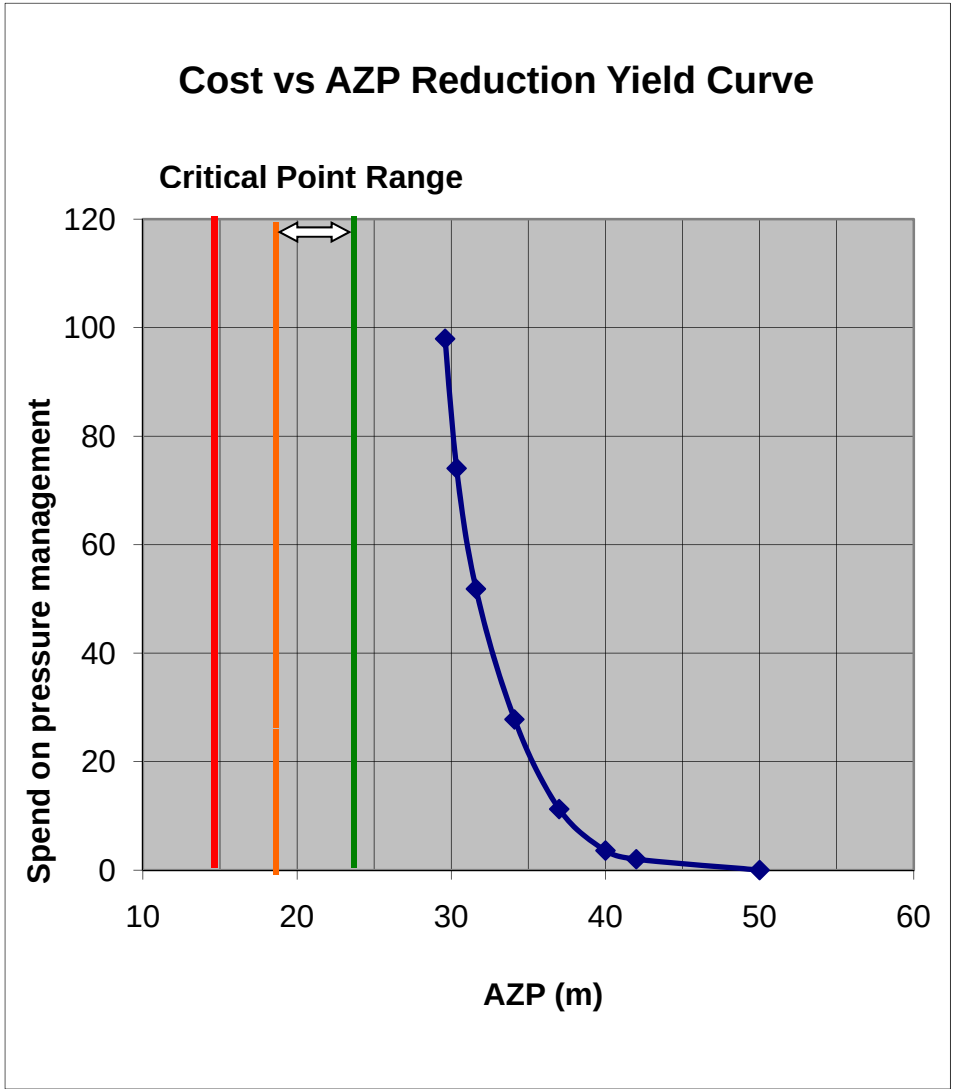
- Model 1: $\frac{dL}{dt} = NRR - c.S.Lv$



Pressure management yield curve

- Seven stages:

1. "Natural" AZP- 50m
2. Current AZP -42m
3. Flow modulation on existing- 40m
4. Further reduction on existing zones -37m
5. PRVs on all existing DMAs- 34m
6. Splitting DMAs(x2) - 31m
7. Individual properties- 30m

