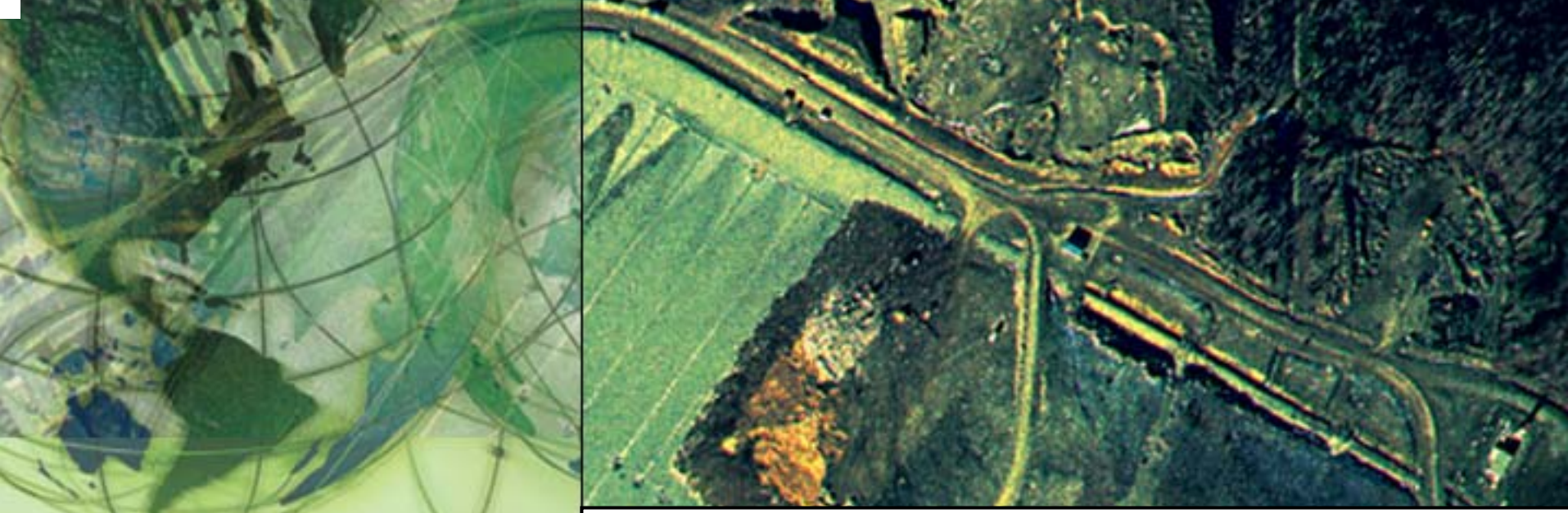

Monolithic WAC

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Introduction

- Waste Acceptance Criteria (WAC) are about to be introduced for wastes sentenced to hazardous and inert waste sites, or for stabilised non-reactive hazardous wastes sentenced to non-hazardous landfills.
- These criteria (agreed by the European Council) cover granular wastes only and not monolithic waste forms.

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Introduction

- The EC has left it to Member States to develop criteria for monolithic wastes that provide comparable environmental protection.

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Monolithic

Island of Rhodes…..
This monastery sits on a monolith


Μονόλιθος
Monolithos

Leaching

- Monolithic wastes leach via diffusion.
- Testing usually via a tank test over a period of a few days up to 64 days.
- Test yields data on the rate of leaching (mg/m^2 over a set time period).

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The Challenge

- To develop a set of criteria that matched the environmental protection standards of the granular wastes but for a different contaminant source term.
- The generalised scenario (hydrogeological conditions, site size and liner degradation rates) remained the same as that used for granular wastes.

