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Essentials of CLM 4

Remediation and Risk Management

October 2024

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IAQM Institute of Air Quality Management

The Scottish Government

ENVIROCONSULT
Environmental and acoustic consultancy

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AECOM

SBS
SOUND BARRIER SOLUTIONS

Programme of the day

October 2024

Session 1: What is Risk Management?

Session 2: Waste Legislation

Session 3: Remedial Techniques (Part 1)

Session 4: Remedial Techniques (Part 2)

Session 5: Options Appraisal

Session 6: Remediation Strategy and Verification Reports

Air Quality Monitoring

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At Ricardo we have a dedicated team of AQ specialists and look forward to helping you with any of your air quality challenges:

- ISO 17025 UKAS accredited **QA/QC audits** – required by LAQM TG (22)
- **Data management**, data collection, checking, validation, ratification etc
- **Local site operations**, calibrations/call outs
- **Web reporting**
  http://www.airqualityengland.co.uk/
- **Routine data reporting** –
  weekly, monthly, quarterly, annual – for example
  http://www.airqualityengland.co.uk/assets/reports/291/KensingtonChelsea_month_2019_01.html
- **Short term monitoring surveys**
  (site installation/decommissioning through to reporting)
- Long term station hire
- Free advice on station installation and best practice
- Procurement of analysers and installation to LAQM TG (22) or AURN standards

- **Low cost sensor measurements**, network management
- **Real world vehicle emissions monitoring**
  aiding Action Planning
- **Mobile Monitoring**
  for point source and concentration contour mapping
- **Diffusion tube surveys**
- **Air quality forecasting** and public dissemination
  (via sms text, email, web, social media etc.)
- Air quality reporting
- LAQM TG (22) Annual Status Reporting (ASR), Detailed Assessment
- CAZ/LEZ consultancy
- Expert witness and Expert Advice
- Air Quality Modelling

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RICARDO EMAQ+

Judith Nathanail

- Director of Land Quality Management Ltd
- Environmental Consultant > 30 years
- Experienced in all aspects of contaminated land management, PRA, site investigation, risk assessment and remediation.
- Peer review of reports for various Local Authorities
- Trainer with EMAQ since 2005

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Essentials of Contaminated Land Management

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- 5 “stand-alone” seminars/webinars that, together, comprise a complete ‘Essentials of CLM’ Training Course
- A partnership between an individual and his sponsoring authority or organisation
- Curriculum based on the EMAQ Essentials Syllabus and government guidance
- Combines knowledge with practical experience of contaminated land management to:
  - Provide evidence of an individual’s ability to implement Contaminated Land Management (CLM) requirements;
  - Build the individual confidence to operate effectively.

Essentials of Contaminated Land Management

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KEY ELEMENTS

1. Register and identify a “supervisor”
2. Attend the seminars\webinars
3. Demonstrate an understanding of the seminar\webinar material – via an on-line knowledge check,
   (A CLM credit will then be issued in addition to the CPD certificate that all those attending will receive.)
4. Agree a development programme with a supervisor (or mentor) which, by the end of the five seminar\webinar programme, will show evidence of having satisfactorily undertaken the following practical operations of CLM:

   - Procedural / Legal
   - Practical / Technical
   - Management

   (supervisor to verify attainment)

Essentials of Contaminated Land Management

A Certificate in Contaminated Land Management will be issued to those who have:

- Registered and paid the fee
  - Contact EMAQ for current fee
- Gained all 5 credits
- Successfully sat the on-line ‘Proficiency Test' designed to show a co-ordinated knowledge of all the aspects of CLM programme
- Whose Supervisor has:
  - verified the bona fides of the candidate and that the test was undertaken under the required conditions
  - confirmed that the candidate has had experience of the practical elements of CLM listed in their development plan

Essentials of Contaminated Land Management: Mechanics

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- Online: instructions, registration, testing, record updating, certificate production
- Register – via the EMAQ+ website
    - include the name and contact details of supervisor
- Attend live seminars or view webinars on-line
- Obtain CLM credit via on-line ‘Knowledge Check’ 20 multi-choice questions which are to be completed on-line within one unbroken 2 hour period, gain a pass by getting 75% or more correct
    - Knowledge Check opens same time as webinar and delegates have 3 opportunities to pass
    - Proficiency Test, 20 multi-choice questions, drawn from the entire syllabus
    - When logging on, supervisor will be asked first to verify the candidate’s identity
    - Supervisor to verify practical experience
    - 20 test questions which must be undertaken within an unbroken two hour period
    - Successful candidates must correctly answer 75% of the questions. Candidates will have 2 opportunities to pass

Essentials of Contaminated Land Management: Modules

1. Introduction to Land Contamination Risk Management
2. Site Characterisation
3. Risk Assessment
4. Remediation and Risk Management
5. Peer Reviewing Third Party Reports

CLM 4 – Remediation and Risk Management

Session 1

What is Risk Management?

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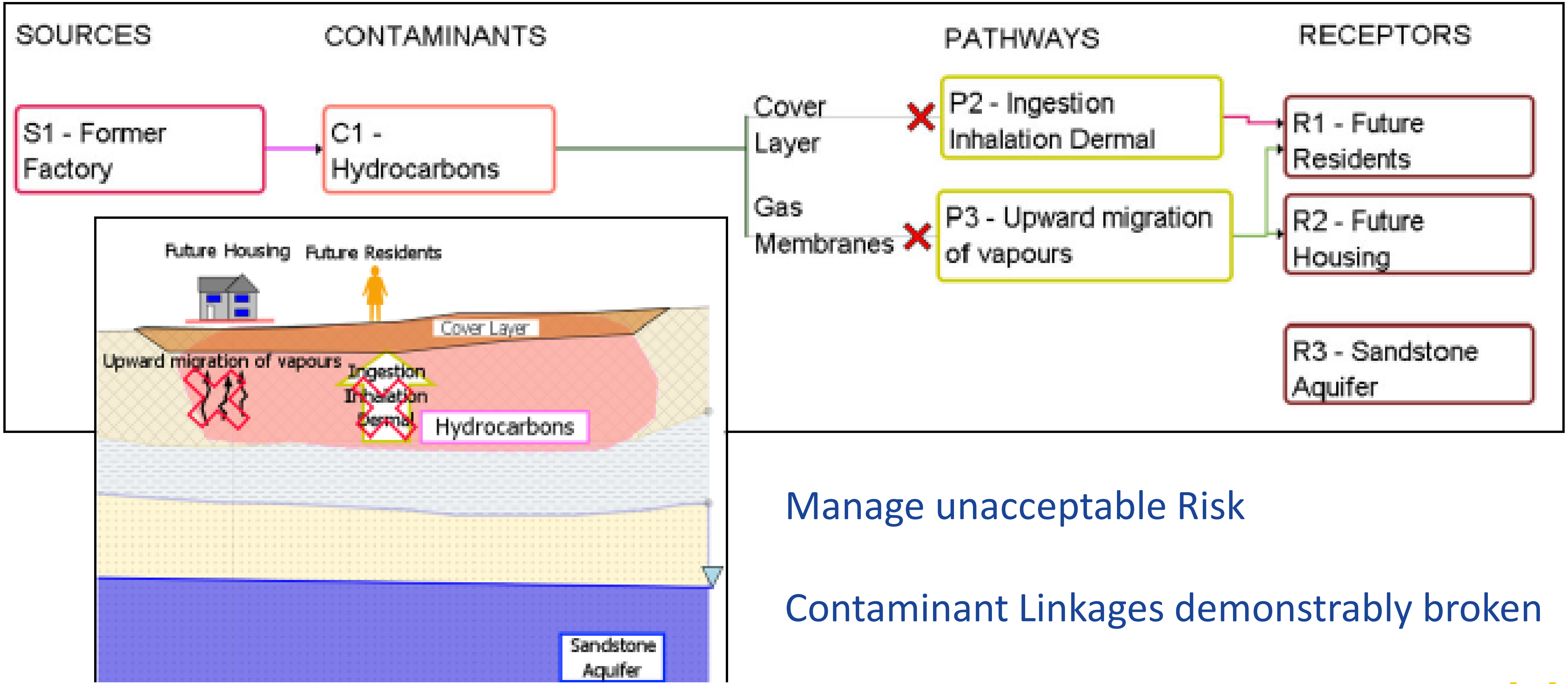
Defensible decisions

What is Risk Management?



Manage unacceptable Risk

Contaminant Linkages demonstrably broken

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Is risk management needed ?

- Depends on legal context
  - Planning/Building control: Only if pollutant linkage(s) pose **unacceptable risks** (cf NPPF: safe and suitable for use)
  - Part2A: Only if contaminant linkage(s) pose "**significant possibility of significant harm**" or "significant possibility of significant pollution of controlled waters**"**
    - subject to other tests in Statutory Guidance
- How do I know ?
- Need good conceptual model based on:
  - Good practice guidance
  - Competent SI - Sufficient quantity and quality of data to support decision
  - Suitable quantitative risk assessment for **all** potential receptors (including people and controlled waters)

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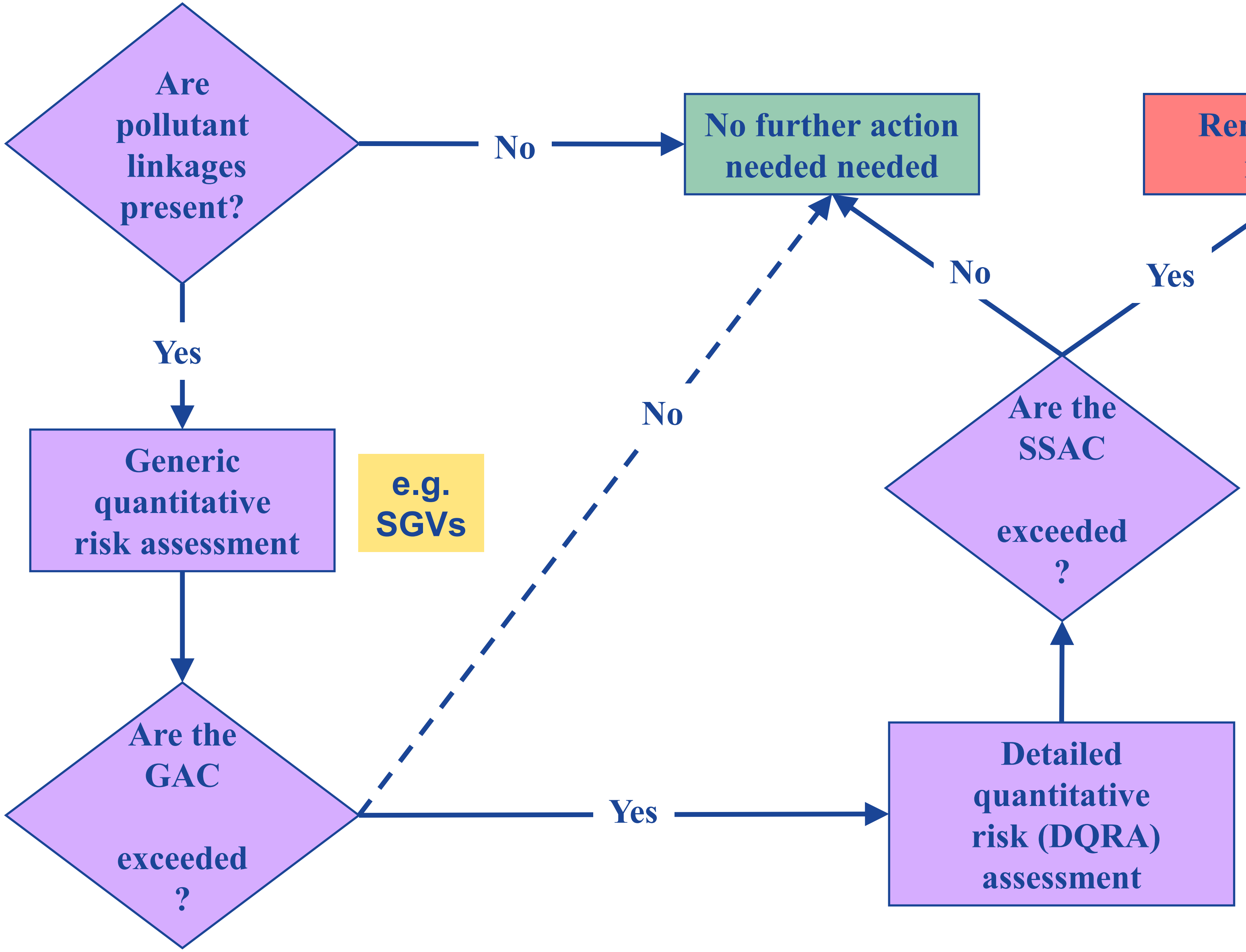

Are pollutant linkages present?
No
No further action needed needed
Remediation needed
Yes
No
No
Yes
Generic quantitative risk assessment
e.g. SGVs
Are the SSAC exceeded ?
Are the GAC exceeded ?
Yes
Detailed quantitative risk (DQRA) assessment

Competent and robust DQRA may:

- Show no risks need managing (no remediation)

OR

- Limit scope of remediation by:
  - Demonstrate some materials are “suitable for use”
  - Reduce volumes needing treatment
  - Reduce the level of treatment needed
- Save time and money

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Aim of risk management

<u>Demonstrably break</u> all the pollutant linkage identified in the <u>conceptual model</u>

- Regulators and stakeholders will require proof
- Verification is a key component not an afterthought
- All linkages must be broken
- Any remaining linkages still pose unacceptable risk:
  - Not "suitable for use"
  - Potential Part 2A

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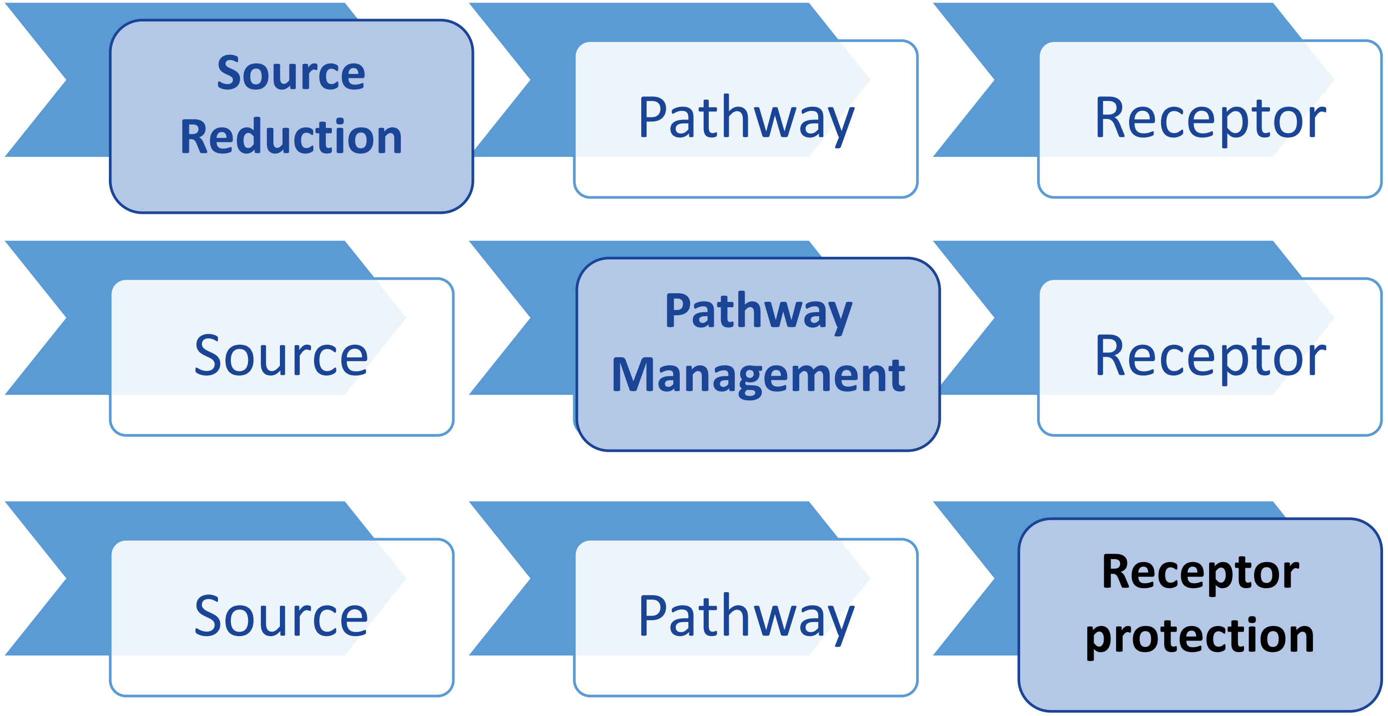
Approaches to breaking linkages



- Risk Management may involve:
  - Risk reduction (i.e. remediation); or
  - Risk avoidance
  - Both have their place, when appropriate

Source Reduction

- Reducing, removing, modifying or destroying the source of contamination
- Applicable techniques include:
  - Excavation and disposal
  - *In situ* or *ex situ* methods:
    - Physical
    - Biological
    - Chemical
    - Thermal

Risk Management

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Pathway Management

- Preventing the further movement of contaminants *en route* to receptors
- Applicable techniques include:
  - Remove/destroy contaminants during migration e.g. sparge curtain, bioactive zones, PRBs
  - Prevent pathway operating e.g. capping, stabilization techniques, slurry walls

Risk Management

Receptor Protection

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- Protecting the receptor by modifying activities/behaviour to reduce exposure
- Not usually classed as remediation but risk management or risk avoidance:
  - Install alternative water source
  - Restrict or change land use
    - Residential with gardens → without gardens
  - Use alternative design/layout or construction techniques
    - Hard standing or landscaping problem areas
    - Using different construction techniques and/or materials
  - Restrict access of receptor
    - Fencing, security, ditches etc.