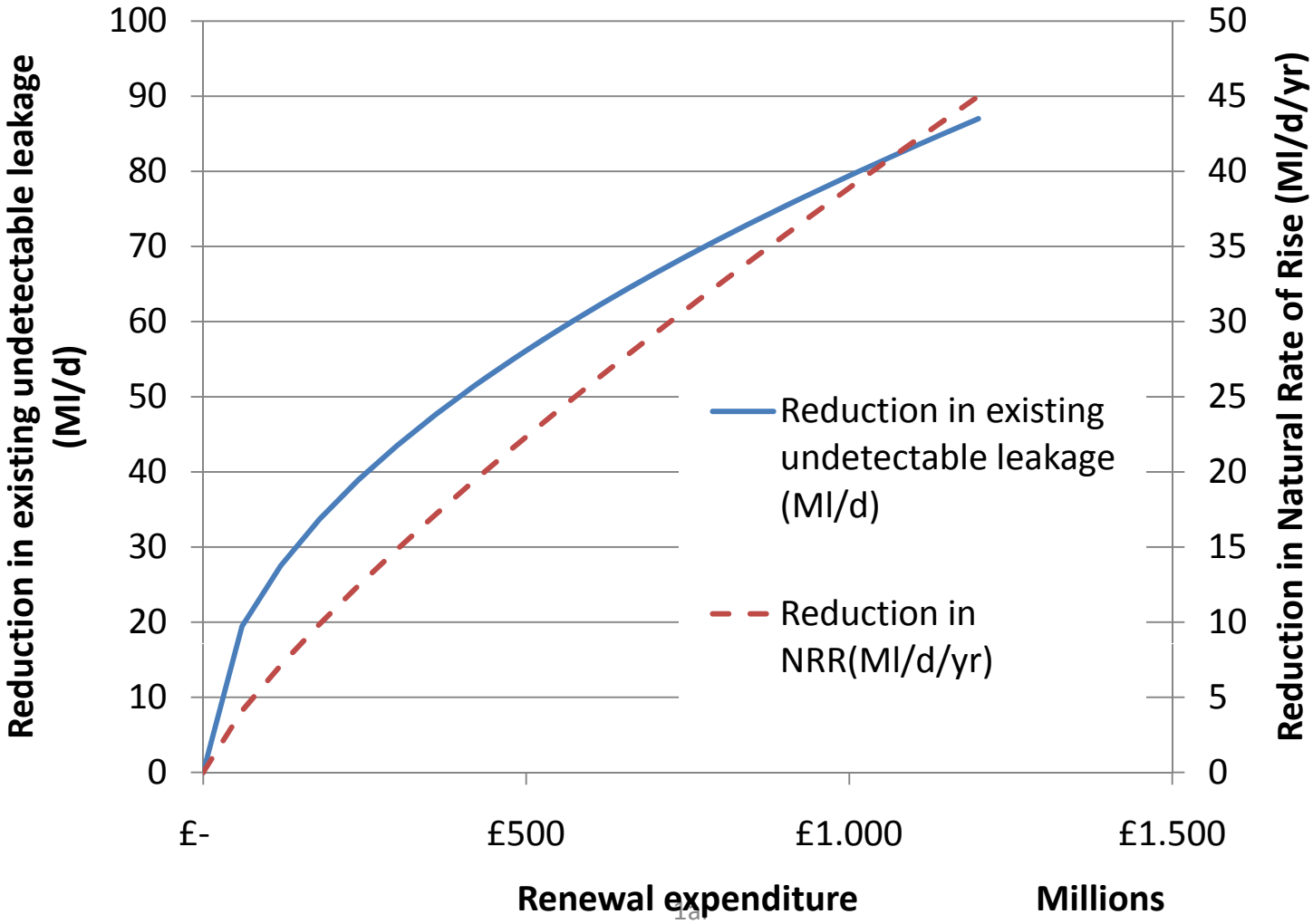


Leakage model-renewal

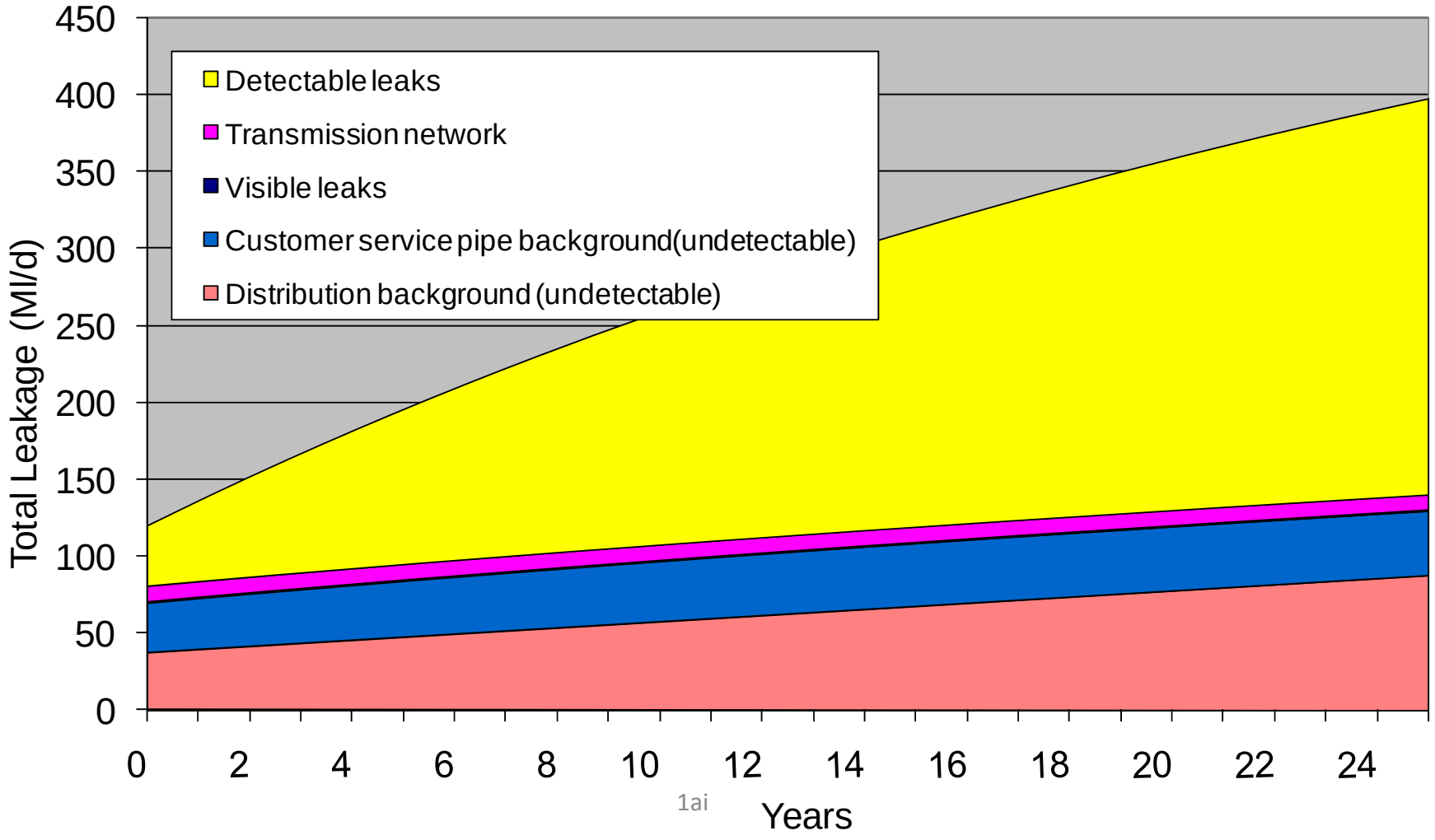
- Pareto curve giving distribution of background
- Pareto curve giving distribution of NRR
- Select worst first (in background or NRR)
- Apply new background and NRR to renewed network using research results

