UK Sustainable Remediation Forum

Glasgow Workshop – Wednesday 19th January 2011

Glasgow City Council Offices, Conference Rooms 1 & 2, 229 George Street, Glasgow, G1 1QU

A G E N D A

Time	Topic	Presenter
09:30 – 10:00	Arrival tea and coffee	
10:00 – 10:10	Welcome and introductions	Nicola Harries CL:AIRE
10:10 – 10:40	Overview of SuRF-UK Framework	Richard Boyle HCA
10:40 – 11:10	Case Study 1: Petroleum Retail Site	Jonathan Smith Shell Global Solutions
11:10 – 11:40	Case Study 2: Historic Copper Mine	Paul Bardos r^3 Environmental Technology Ltd
11:40 – 11:50	Questions	
11:50 – 12:10	Group Work Introduction and Brownfield Development Overview	Naomi Regan National Grid
12:10 – 13:00	Exercise One in two groups	
13:00 – 13:15	Feedback	Group Spokespeople
13:15 – 14:00	Lunch	
14:00 – 16:00	Exercise Two in three groups (Includes working tea/coffee break)	
16:00 – 16:50	Feedback	Group Spokespeople
16:50 – 17:00	Close	Jonathan Smith Shell Global Solutions

SuRF-UK Phase 2 Case Study Workshop

January 19th 2011 at Glasgow City Council Offices, Glasgow G1 1QU

Attendees:
Jonathan Smith – Shell Global Solutions
Nicola Harries – CL:AIRE
Richard Boyle – HCA
Paul Bardos – r3
Naomi Regan – National Grid
Caroline Thornton – SEPA
Iain Hall – Grontmij
Alistair Kean – IKM Consulting
Simon Watson – Glasgow City Council
Iain McLellan – Environmental Protection UK
David Underwood – Shell Downstream
Alasdair Cruickshank – Glasgow City Council
Ken Meek – South Lanarkshire Council
Ann Connolly – Edinburgh City Council
Janet Harris – Glasgow City Council
Andrew Mackenzie – ERS
William Devlin – Clyde Gateway Project
Ian Ross – Arcadis
Martyn Dunk – Exxon Mobil

AGENDA

1.	Welcome and Introductions	Nicola Harries
2.	Overview of SuRF-UK Framework	Richard Boyle
3.	Presentation of Case Study No. 1 – Petroleum Retail Site	Jonathan Smith
4.	Presentation of Case Study No.2 – Historic Copper Mine	Paul Bardos
5.	Questions and Discussion	
6.	Group Work Introduction and Brownfield Development	Naomi Regan
7.	Exercise One in two groups	
8.	Feedback	
9.	Exercise Two in three groups	
10.	Feedback	
11.	Discussion and Wrap Up	Jonathan Smith

ITEM	
1.	**Welcome and Introductions** Nicola Harries (NH) welcomed everybody on behalf of the SuRF-UK Steering Group, thanked them for attending and thanked Glasgow City Council for hosting. She then provided the house keeping details. NH explained the agenda for the day and that this was the third and final workshop to engage with the brownfield and contaminated land community since the publication of the framework. She reiterated the Steering Group would value any feedback that people have on the framework, particularly from those that have tried to use it. NH explained that the Steering Group were now working on Phase 2 and outlined the work