Risk Avoidance

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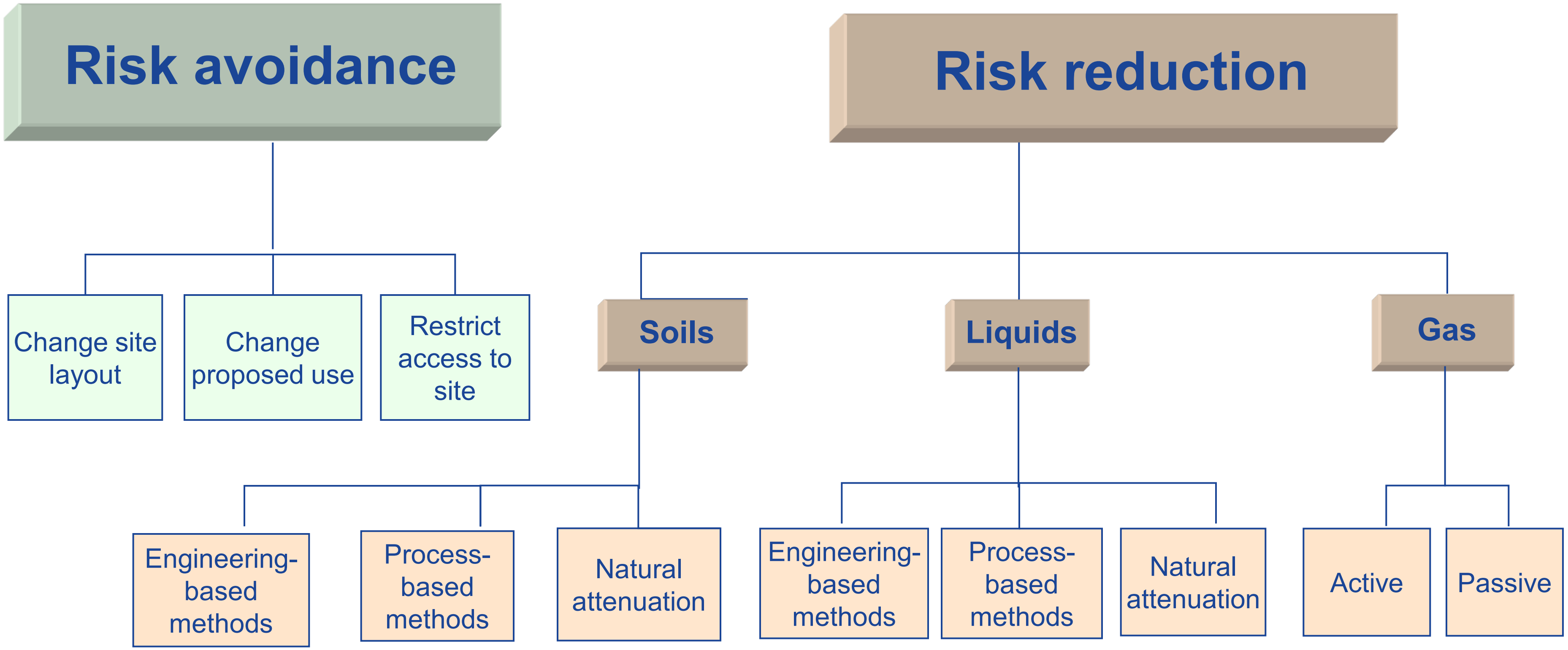
Classification of technique



Multiple media & multiple contaminants

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- Multiple contaminants are present at most sites
  - A few techniques are appropriate for a wide range of contaminants
    - e.g. excavation and disposal to landfill
  - Most techniques are suitable for distinct subsets of contaminants
    - e.g. SVE for all volatile contaminants
    - e.g. composting good for many organics but not metals
  - A combination of techniques is often needed e.g. for organics and metals
- Soil and groundwater may be dealt with together or separately
- Gas issues usually addressed separately
  - Not covered today

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Classification of Technology Types

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- On site or off site
- Contaminant or matrix treated
  - organic, metal *etc.*
  - soil, groundwater, NAPL, vapour *etc.*
- Active or passive
- *In situ* or *ex situ*
  - ***Ex situ*** - excavated contaminated material is treated on site or off site at a fixed treatment facility
  - ***In situ*** - contaminated material is treated at source or along its pathway with minimal disturbance to the subsurface

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Advantages:

Ex situ

- Improved control of process conditions
- Improved contact of contaminants with process reagents
- Control of process emissions
- Relatively short treatment period (months)

In situ

- Less intrusive approach
- Less capital expenditure
- Production of less process emissions and secondary wastes
- Perceived as being less damaging to soil structure

Disadvantages:

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Ex situ

- Excavation of contaminated material can increase their mobility
- Excavated material requires pre-treatment e.g. screening
- Changes soil structure

In situ

- Relatively long treatment period (months to years)
- Poor delivery of process reagents and additives to contaminated area

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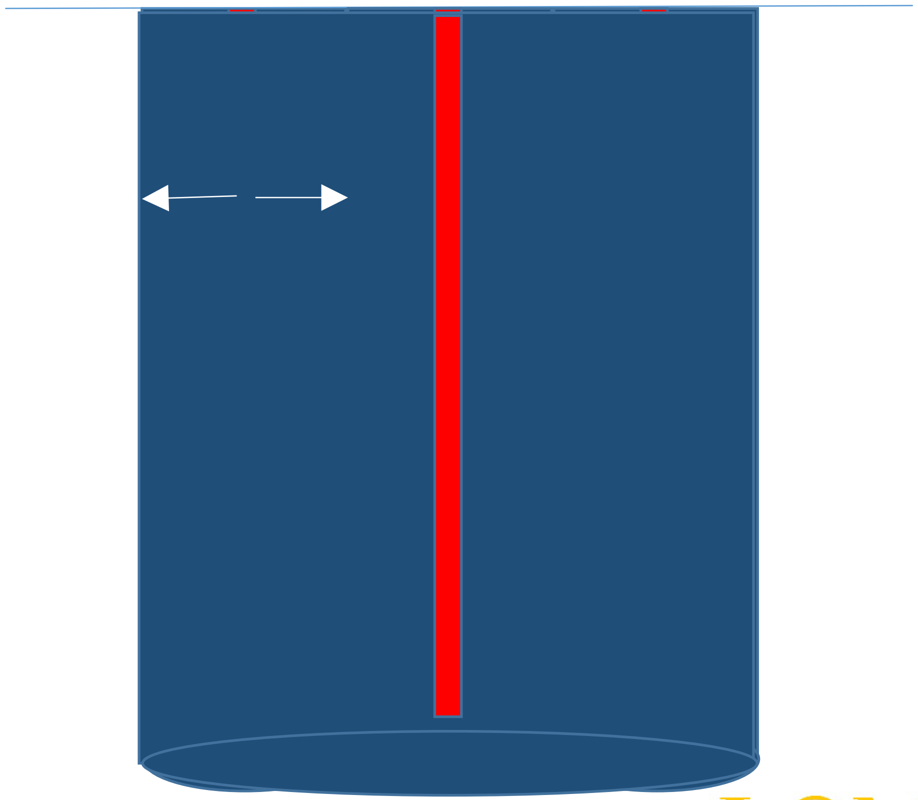
In situ terminology:
Zone of influence

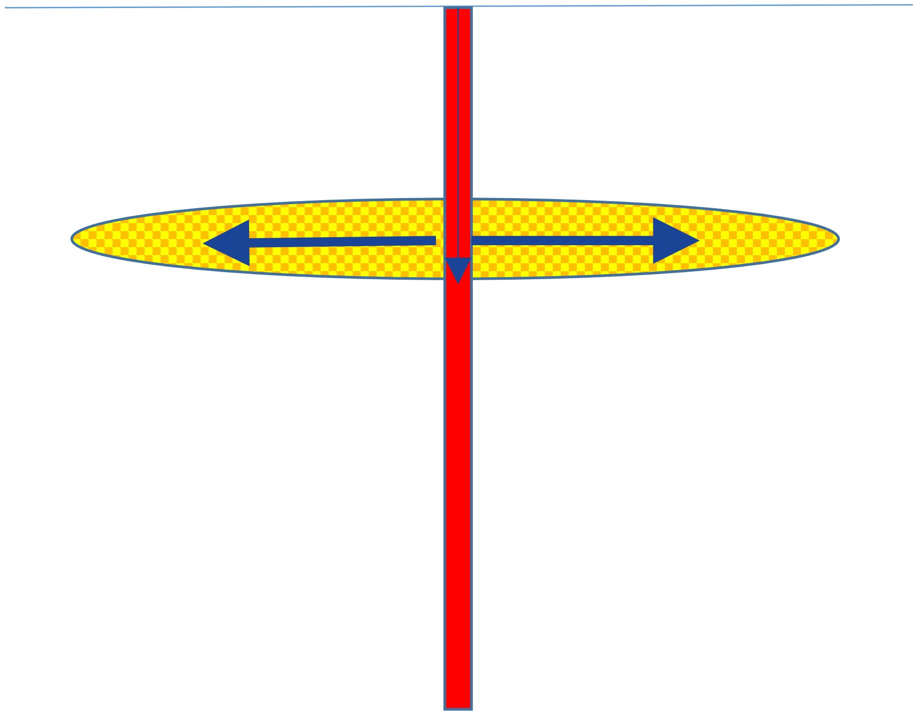
- The area or zone influenced or treated around each treatment point or well
- Critical design parameter
  - Large ZoI → few wells → lower costs
- Normally established in pre-treatment trials



In situ terminology:
"short circuits"

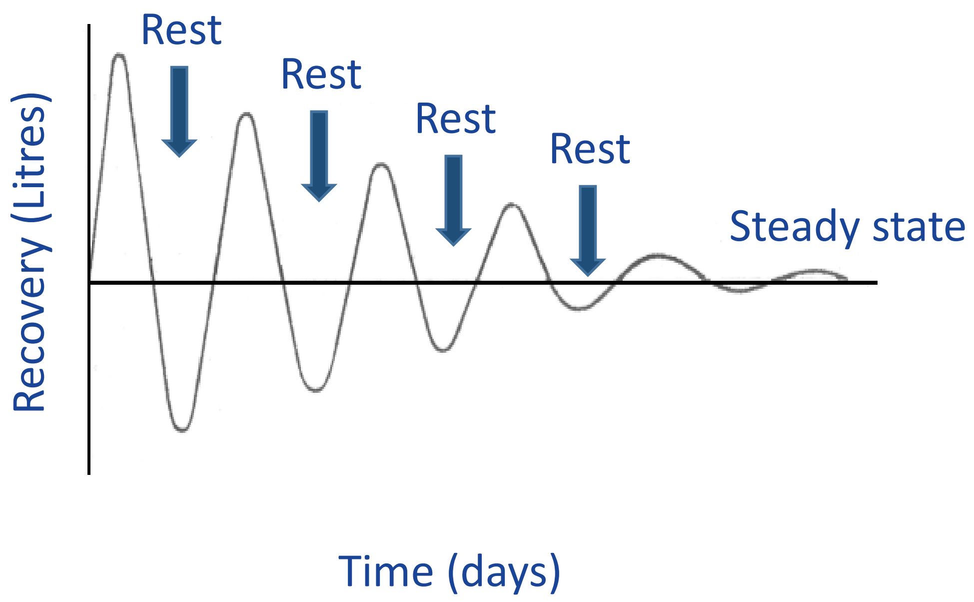
- Mechanisms by which effective treatment does not occur due to lack of control of subsurface injection of extraction
- Usually due to natural or man-made heterogeneity in the ground
  - Particularly in permeability
- For example, due to:
  - sand or gravel lenses
  - Backfill in service runs

Actual injection/treatment



In situ terminology: Rebound

- Mainly relates to in situ treatments
  - But can apply to some ex-situ methods
- Describes the (apparent) return of contamination after effective treatment
- Possibility of rebound should always be considered
  - Rest entire system then reactivate?
  - Rest individual wells?
  - Switch between active and passive treatments
    - eg SVE and bioventing – more later



Current Trends

- "Dig & dump" (and capping if excavation needed) have become less financially viable
  - But the only last minute options
- Better classification of waste soils:
  - Use of DQRA – does it need treating?
  - **Delineate hotspots– treat only what needs treating!**
  - **Strict separation of haz and non-haz soils - minimise hazardous waste needing treatment!**
  - Use of rapid field measurement techniques
- Switch to more sustainable soil treatment technologies?
  - Including in-situ and off-site treatment centers
  - Up-to-date data on the UK market is difficult to obtain. **But….**

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Soil Treatment Facilities

- Avoids landfill tax
- Initially generally associated with landfills or former quarries
  - used treated soils as daily cover or landscaping materials
- Increasing numbers supplying reused aggregates - “circular economy”
- Treat excavated soil and stone - eg hydrocarbon, asbestos, heavy metals
- May utilise 1 or more technologies:
  - Biopiles and windrows
  - Soil washing
  - Solidification (Reused as aggregate)
  - (Thermal desorption)

Soil Treatment Facilities

News ▸ Nottingham News ▸ Retford

Health concerns over plans to process asbestos-contaminated soil at recycling tip near Retford

Local residents say the site could be a danger to public health

SHARE COMMENTS

By **Emily White**
15:56, 8 SEP 2020 | **UPDATED** 12:13, 10 SEP 2020

Concerns have been raised over plans to process 30,000 tonnes of asbestos-contaminated soil a year at a recycling centre near Retford.

Plans for a new soil treatment facility and asbestos picking operations located at Daneshill Landfill Site on Daneshill Road **in Lound** have been lodged with **Nottinghamshire County Council.**

The plans would see 500,000 tonnes worth of soil, including asbestos-contaminated soil processed at the site and used to cap the landfill site, imported into the site from building sites and sites of demolition.

The proposals state that the asbestos would be removed from the soil in a contained picking station before being used to fill in the former landfill.

The planning application states: "This application, therefore, provides confirmation of the material to be brought into the site and subsequently used to fill the remaining landfill void and restoration area.

"The fill was always required to be imported into the site at a point in the lifetime of the landfill site to complete the restoration process.

"As such, the principle of importing waste material was already established when the landfill site was granted its original permission and this proposal will ensure that the restoration is completed in a timely and compliant manner."

https://www.nottinghampost.com/news/nottingham-news/retford-daneshill-asbestos-recycling-landfill-4486482

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Summary

- Risk management vs Remediation
- Contaminants can be treated
- Remediation classification
  - Different approaches
    - Source removal /Pathway interruption / Receptor protection
  - Process
    - Biological /chemical /physical...
  - Where contamination is treated
    - In situ
    - ex situ (including soil treatment facilities)

Session 2

Waste Legislation

Including EU and UK legislation, what is waste, DOWCOP, Landfill tax, environmental permits

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UK Waste Policy

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- Promote sustainable waste management based on the waste hierarchy:

  - Reduction/prevention
  - Reuse
  - Recovery
  - Disposal

Most Preferable

Least Preferable

After Environment Agency presentations at FIRST Faraday Remediation courses, 2005

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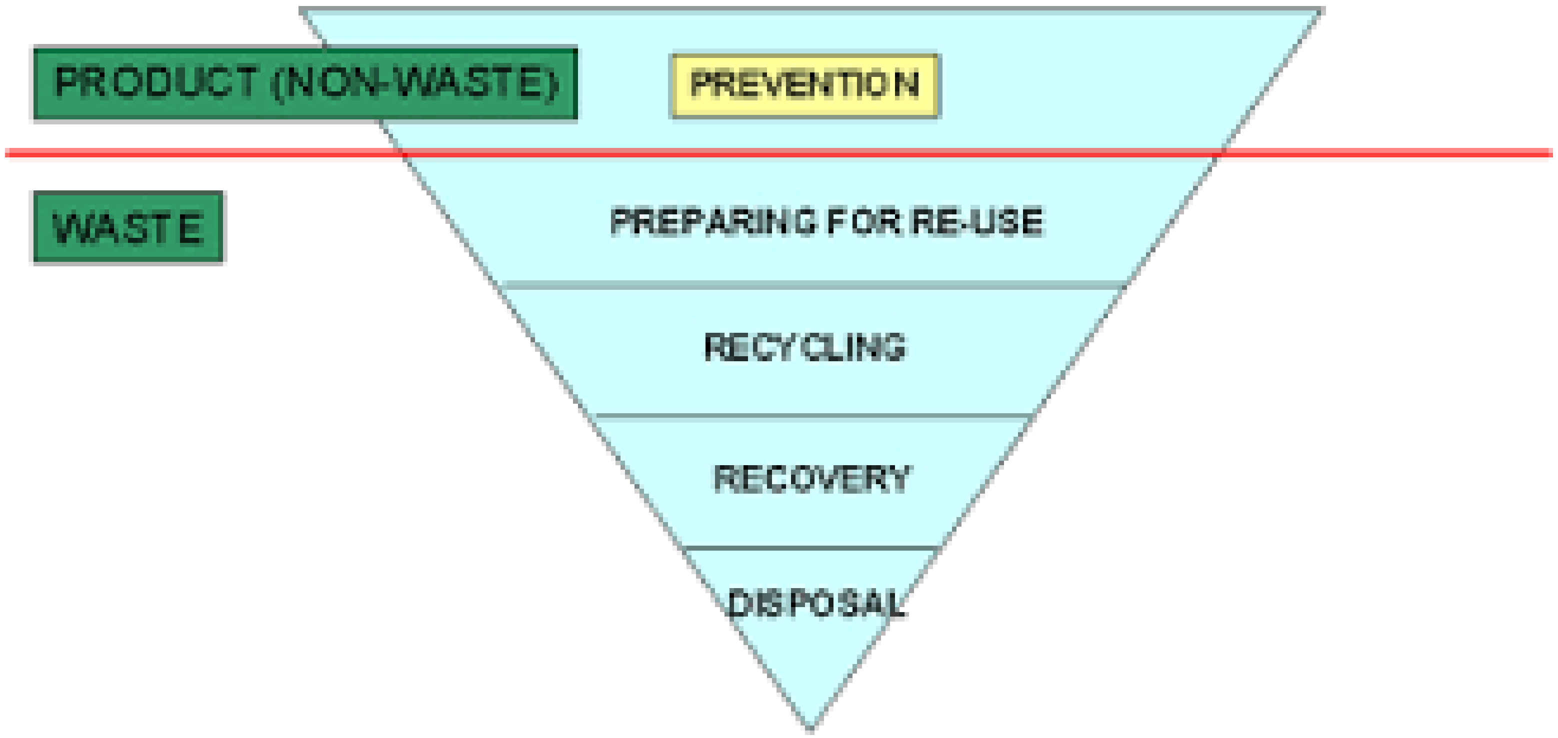
Waste Hierarchy - Soils



DQRA

CL:AIRE DOW:COP
Definition of Wate:
Code of Practice

Directive 2008/98/EC on waste (Waste Framework Directive)

Waste legislation may affect:

- Contaminated and uncontaminated soils:
  - Whether you can move soils around your site
  - Whether you can move soils to another site
- Contaminated soils
  - Whether and how you can dispose of soil to landfill
  - Whether you can treat the soil at your site
  - Whether you can treat the soil at another site
  - Once treated, Whether you can reuse the soil at your site
  - Whether you can import clean or treated soil from another site
- *i.e.* everything!

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EU Waste Framework Directive:
Revised directive 2008/98/EC

- Implemented by
  - Waste (England and Wales) Regulations 2011 from April 2011
  - In Wales, supplemented by the Waste (Miscellaneous Provisions) (Wales) Regulations 2011)
  - The Waste Regulations (Northern Ireland) 2011 as amended 2019
  - The Waste (Scotland) Regulations 2012
- Intended to :
  - Replace earlier directive(s) and clarify what is waste
  - Reduce landfill & encourage waste prevention, reuse and recycling
- Waste is
- *"substance or object … which the holder discards or intends or is required to discard;.."*

Article 3(1) of the Waste Framework Directive

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EU Waste Framework Directive:
Revised directive 2008/98/EC

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- Waste is **either** processed by Disposal operations (Annex 1) or Recovery operation (Annex 2)
  - No halfway house
- Disposal
  - Activity to get rid of waste
- Recovery
  - "…any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfill a particular function, or waste being prepared to fulfill that function"

BUT: soil which complies with CL:AIRE DoWCoP2 is NOT waste

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EU Waste Framework Directive:
Revised directive 2008/98/EC

- Exemption:
  - "**uncontaminated soil** and other naturally occurring material excavated in the course of construction activities where it is certain that the material will be used for the purposes of construction in its natural state on the site from which it was excavated"
  - "land (in situ) including **unexcavated contaminated soil** and buildings permanently connected with land" cf Van der Vaal case
- But
  - "The waste status of uncontaminated excavated soils and other naturally occurring material which are **used on sites other than the one from which they were excavated** should be considered according to the waste definition and the provisions on by-products or on the end of waste status under this Directive."

UK Waste guidance

- Check if your material is waste
  - https://www.gov.uk/guidance/check-if-your-material-is-waste
- You have to work out if your material:
  - Is waste – it has been discarded
  - was never waste – it meets the ‘by-product’ test or the ‘reuse’ requirements
  - has stopped being waste – it meets the ‘end of waste’ test

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Definition of Waste: Development Industry Code of Practice

- Version 2 published by CL:AIRE in 2011 (DoWCoP2)
  - Developed with the Environment Agency
- **Voluntary** guidance for the person commissioning excavations (not just remediation) and to contaminated and uncontaminated materials
  - Now used at most sites
- DoWCoP2 sets out good practice for the development industry to use when:
  - Assessing on a site-specific basis whether excavated materials are classified as waste or not; and
  - Determining on a site-specific basis when treated excavated waste can cease to be waste for a particular use

BUT Soil which complies with CL:AIRE DoWCoP2 is NOT waste

What DoWCoP2 covers:

- Not just soils, applies to:
  - Top and subsoils, parental material and geology
  - Dredgings
  - Made ground
  - Segregated demolition arisings
- Saves time and money by allowing materials not deemed to be wastes to be reused:
  - At its **site of origin** (if "clean" or successfully treated)
  - at another site only for **clean naturally-occurring materials** (Direct transfer)
  - Between sites in a **Cluster projects** (potentially including fixed soil treatment facilities)
- Any material outside of the DoWCoP2 (contaminated or not) is waste!

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What DoWCoP2 covers:
Is it a waste?