- Background deteriorates with time
- Selection by NRR or background makes little difference
- Assuming no correlation between background and NRR (conservative assumption)

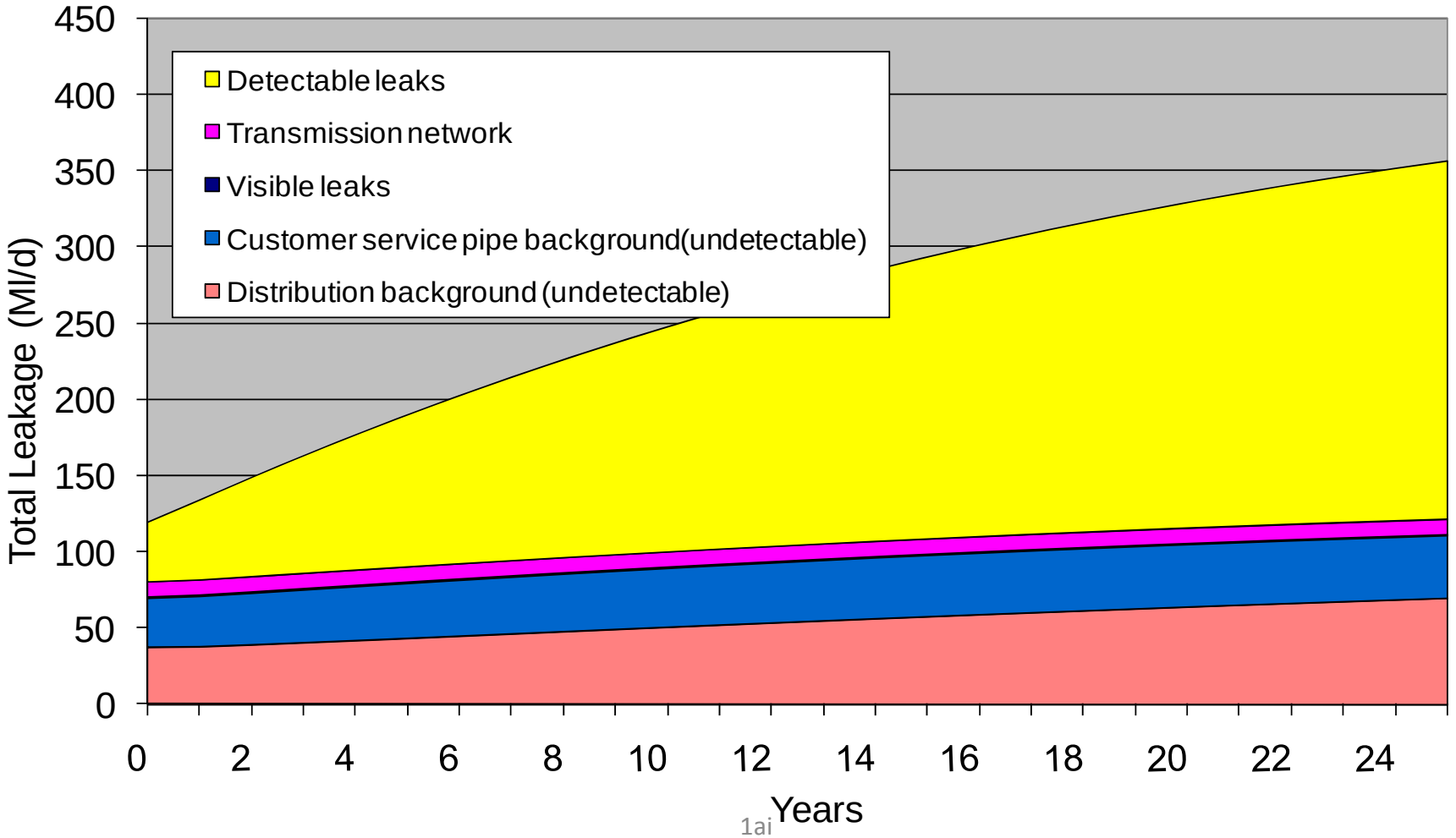
Yield curve: renewal



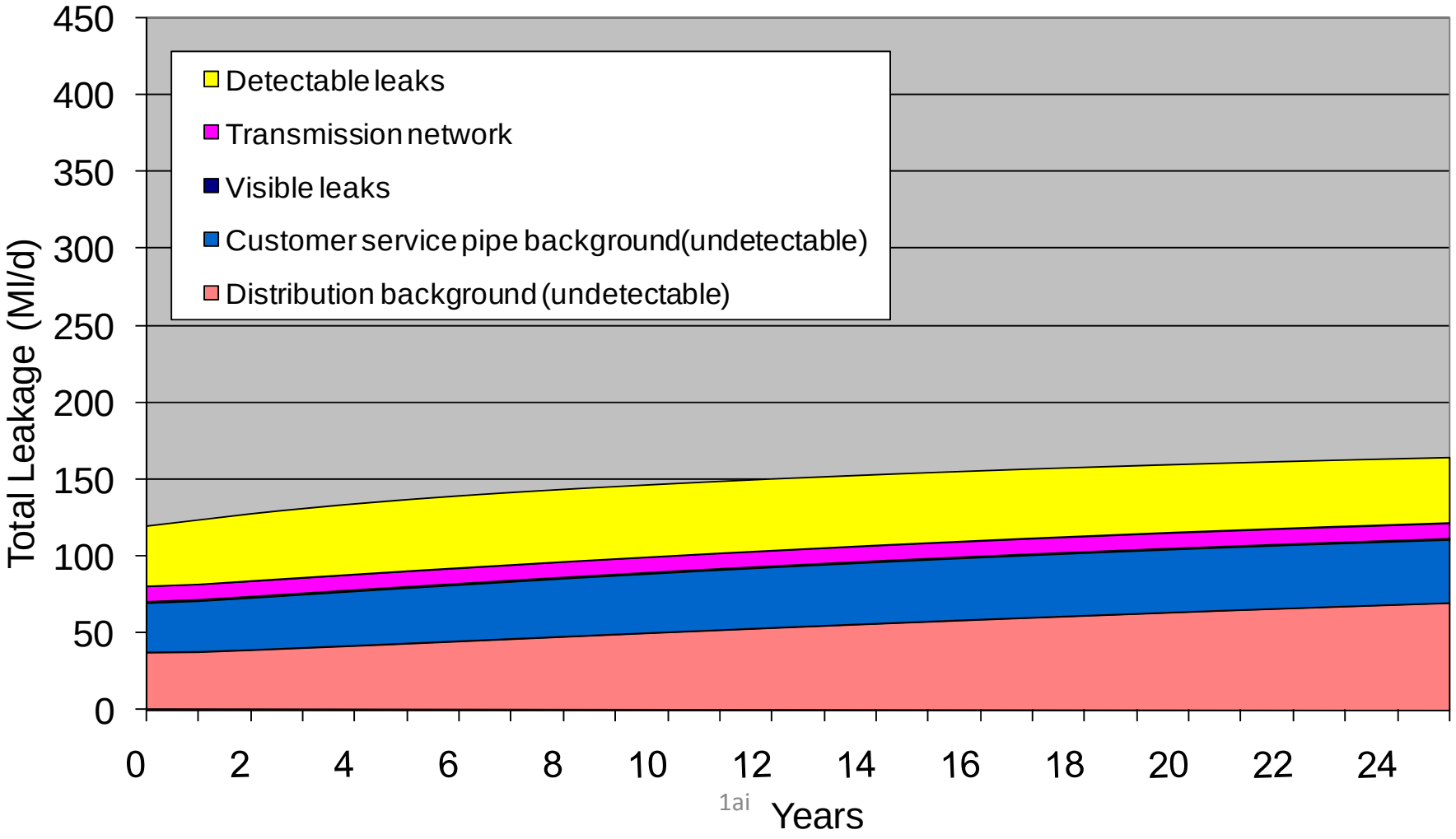
Outputs for an example company: do-nothing baseline



