CONSOIL Special Session 21 Abstract

MEASURING SUSTAINABILITY IN REMEDIATION

Organiser: Contaminated Land: Applications in Real Environments (CL:AIRE), UK

With an increasing focus on the sustainability of general business practices, the management of contaminated land has also come under the spotlight. Work on contaminated sites has traditionally been compartmentalised, which has not allowed the consideration of the environment in a holistic sense. To enhance the sustainability of outcomes in the management of contaminated land, this mindset must change. The consideration of sustainability in the remediation decision-making process is receiving attention from groups such as the Sustainable Remediation Forum (SURF) in the United States and the United Kingdom. These groups are currently trying to understand the key indicators associated with sustainability so that remedies for contaminated sites can be assessed and considered to aid decision-making. The off site impacts and benefits associated with the remediation of contaminated sites have not usually been incorporated into the decision making process. Incorporating off-site environmental, societal impacts, and economic impacts into decision-making will facilitate more sustainable and useful decisions.

The Special Session will include four papers and a panel discussion. Papers presented are:

- Setting the scene – UK SURF: Frank Evans, National Grid
- Cost Benefit Analysis – David Reinke, Shell Global Solutions
- US SURF and EPA case studies – David Ellis, Dupont

The Special Session will be chaired by Professor Stephan Jefferis and the Expert Discussion Panel will include:

- Brian Bone – UK Environment Agency
- Paul Bardos – R^3 , David Ellis – Dupont
- Johan de Fraye – NICOLE Chair
- Richard Boyle – English Partnerships

MEASURING SUSTAINABILITY IN REMEDIATION

SPECIAL SESSION 21

Organised by Contaminated Land: Applications in Real Environments (CL:AIRE)

CL:AIRE

Contaminated Land: **Applications In Real Environments**

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CONTENT

- Chairman Introduction – *Professor Stephan Jefferis*
- Setting the Scene to SuRF UK – *Frank Evans, National Grid*
- Soil and Groundwater Risk Management, Sustainability and Net Environmental Value – *David Reinke, Shell*
- Dupont's Work on Sustainability in Remediation – *David Ellis, Dupont*

- Panel Discussion – Richard Boyle: English Partnerships; Johan de Fraye: NICOLE; Frank Evans: National Grid and Paul Bardos: R^3 Environmental Technology Ltd.

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SUSTAINABILITY

Sustainability is the goal – to aim for

- We may never get there

- Sustainable development is the pathway
- Pathway will depend on where you start from
  - Who: recognising peoples' diversity of vision and perspective
  - When: concerns change over time and will depend on state of development
  - Where: recognising geographical and climatic diversity
  - What: telling people what they have to do will fail

Sustainable development must be founded on ethics (via equity)

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SUSTAINABLE DEVELOPMENT
UK contaminated land starting point

- Range of contaminated site sizes
  - Many small sites
  - Relatively few mega sites
  - Some are still operational
- Many contaminated sites are near or within towns/cities
- Strong pressure on land
- Government drive for new housing on brownfield land
- Experienced cadre of contaminated land specialists
- Still evolving government guidance
- Clean-up generally funded by development
- Profit on the land is a major driver

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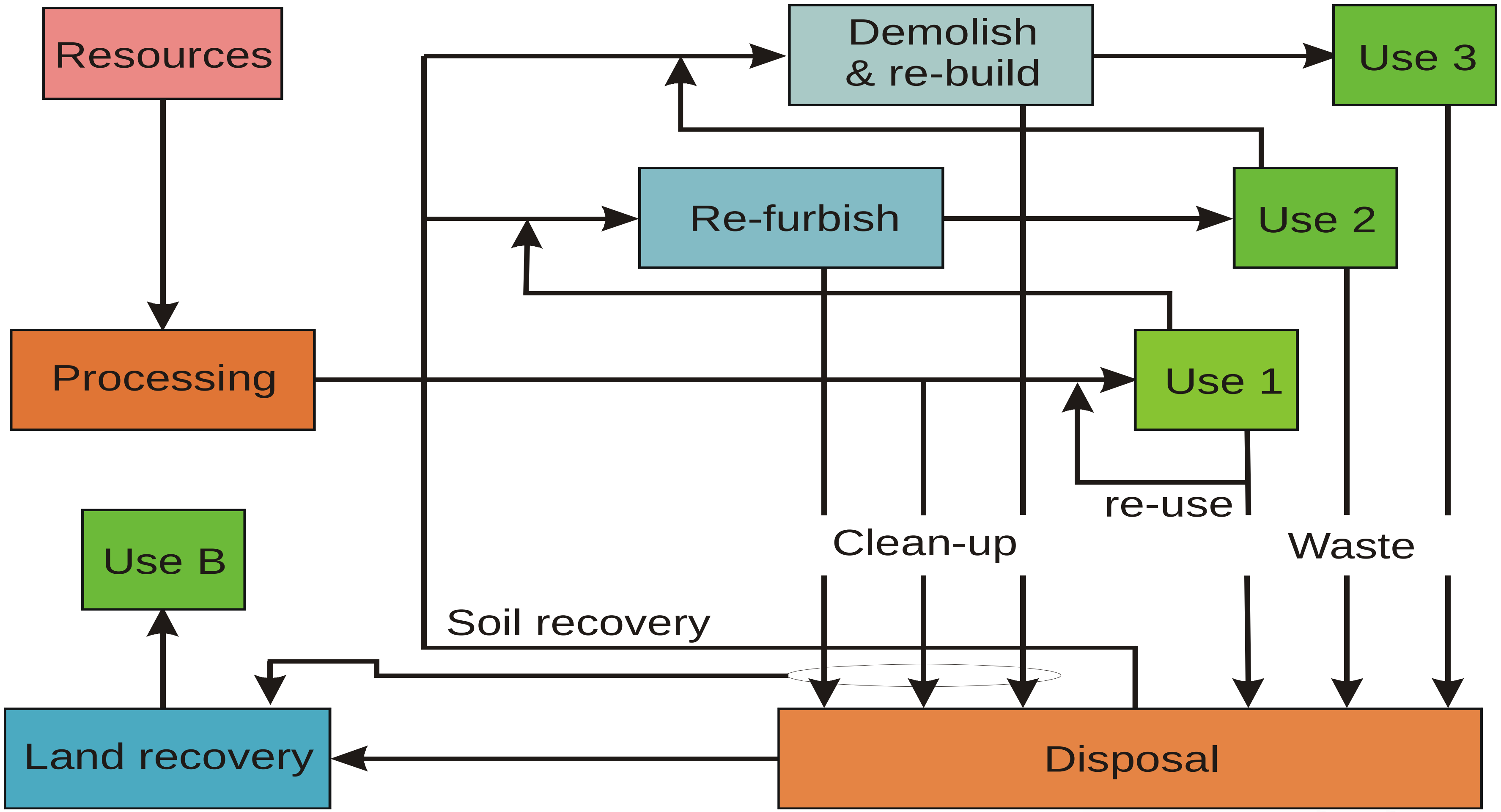
THE INDUSTRIAL ECOLOGY OF LAND



Industrial ecology emphasises who, when, where, what problems of Sustainable development

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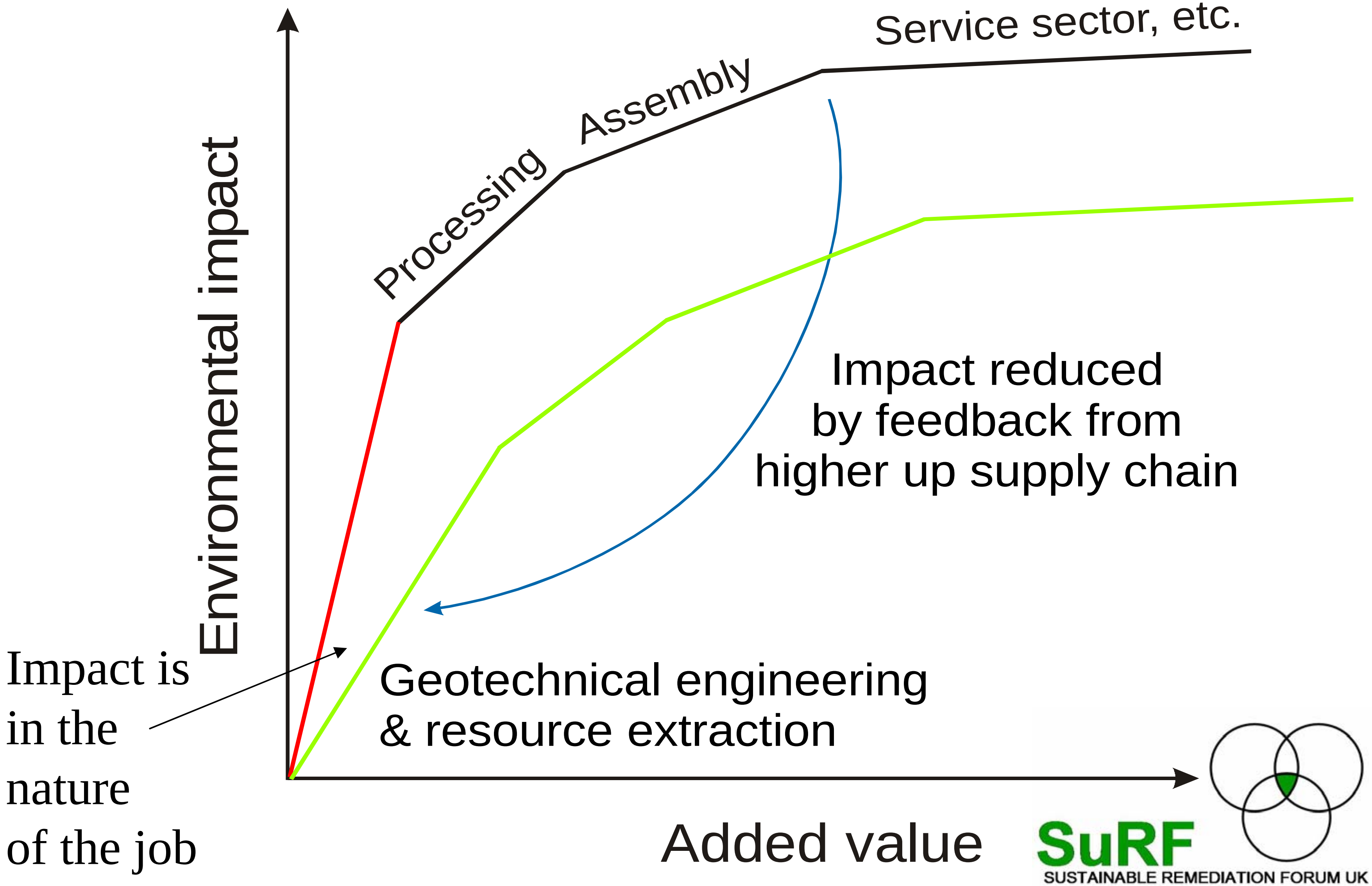
INDUSTRIAL ECOLOGY