- Only if the holder intends or will be required to discard it !
- Consider:
  - **Suitability for use** – demonstrate chemical and geotechnical properties
  - **Certainty of use** – demonstrate that the materials will be used, not just a probability
    - Any out of spec materials will be waste
  - **Quantity of material** – only quantities necessary. Disposal of excessive quantities indicates waste
- Unsuitable, untreatable, excess or out of spec materials will be waste, and will be regulated accordingly
  - Dispose or treat of appropriate
  - Likely to increase costs

What DoWCoP2 covers:
Materials management plan

- A MMP is required to demonstrate compliance with the DoWCoP2:
  - based on an appropriate soils risk assessment ensuring protection of people and environment
  - Includes contingency plans (*e.g.* extra or out of spec arisings)
  - Prepared together with, or at the same time as, the remedial strategy
- "Qualified person" should review MMP and submit a Declaration to CL:AIRE/EA **before** use or transport of the materials
- A verification report **must** be produced
  - Auditable records of materials movement and fate needed
  - Any deviation from the MMP must be noted

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DoWCoP: The future

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- Version 3 - in preparation
- Pressure within EA to abandon it
  - DoWCoP performance is questionable
  - Exploited by waste crime
- Industry is pro DoWCoP
- DoW CoP Soil Passports
  - https://www.claire.co.uk/home/news/1855-dow-cop-international-soil-passports
- CL:AIRE Guidance Bulletin 3 May 2023
  - https://www.claire.co.uk/component/phocadownload/category/7-guidance-bulletins-and-documents?download=241:guidance-bulletin-3-definition-of-waste-development-industry-code-of-practice

LA = SSU / Not P2a
Waste Regulation = EA

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Landfill Tax

- Applies to all waste disposed of to Landfill
  - On/After 1 October 1996
  - Not covered by exemption

	Rate from 1 April 2024	Rate from 1 April 2023	Rate from 1 April 2022
Standard rate	£103.70 per tonne	£102.10 per tonne	£98.60 per tonne
Lower rate	£3.30 per tonne	£3.25 per tonne	£3.15 per tonne

- Exemptions
  - dredging activities
  - quarrying and mining
  - pet cemeteries
  - inactive waste used for filling quarries

- Rates
  - Lower Rate – less polluting materials
  - Standard Rate – other materials

Made Ground

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Landfill Tax

• changes – England - 2018

- Standard Rate will be payable on ALL waste (disposals) “not made at landfill sites”
  - *i.e.* unlicensed and illegal disposal
- HMRC will seek to recover the tax for any wastes disposed of illegally (plus 100% fine and possible prosecution for tax evasion)
  - This is intended to generate revenue!
  - Ie retrospective tax at up to twice the Standard Rate
- All material at illegal sites on 1 April 2018, and any material disposed at such sites after this date, will be caught by the tax
  - This could include materials reused under DowCop, if the Code has not been followed fully (*e.g.* where no verification report is submitted)!
- Anyone who knowingly facilitates the disposal may be jointly and severally liable to any assessment (could include consultants)
  - **You MUST have proof you follow the Waste Duty of Care**

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Landfill Tax changes

- **Wales:** Have implemented a similar tax system to England via:
  - Landfill Disposal Tax (Wales) Act 2017 & Landfill Disposal Tax (Administration)(Wales) Regulations 2018
  - Different tax rates but includes 150% penalty for unauthorised disposal
- **Scotland**: “Scottish Landfill Tax may be charged to anyone found to be running an illegal waste disposal activity, such as an unlicensed landfill site”
  https://www.sepa.org.uk/regulations/waste/scottish-landfill-tax/
- **Northern Ireland**: Landfill tax is not devolved and is administered by HMRC. The recent changes to Landfill Tax in England apply.

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Landfill Regulations

- Landfills must be registered to receive either inert, non-hazardous, hazardous or "Stable, non-reactive hazardous waste" (SNRHW)
  - Soils are normally either non-hazardous or hazardous depending on type and concentrations of contaminants
- A landfills can only accept waste that meets its "waste acceptance criteria" (WAC)
- Hazardous and non-hazardous waste must be Pre-treated before landfill
- Hazardous waste containing >6% organic carbon cannot be landfilled
- Disposal of certain hazardous and liquid wastes to landfill has been banned

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Classification & WAC testing

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- All waste soils **must** be properly characterized **before** being sent to landfill
- A. Adequate testing to classify the waste:
  - Hazardous, non-hazardous or inert etc.
  - Assign appropriate EU waste catalogue entry
- B.WAC testing required for hazardous (or inert) waste
  - Costs ~£100 per sample
- C. Identify appropriately licensed landfill

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Classification of waste soils

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- Classification of soils is not a trivial task!
  - Particularly if asbestos, coal tar or oil contamination is involved!
  - Each hazardous property should be assessed based on "worst case compounds"
- Waste classification is a skill in its own right and requires suitable qualified personnel
- Waste is classified based on hazard not risk!
  - A soil may not be suitable for use but not be hazardous waste
  - A soil suitable for use may otherwise be hazardous waste

Note: WAC tests must not be used for waste classification and hazardous waste assessment purposes. This analysis is only applicable for landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous

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Classification of waste soils

- WM3 “Waste Classification: Guidance on the classification and assessment of waste”
- Brings wastes in line with “Classification, Labelling and Packaging of Substances Regulation (EC 1272/2008) ”
- WM3 now contains specific guidance on classifying soils as well as :
  - Construction and demolition wastes containing asbestos
  - Waste containing coal tar
  - Wastes containing or contaminated with oil

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AGS Guidance

- Simplified process for "straightforward" sites
- Sampling/Analysis
- Hazardous properties
- Statistics
- Appendices
  - 1 Number of samples
  - 2 Sampling plan
  - 3 Worst Case Metallic compounds (haz codes)
  - 4 Detailed assessment of metals (zinc example)

AGS Association of Geotechnical & Geoenvironmental Specialists

Waste Classification for Soils – A Practitioners' Guide

Table 1: Number of Samples Required for Waste Characterisation (from Environment Agency guidance *Waste Sampling and Testing for Disposal to Landfill*).

Population (tonnes)	Number of Samples (homogeneous waste)	Number of Samples (new/heterogeneous waste)
< 100	2	5
< 500	3	8
< 1,000	5	14
10,000	11	22
+ per additional 10,000	+5 (pro rata)	+10 (pro rata)

Pre-treatment

- All waste soils **must** be pre-treated **before** being landfilled
  - A physical/thermal/chemical or biological process
  - Change the characteristics of the waste:
    - reduce its volume, or
    - reduce its hazardous nature, or
    - facilitate its handling, or
    - enhance its recovery
- **May** include:
  - Careful separation of materials during excavation
  - Using on-site tools to ensure only soils failing the SSAC are removed
  - Screen out bricks and rubble etc - "a reasonable amount of sorted or separated materials are diverted from landfill"

Sound science: Defensible decisions

Disposal to landfill: Hazardous & Non-hazardous

Hazardous Waste

- Hazardous (or SNRHW) landfill only
- Consignment note system
- Duty of care applies
- Max organic carbon content 6%
- **WAC testing required**
- **Pre-treatment required**

Non-hazardous waste

- Non-hazardous landfill only
- Transfer note system
- Duty of care applies
- No WAC test required (unless inert)
- **Pre-treatment required**

SNRHW = Stable Non-Reactive Hazardous Wastes

Sound science: Defensible decisions

Environmental permitting: Environmental permits

- Environmental Permitting (England and Wales) Regulations, 2016
  - Amended by **The Environmental Permitting (England and Wales) (Amendment) (England) Regulations 2023**
- Permit required for any activity that could:
  - pollute the air, water or land
  - increase flood risk
  - adversely affect land drainage
- Now a single framework combining, for instance:
  - Waste licences
  - PPC authorisations
  - discharge consents
  - groundwater authorisations
  - radioactive substances licences
- A single permit and common, user-friendly procedures

Environmental permitting:
Bespoke Permit

- Use a bespoke permit if the operation does not fit the conditions of a standard rules permit
- Requires
  - applicant to be a “fit and proper person”
  - a written management system to minimise pollution risks
  - A risk assessment for activities not covered under generic risk assessments for standard rules permits

Environmental permitting:
Standard Rules Permit No.27

- Standard rules to operate a mobile plant for the treatment of soils and contaminated material, substances or products.
- Appropriate if activities comply with standard rules
  - If not → bespoke
- Generic risk assessments eg
  - Local human population
  - Surface waters close to and downstream of site

Data and information				Judgement				Action (by permitting)	
Receptor	**Source**	**Harm**	**Pathway**	**Probability of exposure**	**Consequence**	**Magnitude of risk**	**Justification for magnitude**	**Risk management**	**Residual risk**
What is at risk? What do I wish to protect?	**What is the agent or process with potential to cause harm?**	**What are the harmful consequences if things go wrong?**	**How might the receptor come into contact with the source?**	**How likely is this contact?**	**How severe will the consequences be if this occurs?**	**What is the overall magnitude of the risk?**	**On what did I base my judgement?**	**How can I best manage the risk to reduce the magnitude?**	**What is the magnitude of the risk after management? (This residual risk will be controlled by Compliance Assessment).**
Local human population	Releases of particulate matter (dusts) and micro-organisms (bioaerosols).	Harm to human health - respiratory irritation and illness.	Air transport then inhalation.	Medium	Medium	**Medium**	There is potential for exposure if anyone is living or working close to the site (apart from the operator and employees). There is potential for increased dust generation from permitted activities during prolonged dry periods e.g. summer months.	SR - (emissions of substances not controlled by emission limits). SR (deployment form). SR (if required) - emissions management plan.	Low
Local human	As above	Nuisance - dust on	Air transport then	Medium	Medium	**Medium**	As above. Local	As above	Low

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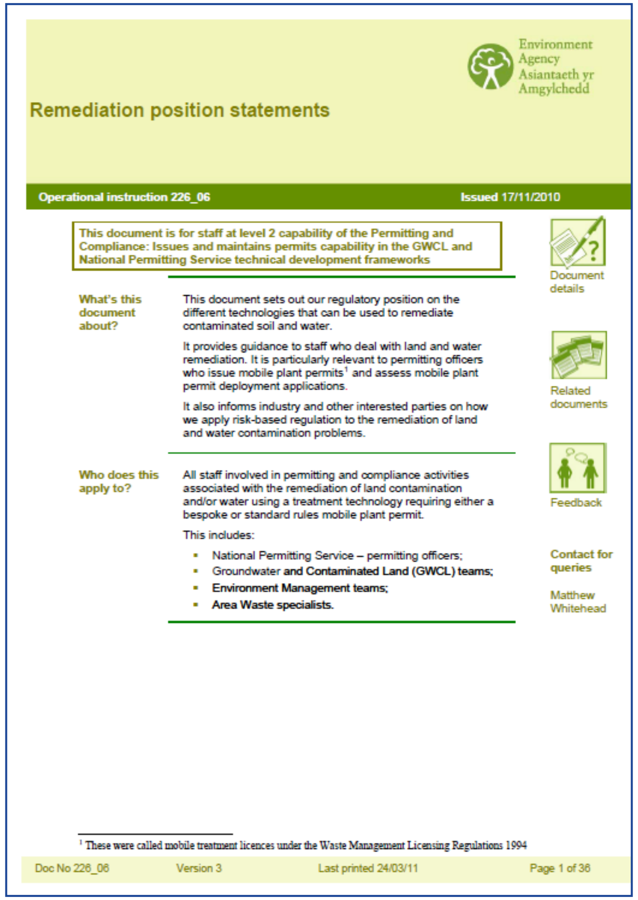
Environmental permitting: Exemptions

- Specific type of low risk waste handling operation that does not require a permit but must be registered with the Environment Agency
  - But not unregulated!
- Activities must **not**:
  - Endanger human health
  - Risk to water, air, soil, plants or animals
  - Cause nuisance through noise or odours
  - Adversely affect the countryside or places of special interest
- Can **not** (currently) be used for soils classified as hazardous waste
- Types and nature of exemptions are being kept under review – eg "Sham waste recovery"

What permits apply to my remediation?

- Remediation Position Statements - Operational instruction 226_06
  - Issued 17/11/2010
- Sets out how different remediation technologies (both soil and water) will be regulated under Environmental permitting
  - Intended as guidance for permitting officers who issue mobile plant permits but also informs industry and other interested parties on how we apply risk-based regulation
  - https://webarchive.nationalarchives.gov.uk/20140328104422/http://www.environment-agency.gov.uk/static/documents/Business/226_06_Remediation_PSs_Nov_2010.pdf



Environment Agency
Asiantaeth yr Amgylchedd

Remediation position statements

Operational instruction 226_06 **Issued 17/11/2010**

This document is for staff at level 2 capability of the Permitting and Compliance: Issues and maintains permits capability in the GWCL and National Permitting Service technical development frameworks

Document details

What's this document about?

This document sets out our regulatory position on the different technologies that can be used to remediate contaminated soil and water.

It provides guidance to staff who deal with land and water remediation. It is particularly relevant to permitting officers who issue mobile plant permits[1] and assess mobile plant permit deployment applications.

It also informs industry and other interested parties on how we apply risk-based regulation to the remediation of land and water contamination problems.

Related documents

Who does this apply to?

All staff involved in permitting and compliance activities associated with the remediation of land contamination and/or water using a treatment technology requiring either a bespoke or standard rules mobile plant permit.

This includes:

- National Permitting Service – permitting officers;
- Groundwater and Contaminated Land (GWCL) teams;
- Environment Management teams;
- Area Waste specialists.

Feedback

Contact for queries

Matthew Whitehead

[1] These were called mobile treatment licences under the Waste Management Licensing Regulations 1994

Doc No 226_06 Version 3 Last printed 24/03/11 Page 1 of 36

Sound science: Defensible decisions

EA Regulatory Position Statement (RPS) 215

RICARDO EMAQ+

- allow operators to remediate SMALL volumes of contaminated soil /water, without the need to apply for a permit
- Conditions apply

Guidance

Treat small volumes of contaminated soil and groundwater: RPS 215

Environment Agency regulatory position on when you can do a small scale remediation scheme or trial to treat contaminated soils and groundwater.

From: Environment Agency

Published 31 August 2018

Last updated 3 October 2023 — See all updates

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Reuse of soils:
No longer waste ?

- If a contaminated soils is deemed to be waste it remains waste until it is “fully recovered” not because:
  - Someone intends to use it
  - It has an economic value
  - Its been processed ready for reuse
  - It isn’t polluting etc.
- Thus, using or depositing imported or treated soil (ie waste) **may** require an exemption/permit!
- WRAP could not agree Quality Protocols for either contaminated soils or topsoils and recommended further development of the DoWCoP
  - A Quality Protocols for aggregates from inert wastes was agreed that may permit the reuse of some wastes (e.g. demolition arisings) as a non-waste

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Reuse of soils: DoWCoP

- DoWCoP = a way to decide if excavated materials are classified as waste
- DoWCoP allows reuse of chemically and physically suitable excavated material without a permit or exemption:
  - On the site of origin
  - Clean/naturally occurring material on another site (Direct transfer)
  - Within Cluster projects (and some fixed soil treatment facilities)
- This includes materials that have been successfully treated (*i.e.* achieve appropriate chemical and physical criteria) on-site or within a cluster project
  - But if treatment was not successful, the materials are waste
  - Currently most soil treatment centres are not classed as cluster sites but some are seeking to qualify

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Reuse of soils:
Reuse of treated wastes

- The Remediation Position Statements make it clear that, outside of a MMP under the DoWCoP, contaminated soils (treated or otherwise) will be wastes and their reuse will require either:
  - Exemptions relevant to the reuse of treated soils, such as
    - U1 (use of waste in construction)
    - T5 (screening and blending waste)
  - Otherwise a site-based permit would be required
- Applies to:
  - any site where the DoWCoP is not adopted,
  - soils where treatment was unsuccessful,
  - screened soils recovered at waste transfer stations

Summary

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- Waste legislation has large implications for all types of remediation
- Will be an important factor in selecting remediation strategy
- DoWCoP allows reuse of chemically and physically suitable excavated material without a permit or exemption

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Session 3

Remedial Techniques (Part 1)

Sound science:
Defensible decisions

Civil engineering techniques: "Dig and Dump"

- Linkage target:
  Source – pathway – Receptor
- Media: Soils
- Treats: Almost all contaminant types
- Type: Civil engineering methods

- Most popular remedial options but not the focus of today. So we will keep it short…

"Dig and Dump"

- Excavation and disposal
- Transfers problem in time and space
- Waste legislation and tax penalties make this approach less favourable
- Roughly 75% of all remediation in 2001-2005
  - Still the most common

“Dig and Dump”

- Excavation can be used:
  - as a complete “solution” with excavated material replaced by “clean” imported material
  - to lower site levels to place a cover system
  - to remove selected heavily-contaminated areas
  - in conjunction with other remedial techniques
- Can be applied on the large or small scale
- If excavated materials are disposed of to landfill:
  - Must be classified and pretreated
  - Landfill tax applies plus gate fees
  - Off-site treatment may be favourable?

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"Dig & Dump"

Pros

- Applicable to nearly all contaminants
- Relatively insensitive to ground conditions
- No permit needed for waste treatment/disposal
- Allows recycling of some materials e.g concrete foundations
- Can integrate well with other treatments
- Great degree of certainty in terms of outcome, cost and time scales

Cons

- Removing hard cover *etc.* may mobilise contaminants
- Practical constraints on the depth of excavation
- Groundwater levels may need to be controlled
- May require physical support of excavation
  - Near-by buildings may need support
- Difficult to apply on operating sites
- Cost of disposal and replacement soil (clean?)
- Sustainability?
- Restricted by some planning conditions
  - Lorry movements – safety?

Sound science: Defensible decisions

Civil engineering techniques: Barriers and caps

- Linkage target:
  Source – Pathway – Receptor
- Media: Soils, Waters, Gases & vapours
- Treats: Almost all contaminant types
- Type: Civil engineering methods

Civil engineering techniques: Barriers and caps

- Horizontal barriers
  - Such as cover systems or capping
  - Prevent vertical migration and exposure
- Vertical barriers
  - Such as “cut-off walls”
  - Prevent horizontal migration
- Well-proven
- May be used on their own or in conjunction with other remedial options

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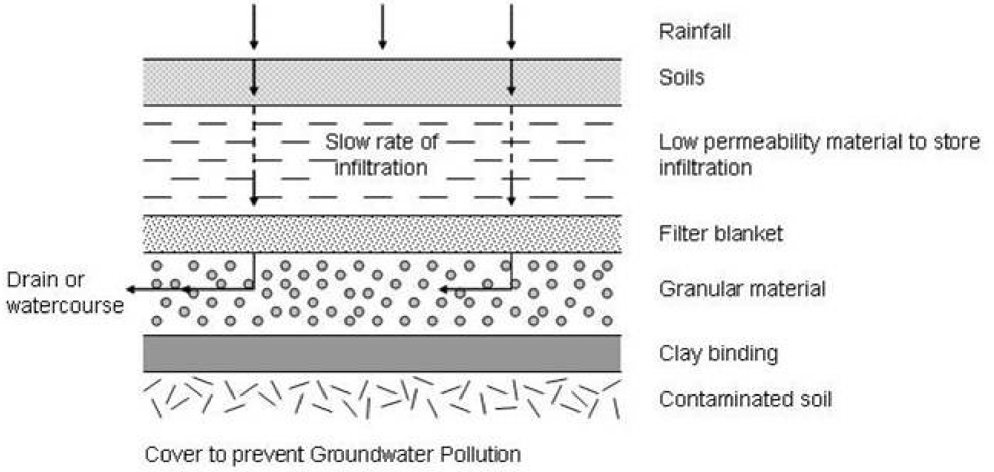
Horizontal Barriers: Cover Systems/capping

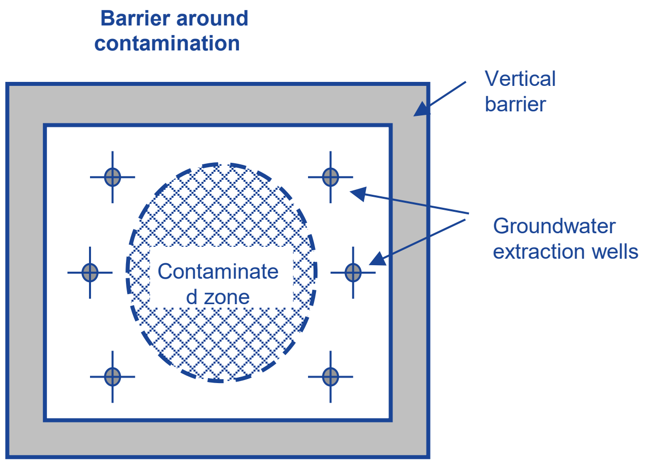
- Simple cover systems usually involve the placement of “uncontaminated” “inert” material over the contaminated ground
- They provide partial containment
  - prevent exposure of the at risk targets to potentially harmful contaminants
  - reduce the infiltration of water thus reducing contaminant migration
- Engineered cover systems may be much more complex but provide greater levels of certainty
- May involve the use of natural or synthetic materials or combinations

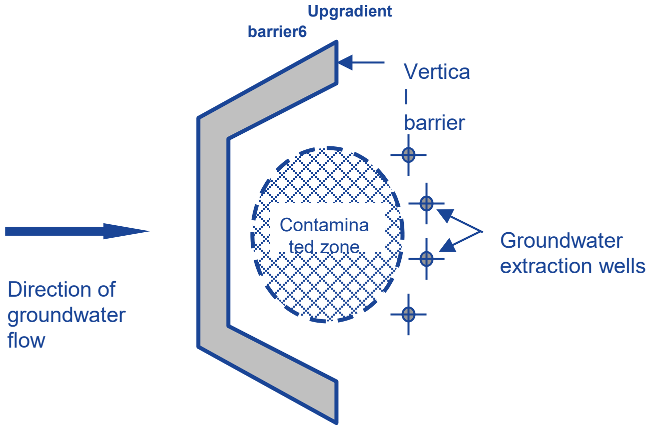


Taken from Contaminated Land Ready Reference after CIRIA and Cairney 2000

Vertical barriers

- Vertical barriers may include:
  - Geotextiles
  - Sheet piles
  - Slurry walls
  - Reworked clay
- Can be used to control:
  - Migration of groundwater – usually in conjunction with hydraulic measures
  - Migration of gas – usually with active or passive venting measures





Taken from Contaminated Land Ready Reference after CIRIA and Cairney 2000

Barriers and Caps

Pros

- Applicable to wide range of contaminants and media
- Economic
- Minimal disturbance of contaminants
- Little/no waste produced
- Can be integrated with other treatments
- No license required (planning still needed)
- Established technique using conventional equipment

Cons

- Does not provide a permanent solution
  - contaminants are not removed or destroyed
  - issues concerned with the long term performance and integrity of containment
  - Liability remains on site
- Building on top of barrier will prevent future maintenance
- What happens when containment fails?
- May not be feasible on operating sites
- Horizontal barriers/capping:
  - What depth?
  - Validation of "clean cover"

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Monitored Natural Attenuation MNA

- Linkage target:

  Source – Pathway – Receptor
- Media: Groundwater (and saturated soils)
- Treats: Most organics and inorganics (varying rates and efficiencies)
- Type: MNA (chemical, physical and biological elements)

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Natural attenuation: Environment Agency Definition:

"The effect of **naturally occurring physical, chemical and biological processes**, or any combination of those processes to reduce the load, concentration, flux or toxicity of polluting substances in groundwater. For natural attenuation to be effective as a remedial action, the rate at which those processes occur must be **sufficient to prevent polluting substances entering identified receptors and to minimise expansion of pollutant plume** into currently unpolluted groundwater. Dilution within a receptor, such as in a river or borehole, is not natural attenuation."