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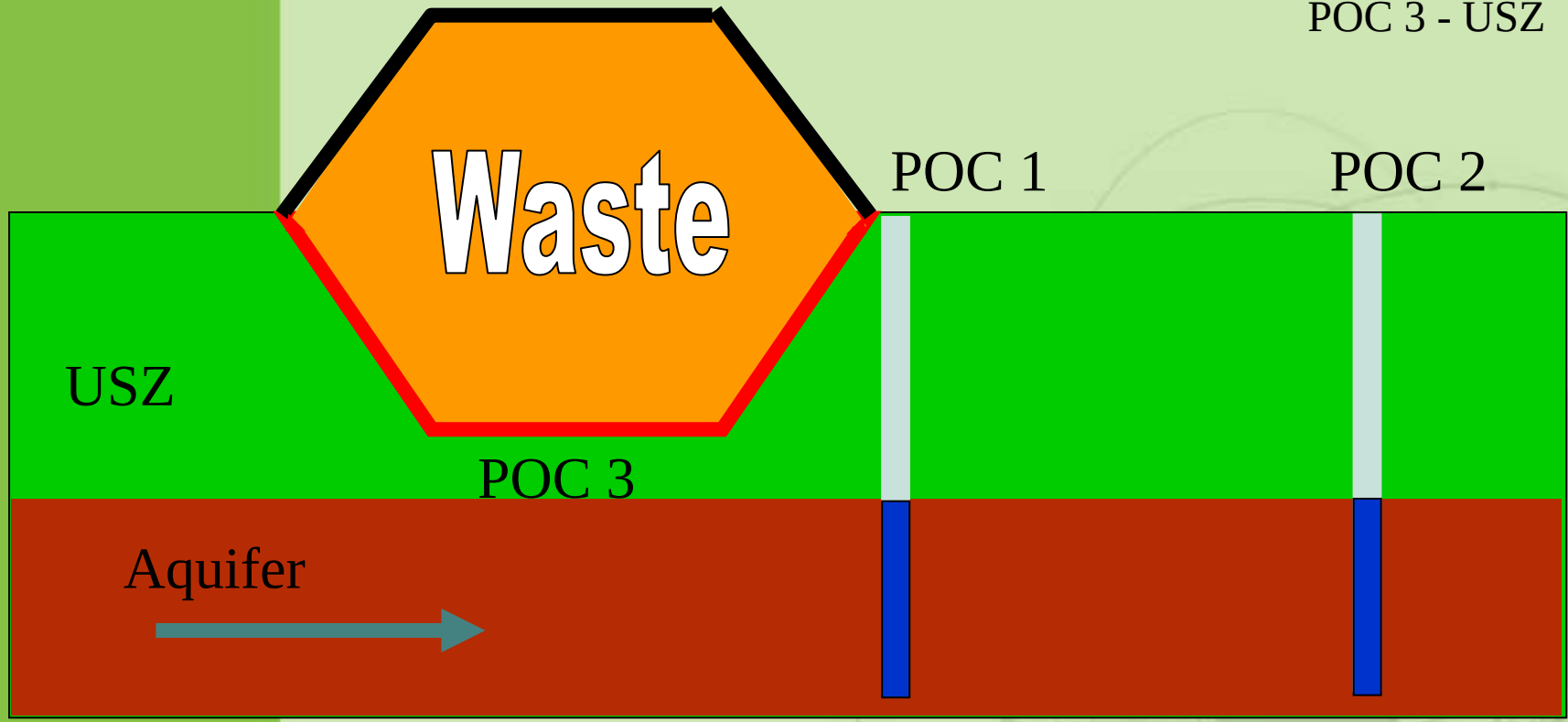
Geometry

Site 200x200x20m
≈ 800,000m^3

POC 1 - 10m
POC 2 - 200m
POC 3 - USZ



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Engineered Barrier

- Liner comprised an high density polyethylene / clay composite liner.
- Membrane component assumed to become non-effective at 250 years

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Leachate Generation

- Leachate generation solely from infiltrating rainfall.
- High rates of infiltration during operational period (250mm/y)
- Lower rates after site completion and capping (50mm/y)

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Source Term Evolution

- Initially attempted to use the Crank Equation but this infinite series needed the first 100,000 terms to be solved to give a stable solution and also required information that is not always readily available.
- Settled on the following:

$$\frac{\sum emission\ to\ t_2}{\sum emission\ to\ t_1} = \frac{\sqrt{t_2}}{\sqrt{t_1}}$$

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Modelling Method

- The modelling was conducted using an implementation of the LandSim algorithms within the performance assessment model GoldSim.
- This provided a highly flexible modelling environment that allows results mining and relatively easy modifications to inputs and algorithms.