Manufacturing supply chain analysis



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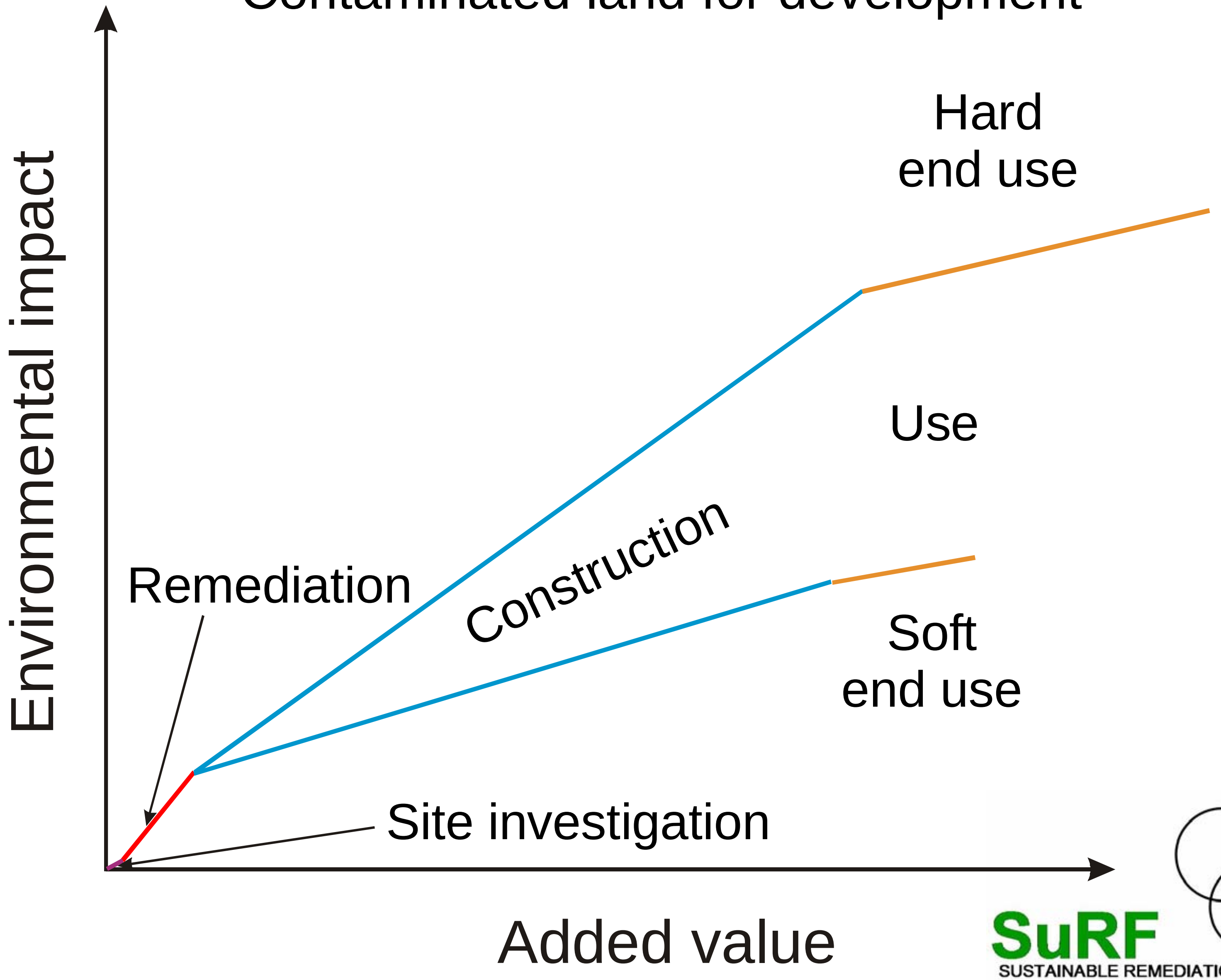
INDUSTRIAL ECOLOGY

Contaminated land for development



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Sustainable development and contaminated land

- Greatest opportunities for sustainable development may lie with project master planners
- Contaminated land team often have ‘control’ of only:
  - Part of the problem – the contaminated areas
  - Part of the time – investigation and clean-up stages
- Although sub-optimal contaminated land team may have to take ‘wins’ where they can
- Sustainability is an extension of ethics via equity

  cannot ignore it must do what we can, for example
  - Maximising stakeholder benefit (neighbours, occupiers ….)
  - Maximising efficiency, equity, environmental benefit
  - etc…..

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Measuring Sustainability in Remediation: Setting the Scene to SURF UK

Frank Evans

National Grid

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Outline of Presentation

- Context of Sustainable Development
- Introduction to SURF UK
- UK Policy
- EU Policy
- SURF UK: Framework Development

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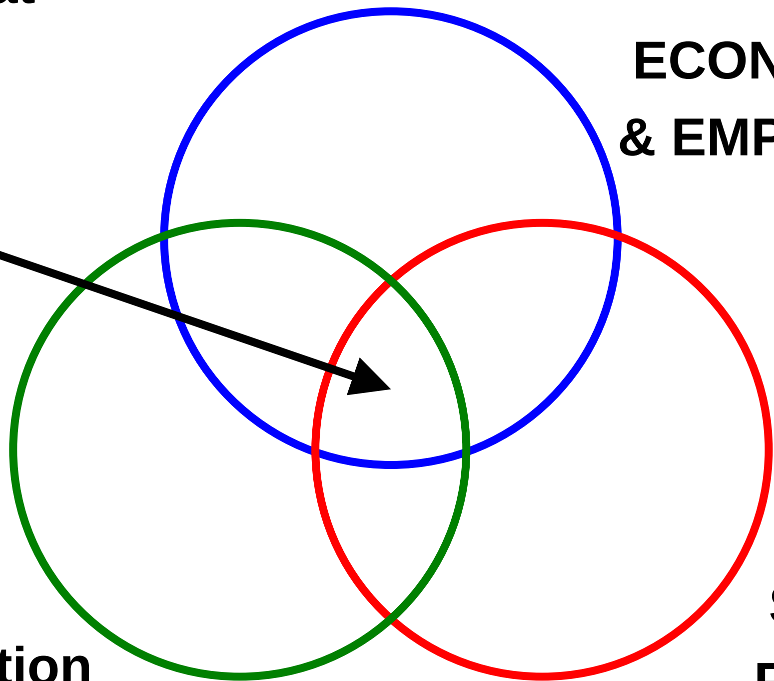
What is Sustainable Remediation?

Is this the point that represents sustainability remediation?