EA, 2000

What is Monitored Natural Attenuation?

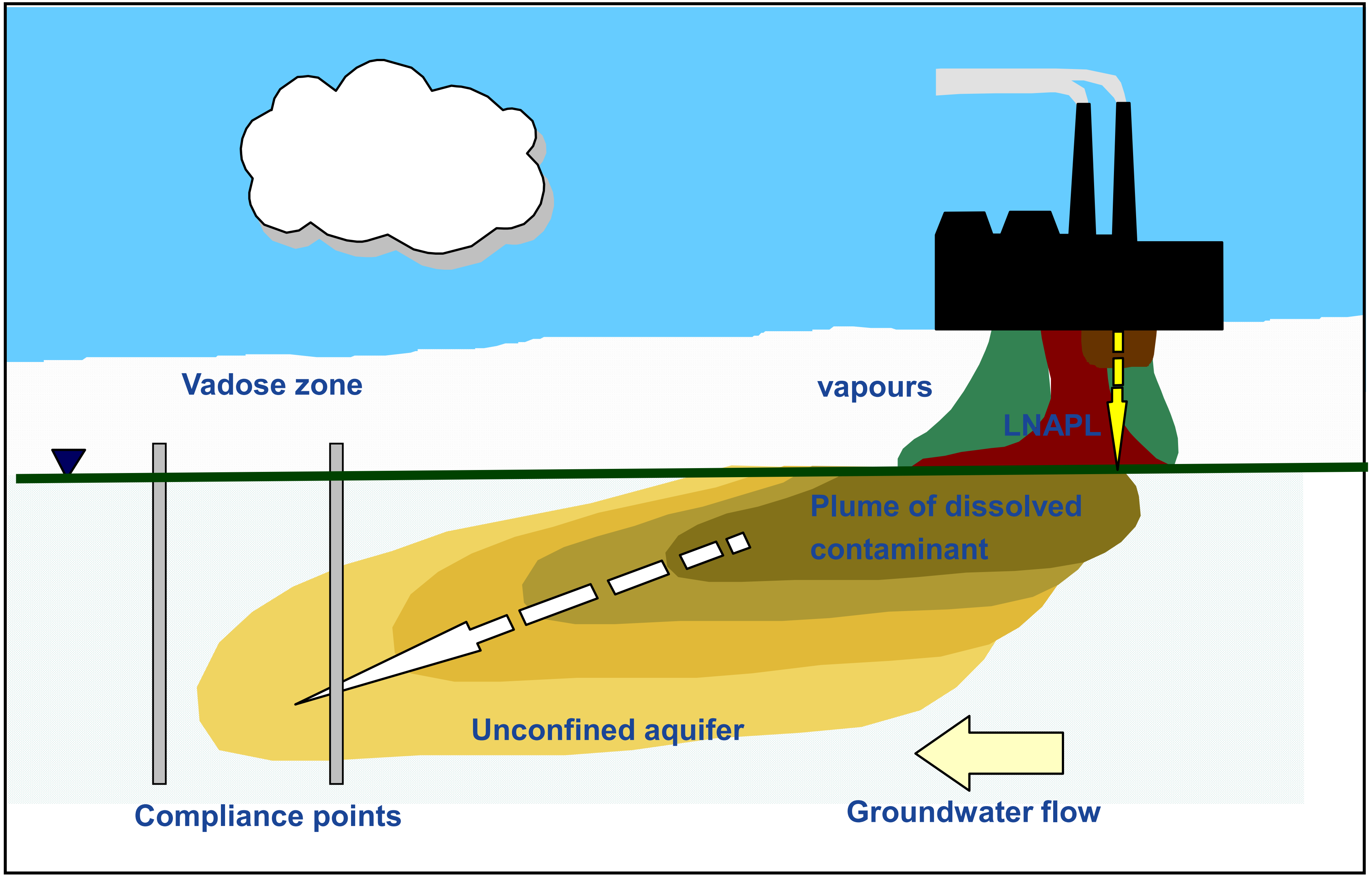
- **Monitored natural attenuation** (MNA) refers to the use of **natural attenuation** processes as part of a contaminant remediation programme in order to meet site-specific remediation objectives in a **clearly demonstrable manner**

"Monitoring of groundwater to confirm whether NA processes are acting at a sufficient rate to ensure that the wider environment is unaffected and that remedial objectives will be achieved within a reasonable timescale; this will typically be less than one generation or 30 years."

EA, 2000

- Usually used to treat groundwater

Typical groundwater plume:



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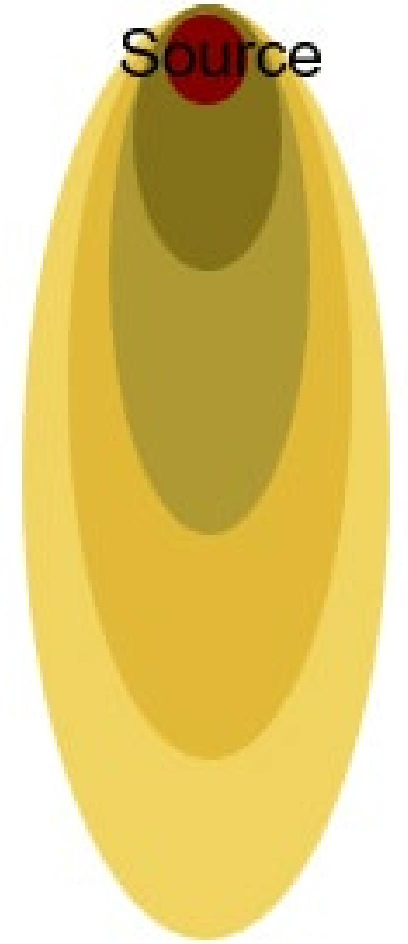
Life cycle of a contaminant plume:

- Expanding:
  - Flux of contaminants from source exceeds assimilative capacity of aquifer
- Stable
  - Insignificant changes
  - Flux from source balanced by NA processes
- Shrinking
  - Source nearly exhausted
  - NA processes reducing plume size
- Exhausted
  - Average plume concentration < 1ppb and unchanging over time



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What is Monitored Natural Attenuation?

- Monitored natural attenuation is **NOT** a “do nothing option”
- Likely to require:
  - Comprehensive site characterisation
  - Thorough understanding of sub-surface conditions
  - Predictive modelling
  - Long-term monitoring
- Can also be used to compliment “active” remedial options
  - Different parts of the site
  - Subsequent to other remediation - polishing

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MNA: Advantages

- Generation of less wastes
- Environmental permit not required
- Decreased risk of human or environmental harm via exposure cf ex-situ methods
- Less disturbances to:
  - ecological receptors
  - Buildings and structures
  - Ongoing commercial operations
- Can be applied to all or parts of site
- Use in conjunction with other remedial measures – ie polishing step
- Potential lower overall costs
- Green sustainable image:
  - reduce use of energy
  - Reduced atmospheric emissions
  - inherent natural process

MNA: Disadvantages

- **Site characterisation more complex and costly**
- Longer time frames
- Institutional controls (covenants etc) may be necessary to ensure long term protectiveness
- During the period of MNA, liabilities relating to the contamination remain
- Long-time monitoring ?
- More extensive communication efforts may be required in order to gain public acceptance of MNA
- Good understanding of the degradation mechanisms is required eg toxic transformation products

Permeable Reactive Barriers (PRBs)

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- Linkage target:
  Source – Pathway – Receptor
- Media: Groundwater
- Treats: Almost all contaminant types (depending on reactive media and design)
- Type: On-site treatment (using chemical, physical and biological elements)

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What are PRBs?

- "an **engineered treatment zone** of **reactive material** that is placed within the **saturated** zone in order to **remediate contaminated groundwater** as it flows through it"
- "reactive materials either immobilise or transform the pollutants"

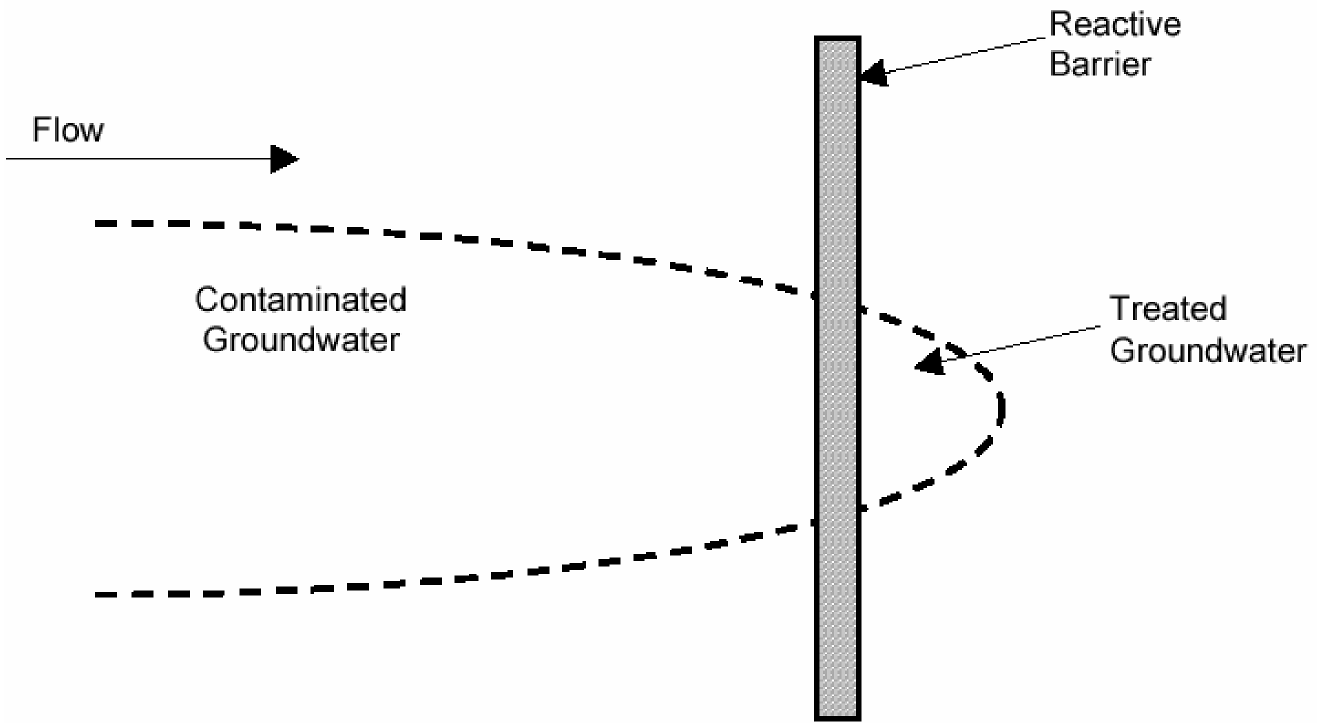
EA Remediation Position Statement No. 13

- Now fairly common across the UK

Reactive media include:

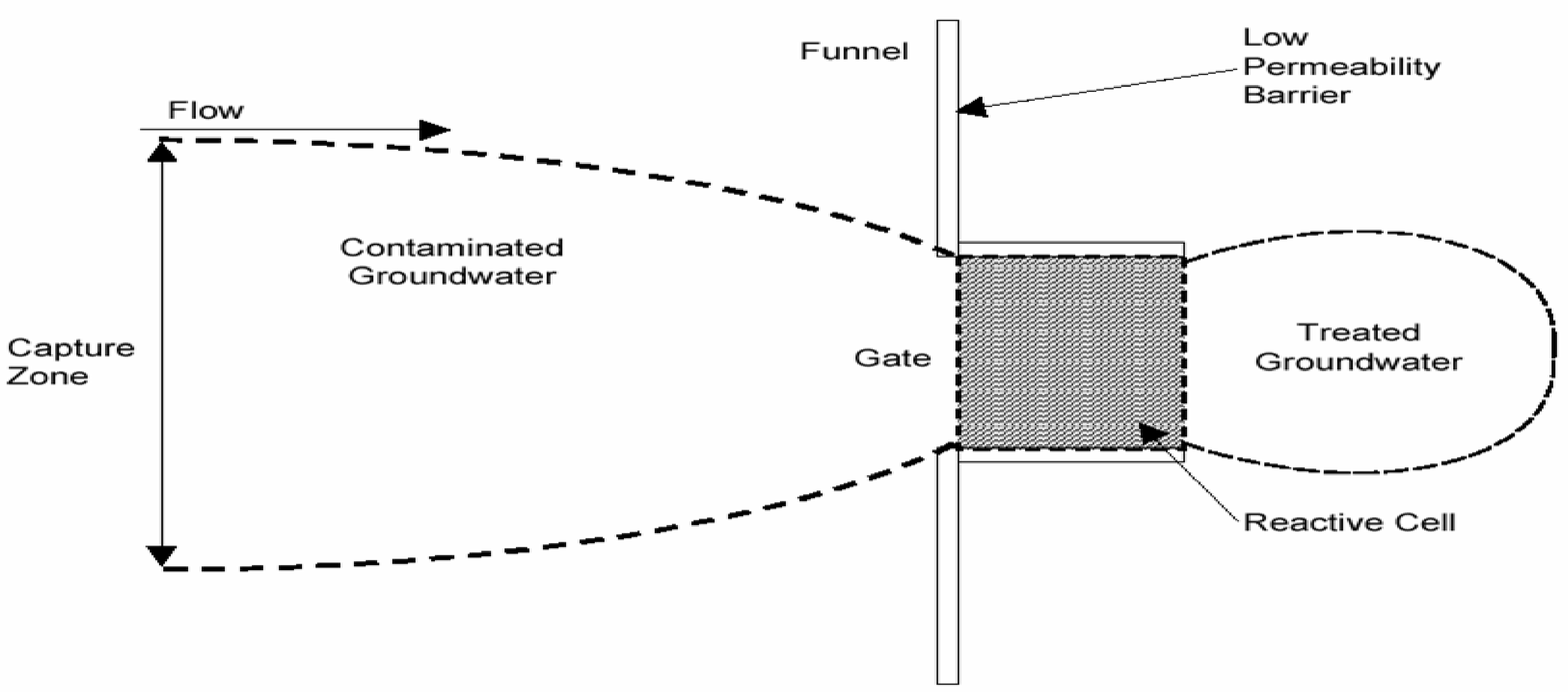
- Chemically-reactive media
  - eg Zero valent iron, Sodium dithionite
- Bioreactors
  - including sequential aerobic and anaerobic reactors
- Sorption & ion exchange media
  - eg Granulated activated carbon, phosphatic compounds (including apatite), zeolites, peat, and synthetic resins
- pH control media
  - eg limestone resulting in precipitation of metals

Continuous reactive barrier



Transects pollutant plume flow-path with unbroken wall of permeable materials, combined with reactive materials (e.g. pea-gravel & reagent filled trench constructed across groundwater flow direction)

Funnel and Gate ™



NB University of Waterloo uses "funnel & gate" as trademark

Impermeable walls (sheet piles or slurry walls) direct contaminated groundwater to 'permeable gate(s)' containing reactive material.

PRBs: Advantages

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- Known to be effective
- Below ground systems – may pose less constraints to surface development
- Typically rely on passive processes - ‘environmentally sustainable’
- No loss of groundwater resource
- Minimise volume of waste / soils & groundwater handled
- Potentially low maintenance and operation costs
- Potential long operational life – decades ?