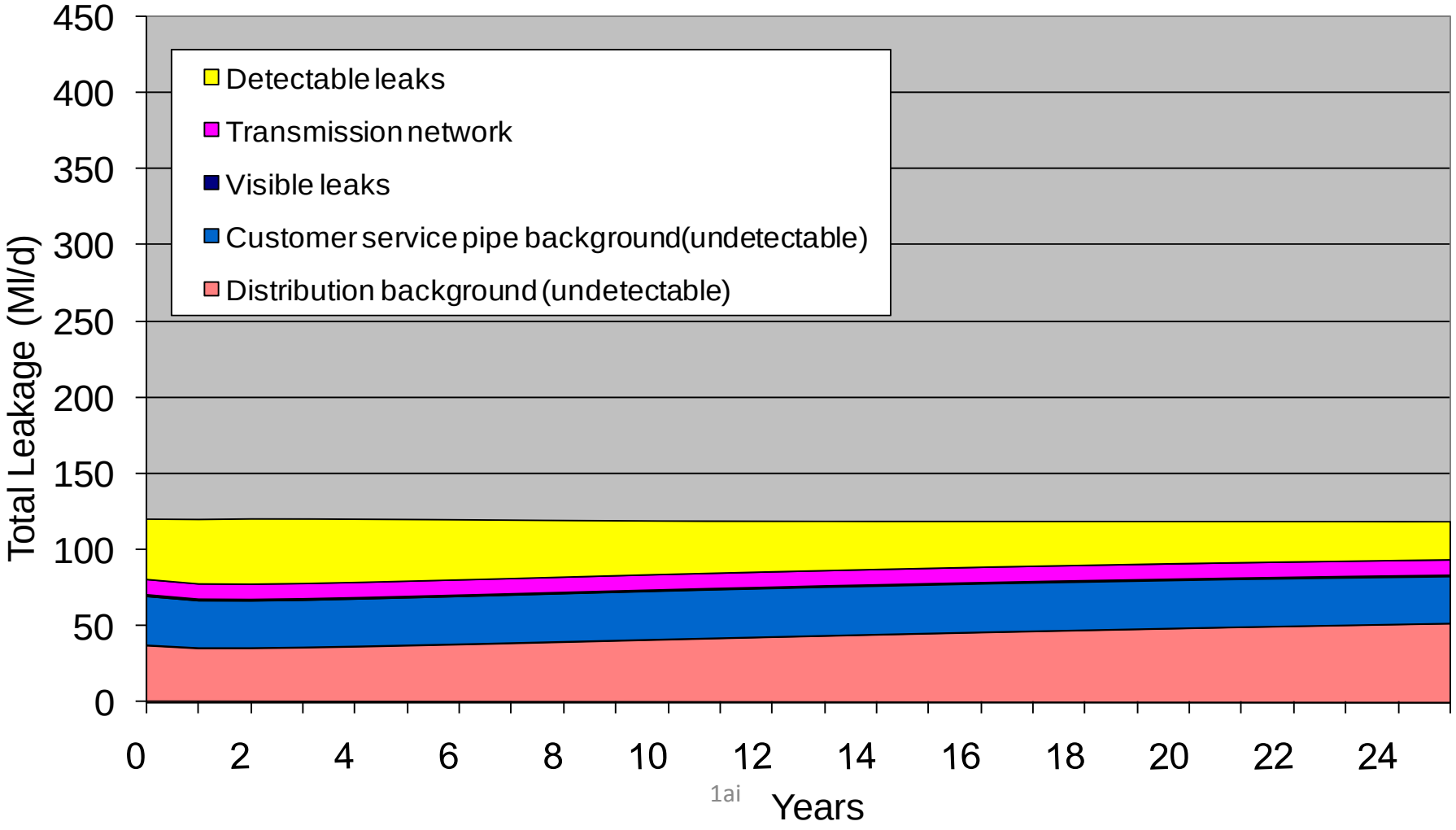
Outputs: 1% Renewal rate



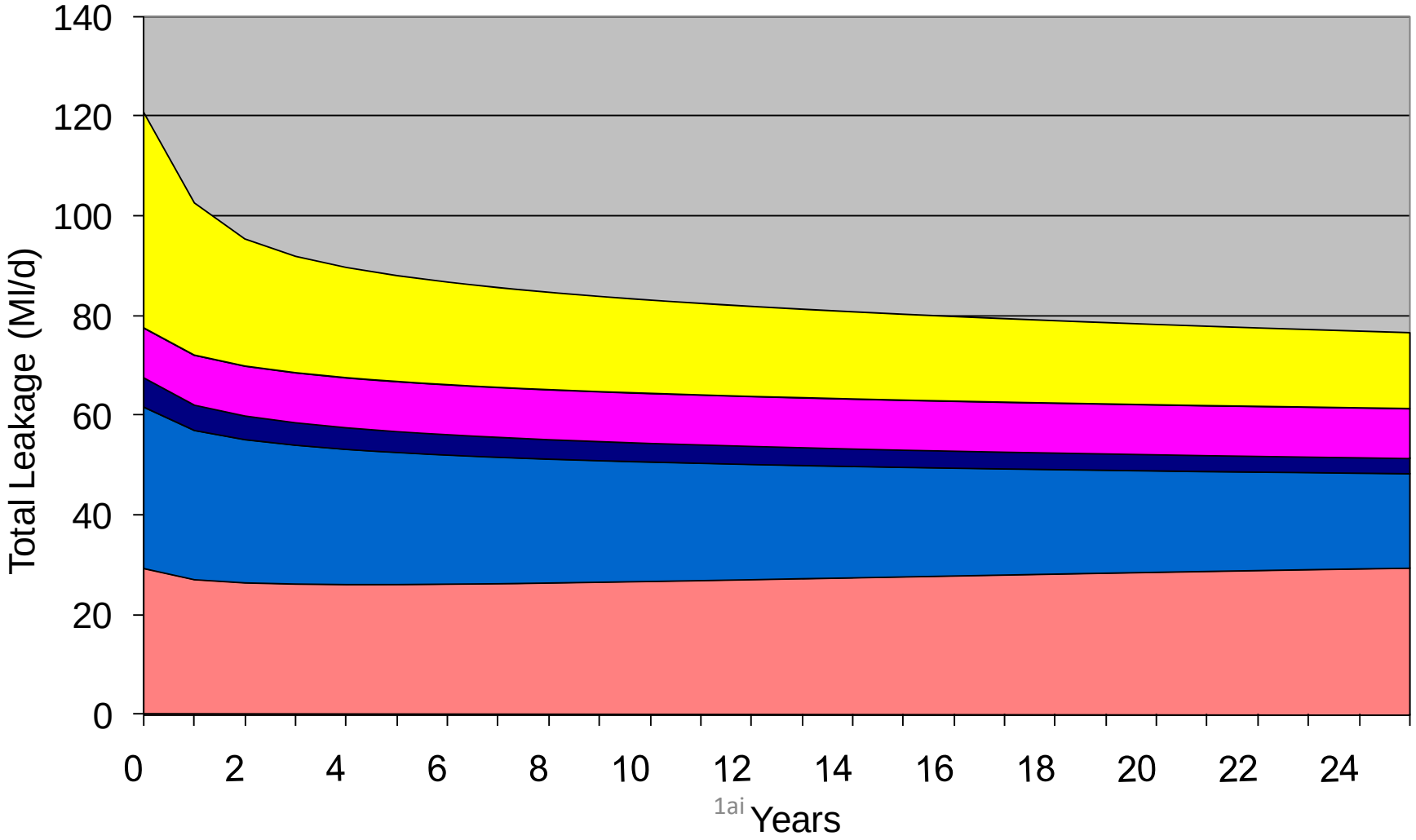
Outputs: plus ALC