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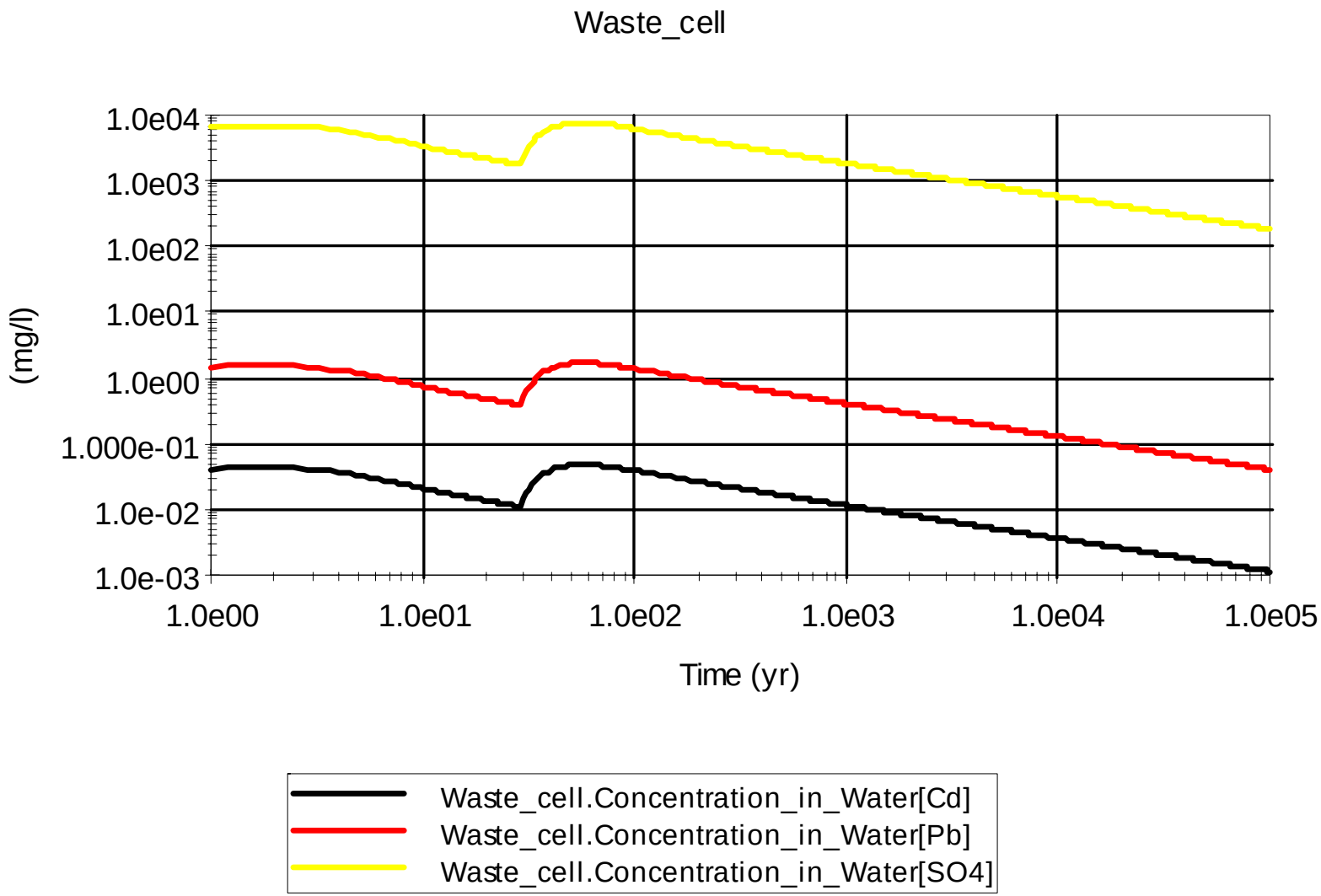
Leachate Source Term