ECONOMIC GROWTH & EMPLOYMENT

ENVIRONMENT

- Effective Protection

- Prudent use of Natural Resources

SOCIAL PROGRESS

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Delivering Sustainable Development

Overarching Definition

(Mission Statement or Policy)

Aims and Objectives

Putting into Practise:

Implementation and Monitoring

Overarching Definition

'Development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (1987, Brundtland)

Delivering Sustainable Development

Overarching Definition

(Mission Statement or Policy)

Aims and Objectives

Putting into Practise:

Implementation and Monitoring

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Aims and Objectives

- Sustainable Development Policies
  - National
  - European
  - Themes
  - Priorities
  - Indicators

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Delivering Sustainable Development

Overarching Definition

(Mission Statement or Policy)

Aims and Objectives

Putting into Practise:

Implementation and Monitoring

‘Sustainable Remediation’

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Introduction to SURF UK

- <u>Su</u>stainable <u>R</u>emediation <u>F</u>orum
- UK-based (also a SURF US)
- Working Mission Statement
- Develop a framework
- Steering Group and Open Forum meetings
- Cross-sector representation

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SURF UK – Working Mission Statement

To develop a framework in order to embed balanced decision making in the selection of the remediation strategy to address land contamination as an integral part of sustainable development

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SURF UK – Working Mission Statement

To develop a framework in order to embed balanced decision making in the selection of the remediation strategy to address land contamination as an integral part of sustainable development

<u>Notes:</u>

- 'framework' not Tool
- 'balanced' mean consider social, environmental and economic
- 'strategy' includes design and implementation
- 'land contamination' includes groundwater issues
- 'development' in context of sustainable development not just building schemes

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SURF UK: Format

- Steering Group
- Open Forum meetings x 3
  - Open to all
  - May 08, Nov 08, Feb 09
- Consultation via CL:AIRE web-site
- Links to:
  - SURF US
  - NICOLE
  - SAGTA

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SURF UK: Lead organisations

- CL:AIRE
- Environment Agency
- SAGTA (Industry)
  - Shell Global Solutions
  - National Grid Property
- R^3 Environmental Technology Ltd
- SURF US

- English Partnerships

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UK Overarching Policy

- Securing the Future - UK Government sustainable development strategy (2005)

…to enable all people throughout the world to satisfy their basic needs and enjoy a better quality of life without compromising the quality of life of future generation (2005, HM Government, Securing the Future)

Securing the Future

5 Principles

- Live within environmental limits
- Achieve a just society,
- By means of sustainable economy
- Good governance
- Sound science

- **4 Priorities**
- Sustainable consumption and production
- Natural Resource protection and environmental enhancement
- Building Sustainable communities
- Climate change and energy

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Sustainable Remediation: UK Policy

- Planning guidance
- Future development guidelines
- Waste Strategy
- Sustainable Construction
- Land Contamination Management

Remediation activities contribute to all these areas of policy and strategy

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Planning Policy: Role of Brownfield

- Priority indicator in terms of UK Sustainable Development
- Creating Sustainable Communities
- ‘Brownfield first’ objective in planning policy

In UK policy terms, developing Brownfield and therefore implicitly, the associated remediation is considered ‘sustainable’

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Future Development Guidelines

- Code for Sustainable Homes
- Zero carbon development (in lifetime of build)
- Developer can be assessed against code (1-6 rating)
- Market differentiation
- Carbon Challenge:
  - Delivered by English Partnerships
  - Accelerate house-building industry's response to climate change
  - Testing ground for the Code for Sustainable Homes and the New PPS on climate change

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UK Waste Strategy

- Includes ex-situ remediation
- Hazardous Waste (Annex C3)
  - Need to reduce volume
  - Encourage sustainable treatment technologies
  - Recognise landfill may have place
- Zero waste to landfill by 2020

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Sustainable Construction Strategy

- Built environment accounts for large part of UK emissions, waste and resource consumption
- Includes most remediation activities
- Targets include:
  - Zero carbon homes
  - Reduced water consumption
  - Waste: by 2020 – zero waste to landfill

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Sustainable Remediation: UK Policy review

- Planning Policy: **Brownfield First**
- Future Development Guidelines: **Zero carbon development (Lifetime)**
- Waste Strategy: **Zero by 2020**
- Sustainable Construction: **Waste and Emissions targets**

- No one clear overarching policy steer
- Indirectly part of several policies and strategies

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Sustainable Remediation: UK Policy review

Comments:

- Similar to EU and UK regulation – falls between regulations for water, waste and soil
- Brownfield regeneration needs remediation
- Waste: Remediation often tackles a legacy: unable to reduce and re-use
- How do remediation carbon emissions compare with lifetime of property. What % are we?

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UK Land Contamination Management

- Risk-based approach to assessment and remediation
- Cost – benefit decisions regarding clean-up
- Many remediation activities require formal planning permission – a formal stakeholder consultation with local communities
- Spatial land-use planning takes into account social and economic factors

The foundation for managing land contamination are already in place to allow development of sustainable remediation strategies

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EU Policy Context

- EU Sustainable Development Strategy (2006)
- Seven key challenges/themes
  - Climate Change and Clean Energy
  - Sustainable transport
  - Sustainable Consumption and production
  - Conservation and management of natural resources
  - Public Health
  - Social Inclusion, demography and migration
  - Global Poverty

2008 review of EU SD Strategy

- Progress report on EU Sustainable Development Strategy issued in 2008
- Climate change is currently most important and other themes are in practise of lesser importance
- EU and member state strategies not aligned
- Successes: minimising waste
- Spatial planning/land-use/urban development or addressing ‘wastelands’ - relevant to sustainable development but not explicitly covered

Influence of EU Directives

- In practise, remediation activities and contaminated land regulated indirectly by directives
  - Landfill
  - Waste Framework
  - Water Framework
  - Soil Protection
  - Environmental Liability

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SURF UK – Working Mission Statement

To develop a framework in order to embed balanced decision making in the selection of the remediation strategy to address land contamination as an integral part of sustainable development

Framework: Sustainable land-use

- Any site is a parcel of land that is somewhere in a life-cycle
- Brownfield land is in at least a 2nd phase of lifecycle

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Possible ideas for a Framework?

- Technical framework for structured decision-making: defines stages, record decisions, processes and procedures
- Links to decision-making during lifecycle of a property (a time and space boundary)
- To reflect different decision points for considering sustainability
- Recognise that some ‘sustainability’ decisions are implicitly made (e.g. planning permission)
- Recognise that may need to be a voluntary code – a way of differentiating an organisations sustainable credentials
- Must be verified – case studies, testing

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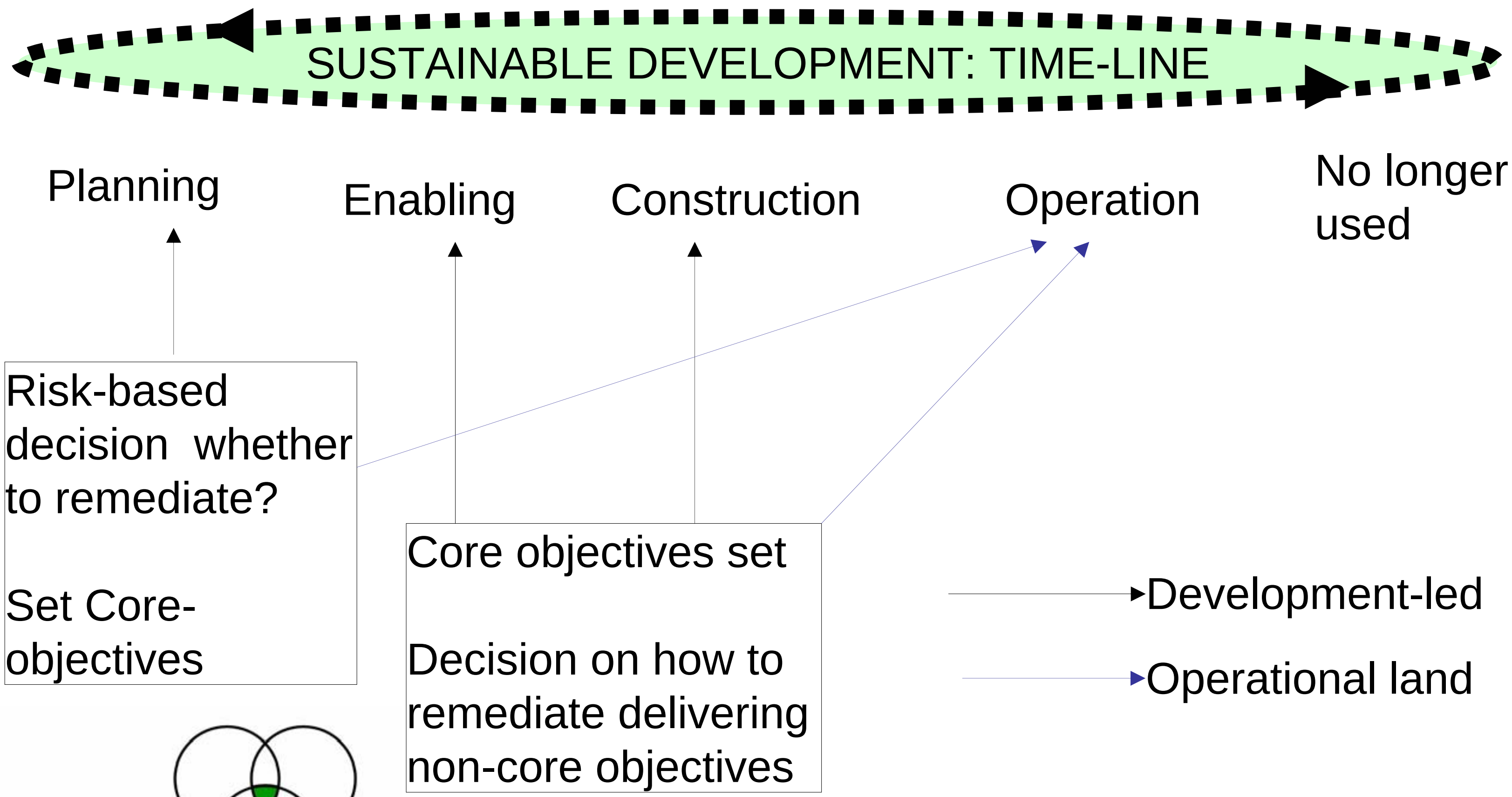
Framework: When to assess sustainability?