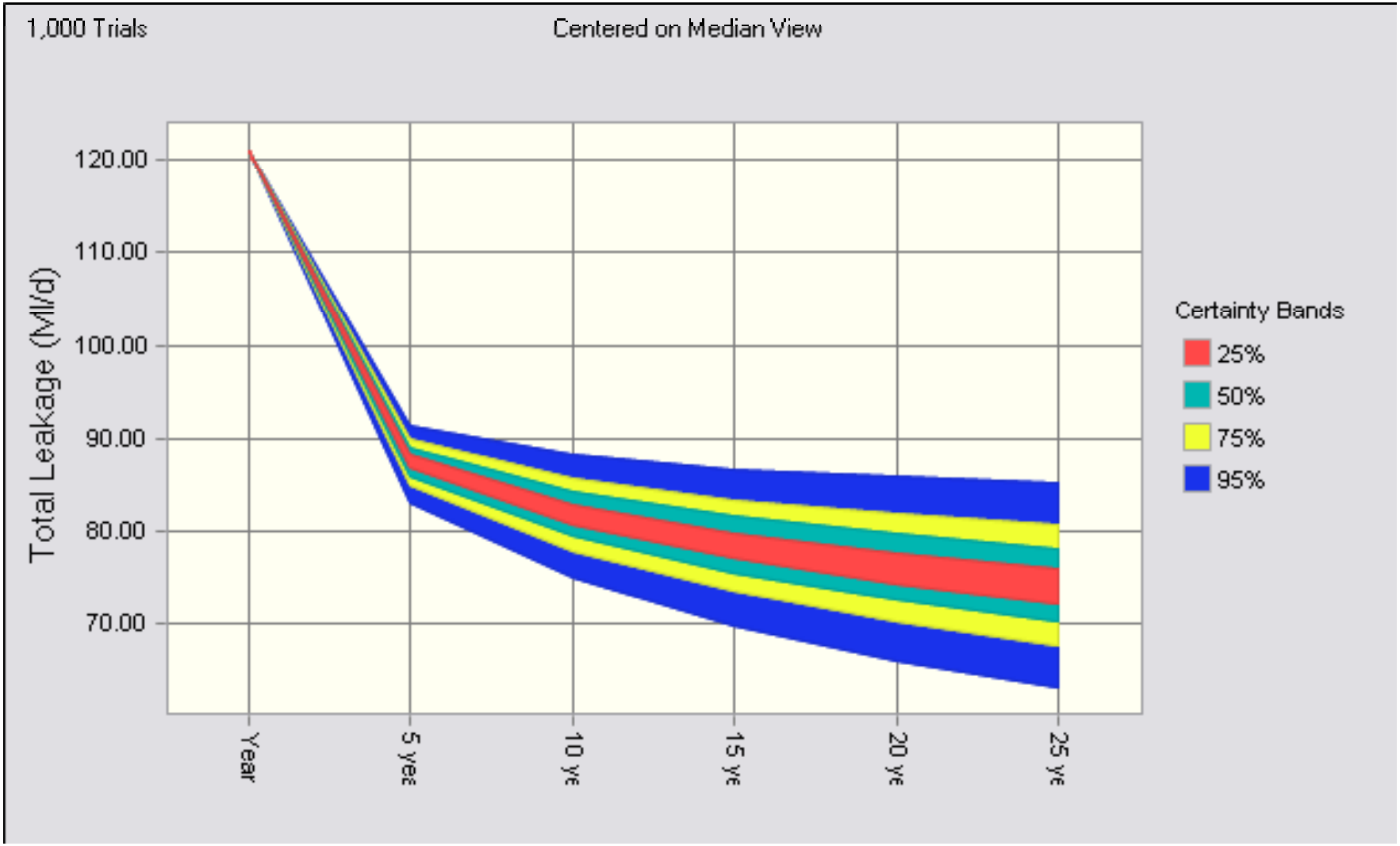
Output: plus pressure management



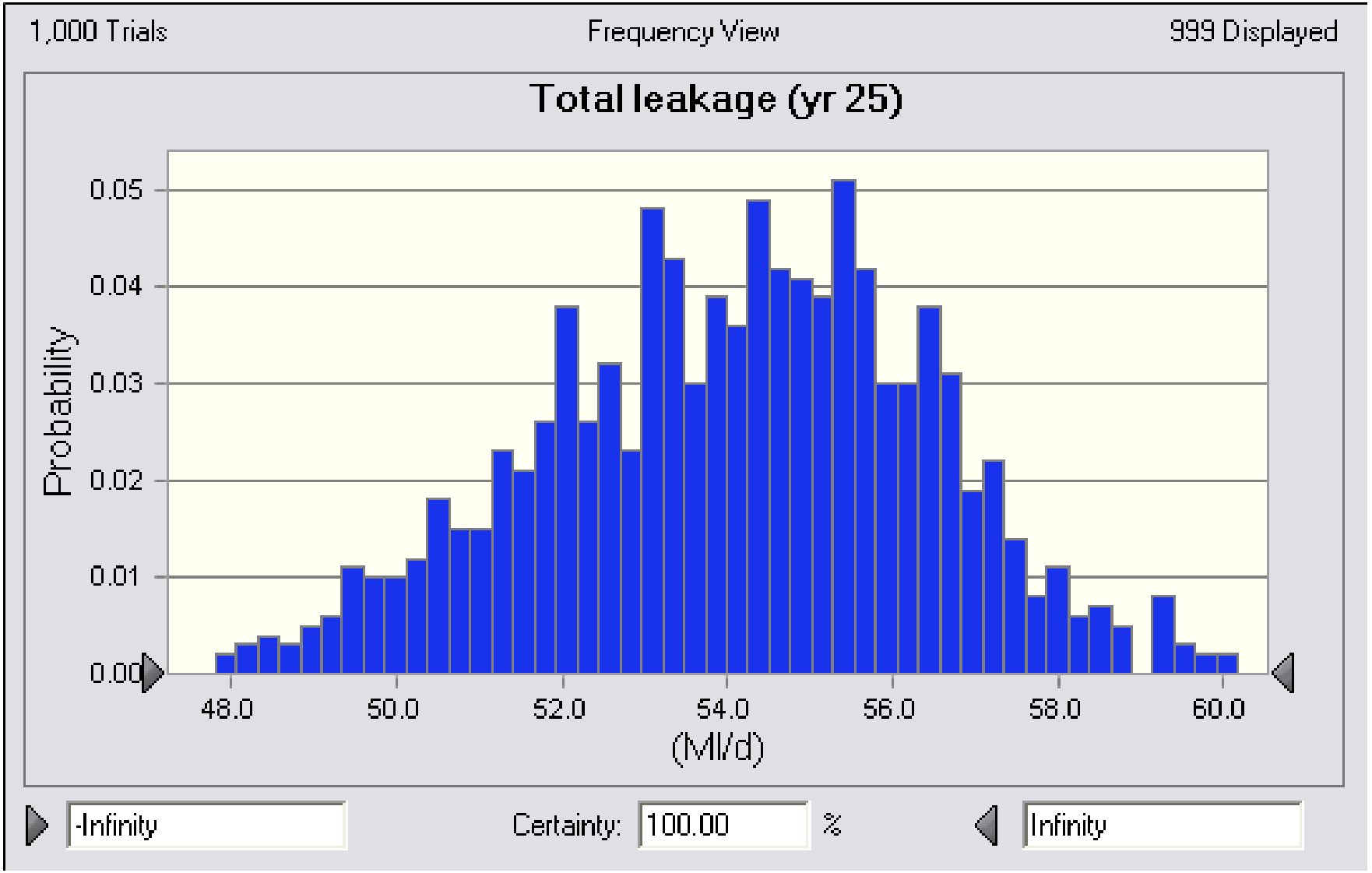