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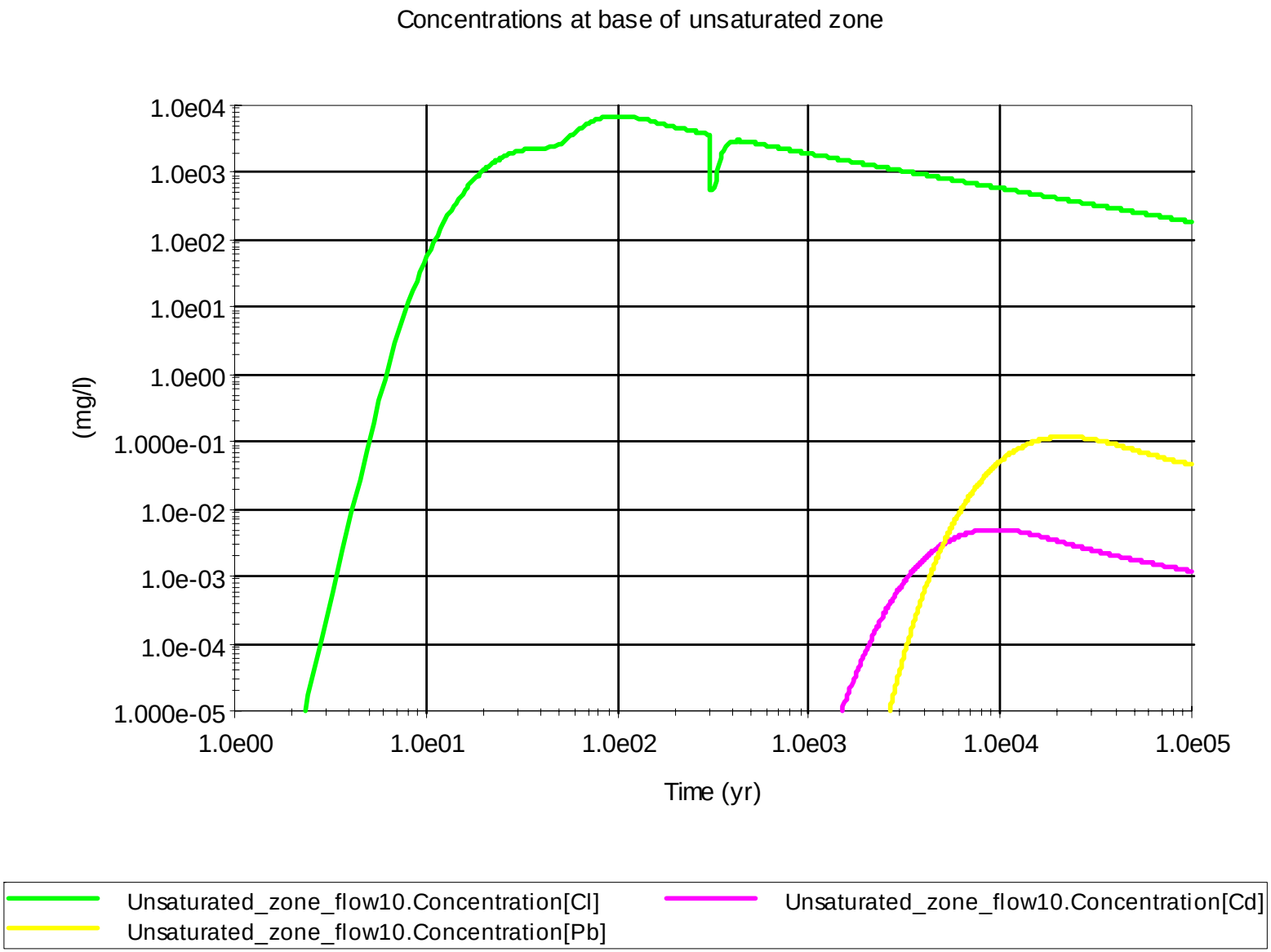
Base of the Unsaturated Zone



Method

- The Water Quality Standards defined for the granular WACs have been used in this study.
- The model is run with an initial “good guess” of the likely emission rate for each of the contaminants considered.
- The model is then allowed to run sufficient iterations to converge on an emission rate (for each contaminant at its respective receptor point).

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Sensitivity

- There were a few unknowns that needed specific attention:
  - Surface area for diffusion to occur (related to block size)
  - pH dependent solubility
  - Availability and depletion
  - Filling Sequence of the landfill