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Core vs Non-core Objectives

- Remediation decision-making has several points at which the sustainability of scheme can be considered
- Why remediate? What clean-up standard?
  - CORE objectives
  - e.g. residential, on-going refinery, open space
- How to remediate?:
  - NON-CORE objectives
  - E.g. bioremediation, in-situ thermal etc..

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SURF UK: Next steps to resolve

- What will framework look like?
- What are key indicators to consider?
- How will tools fit in?
- How will case studies fit in?
- What are boundaries
  - When? SI and Remediation stage only?
  - Where? Contamination zones only?
- What is role of spatial land-use planning at regional level?
- How to capture international influences and work to date?

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Soil and Groundwater Risk Management, Sustainability and Net Environmental Value

David Reinke – Shell Global Solutions (UK)

Philippa Scott – Shell Global Solutions (UK)

Stuart Arch – WorleyParsons Komex

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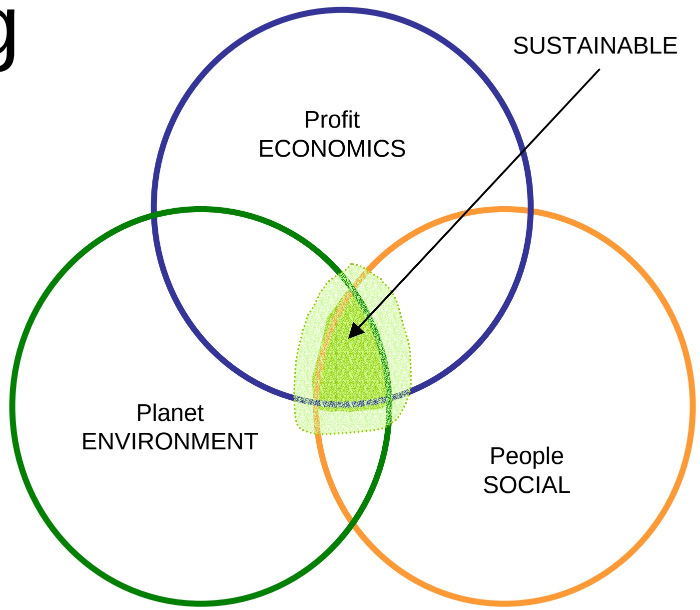
Contents of Presentation

- Balanced Decision Making Concept
- Cost Benefit Analysis (CBA) Approach
  - Example Project
  - Potential for Application
- Request for Input



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Balanced Decision Making

- Risk based management is the key first step to sustainability in addressing land contamination
- Identified risks need to be managed
- How do you balance the economic, social, and environmental considerations of proposed corrective actions?
  – Qualitative (yes/no, good/bad)
  – Quantitative
    - Multi Criteria Analysis 0.5 x  + 2 x  = 3 x 
    - Cost Effectiveness Analysis
    - Cost Benefit Analysis (CBA) $$$ 
    - Net Environmental Value (NEV)

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Cost Benefit Analysis (CBA)

- UK Environment Agency existing guidance on assessing the costs and benefits of soil and groundwater remediation
- Working with WorleyParsons Komex
  - Co-authored UK CBA guidance on groundwater remediation
  - Prof. Paul Hardisty co-authored book “The Economics of Groundwater Remediation and Protection”
- CBA (including externalities) used on refinery, gas works, and fuel storage sites in UK
- Assess potential for application of this approach for incorporating sustainability into remedial decision making (i.e. is this a suitable tool/framework?)

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CBA – Using the Language of Money

$$NPV = \sum_{0}^{t} \left[\frac{(B_p + B_x) - (C_p + C_x)}{(1+i)^t} \right]$$

NPV = Net Present Value ($)

t = Time (years)

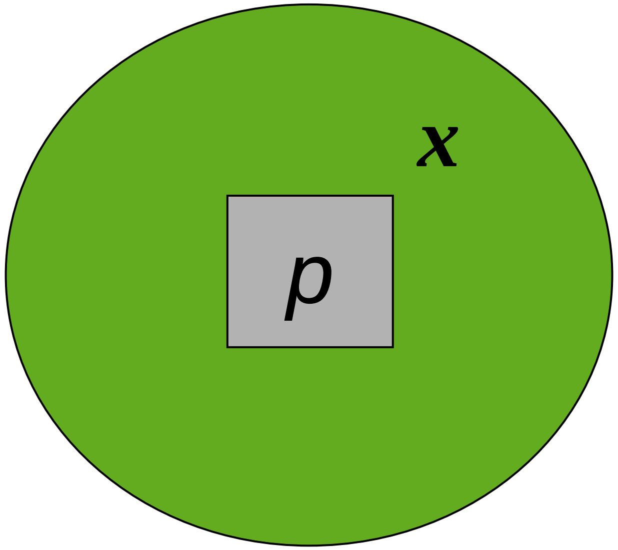
B = Benefit ($)

C = Cost ($)

i = Discount rate (%)

P = project (internal)

x = society and environment (External)



Slide courtesy of:

WorleyParsons Komex

resources & energy

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CBA – Approach

- High level economic evaluation
- Compares a range of remedial approaches
- Monetize risk / damage averted
- Different approaches accrue different benefits / risks
- Which approach gives greatest net benefit to society?

Slide courtesy of:

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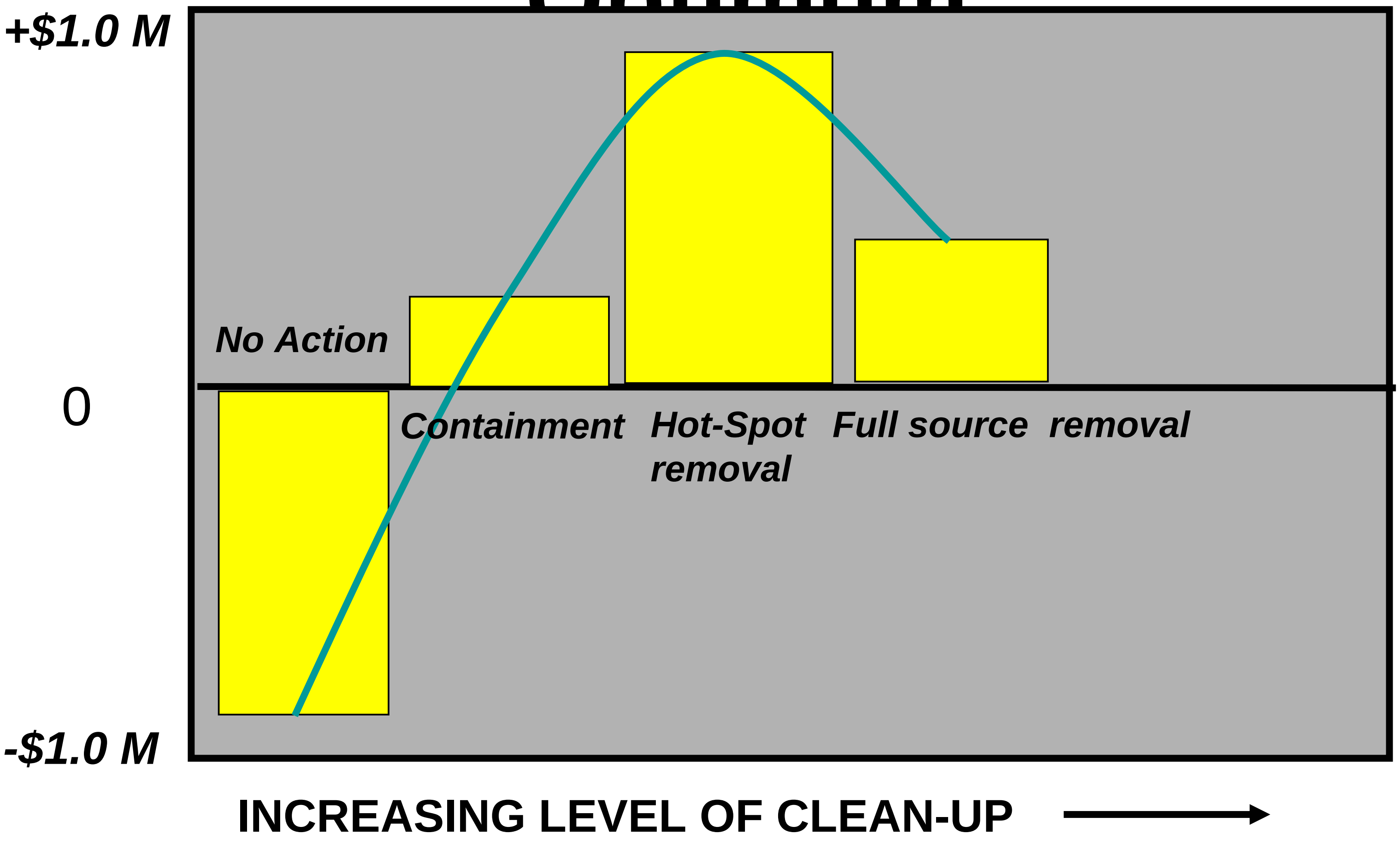
CBA – Finding the Economic Optimum



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CBA – Types of Costs/Benefits

	Costs	Benefits
Private	Borne by problem holder: • Labour • Plant • Materials • Energy • Reputation damage	Accrued by problem holder: • Property value increase • Fines/claims avoidance • Reputation enhancement
External	Borne by third parties: • Air emissions from remediation (CO_2, SO_x, NO_x, PM, VOCs) • Landfill space used by soil disposal	Accrued by third parties: • Improved water quality • Ecosystem protection • Human health protection • Property value increase