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PRBs: Disadvantages

- Long time (decades) may be required to manage risks from persistent sources
- Possible need to remove reactive media at end of operation, or replace during operation
- Long-term monitoring necessary
- Site characterisation normally more complex and costly
- Below ground structures (e.g. services, foundations) may present problems in construction
- Deeper plumes more challenging
- Use can be constrained by geological conditions (eg fractured rocks)
- Heavily patented technology

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Biological Techniques

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- Basis of the carbon and nitrogen cycles etc
  - Micro-organisms breakdown dead plant and animal tissue to recycle inorganic constituents
- Biodegradation and biotransformation:
  - micro-organisms (‘bugs’) act to breakdown organic contaminants and modify some inorganic contaminants
- Biodegradation is used in a variety of remedial techniques
- Bugs need:
  - something to eat (Electron donor) Dinner
  - Something to “breath” (Electron acceptor) Air
  - Water
  - Minerals and trace elements

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Biological Techniques: UK applications

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- *Ex situ:*
  - Landfarming
  - Biopiles and Windrow composting
  - Bioslurry reactors
- *In situ:*
  - Monitored natural attenuation (MNA) – intrinsic bioremediation – discussed earlier
  - Biological permeable reactive barriers – discussed earlier
  - Enhanced bioremediation
    - Aerobic & anaerobic
  - Bioventing & biosparging

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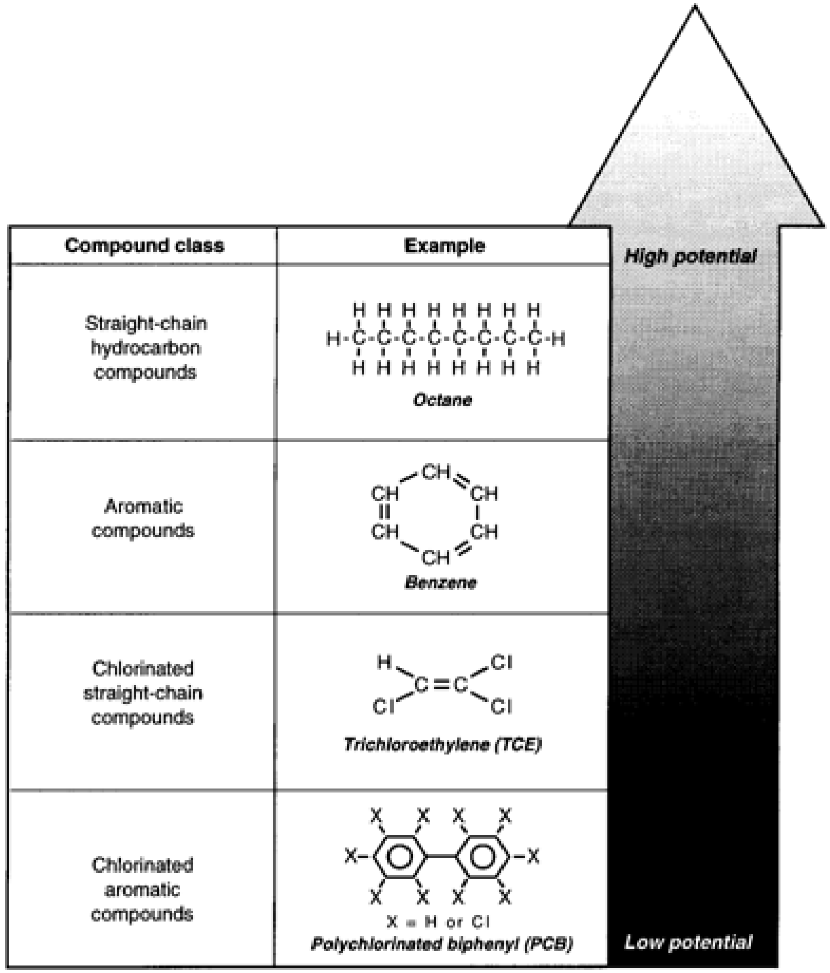
Biodegradability of organic contaminants

Eg aliphatics

Eg aromatics

Eg Chlorinated aliphatics

Eg Chlorinated aromatics



Biological Techniques: Biopiles and Windrows

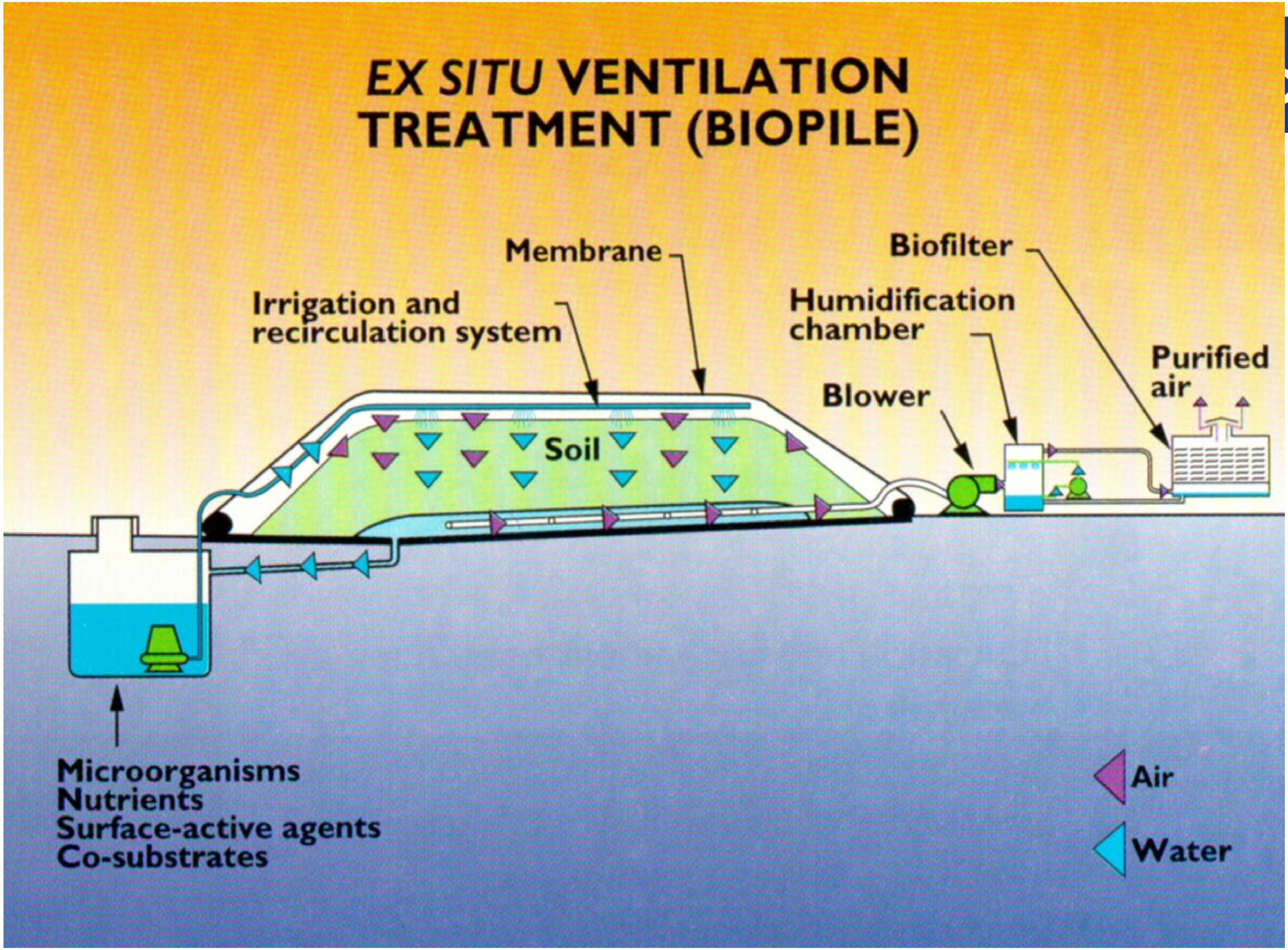
- Linkage target:
  Source – Pathway – Receptor
- Media: Soils
- Treats: Organics (particularly hydrocarbons but also solvents and explosives)
- Type: Ex-situ treatment (Biological)

Biopiles and Windrows

- **Biopiles** - Aerated static soil piles using forced aeration
- **Windrows** – elongated piles aerated by frequent turning
- Soil may be blended with amendments/bulking agents to improve drainage, ventilation, thermal properties and stimulates intense biological activity
- If organic amendments (e.g. green waste, manures, wood chips, spent mushroom composts etc) are added, composting processes can increase the rate and extent of degradation

Biopiles

- Usually involves a lined treatment area
- Contaminated soil excavated and combined with amendments (if needed)
- Soil/compost formed into static piles
- Oxygen is provided by forced aeration
  - Vacuum aeration allows volatile or odorous emissions to be treated
- Cover prevents rain-generated leachate and retains heat, moisture and odours
- Relies on biostimulation (not bioaugmentation)
- More pipework supplies water (and nutrients, if needed)
- Generally, a slower, cooler process but compact



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Windrows

- Contaminated soil excavated and combined with amendments (if needed)
- Soil/compost laid out in elongated rows
- Aeration is achieved by periodic turning usually involving specialised windrow turner
- Cover prevents rain-generated leachate and retains heat, moisture and odours
- Relies on biostimulation (not bioaugmentation)
- Water and/or nutrients can be added during windrow turning
- Generally, a faster, warmer process but requires more space

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Defensible decisions

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Biopiles & windrows: Advantages

- May be cost-effective
- Sustainable - avoids disposal to landfill
- Green/environmentally-friendly image
- Ex-situ nature allows effective monitoring and control to optimize process
- Contaminants are usually permanently destroyed (reducing liability). Reductions of >80% contaminant mass frequently achieved – compared to solidification/stabilization or capping solutions etc
- Often improves soil structure and properties – compared to thermal desorption etc
- Treated material may be suitable for reuse on site (e.g. as a growing medium etc)

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Biopiles & windrows: Disadvantages

- Soils must be excavated
- Atmosphere emissions from treatment of VOCs
- Time and space needed – treatment may take days or months
- Not suitable for inorganics (e.g. heavy metals)
- Some organics can be recalcitrant or may form toxic intermediates
- Residual level of contamination will remain
- Experienced staff and careful monitoring may be needed to ensure successful/timely treatment
- Lab and field trials needed to optimise the process
- Potential odour and leachate issues – control and treatment requirements

Biological Techniques
Enhanced bioremediation

- Linkage target:
  Source – Pathway – Receptor
- Media: Soils and waters
- Treats: Mainly organics
- Type: In-situ treatment (Biological)

Enhanced bioremediation

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- Mainly used for organics but can be applied to some inorganics
- The rate of natural attenuation may be limited by a number of factors:
  - Lack of oxygen (electron acceptor)
  - Lack of nutrients or electron donor
  - Redox or pH conditions
  - Lack of appropriate degradative capability within microbial population etc
- Enhanced bioremediation involves actively intervening to alleviate these limiting factors by:
  - Adding aeration, ORC®, sulphate etc
  - Adding nutrients or carbon sources (eg lactate)
  - Modifying pH or redox
  - bioaugmentation

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Bioaugmentation

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- Almost **never** necessary
- Beware the snake oil salesman !
- The genetic ability to degrade most contaminants is naturally present in most soils
- Non-native organisms are not usually able to survive and our out competed by indigenous species
- However, where natural degraders are not present the addition of competent micro-organisms can improve performance
- Laboratory trials will help indicate when bioaugmentation is cost-effective

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Enhanced bioremediation: Advantages

- Many limitations can be controlled with proper attention to good engineering practice
- Natural degraders are usually present (no bioaugmentation)
- Sustainable, green image
- No excavation needed
- Can be cost effective
- After treatment, ongoing liabilities should be minimal (contaminant is destroyed)
- Limited disturbance - Can be used on operational sites/under buildings etc

Enhanced bioremediation: Disadvantages

- Clean up limited by bioavailability
- Longer treatment times (6 months to 5 years; depends on many site-specific factors)
- Circulating solutions may increase contaminant mobility
- Potential chemical precipitation and biofouling
- Limitations of delivery systems – zone of influence and short circuits
- Unsuitable in for low permeability (ie clay) or heterogeneous soils
- High contaminant concentrations/combinations may inhibit biodegradation
- Requires good site characterisation data and usually long-term monitoring

Chemical techniques: UK applications

- Techniques that destroy, fix or concentrate contaminants using one or more types of chemical reaction
- *Ex situ*
  - Chemical Dehalogenation (e.g. APEG Process)
  - Solvent extraction
  - Chemical oxidation
  - Pump& treat – chemical treatments
- *In situ*
  - Chemical oxidation
  - Soil flushing/extraction
  - PRBs – described earlier
- Overlap with stabilization

Sound science:
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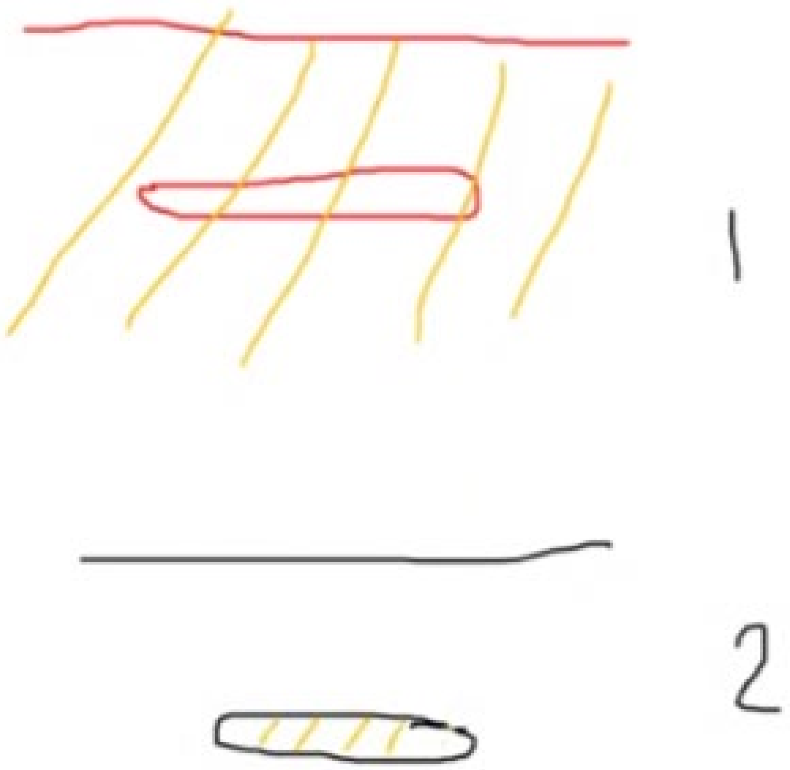
Rebound



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Chemical Techniques
Chemical Oxidation (ChemOx)

- Linkage target:
  Source – Pathway – Receptor
- Media: Soils and vapours
- Treats: Most organics (inc. “difficult” contaminants such as PAHs, chlorinated solvents and PCBs)
- Type: In-situ or ex-situ treatment (chemical)

In-situ chemical oxidation

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- Injection of chemical oxidants into soil and/or ground water to oxidize contaminants.
    - rapid and **complete** degradation, or
    - **partial** degradation to intermediates that can be subsequently biodegraded

Courtesy of QDS and BWB partnership

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Health and Safety

- Each oxidant poses different hazards !
  - All present inhalation hazards
  - All present extreme contact risk, especially to eyes
- A suitable and sufficient COSHH assessment including:
  - Identify appropriate PPE (It is likely that eyewash and shower will be needed)
  - Appropriate storage arrangements (ie avoid storing incompatible materials together)
  - Appropriate medical and emergency provisions

In-situ chemox: Advantages

- Fast (days to months), in-situ destruction of a wide range of volatile and semi-volatile organics to very low residual levels
- Can treat high concentrations
- Can achieve stringent clean up standards
- Temporary facilities
- Effective on some hard-to-treat compounds
- Considered environmentally benign
- Oxidants short lived or already naturally present

Sound science:
Defensible decisions

In-situ chemox: Disadvantages

- Involves large quantities of hazardous reagents
- Limited by organic content and porosity of soil
- Requires earlier spending commitment
- Involves handling powerful oxidants, and carries special safety requirements
- Heterogeneity can cause non uniform distribution of oxidant
- Peroxide and permanganate can form precipitate which may lower permeability
- >1 application of oxidant to remediate rebound effects.
- Violent reaction
- Fenton’s: not at high pH
- Destroys natural soil organics
- Site specific pilot studies needed

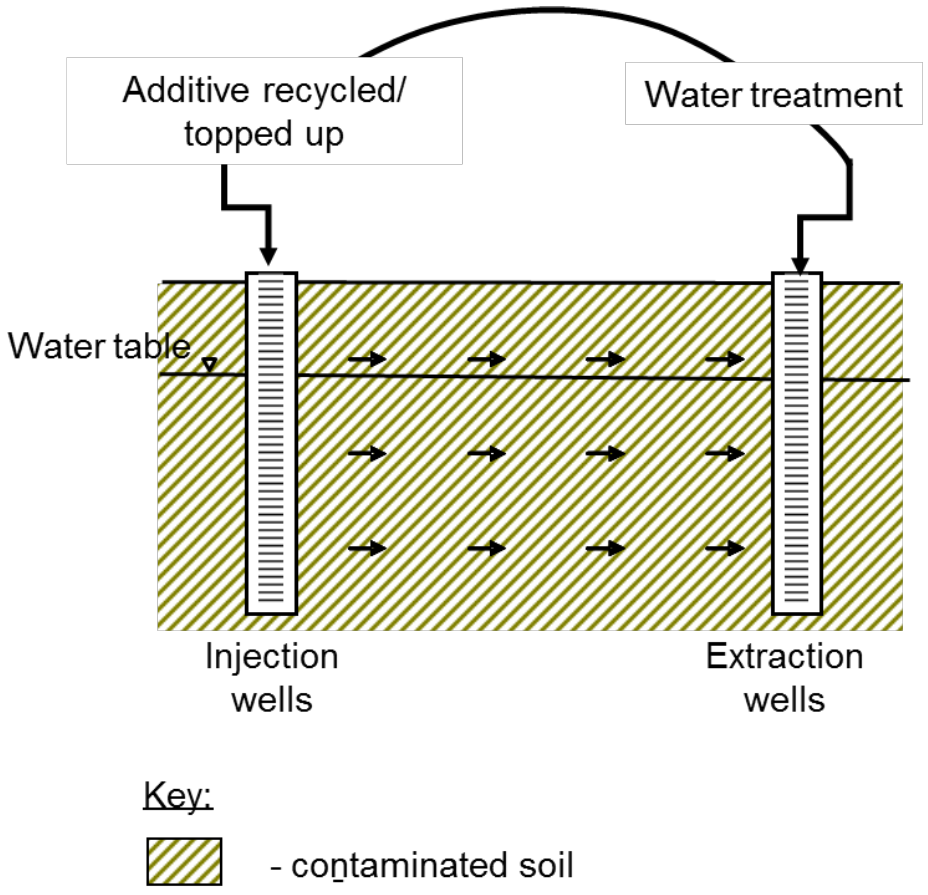
Chemical Techniques
In-situ Flushing

- Linkage target:
  Source – Pathway – Receptor
- Media: Soils, waters and vapours
- Treats: organic and inorganic contaminants (depending on leachant and design)
- Type: In-situ or ex-situ treatment (chemical)

Sound science:
Defensible decisions

Soil flushing

- Treats NAPL in saturated and unsaturated soils
- Effectiveness may be improved by surfactants or co-solvents (e.g. alcohols etc.)
- Contaminant removed and leachant recycled



Soil flushing

Pros

- Suitable for difficult to treat NAPLs
  - May be the only option
- Surfactant/solvent may enhance bioremediation
- Can be used with other techniques
- Contaminant/liability is removed/destroyed

Cons

- Increases contaminant mobility
- Introduces additional contaminants to groundwater (ie surfactant or solvent)
- Through understanding of groundwater regime needed

Session 4

Remedial Techniques (Part 2)

Sound science:
Defensible decisions

Remedial Techniques (Part 2)

- Civil engineering techniques
- MNA
- PRBs
- Biological Techniques
- Chemical Techniques
- Physical Techniques
- Thermal Techniques
- Solidification /Stabilisation

Sound science:
Defensible decisions

Physical techniques: UK applications

- *Ex situ:*
    - Soil washing / physico-chemical washing
    - Solvent extraction
    - Screening
    - Electro-remediation (e.g. electrokinetics, electrophoresis)
    - Pump& treat – physical treatments
- *In situ:*
    - Soil vapour extraction, dual-phase extraction & air sparging
    - In-situ soil flushing (e.g. co-solvents or surfactants)
    - Electro-remediation (e.g. electrokinetics, electrophoresis)
    - PRBs – discussed earlier

- All produce a concentrated waste requiring disposal or treatment

Sound science: Defensible decisions

Physical Techniques

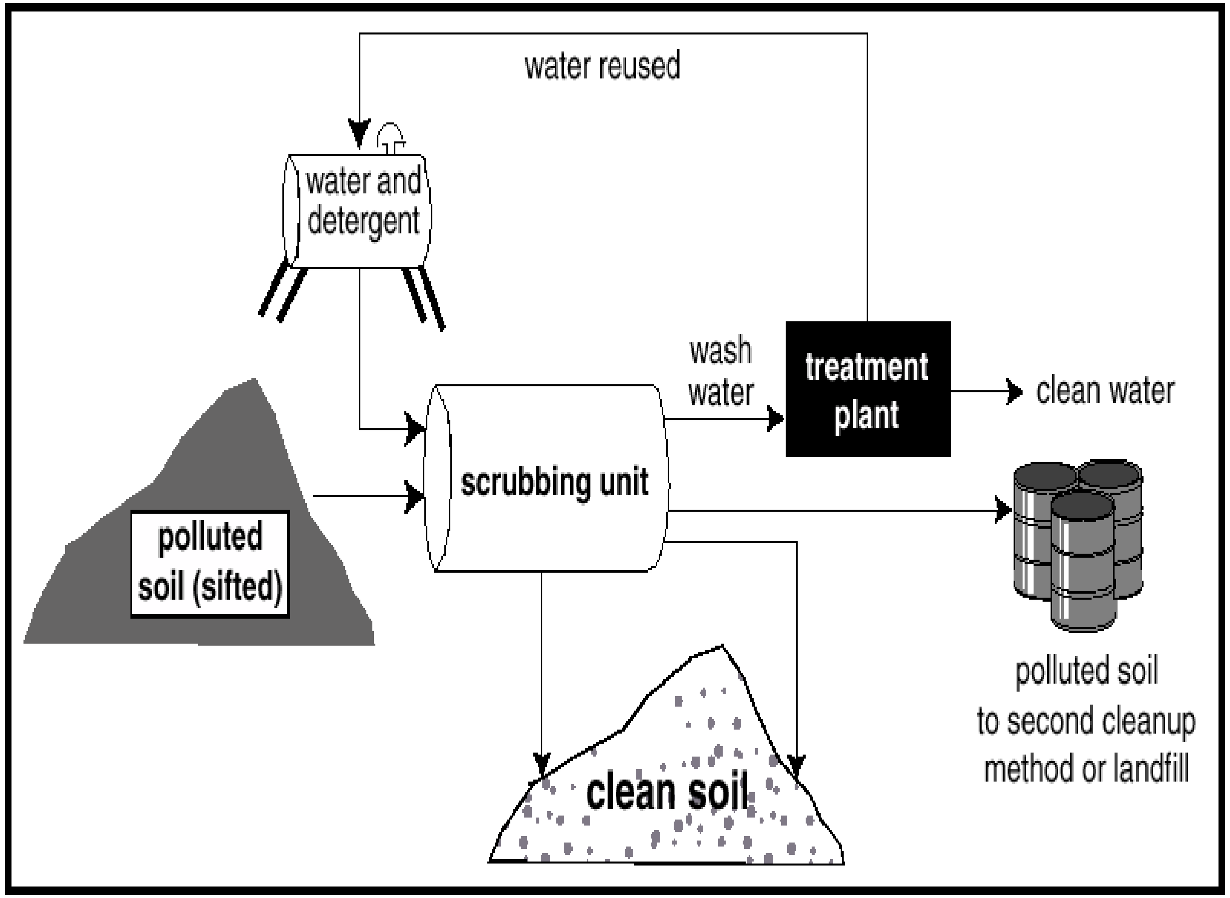
- Separate:
  - Soil and the contaminant (e.g. soil vapour extraction)
  - contaminated and uncontaminated soil particles (e.g. soil washing)
- Exploits variations in:
  - Size, density, shape, solubility
  - Electromagnetic properties
  - Surface characteristics
  - Solubility and vapour pressure

Physical Techniques
Soil Washing

- Linkage target:
  Source – Pathway – Receptor
- Media: Soils
- Treats: Wide range of contaminants (inc. metals, cyanides, hydrocarbons and solvents, PAHs, PCBs etc.)
- Type: Ex-situ treatment (Physical/chemical)

Soil washing …

- Dig it up
- Haul it
- Wash it
- Dispose of the residues
- And reuse the majority !