Lowest cost solution: minimum NPC



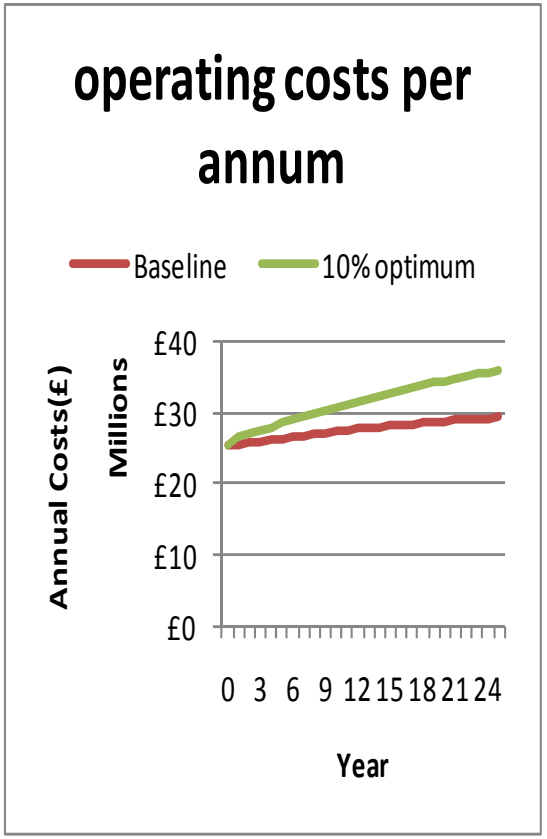
Uncertainty in lowest cost leakage forecast