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CBA – Categories of Costs/Benefits

	Costs		Benefits
Economic	Labour Plant Materials Energy Reputation damage	Property value Permits Fines/claims Waste disposal Lost production	Property value Fines/claims avoidance Reputation enhancement
Environ-mental	Air (CO_2, SO_x, NO_x, PM, VOCs) Land (landfill space, quarry, soil quality) Water (groundwater quality & quantity, surface water quality) Ecology		Land (improved soil quality) Water (improved groundwater and surface water quality) Ecology
Social	Health and safety Odour Visual amenity Traffic congestion	Noise Vibration	Human health protection Employment Community building (redevelopment of derelict land)

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CBA – Example Project

- Retail site operated since 1970's
- Product loss in 2002 (~7,000L petrol)
- Remediation
  - Pump & treat + dual phase extraction
  - Met "interim" target agreed with regulator
    - no measurable free product
    - 50mg/L TPH in groundwater
- Perform CBA to assess sustainability of further actions

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Background – Site Layout

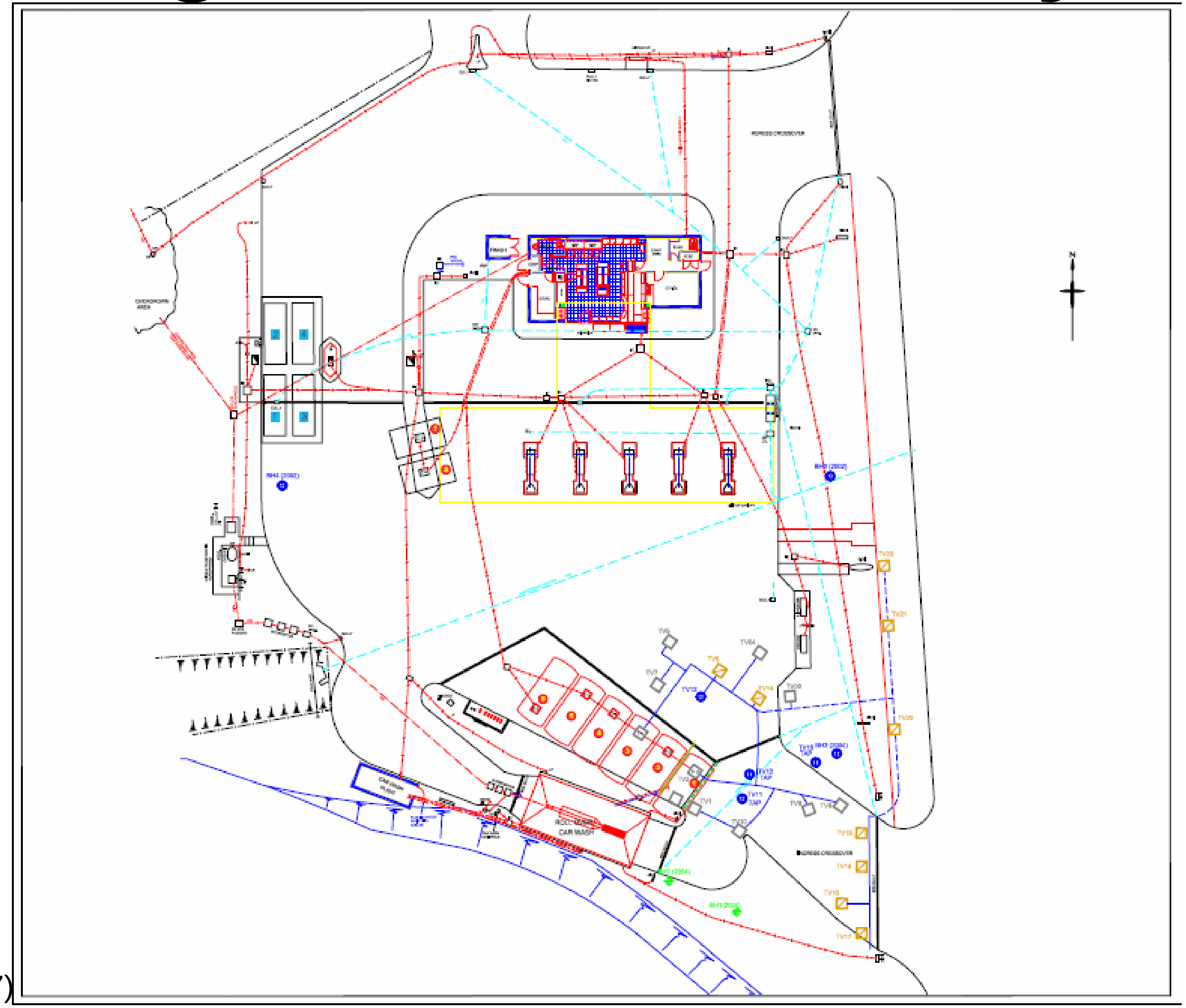

Figure from RSK (2007)

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Background – Site Setting

Figure from RSK (2007)

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Background – Geology/Hydrogeology

- Geology
  - – Fill material (<1.8m thick), overlying
  - – Alluvium comprising clay and gravel recorded to depths of up to 2.7m bgl, overlying
  - – Sandstone bedrock
- Hydrogeology
  - – Groundwater ~ 9m below ground
  - – Groundwater flows south-east
  - – Closest abstraction bore ~ 1.9km
- Surface Water
  - – River ~ 180m east of site

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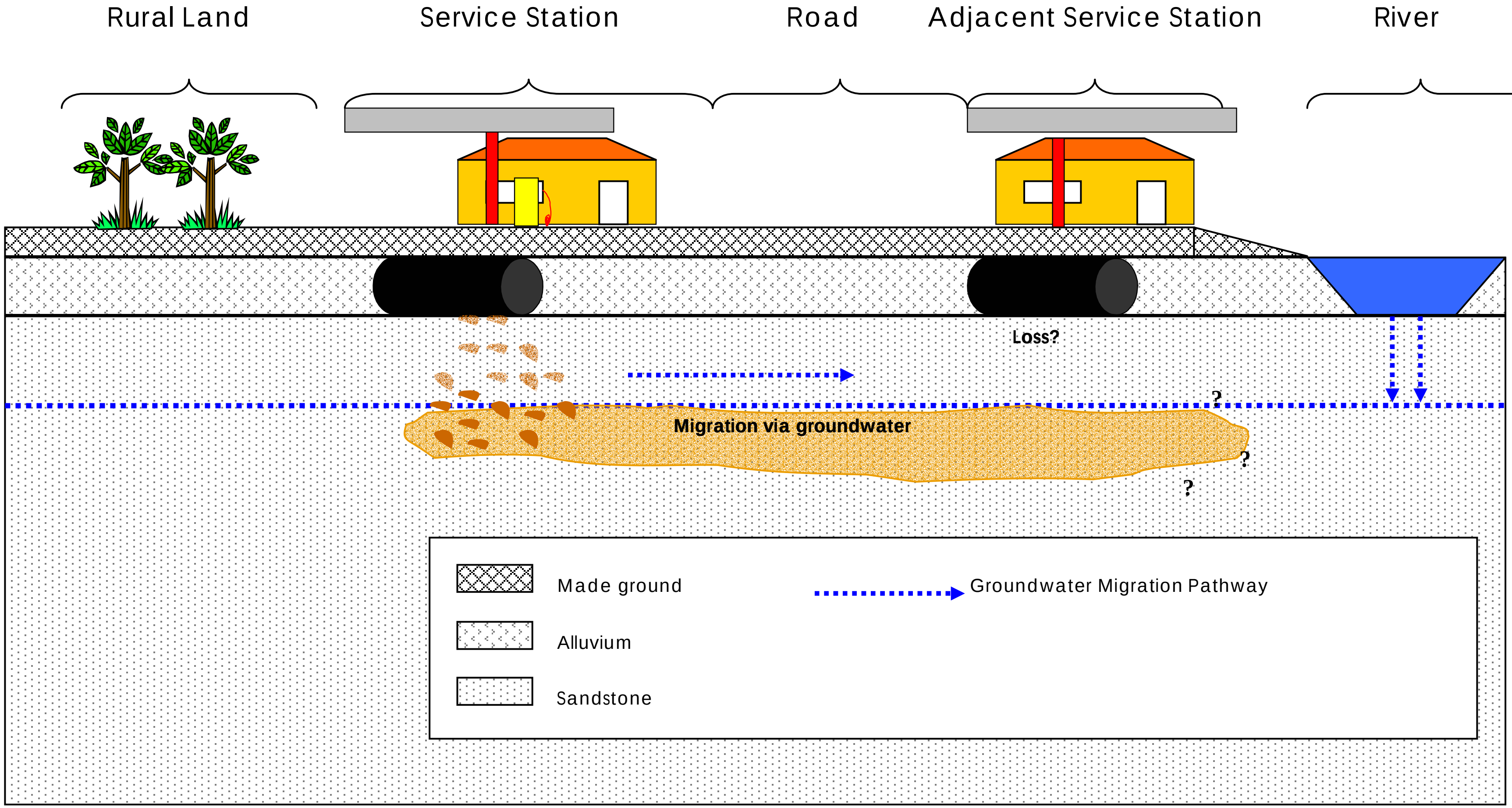
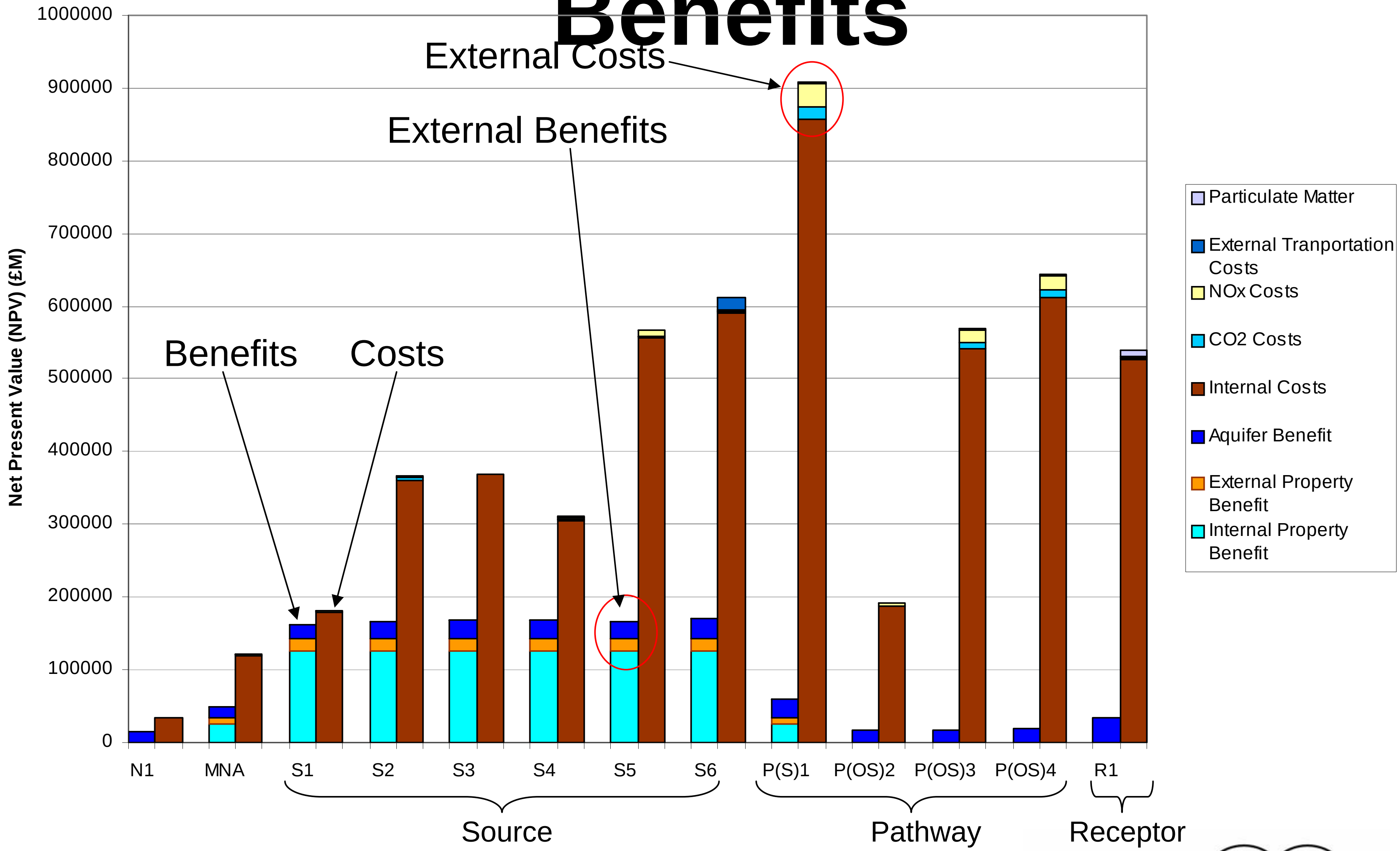
Conceptual Site Model (CSM)