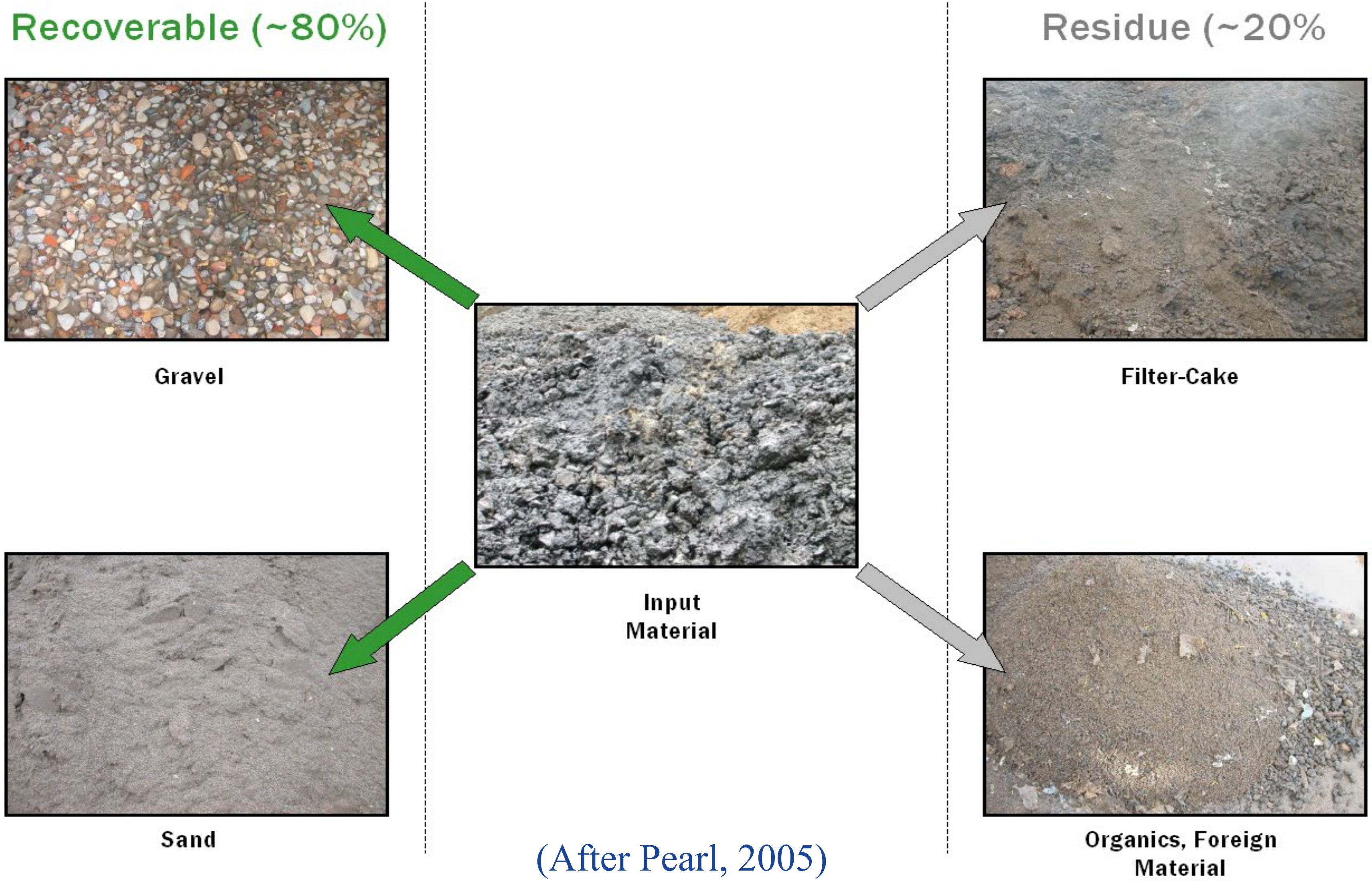
Soil washing

- Removal of surface bound and adsorbed contaminants into an aqueous phase
- e.g. attrition, scrubbing, chemical reagents
- Separating and collecting a fine 'dirty' fraction for disposal
- Throughput: Approx. 50 tonnes/hr

- Commercially Available Equipment include
  - Wet-Screening
  - Hydrocyclones
  - Upstream Classification
  - Spiral-Separators – media shape separator
  - Gravel-washing
  - Counter-current classifiers
  - Attrition Scrubbing
  - Flotation Tanks
  - Settling Tank
  - Belt-press
  - Water Treatment

Soil washing

Recoverable vs Residue



(After Pearl, 2005)

Sound science:
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Soil washing

Pros

- Volume reduction in waste requiring disposal !!! -> cost savings
- Wide range of contaminants
- Graded materials can be recycled
- Can remove surface bound/ adsorbed contaminants
- Relatively rapid compared to some treatments
- sustainable

Cons

- Waste still requires treatment/disposal
- Mobilisation only economic for larger sites
- Site area and services required
- Impact on soil structure and integrity
- Energy demands

Sound science:
Defensible decisions

Physical Techniques
Soil Vapour Extraction (SVE)

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- Linkage target:
  Source – Pathway – Receptor
- Media: Soils and vapours
- Treats: Volatile organics (e.g. petrols and solvents)
- Type: In-situ treatment (Physical/biological)

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Soil Vapour Extraction

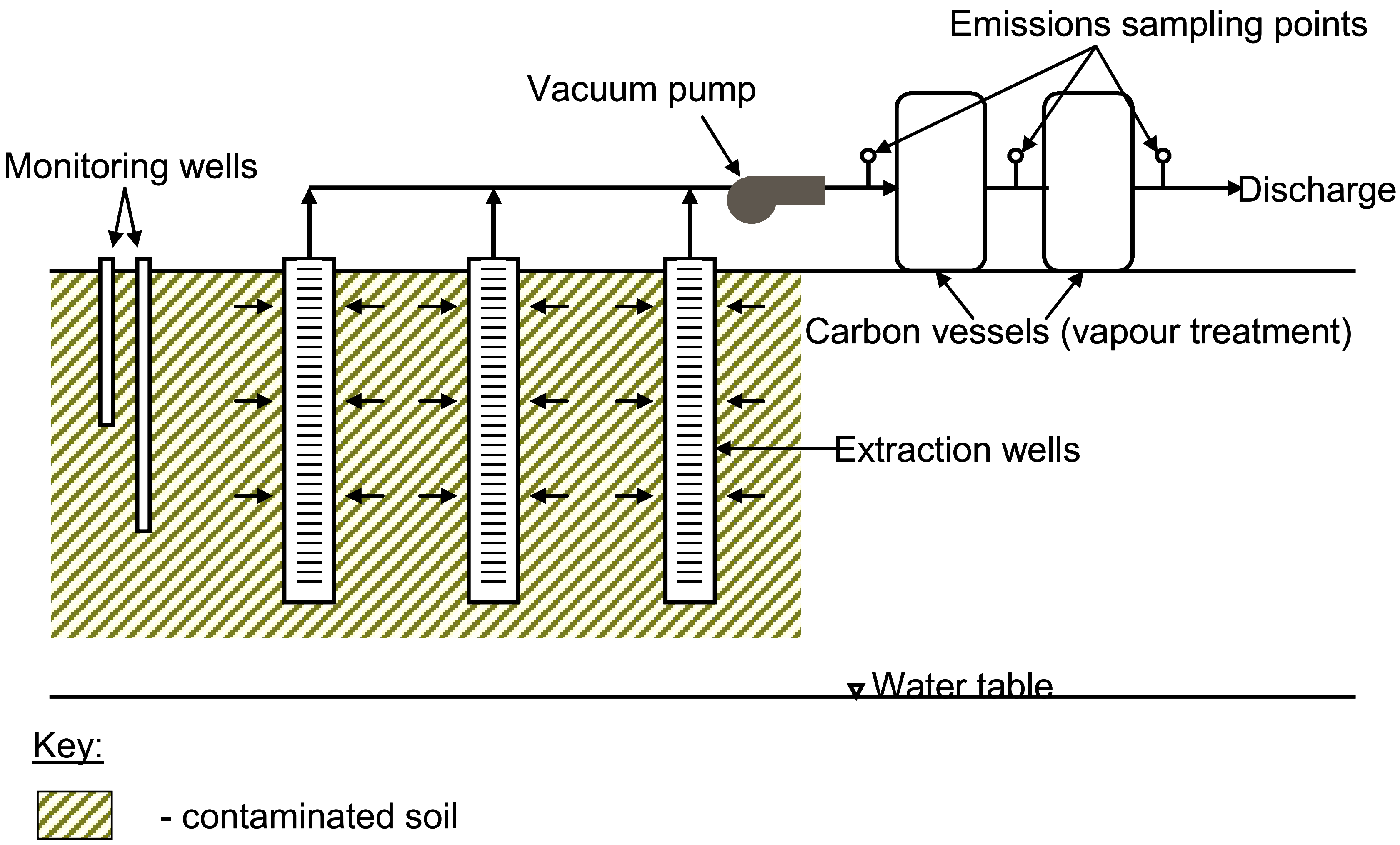
- Sub-surface vapours extracted from soils
- Removal is controlled by:
  - volatility of the contaminants
  - permeability of soil to air (May be modified using hydrofracture or pneumatic fracture methods)
  - rate of transfer between the contaminant in soil/pore water and in pore air

Sound science: Defensible decisions

SVE vs Bioventing

- SVE
  - Primarily physical method
  - Aim: remove maximum amount of vapour from soil
  - Suck vapours from wells
  - Off gas treatment
  - High vacuum/ flow rates used
- Bioventing
  - Primarily biological technique
  - Aim: aeration of the unsaturated zone promoting biodegradation
  - Sucking/blowing air gently - Low vacuum / flow rates
  - Often used as a polishing step after SVE etc

In-situ SVE



Taken from Contaminated Land Ready Reference

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SVE/Bioventing: Limitations

- Only applicable to volatile
  - Semi-volatile contaminants can be treated using thermally enhanced systems
- Success of SVE depends on permeability of soil, organic matter and moisture content
- Using high vacuum could cause the water table to rise
- Dependent on zone of influence
- Low permeabilities / high moisture contents require higher vacuums (increasing costs) and/or hinder operation
- Difficult in heterogeneous soils
- Off-gas treatment produces wastes (residual liquids and Spent activated carbon) requiring treatment/disposal.
- SVE is not effective in the saturated zone; however, lowering the water table can expose more media to SVE (this may address concerns regarding LNAPLs).

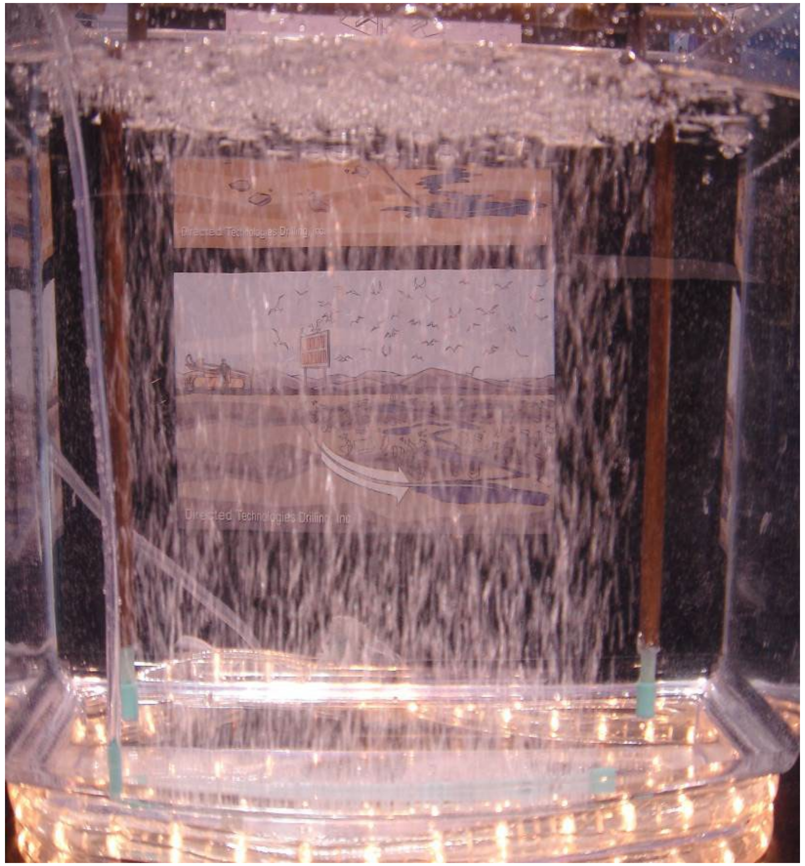
Sound science: Defensible decisions

Physical Techniques
Air Sparging

- Linkage target:
  Source – Pathway – Receptor
- Media: Soils, waters and vapours
- Treats: Volatile organics (e.g. petrol and solvents)
- Type: In-situ treatment (Physical/biological)

Air sparging vs biosparging

- Air sparging
  - Violently (0.4 - 0.8 m3/min) blowing air through groundwater to volatilise dissolved VOC – eg BTEX
  - Mobilises the contamination so that it can be recovered via - or degrade in - the unsaturated zone
- Biosparging
  - Gently (<0.2 m3 /min) blowing air through groundwater to stimulate in situ biodegradation
  - Increases available dissolved oxygen
  - Reduce rate of volatilisation so SVE not needed



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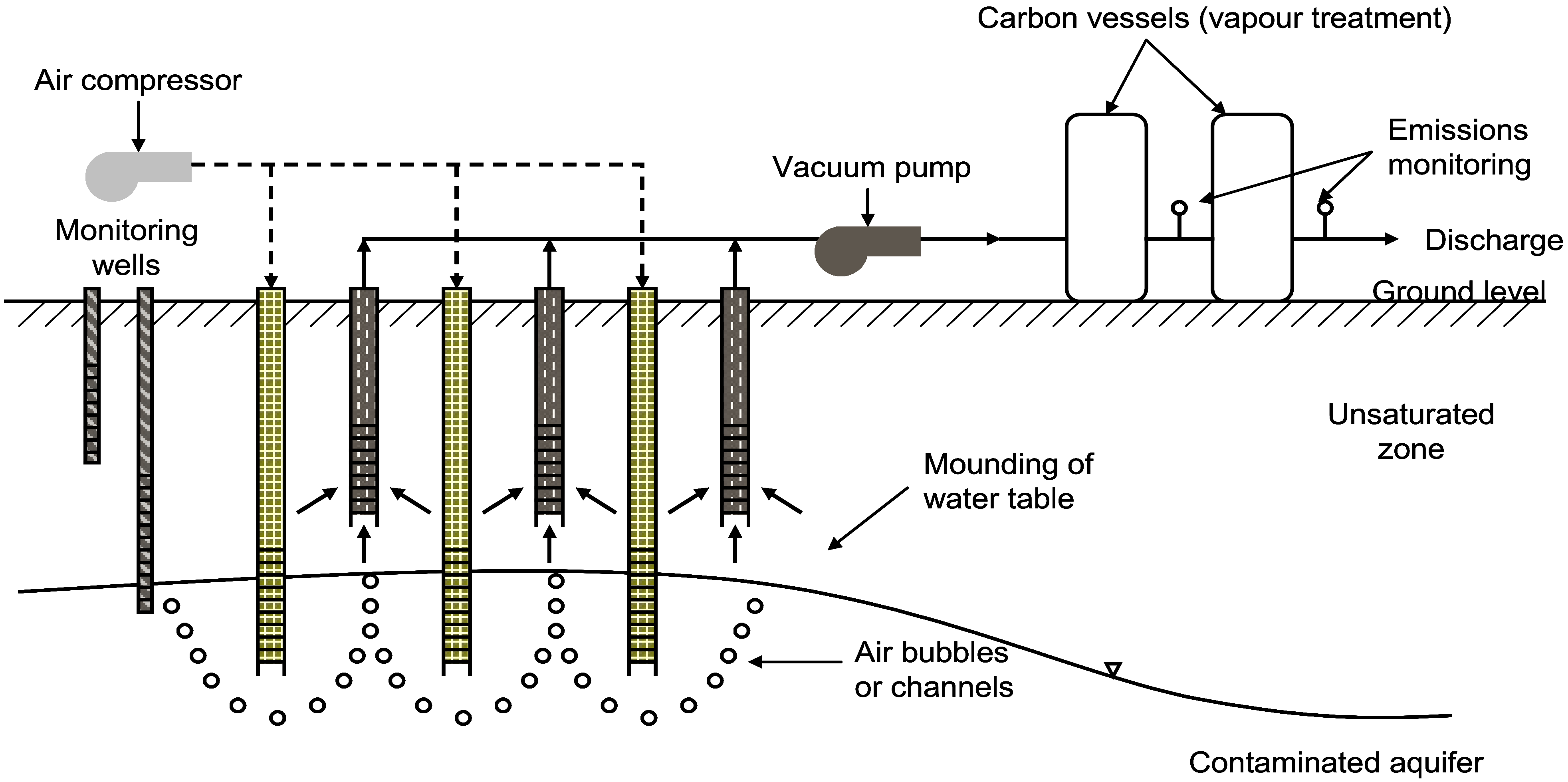
Air sparging/ Biosparging



Taken from Contaminated Land Ready Reference

Air sparging/Biosparging

Pros

- Minimal site disturbance
- Cost effective
- Can be linked with other methods
  - Dual phase extraction
  - Bioventing
  - Biosparging

Cons

- Limited to volatiles
- Service runs etc. can short circuit recovery
- Emissions usually require treating – Eg SVE
- Unsuitable for low permeability soils
- Difficult to predicted air distribution
- long-term performance (cleanup levels, cleanup times, etc.) difficult to predicted
- Confined aquifers
- Can induce (lateral) migration of contaminants

Sound science: Defensible decisions

Removal of PFAS by foam fractionation - *Ex Situ, Water*

RICARDO EMAQ+

Photo: Copyright C P Nathanail, with thanks to A A Environmental Ltd

- Linkage target: Source – Pathway – Receptor
- Media: Waters
- Treats: Long Chain PFAS
- Type: Ex-situ treatment (Physical)
- Air is sparged upward through a column of PFAS contaminated water forming bubbles
- PFAS sorbs to foam → concentrated in foam
- Foam removed → PFAS removed
- PFAS incineration