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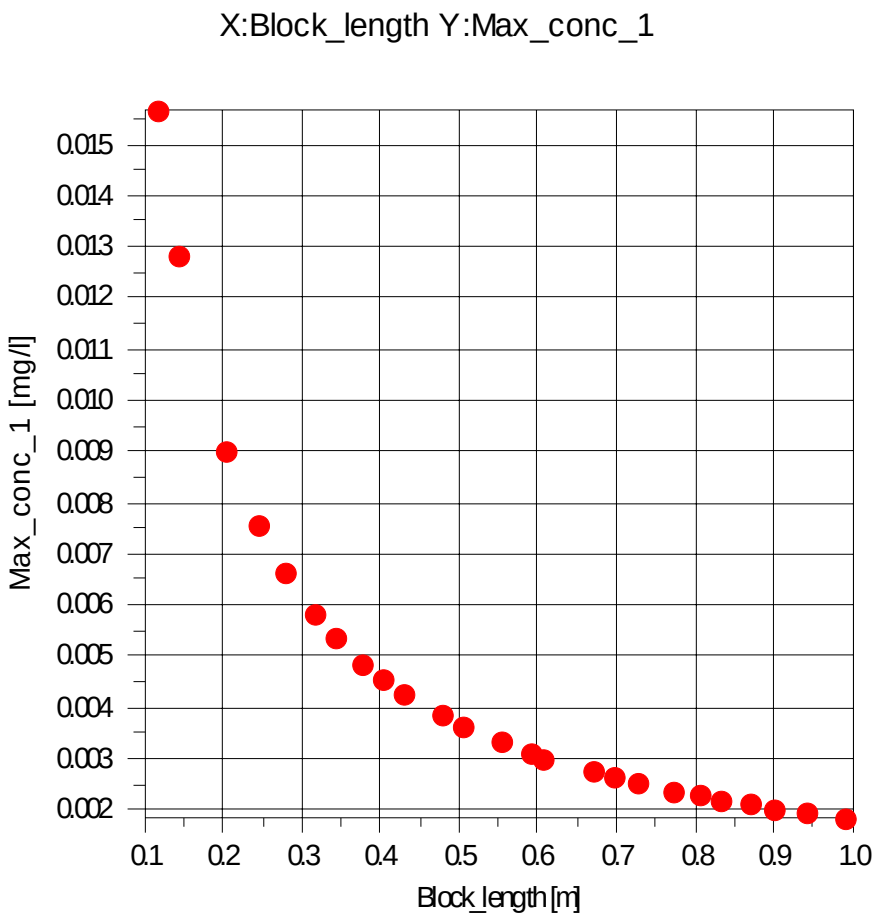
Fracture Area



Copper – displaying idealised relationship

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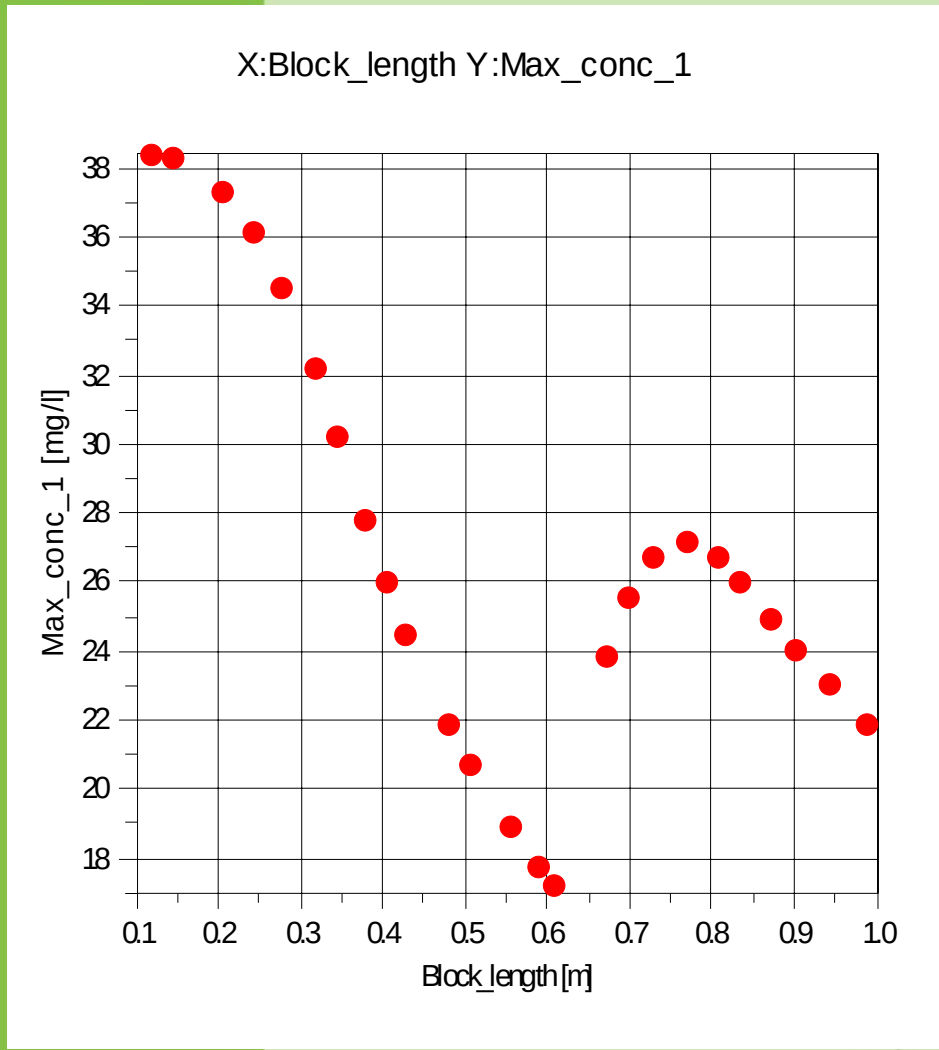
Fracture Spacing