Project Results – Costs and Benefits



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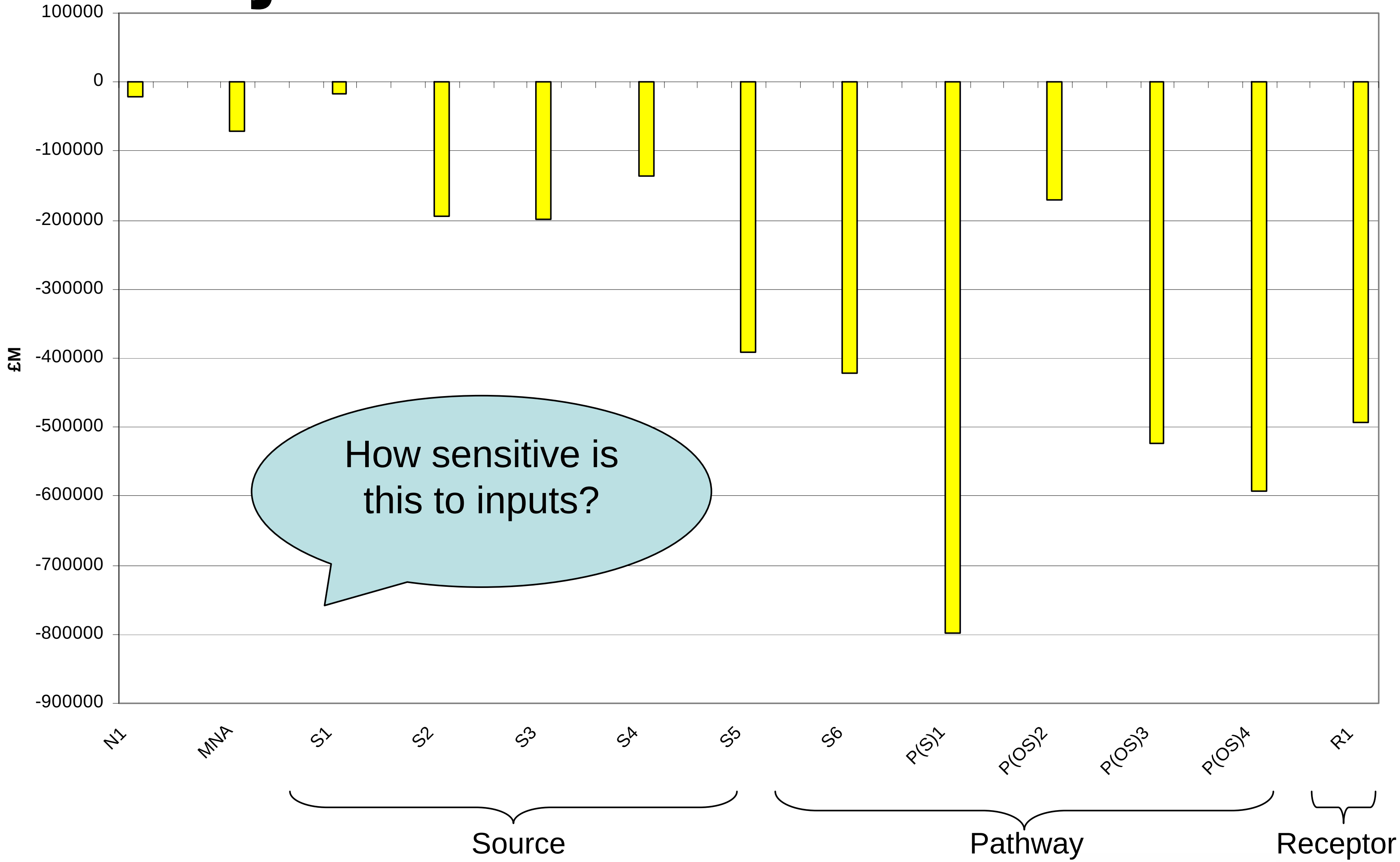
Project Results – Net Benefit



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Other Project Examples

- Refinery
  - Initial advocated approach of remediation of a local area within a larger facility
  - More sustainable if the whole facility is considered at time of decommissioning
  - CBA helped stakeholders reach agreement
- Distribution Site
  - Remediation proposed at site closure for redevelopment – future site use to be determined
  - CBA undertaken to support internal business decision

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Potential for Application

- Need to consider sensitivity – helpful for stakeholder engagement (facility, regulator, community)
  - Discount rate - Groundwater volume/price
  - Time frame - Property values
  - Boundaries

- Monetisation can be difficult / controversial
  - Valuation of groundwater resources
  - Use sensitivity analysis to understand impact of these parameters on overall outcome

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Potential for Application (cont')

- Logical and quantitative approach for balancing economic, environmental and social aspects
- Helps identify what goal is most sustainable, not just how to achieve a particular goal in the most sustainable way
- Common unit of measure – easily understood
- Tiered approach
  - Level of detail proportional to size and complexity of problem

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Summary

- SURF UK collaborating on sustainable remediation decision making
- Trialled CBA
  - Existing guidance
  - Quantitative approach with a common denominator
  - Is a way of incorporating sustainability
  - Shows promise
  - Monetisation can be difficult, but not impossible
- Work will continue – what are your views?