PFAS = Polyfluoroalkyl substances

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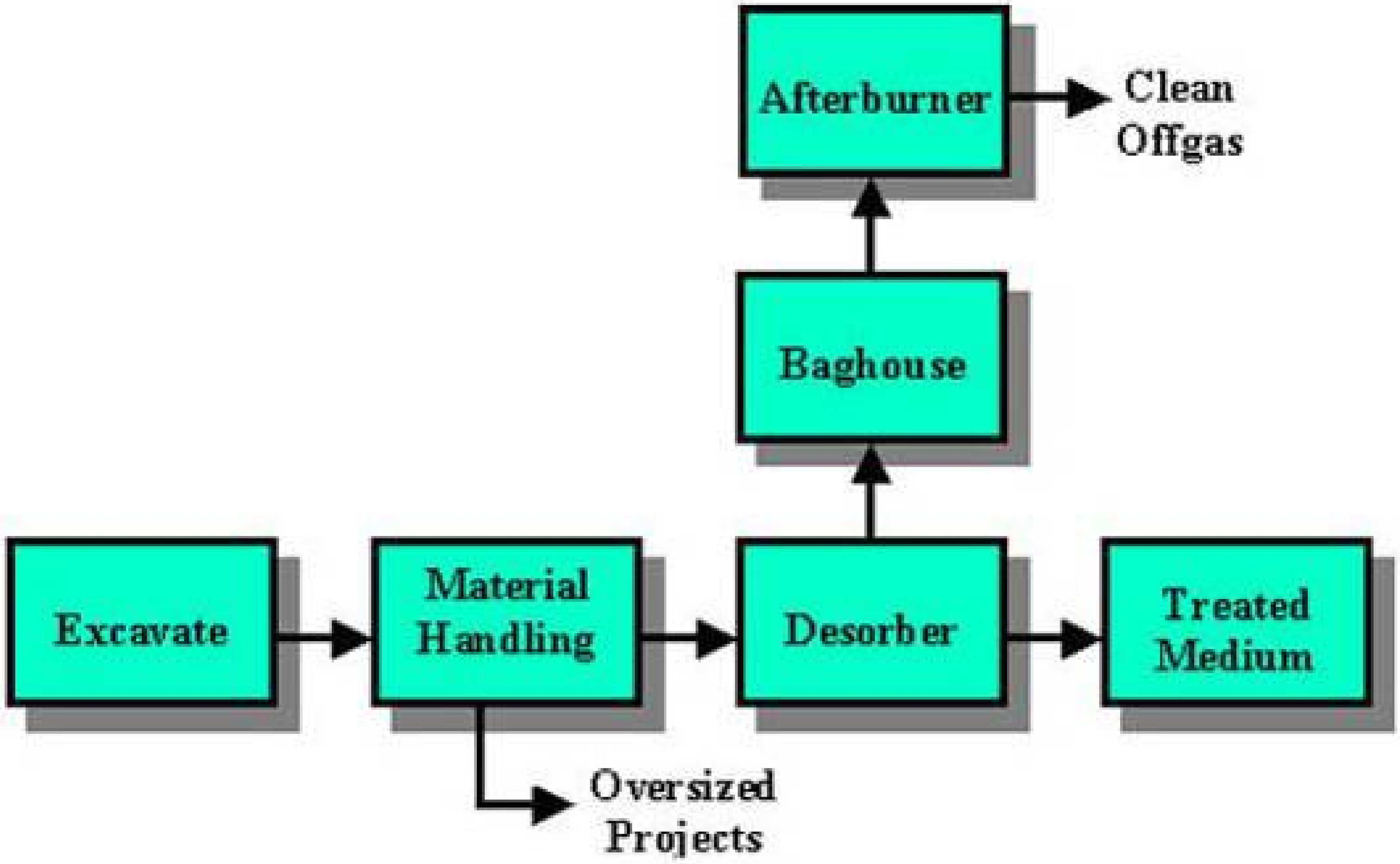
Thermal Techniques: UK applications

- *Ex situ*
  - Incineration
  - Thermal desorption
  - Vitrification
- *In situ*
  - Thermal desorption / Thermally-enhanced extraction
  - Vitrification
- All usually destroys soil properties

Thermal Techniques
Thermal Desorption

- Linkage target:
  Source – Pathway – Receptor
- Media: Soils
- Treats: Mainly Organics (inc. hydrocarbons, solvents, PAHs, PCBs, Explosives, phenols and cyanides)
- Type: Ex-situ treatment (thermal)

Thermal desorption



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Thermal desorption

- Two stage process
  - Organics are volatilised at low temperatures (400-800°C) and cleaned “soils” separated
  - Off-gases/dusts treated e.g. filters, combustion etc
- Soil may need pre-treatment
  - Remove rubble/scrap metal
  - Reduce moisture content

Heating soils produces:

- Contaminant vapours
- Volatile metals
- Gases
  - CO_2
  - Sulphur and nitrogen oxides (SOx & NOx)
  - Corrosive (acidic or alkaline)?
- Steam/Water vapour
- Dust
- Abatement, monitoring and control needed

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Defensible decisions

Thermal desorption: Advantages

- Effective
  - against a wide range of contaminants
  - Against unknown mixtures of volatile/ semi volatile contaminants
- Potential for high removal efficiencies/ to meet stringent remedial targets
- Cost effective compared to landfill for larger volumes
- Pollutants are destroyed – removing long-term liabilities
- Well understood with large amounts of technical experience
- Timescale guarantee ?
- Products can be reused – sustainable
- flexible process – bolt-on adaptations

Thermal desorption: Disadvantages

- High energy use $\rightarrow$ high costs
- Air emission controls
- Potential resistance to an "incinerator"
- Soil structure and fertility is usually destroyed – limits reuse
- Potential generation of dusts/silt
- Extremes of soil pH can corrode internal systems
- High SOM may cause complications
- Tightly aggregated soils can reduce the system performance
- Presence of volatile metals are applied temperatures can cause a pollution control problem

Case study:
Thermal Desorption

- Feasibility study (not full-scale)
- 38 tonnes of soils from tank farm at a former chemical works
- Contaminants: hydrocarbons (incl. BTEX)
- Typical analysis, low levels of metals, VOCs ~6.4 %, sulphur content <10 mg/kg, calorific value ~ 175 kJ/kg
- Treatment temperature: 200-300 °C
- Trial indicated:
  - Potential treatment rate of 1150 tonnes per week
  - Estimated costs for 50,000 tonnes, £50 per tonne

Source: CL:aire Fact Sheet TDP1 www.claire.co.uk

Thermal Techniques
Thermally-enhanced extraction

- Linkage target:
  Source – Pathway – Receptor
- Media: Soils (waters)
- Treats: Volatile and Non-volatile Organics
- Type: In-situ treatment (thermal/physical)

Thermally-enhanced extraction

- Heat assists removal of SVOCs – such as creosote, PCP, chlorinated solvents PCBs and diesel
- Heating may be by:
  - Hot air
  - Steam injection
  - Electrical resistance heating
  - Electrical conductivity heating
  - Microwave/radio-frequency heating
- SVE or “pump & treat” wells used to recover contaminants as vapours or solutions

Sound science:
Defensible decisions

Solidification and stabilisation

- Linkage target:
  Source – Pathway – Receptor
- Media: Soils
- Treats: Nearly all contaminants (depending on binder selection)
- Type: In-situ and Ex-situ treatment (Solidification and stabilisation)

What is Solidification & Stabilization ?

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"Stabilisation/solidification (S/S) is a remediation technology that relies on the **reaction between reagent and soil** to reduce the mobility of contaminants. Immobilization is achieved by reaction of contaminants with reagents to promote sorption, precipitation or incorporation into crystal lattices, and/or by physically encapsulating the contaminants"

Environment Agency, 2004

Aka: immobilisation; fixation

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Solidification

- Involves the addition of reagents to a contaminated material to impart **physical/dimensional stability** to contain contaminants in a **solid product** and **reduce access** by external agents (eg air, rainfall).
- **Physical** modification of properties
- Often modification of existing civil engineering methods for improving soil properties eg higher strength, lower permeability

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Defensible decisions

Stabilization

- Involves the addition of reagents to a contaminated material (eg soil or sludge) to **produce more chemically stable constituents**.
- **Chemical** modification of properties
  - Less mobile, less leachable or less toxic
  - Reversibility?

Solidification & Stabilization: Inorganic contaminants

- Routinely treated outside UK
- Inorganic contaminants treated by S/S include:
  - Volatile metals
  - Non-volatile metals
  - Radioactive materials
  - Asbestos
  - Inorganic corrosives
  - Inorganic cyanide

Sound science: Defensible decisions

Solidification & Stabilization: Organic contaminants

- More challenging than inorganics
- Usually involved bespoke additive formulations
- Organic contaminants treated by S/S include:
  - PCBs and dioxins
  - Coal tar/creosote (PAHs and phenols)
  - Diesel etc
  - TCE

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Solidification & Stabilization: Durability is affected by …

- Physical weathering
- Chemical weathering
- Biological effects
- Mechanical erosion
- Poor design
- Bad workmanship
- Inhibitory contaminants
- Heterogeneity – thermal expansion stresses etc.

Site- specific variables

Solidification & Stabilization: Ex-situ Soil Mixing

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- In drum process
  - Used in the nuclear and hazardous waste industry
  - Waste is stabilized and contained in drums for disposal
- Batch or continuous mixing
  - Soil is excavated and mixed with binder using a pug mill etc
  - Soil is re-laid in final destination and compacted, as required

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Solidification & Stabilization: In Situ Soil Mixing

- Rotating auger for deep mixing
  - as lowered into soil the rotating blades cut and mix the soil around them
  - ports at the base of the auger inject solidification, stabilisation agents and water into the mixing zone
  - Soil properties may limit effective depth
  - Were volatiles may be liberated a vapour extraction manifold may be appropriate
- Surface harrows/rotavators for shallow mixing

Surface-mixing harrows

Field trial indicating inappropriate equipment !

Column-mixing augers

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Defensible decisions

Solidification/stabilization: Advantages

- Relatively short treatment times (cf biopiles, MNA etc)
- Small footprint of process (eg suitable for smaller sites)
- Proven remedial technique
- May be cost-effective
- Used in conjunction with other techniques, if required
  - "Treatment train"
- Suitable for wide range of contaminants (organic and inorganic)
- May improve structural properties of soil (particularly load-bearing strength)
  - May be integrated with other engineering works need at the site

Sound science:
Defensible decisions

Solidification/stabilization: Disadvantages

- Inhibitory substances (eg sulphate, oils)
- Does not destroy/remove contaminants - Residual long term liability
- May require long-term maintenance and/or monitoring
- Potentially reversible effects
- Potential for volume increase
- Organics are more difficult to treat – particularly at high levels
- Exothermic reactions may volatilize contaminants from soil
- Need to demonstration of integrity & durability to regulator - Current UK study underway

Sound science: Defensible decisions

Session 5

Options Appraisal

Options Appraisal

Designing a remedial strategy

“the design of a remedial strategy involves a component of creative thinking allied with sound professional and scientific judgement (a blend of ‘art’ and ‘science’)”

“Issues for the selection of remedial strategies”, EA paper

Sound science:
Defensible decisions

In general

- Higher potential remedial costs justify greater effort in selecting appropriate options
  - Simple decision at small/simple sites
- Better selection process = greater cost-effectiveness (savings ?)
- Remedial costs will be higher for:
  - Large sites
  - Large volumes needing treatment
  - Sites with multiple pollutant linkages
  - Sites with multiple contaminants
  - Sites with multiple media (eg contaminated soils and/or waters and/or gases/vapours)

The Old (CLR11) and the New (LCRM)

- Chapter 1 – Overview
- Chapter 2 – Risk Assessment
- **Chapter 3 – Options Appraisal**

  Steps

  - **Identify feasible options**
  - **Evaluate options**
  - **Produce remediation strategy**
- Chapter 4 – Implementation

  Steps

  - Preparing the implementation plan
  - Design, implement and verify remediation
  - Long-term monitoring and maintenance

- Stage 1 – Risk assessment
- **Stage 2 – Options appraisal**

  Steps

  - **Identify feasible options**
  - **Evaluate options**
  - **Select remediation options**
- Stage 3 – Remediation

  Steps

  - Develop a Remediation Strategy
  - Remediation and verification
  - Long-term monitoring and maintenance

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Options appraisal

- Identify optimal option or combination of techniques
- Driven by conceptual model
- Need clear remedial objectives
- Three stages:
  - Tier 1: Identify feasible options
  - Tier 2: Detailed evaluation of options
  - Tier 3: Produce remediation strategy

Sound science: Defensible decisions

Options appraisal:
Tier 1: Identify feasible options

- Screen all available technologies
- For each linkage, can each technique meet the objectives? In particular can it:
  - treat the appropriate media
  - treat the contaminant(s)
- $\rightarrow$ feasible option(s)
- **Avoid pre-conceptions – do not rule out all options except the one you prefer/have experience of etc.**

Sound science:
Defensible decisions

Activity – LCRM options appraisal matrix

- https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm/lcrm-stage-2-options-appraisal
- https://www.gov.uk/government/publications/land-contamination-remediation-option-applicability-matrix

www.gov.uk/government/publications/land-contamination-risk-management-lcrm/lcrm-stage-2-options-appraisal

uTube Music History Periodic Table – Roy... MolView PubChem Electronegative - C... TechUp Women Ind... Data4Sustain BETA 3 00 J_Notes PROJECTS gsuite tech tutoria

- any indirect benefits – will it enhance the amenity or ecological value of an area, remove blight or encourage regeneration
- legal, financial and commercial context of the site, including any specific legal requirements the remediation has to comply with

Part 2A requirements

For Part 2A sites, you must refer to section 6 of the contaminated land statutory guidance. This states that decisions must be based on reasonableness and the use of best practical techniques.

The regulator for Part 2A will consider whether the remediation option:

- is practicable, effective and durable – all criteria must be treated equally
- has an impact on health and the environment
- is financially viable
- has benefits
- can meet the aims of the remediation required

Select the most feasible remediation options

You can use the remediation option applicability matrix to help select which options are most feasible.

The matrix contains information on the potential applicability of a range of common remediation options to particular contaminant-media type combinations.

It covers a range of:

- common methods that are generally available
- applicable media – soils, made ground or sediments, groundwater or surface water
- organic and inorganic contaminants

The matrix:

- indicates the broad capabilities of a remediation option
- indicates where a pre-treatment step may be necessary or if case study information is required

You can regularly check the current technical literature to keep up to date.

www.gov.uk/government/publications/land-contamination-remediation-option-applicability-matrix

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Guidance

Land contamination: remediation option applicability matrix

You can use the matrix to select which remediation options are most feasible when you're doing your land contamination risk management options appraisal.

From: Environment Agency
Published 5 June 2019

Documents

Remediation options applicability matrix
ODS, 11.8KB
This file is in an OpenDocument format

Related content

PHE spend over £25,000: November 2019
Monthly sea fisheries statistics April 2018
Recent trends in mortality in England: review and data packs

Brexit
Check what you need to do

Details

The matrix:

- indicates the broad capabilities of a remediation option
- covers common methods that are generally available for particular contaminant-media type combinations

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Options appraisal:
Setting OA objectives

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- Define a series of objectives that the remedial strategy must meet to be acceptable
- **Remediation objectives**: *"site-specific objective that relates solely to the reduction or control of the risks associated with one or more of the* ***relevant contaminant linkages****"*;
  - To ensure that after treatment soil will not pose an unacceptable risk to human health
  - To remediate a groundwater plume to an acceptable standard
  - To design and install an in ground barrier that protects a receptor
  - To ensure an appropriate thickness of a composite surface cover in all affected gardens

CL
↓
RO
↓
RC

- Remediation criteria (based on the remediation objectives) will be used verify that the remediation has been successful

Early version of LCRM – 'relevant contaminant linkages' was referred to as 'relevant pollutant linkage'

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Options appraisal:
Tier 2: Detailed evaluation of options

- The level of detail will depend in site-specific circumstances
- Evaluate all feasible options:
  - Assess the limitations, advantages and disadvantages of each option
  - Establish which options are most suitable – singularly or in combination
  - Get detailed information on each option, including cost
  - Develop and use OA evaluation criteria to assess each option
- Evaluation may be qualitative or quantitative (e.g. using a scoring matrix)
  - “Best Practical Environmental Option” (BPEO) approach
  - For Part2A, also consider the “reasonableness” requirements in the “Statutory Guidance”

Sound science: Defensible decisions

Options appraisal:
Factors affecting selection

- Soil, water, NAPL, vapour, gas ?
- Contaminant characteristics: form, concentration etc.
- Soil characteristics: porosity, %clay, moisture, SOM
- Site characteristics: Size, nearby houses?, operational
- Context: Legal, commercial, financial
- Health & Safety considerations
- Stakeholder Views: Site owner, investors, insurers, regulator, neighbours, pressure groups, politicians…
  - tolerance to residual risk, impact on property values, disruption
- Time-scale and **cost**
- Licensing issues: environmental permits for waste, discharges or abstraction etc.

Sound science: Defensible decisions

Options appraisal:
Evaluation criteria

- LCRM provides a “checklist” including:
  - Effectiveness: Will clean up targets be achieved?
  - Ease of verification
  - Limitations (contaminants, soil types, inhibitory conditions)
  - Commercial availability and track record
  - Compliance with environmental and health & safety requirements
  - Effects (e.g. nuisance) on neighbours or sensitive landuses
  - Impact on redevelopment design/construction
  - Durability
  - Ongoing liabilities
  - Cost
  - Space requirements
  - Able to meet required timescale
  - Availability of water/power etc.

Sound science:
Defensible decisions

Options appraisal:
Evaluate costs

- Cost is likely to be a big factor
- But it can be very challenging to get reliable cost estimates
- To estimate costs:
  - Use recent or previous experience
  - Use information from remediation contractors
  - Use published information
- But costs are often confidential
- When published, may not be comparable or easy to use:
  - Volume-based (per m^3), area-based (per m^2), time-based (per hr), concentration-based (per mg/L) etc.
  - May cite minimum and maximum costs

Sound science: Defensible decisions

Options appraisal: Cost components

Expensive:

- Quick
- ex situ
- Energy input
  - eg moving soil or water, heating soils
- Transport
  - Export
  - import

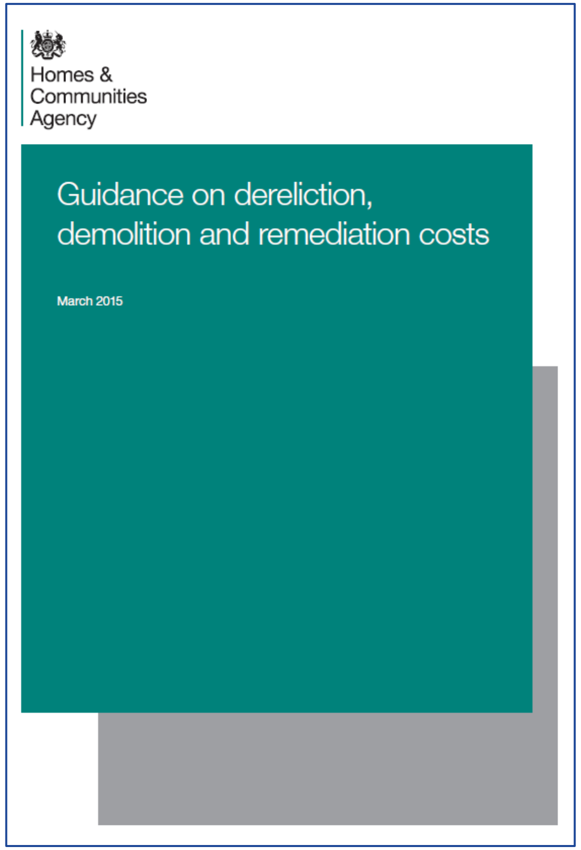
Cheaper:

- Slower
- In situ
- Less energy
- Automated/ remote controlled/ real time monitoring

Sound science: Defensible decisions

Options appraisal:
Evaluate costs

- Guidance on dereliction, demolition and remediation costs (HCA 2015)
  - https://www.gov.uk/government/publications/guidance-on-dereliction-demolition-and-remediation-costs
- *“to assist [HCA] project managers and development partners form, at an early stage, an opinion as to the costs of the remediation of the contamination and demolition of buildings, for inclusion in a project appraisal, possibly even prior to the appointment of consultants and the provision of site-specific advice”*



Sound science: Defensible decisions

Guidance

Guidance on dereliction, demolition and remediation costs

This guide helps a project sponsor understand some of the key issues when dealing with the redevelopment of previously developed land.

From: Homes and Communities Agency
Published 18 March 2015

Get emails about this page

This publication was withdrawn on 24 May 2022

This content has been withdrawn as it's no longer current. The Homes and Communities Agency now operates as Homes England.

Documents

Guidance on dereliction, demolition and remediation costs (3rd edition)

PDF, 839KB, 56 pages

This file may not be suitable for users of assistive technology.

▶ Request an accessible format.