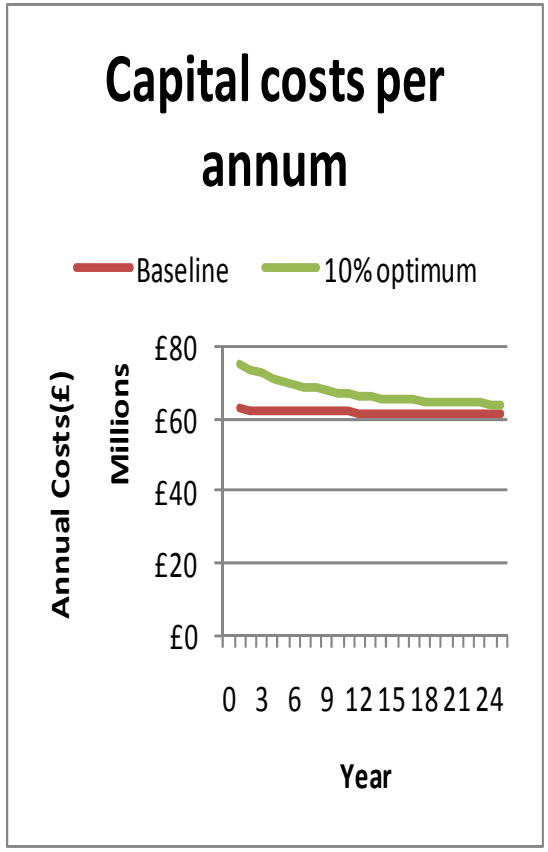


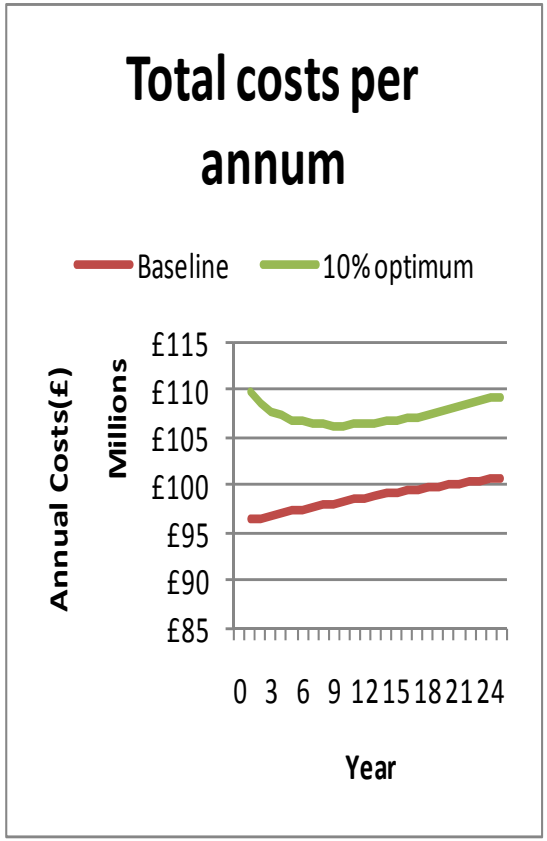
Sensitivity test optimum yr 25 leakage



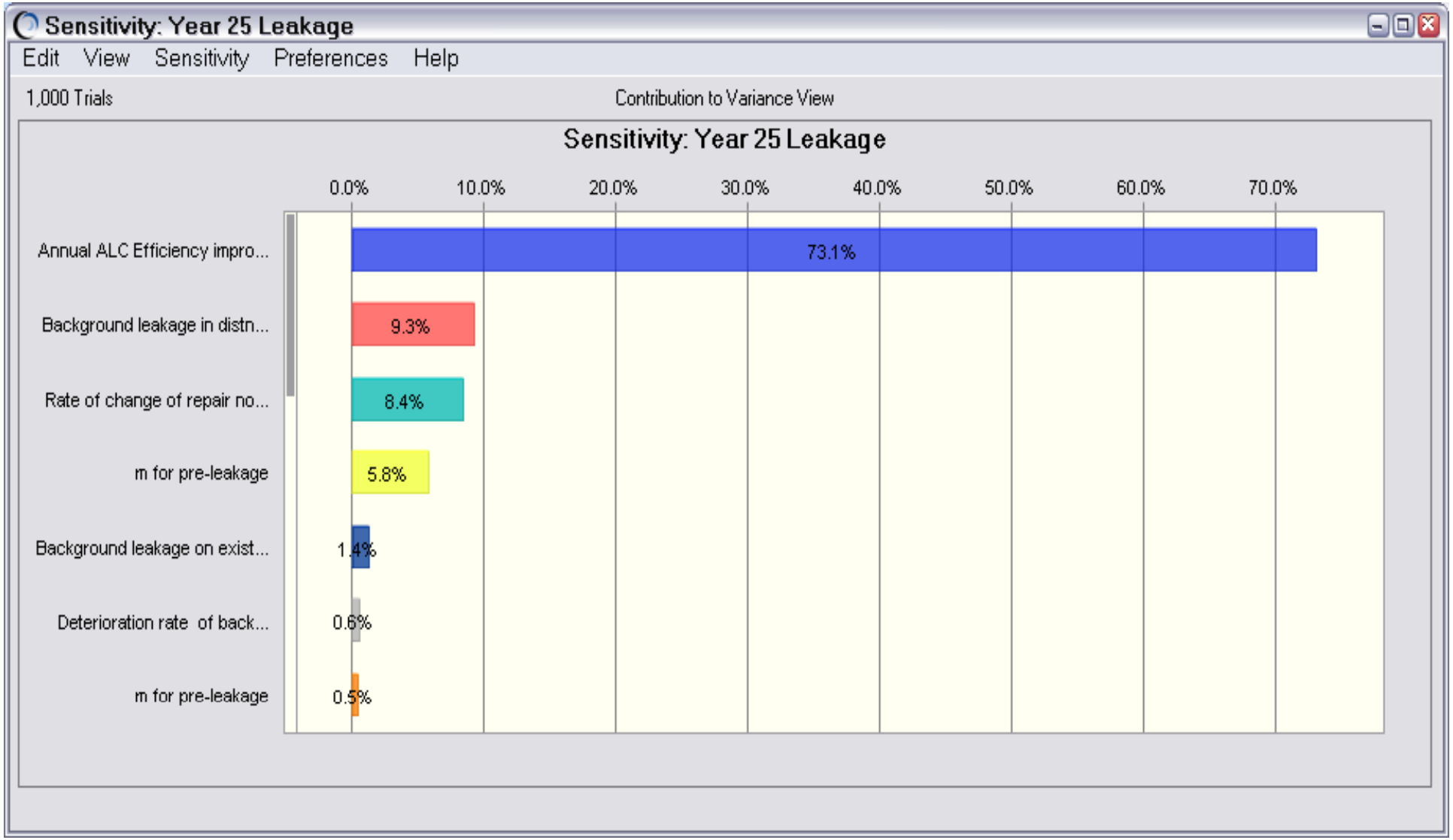
Outputs: financial projection







Contributions to the uncertainty



Conclusions

This approach provides a way to assess:

- the optimum long term leakage level
- The uncertainty in that leakage forecast
- the uncertainty in the expenditure forecast
- the parameters that contribute to the uncertainty

The approach was:

- Developed to understand long term leakage levels in whole countries
- Customisable to individual companies and individual supply zones

Thank you

Steve.Tooms@hyderconsulting.com

StuartTrow@hotmail.co.uk