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Thank you

Questions:

Please contact

David.Reinke@shell.com

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DuPont's Work on Sustainability in Remediation

David E. Ellis Ph.D.
DuPont Engineering
Wilmington, DE, USA

ConSoil
June 3, 2008

Some Observations on Cleanups

Science tells us that cleanup rates are limited by diffusion and desorption, some cleanups take centuries

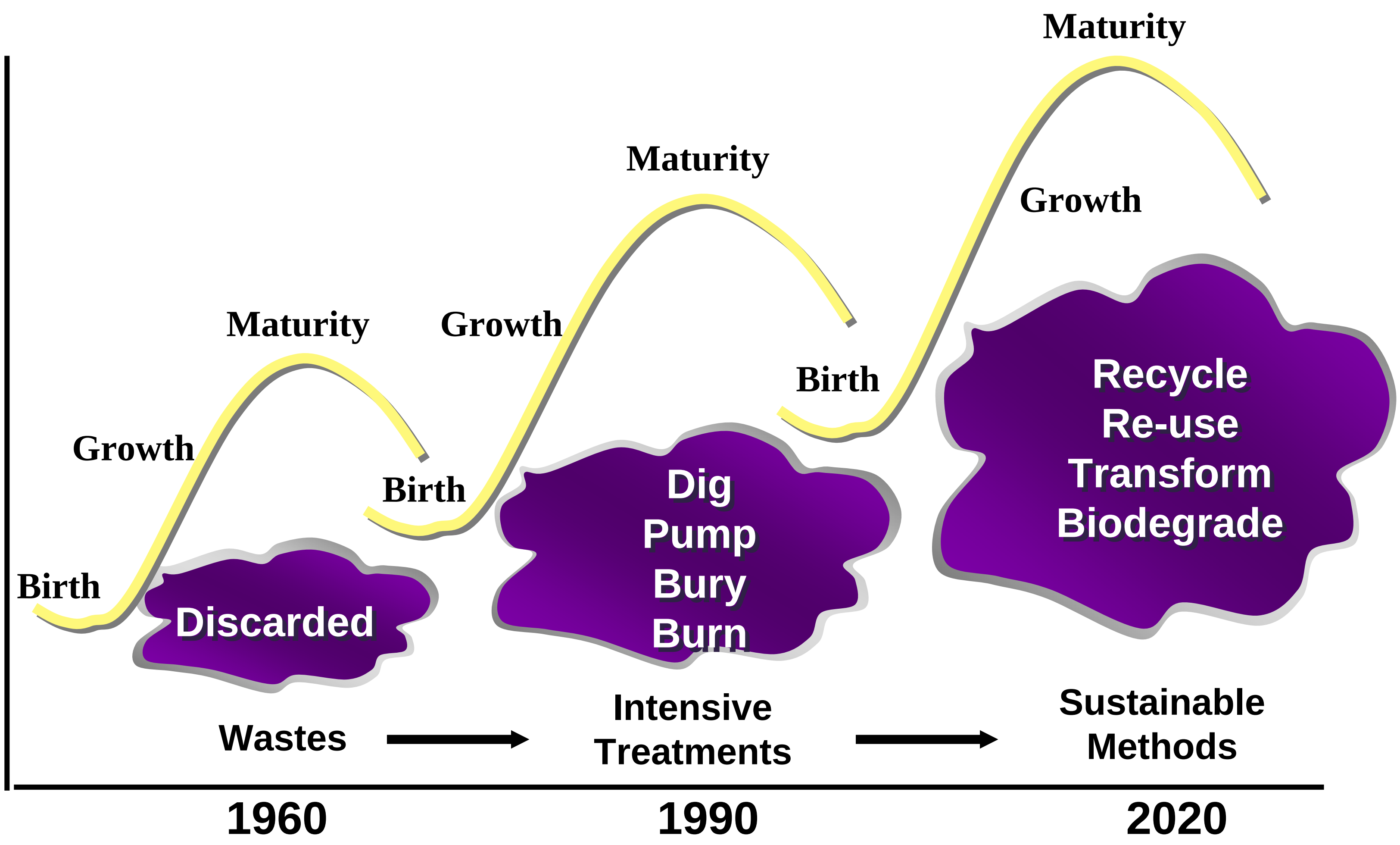
Cleanups emit CO_2 and other greenhouse gasses, send a lot of material to landfills, occupy substantial number of worker hours, etc., etc…

Focus has been solely on the contaminated spot

Dirt is constantly being buried and permanently lost in landfills. Why?

Surely we can do better!

How Can We Transform Our Thought Process?



Sustainability and Cleanup Methods

DuPont is trying to learn how we can connect sustainability and remediation

DuPont wants to be certain to use the most sustainable methods we can identify, and suggests that more sustainable cleanup methods should be given priority.

Selecting a sustainable remedy considers: protecting HH&E, global warming, recycling, resource preservation, waste generation, safety, etc…

However, without a common language or system of measurement, these claims will be confusing.

Sustainable Remediation Principles

Our working concept:

DuPont, in fulfilling its obligation to remediate sites to be protective of human health and the environment will embrace sustainable approaches to remediation that provide a net benefit to the environment.

To the extent possible, these approaches will:

- Minimize or eliminate energy consumption or the consumption of other natural resources
- Reduce or eliminate releases to the environment, especially to the air
- Harness or mimic a natural process
- Result in the reuse or recycling of land or otherwise undesirable materials
- Encourage the use of remediation technologies that permanently destroy contamination

RCRA Remedy Selection Criteria

Threshold Criteria

- Protect Human Health & the Environment
- Control Sources
- Meet Cleanup Objectives

Balancing Criteria

- Long-term reliability
- Reduction of toxicity, mobility or volume
- Short-term effectiveness
- Ease of implementation
- Cost
- Community acceptance
- State acceptance
- ***Sustainability***

Brief Real World Example

Source Area Quantities

Areas	Acreage	Depth, ft	Volume, CY
Landfill-A	28.2	42	1,910,832
Landfill-B	20.0	20	645,333
DNAPL Area	6.2	40	400,107
Northern Basin Area	26.7	10 - 15	567,087
Western Fill Area	30.1	20	971,227
Southern Fill Area	14.5	20	467,867
Total	125.7		4,962,452
Unimpacted Area	11.3	-	
Total	137.0	-	4,962,452

Technologies Screened

Retained

Excavation

Stabilization

Capping

Bioventing

Landfill Bioreactor

Enhanced DNAPL Recovery (Steam and Possibly Surfactants)

Groundwater Capture

Not Retained

Barrier Walls – Sheet Pile or Slurry Wall

Chemical Oxidation

Other In Situ Thermal DNAPL Recovery

Sustainability: Environmental Footprints

Green house gas (CO_2 equivalents)

- Implement remedy
- Consumables

Resources

- Land
- Water
- Landfill space

Energy

- Implement remedy
- Consumables

Occupational Risk

- Exposure hours
- Highway miles

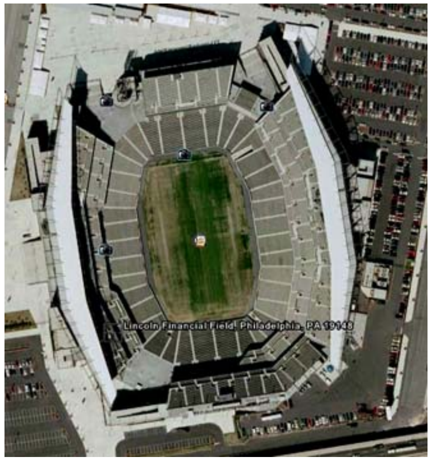
Measures of Remediation Sustainability for SWMU 8

	Excavation	Stabilization	Bioremediation
Destruction	No	No	Yes
In-situ	No	Yes	Yes
Mobility	☺	☺	😐
Toxicity	😐	😐	☺
Volume	☹	☹	☺
Tons CO_2	2,700,000	920,000	190,000
Exposure Hours	4,900,000	540,000	82,000
Highway Miles	56,000,000	8,000,000	1,000
Odor	High	Moderate	None
Light	High	Moderate	None
PM 10, tons	50,463	7,163	292

Some Equivalents of that CO_2 Differential

Take all 20,000 Univ of Delaware students to Hawaii for Spring Break 40 times

Drive 18,550,000 kilometers in Dave's Z4



Smelt 500,000 tonnes of steel to build 40 football stadiums

8% of DuPont's annual CO_2 production

DUPONT

Unit H1 - Former Finish Oil Disposal Pond

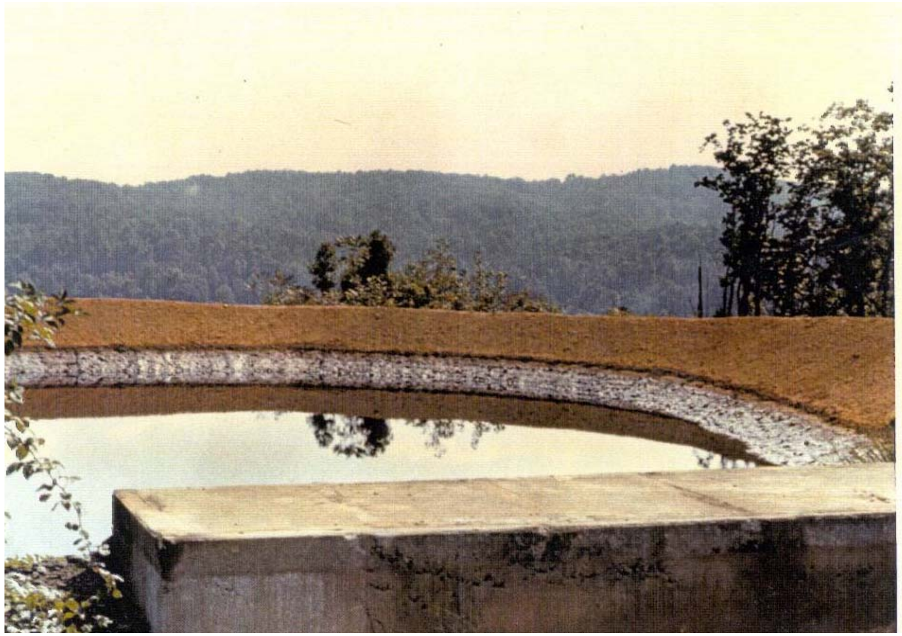
COPC: Chlorinated VOCs in soil, soil vapor and groundwater; PCBs, coal ash (arsenic) in soil only.