Sulphate - more complex response

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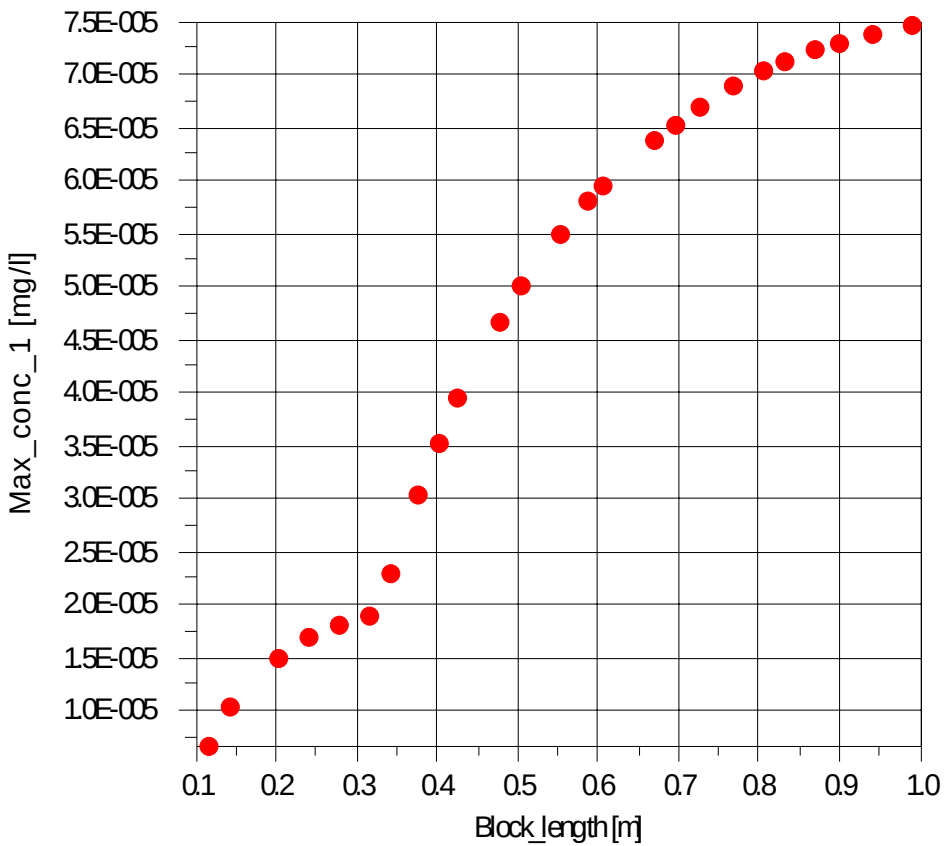
Fracture Spacing



Arsenic – completely counterintuitive response

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Conclusions

- WAC for monolithic wastes have been derived
- Sensitivity analyses showed:
  - Insensitive to filling sequence
  - Minimum fracture spacing should be 0.4m
  - Factors such as pH dependency and availability important for the any site specific risk assessment, but not for the setting of WAC values

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Acknowledgements & Disclaimer

- I am indebted to my colleagues at Golder Associates for the assistance given during this project
- The views expressed in this presentation are solely those of the presenter, and not necessarily those of the Environment Agency who funded this work.
- Thank you for your attention.

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