Related content

VAT Construction

- Withdrawn May 2022
- Inflation

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Options appraisal:
Tier 3 Select remediation options

- Select the final remediation option(s) that will deal with the site as a whole
  - Identify a different option that will address the site as a whole; or
  - Consider if you can combine options
    - Different techniques needed for different areas; or
    - “Treatment trains”
    - Pretreatment, treatment and post treatment/polishing
- Base your final selection on:
  - Meeting the OA remediation objectives and other objectives and constraints
  - Your OA evaluation results
  - Costs
  - Technical merit

Sound science: Defensible decisions

Options appraisal:
Select options - example

- **Method A**: well-established technique used routinely in UK and offers a good long term solution. Remediation can easily be completed within the required timescale. The estimated cost is £1 million.
- **Method B:** less established but does have a track record of successful use in similar applications. Offered by a reasonable number of specialist contractors. Likely to pose fewer short-term health and safety and environmental risks than Method A. But uncertain if it will meet remediation objectives within the required timescale. Post-remediation monitoring likely to be needed. The estimated cost of is £500,000.
- **Justification:** Method B was selected because:
  - Technical performance was not significant
  - Substantial potential cost savings, even accounting for longer term monitoring

Sound science: Defensible decisions

Options appraisal:
Reporting requirements

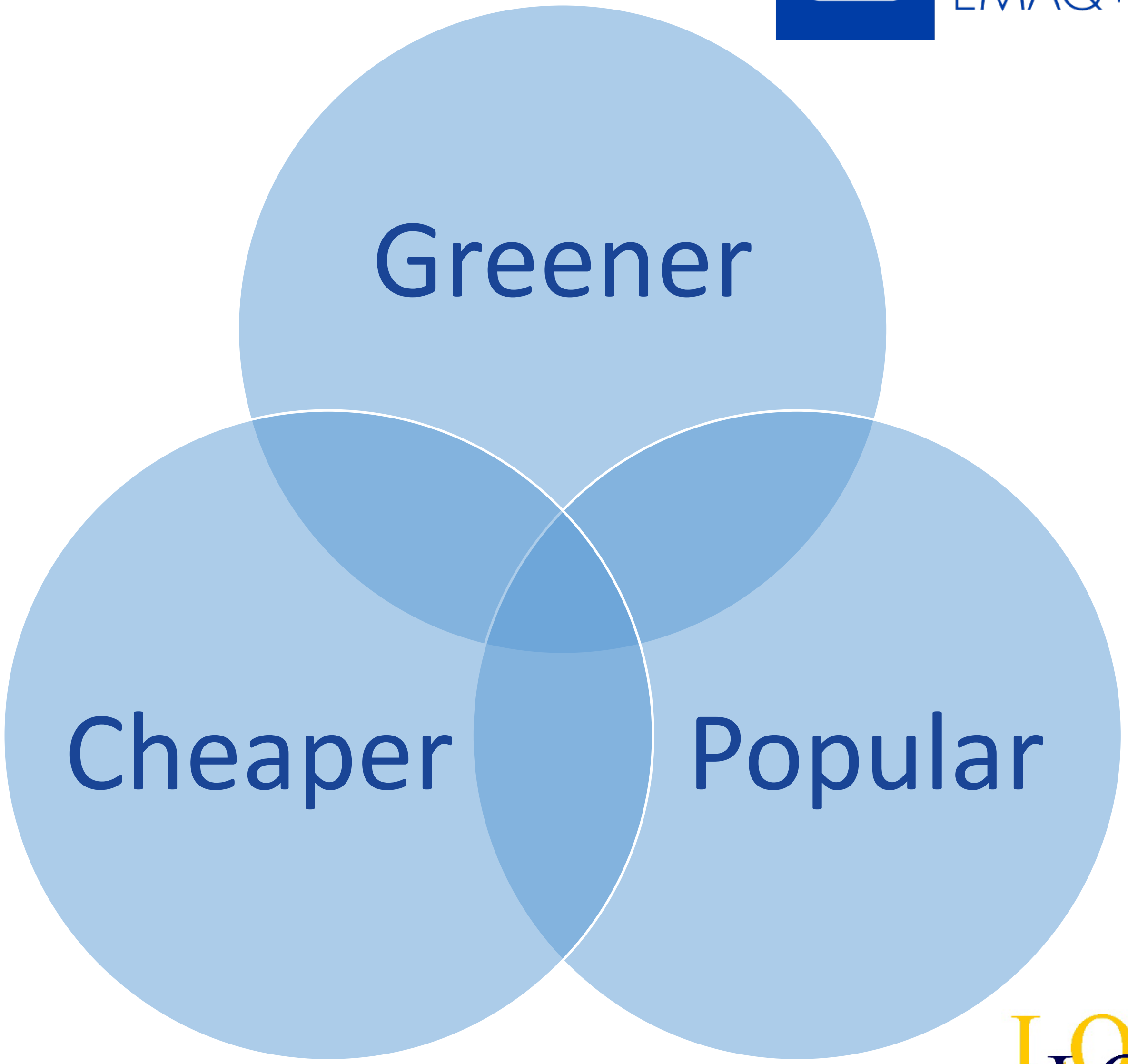
- The LCRM requires decisions to be recorded and justified in your OA report
  - Requirements are listed at https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm/lcrm-stage-3-remediation-and-verification#remediation-and-verification-reporting-requirements
  - Including:
  - General information
    - Basic site details
    - brief summary of previous RA reports
    - Updated CSM – which linkages require management
    - The remediation objectives and criteria (and other objectives and constraints)
  - Selection of feasible options
  - Detailed evaluation
  - Justify remediation option(s) selected

Sound science: Defensible decisions

The Sustainable remediation *triathlon*

Has there been consideration on how to make the remediation:

- ✓ More Popul*ar* – social acceptance
- ✓ Cheaper – economic affordability
- ✓ Greener – environmental beneficial



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BS ISO 18504:2017 – Sustainable Remediation

Risk management: *"demonstrably breaking source-pathway-receptor linkages"*

Sustainable Remediation: Elimination and/or control of unacceptable risks *in a safe and timely manner* ***whilst optimising the environmental, social and economic value of the work***

ISO 18504 does:

- Provide standard methodology & terminology
- Advise on the assessment of the **relative sustainability** of alternative remediation strategies
- Promote consideration of SR throughout the planning design and implementation process

ISO 18504 does not

- Prescribe methods of assessment
- Prescribe indicators or their metrics
- Endorse or discuss "Green" or "Green and Sustainable" Remediation"

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ISO 18504:2017

24 pages!

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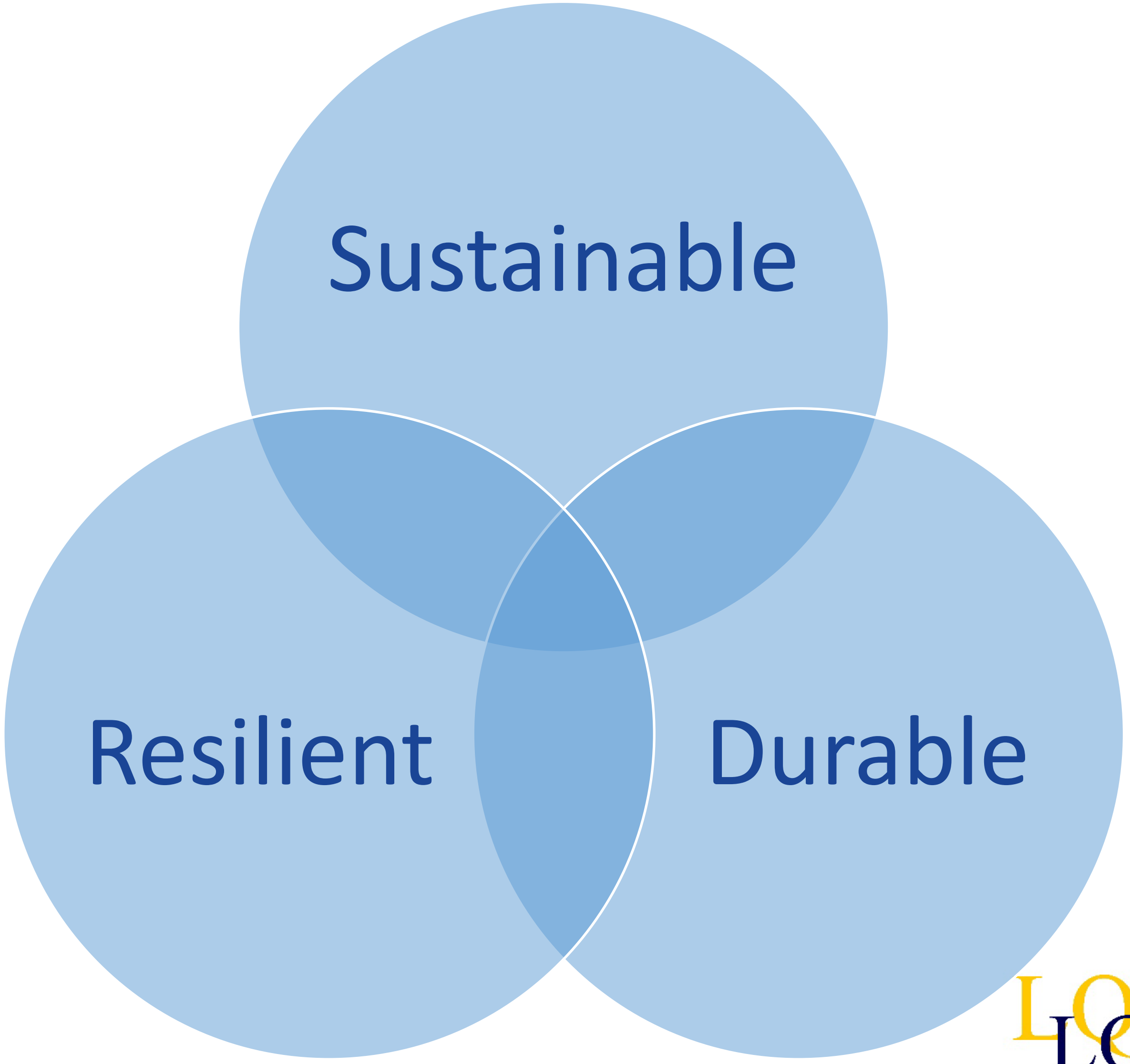
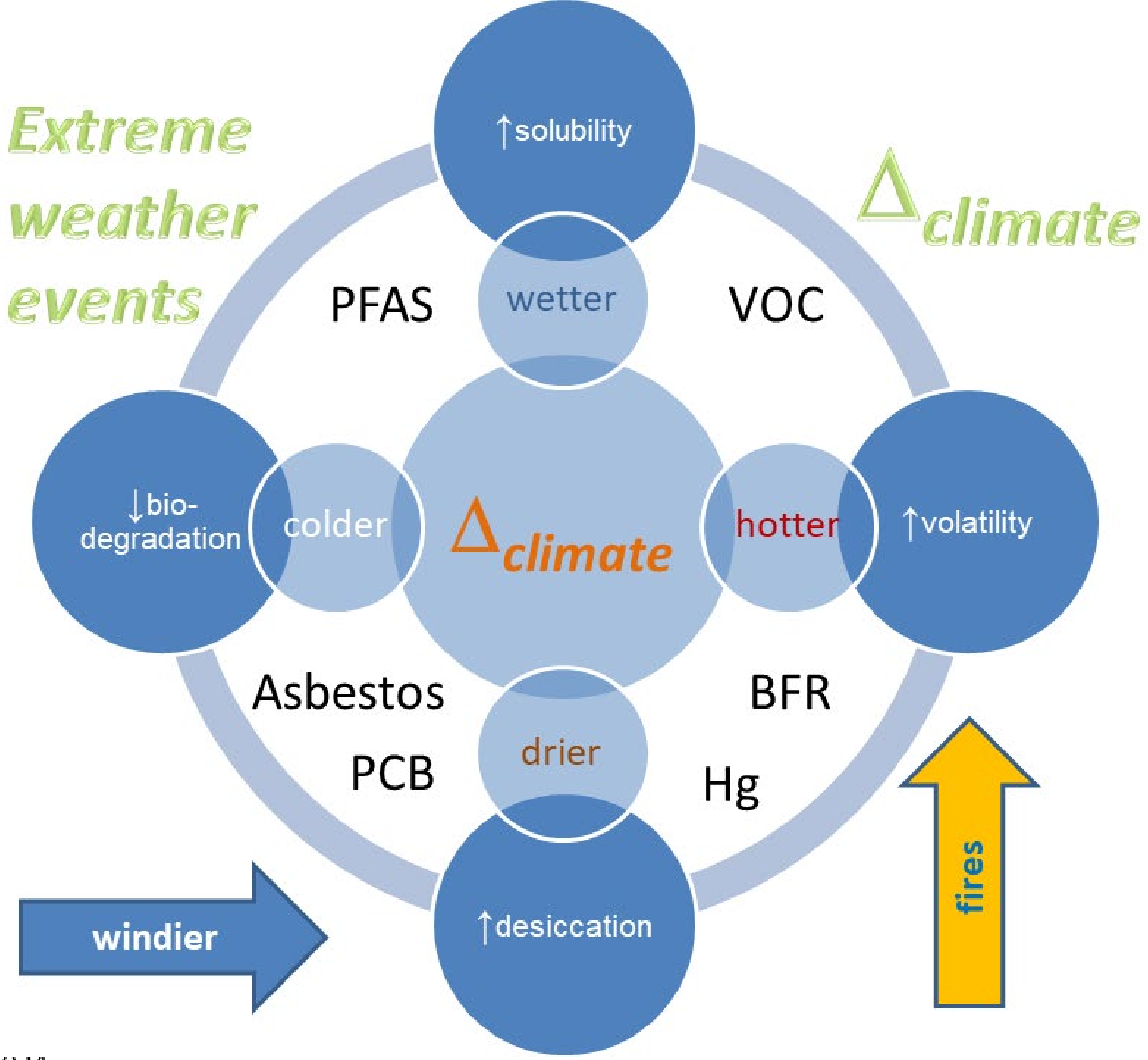
Sustainability is not [detailed] enough

Climate change and extreme weather events should be considered when choosing and implementing a remediation strategy

- Source removal vs pathway management
- Effects of EWE on performance
- Effects of Climate Change on design





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Greenhouse Gas Emissions

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- Estimate GHG from different remediation options

Collection

Government conversion factors for company reporting of greenhouse gas emissions

The government conversion factors for greenhouse gas reporting are for use by UK and international organisations to report on certain greenhouse gas emissions.

https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting

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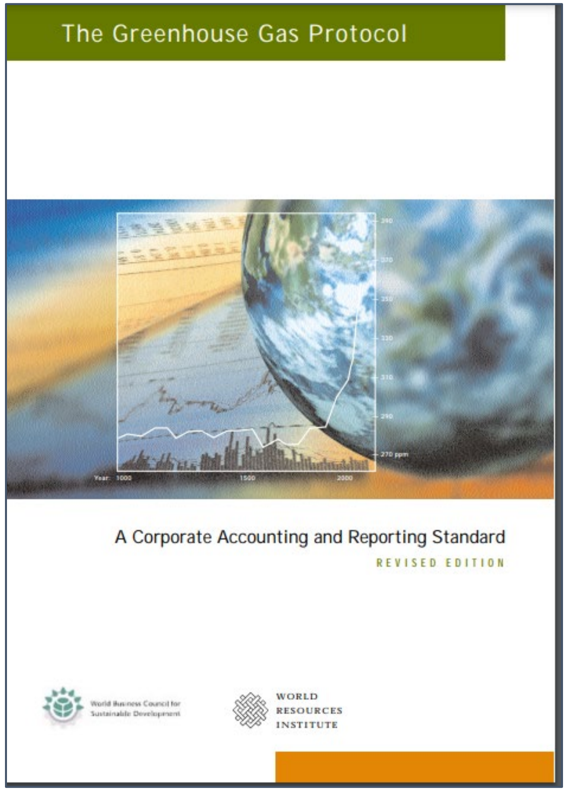
Review of available tools and methodologies to calculate CO2 emissions of soil and groundwater management activities

Published: June 2024
REF/ISBN: 978 1 78725 432 9
Edition: 1st
Status: Current

Reducing greenhouse gas (GHG) emissions is a legal requirement and a corporate objective for many organisations globally. In 2018, the construction sector, including land remediation, was responsible for 39% of global energy and process-related CO_2 emissions, as estimated by the International Energy Agency (IEA). To effectively reduce these emissions, robust estimates, particularly for soil and groundwater management, are crucial. These estimates help manage emissions from site investigations, remediation operations, waste management, travel, and laboratory analyses.

This report reviews available tools and methodologies for calculating CO_2 emissions from soil and groundwater remediation activities.

https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf



https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf

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Checklist for using BS ISO 18504:2017 on a specific site

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- Objectives – risk reduction
- Short list of technically valid options
- *Design considers long term climate change*
- *Design withstands extreme weather events*
- Site specific indicators
- Strategy relevant indicators
- Environmental ranking/ rating
- Social ranking/ rating
- Economic ranking/ rating
- Overall appraisal - Is there a clear ‘winner’?
- Document the process and its outcome

Site specific

Session 6

Remediation Strategy and Verification Reports

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Remediation Strategy and Verification

Stage 3 LCRM: Remediation and verification

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- Steps /Tiers

1. Develop a remediation strategy.
2. Remediate.
3. Produce a verification report.
4. Do long term monitoring and maintenance, if required.

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Remediation strategy:
Tier 1: Develop a Remediation strategy

- Describes how the risks will be managed/remediation implemented and verified
- A suitably qualified person with training, knowledge and experience in remediation must produce the remediation strategy including consultation with:
    - the client
    - regulatory authorities
    - a quantity surveyor
    - legal advisers
    - the contract laboratory
    - landfill or waste treatment operators
    - a civil engineering consultant
    - a project management consultant
- You must agree the RS with relevant stakeholders

The strategy:
Remediation strategy

- Reporting requirements are listed in the LCRM:
  - https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm/lcrm-stage-3-remediation-and-verification#remediation-and-verification-reporting-requirements
  - This seems much more detailed that the requirement specified in CLR11 and includes:
  - Introduction
  - Outline of the strategy
  - Full details of how it will be implemented
  - Full details of how it will be verified, including the required monitoring

Verification of remediation

- Needs to be considered from the beginning not as an after thought!
  - Description of verification is part of remediation strategy (ie Tier 1) – Verification Plan
  - Execution and reporting of verification is part of Tier   (Remediation and Verification) – Verification Report
- If you can't demonstrate what was done you may as well not have done it !
- "Verification of remediation of land contamination" published by Environment Agency Feb 2010
  - http://publications.environment-agency.gov.uk
  - "verification" not "validation"
- "…guidance on designing and implementing verification activities to demonstrate the effectiveness of, and to increase confidence in the outcome of, a remediation strategy."
- Should be used in conjunction with CLR11/LCRM

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Verification:
Verification should …

- "…use of an evolving conceptual model and multiple lines of evidence"
- "…address the uncertainties associated with remediation performance"
- "…provide an evidence-base to increase confidence in the outcome"
- But:
- "Too often in the past remedial criteria have been set, and agreed, with little or no documented evidence for how compliance should be measured or the number of samples that will be needed to meet a desired level of confidence"
- "…now widely accepted that assessing the concentration of a contaminant in a few samples against a target concentration may not be sufficiently robust to be confident in the outcome of a remediation project."
    - particularly for complex remediation processes, heterogeneous strata and/or difficult contaminants.

EA 2010 "Verification of remediation of land contamination"

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Verification:
Verification report

- May be one report or a series of interim reports
- Contents will vary from site to site but may include details of:
  - Background & site details
  - Reasons & objectives for undertaking the work
  - Details of project personnel & their roles
  - Methodology & programme of the works
  - Verification of works undertaken
  - Emissions controls monitoring
  - Plans, drawings & photographs
  - Waste records
  - Chemical & physical testing results
  - On-going monitoring needs

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Verification:

Verification report

- Example conclusions

- Planning
  - The site has been appropriately remediated in keeping with the agreed remedial strategy and, post remediation, does not pose a significant possibility of significant harm to human health or the significant possibility of significant pollution to the water environment.
- Part 2A
  - The significant pollutant linkage which formed the basis of the site being identified as Contaminated Land has been removed.

Summary

- Remediation strategy
  - Summary of OA
  - What the remediation will comprise
    - Detailed
    - Site Specific
  - How the work will be verified
  - CSM – show how linkages will be broken
- Verification report
  - Evidence
  - CSM – show linkages are broken

Relevant Contaminant Linkages

Demonstrably broken