Former pond filled with coal ash and site soils

Nearly round, approximately 100’ diameter

Residuals impacts 3.5 to 4.5 feet bgs

Then - 1970’s



Now - 2004

Framework for Sustainable Remediation Assessment

Information Sources		People Involved
• RI and Other Reports	**Assess soil and ground water impacts** • Aerial and vertical extent • Groundwater: volume, flow, constituents (concentration and mass) • Soil: volume, constituent mass	• Project Team • Sustainability Resources
• Regulations • Business needs	**Identify remedial action objectives**	• Project Team • Sustainability Resources • Regulators, community
• ITRC • Technology Forums	**Identify candidate technologies**	• Project Team • Sustainability Resources • Technology Specialists • Regulators
• Prior Assessments	**Scope remedial option tasks** • Duration • Staff • Materials • Equipment	• Project Team • Sustainability Resources • Technology Specialists • Regulators
• Life Cycle Analysis	**Estimate remediation impacts** • Structure templates to reflect technologies	• Project Team • Sustainability Resources • Technology Specialists
• Regulatory Framework	**Analyze remedial alternatives** • Include with balancing criteria	• Project Team • Sustainability Resources • Peer Review • Regulators

April 10 Outcome: Unit H1 Potential Remedial Measures

Source remediation – mitigate groundwater impacts

Soil

- ****Excavation (source material removal) and landfill**
- ****Cap (geomembrane)**
- ***SVE**
- In-situ Stabilize
- ****Chem-reduction - ZVI/Clay optimized treatment**
- Enhanced bio
- In-situ thermal & vapor capture
- **(--)Excavate & Ex-situ thermal treatment**
- **(--)Excavate & Chem-ox (not effective chlorinated orgs & high oil demand)**
- Excavate and soil wash

- **Groundwater – Meet MCL's (GPS) in plume and surface water standards in discharge to river**
- **Groundwater (source area or river)**
  - ***MNA**
  - **(--)PRB – Iron (river)**
  - ***Enhanced bioremediation**
  - ***Pump and treat (strip and carbon adsorption) – source and river**
  - Air sparge w/vapor capture (akin to Unit G) – option w/windmills - source
  - In-situ chem-ox (source)
  - In-well stripping

Example Table 1 – Technology Screening

Source Area Remedies	Protect HH &E	Control Sources	Meet Cleanup Objectives	Selection
Bio-barrier	Unlikely	Unlikely, source concentrations high (bio not very effective at high concentrations)	Unlikely	**Poor**
Bioventing	Unlikely	Uncertain, oxygen demand will be very high due to waste oil in source	Uncertain. Reduces some constituents, but source concentrations likely inhibit degradation.	**Poor**
Capping	Yes, when combined with MNA	Yes, by eliminating migration	Yes (constituents remain)	**Good**
Chemical Oxidation (In Situ)	Unlikely	Uncertain, oxygen demand will be very high due to waste oil in source. CFC-11 expected to be highly resistant to oxidation	Uncertain. Other constituents, including waste oils may interfere with reaction	**Poor**
Chemical Reduction	Unlikely	Source is already highly reduced. CFC-11 appears resistant to reduction.	Uncertain. Other constituents, including waste oils may interfere with reaction.	**Poor**
Excavation & Off-Site Disposal	Yes, when combined with MNA	Yes, by removal	Yes (complete removal)	**Good**
Ex-Situ Thermal Desorption	Yes, when combined with MNA	Yes, by treatment	Yes (some constituents remain, metals)	**Good**
In Situ Bioremediation	Unlikely	Unlikely, No evidence of degradation to CFC-11	Unlikely	**Poor**
Options graded "**Good**" are considered adequate treatment options and are passed onto the selection screening, which factors in balancing criteria.				
Options graded "**Fair**" are not recommended and would only be considered in the absence of more effective options.				
Options graded "**Poor**" are either not applicable to the treatment of the constituents present or there is such great uncertainty regarding the effectiveness of the option at this location				

Example Table 2 - Remedy Selection Matrix

	Protect HH &E	Control Sources	Meet Cleanup Objectives	Long-term reliability	Reduction of T, M, V	Short-term effectiveness	Ease of implementation	Cost	Community acceptance	State acceptance	Sustainability
Source Area Remedies											
ZVI-Clay In-Situ Treatment	Yes, when combined with MNA	Yes, by treatment	Yes	High	High due to treatment	Moderate 3,800 hours 9,900 miles	Moderate	$$	Highly acceptable	Highly acceptable	CO_2 182 ton Adj. CO_2 41 ton Efficiency: 0.003
Excavation & Off-Site Disposal	Yes, when combined with MNA	Yes, by treatment	Yes	High	None	Moderate 4,400 hours 109,000 miles	Simple	$$	Acceptable	Acceptable	CO_2 251 ton Adj. CO_2 251 ton Efficiency: 0.000
Ex-Situ Thermal Desorption	Yes, when combined with MNA	Yes, by treatment	Yes	High	High due to treatment	Low 7,100 hours 11,800 miles	Complex	$$	Acceptable	Acceptable	CO_2 592 ton Adj. CO_2 451 ton Efficiency: 0.0008
Soil Vapor Extraction	Yes, when combined with MNA	Yes, by treatment	Yes	High	Moderate	Low 6,700 hours 17,000 miles	Moderate	$$	Highly Acceptable	Highly acceptable	CO_2 677 ton Adj. CO_2 536 ton Efficiency: 0.0007
Capping	Yes, when combined with MNA	Yes, by treatment	Yes	Moderate	Moderate, eliminate mobility	High 820 hours 1,600 miles	Simple	$	Acceptable	Acceptable	CO_2 24 ton Adj. CO_2 24 ton Efficiency: 0.000
Groundwater - MNA in addition to those listed above (assessment not included with above)											
MNA	Yes, mitigate migration	N/A	Yes	Yes	High	1,000 hours 8,600 miles	Simple	$	Acceptable	Acceptable	CO_2 5 ton Adj. CO_2 0 ton Efficiency: 0.09

Sustainable Remediation Forum (SURF)

Mission Statement:

To establish a framework that incorporates sustainable concepts throughout the remedial action process, that provides long-term protection of human health and the environment, and that achieves public and regulatory acceptance

Sustainable Remediation Forum

A collaborative forum to develop ability to use sustainable concepts in remedial action decision making

Share perspectives, experiences, site-specific examples

A public forum

- State and federal agencies (US EPA, California DTSC, DNREC, UK Environment Agency, USDOE, USACE, and others)
- Industry (DuPont, BP, Shell, Canadian National Rail, Chevron, Honeywell, British National Grid and others)
- Consultants: GeoSyntec, URS, Terra Systems, Earth Tech, ERM and many others
- Academics: NJIT, Univ. of Edinburgh
- Public stakeholders: CL:AIRE, WRI, Ironbound Community Corporation

Chaired and facilitated by DuPont

All are welcome. Meeting records are publicly available

SURF White Paper - "*Integrating Sustainability Principles, Practices and Metrics into Remediation Projects*"

The purpose of the SURF White Paper is to collect, clarify, and communicate the thoughts and experiences of SURF members on sustainability in remediation

- **Introduction and Scope - Dave Ellis & Paul Hadley**
- **Current Status of Sustainability in Remediation – Dick Raymond**
- **Sustainability concepts and Practices in Remediation – Stephanie Fiorenza**
- **A Vision for Sustainability – Paul Favara**
- **Impediments and Barriers – Dave Major**
- **Success Stories – Brandt Butler**
- **Summary, Conclusions, and Recommendations – Dave Ellis & Paul Hadley**

What Sustainable Remediation Is – and What It's Not

It is:

- A thought process – with luck it is inclusive and creative
- An inclusive method to evaluate all off-site and global impacts
- A way to express your company's values and select cleanup methods that are fully consistent with them

It is not:

- A cost containment tool
- A fully developed method
- A regulatory philosophy, guidance or regulation
- Voodoo
- A code word for MNA or no action

Discussion

Questions

1. Across Europe, which country is the most developed on sustainability?

2. What have they been doing, and how could we work together?

3. What are the barriers to implementing sustainability in remedial decision making?

4. Are there any particular countries where the barriers may be greater?

5. Are there barriers to wide acceptance of sustainability in remediation?

6. Is this issue being driven by government or industry in Europe?

7. Is sustainability divisible - is it valid to consider only the bits the contaminated land team can influence?

8. Are different approaches are required for redevelopment with change of land use, as opposed to remediation of operational sites?

In summary:- lessons to learn, barriers, drivers, boundaries (i.e. when)!

SuRF
SUSTAINABLE REMEDIATION FORUM UK