	programme for Phase 2. She explained that the Steering Group would particularly value feedback on the categories of indicators that were outlined in the framework document. She explained that these had been refined and uploaded onto the SuRF-UK web pages. The Steering Group would value feedback on whether the coverage is adequate, are there any gaps, are there too many too few, is it clear what the indicators are? The Steering Group would value any comments.
2.	**Overview of SuRF-UK Framework** Richard Boyle provided a presentation on the background to SuRF-UK and a brief overview to the framework document and how the Steering Group hope it will be used. **Discussion** The attendees were asked for their intial thoughts. Is it presumed that the most sustainable option is always undertaken? Does the framework give a mechanism to allow less sustainable decisions to be made due to over arching business decisions? It was confirmed by the Steering Group that less sustainable options can be made but there is an emphasis to document the decisions. The aim of the SuRF-UK framework is to help set up the drivers in the first place that less sustainable decisions are not taken. If drivers cannot be changed then decisions made need to be documented. It was discussed that some companies have a corporate policy that they want to minimise all future liabilities and therefore when remediating sites this is carried out in house and no sites are sold dirty. How does the framework work with this scenario? It was felt that decisions are made from a corporate level, perhaps corporate strategy is changed or a decision is made that managing liability is a greater driver than demonstrating how sustainable the company is. These are decisions that companies need to make. The framework is voluntary and it is there for people to use to help develop their sustainability thinking when undertaking soil and groundwater remediation.
3.	**Presentation of Case Study No. 1 – Petroleum Retail Site** JS presented case study No. 1 where Shell had undertaken a tiered sustainability assessment on a petroleum retail site. He explained how he had engaged with colleagues who had not had any involvement in the site to undertake the assessment and that this assessment was undertaken retrospectively as the site had already been remediated. He presented the site and background information and explained the aim was to road-test the SuRF-UK sustainable remediation framework and to compare a single remediation project under different sustainability appraisal tools. He wanted to look at the ease of application, and assessor/auditor skill requirement, cost and time it took to undertake the assessment, data requirements, consistency of resulting environmental management decision and to collect evidence to inform selection of an appropriate tier of sustainability assessment. JS explained the sequential process that they used starting simply and then progressing in complexity. Initially they undertook a Qualitative Assessment where a roundtable conversation was had and different remedial options were given a high/medium/low rating. Then a Semi-quantitative assessment was undertaken using Multi-Criteria Analysis (MCA), this was spreadsheet-based with scoring and weightings applied. Finally a Quantitative assessment using – Cost-Benefit Analysis (CBA) using an Environmental Economic consultancy. CBA was considered and used to inform a decision by the assessors. The conclusions of the exercise were: • Ranking of remediation options is similar in all 3 tiers - Management decision was very similar at all tiers • Clear rules, definitions and participant understanding are critical • Tiers Qualitative assessment successfully distinguishes between groups of options Quantitative assessment necessary to distinguish subtly different options Start simple, and quantify only where needed to resolve complexity

	• For 'simple' remediation decisions (e.g. an operational site, no land-use change), a low-tier assessment was robust
5.	**Presentation of Case Study No.2 – Historic Copper Mine** Paul Bardos (PB) presented a case study where he had undertaken a sustainability assessment on a Historic Copper Mine in Wales using the SuRF-UK framework. He explained that this work was undertaken as part of a wider project known as C-CURE (biochar stabilisation) that had been funded by the Technology Strategy Board. PB explained the site and its history, the remedial options considered, Applying the SuRF-UK framework, objectives and stakeholders, scope, boundaries and technique, sustainability assessment findings, sensitivity analyses and conclusions. In conclusion PB demonstrated In this case study that biochar stabilisation offers the more sustainable remediation across all elements (social, economic and environmental). The sustainability assessment was a simple, cheap qualitative approach that yielded clear outcomes after only two meetings. The case study showed how sensitivity analysis improved the robustness of findings. This work is still subject to validation, with some additional quantitative assessment on carbon footprinting of the bio-char and further and wider stakeholder engagement but it is hoped that this will become a SuRF-UK Case Study when finalised.
6.	**Discussion throughout the day** • It was felt that a tiered approach was an appropriate approach to take which allowed flexibility depending on the size of project. • It was also felt that it was good to undertake a sensitivity analysis. • It was also commented that it would be interesting to see how robust your sustainable solution would be if you revisited after 10 years.
7.	**Case Study Exercise** Naomi Regan (NR) presented the case study where the attendees were asked to develop a sustainability assessment on a brownfield site. NR described the site that the case study was based on, giving the environmental setting, contamination profile, remediation design and development requirements for the site. The exercise was split into two exercises. Exercise 1 the attendees were split into two groups, group 1 was asked to consider who the relevant stakeholders were, both technical and non-technical. Group 2 was asked to consider initial remediation/development options. Exercise 2 – using the outputs from exercise 1 the attendees were split into 3 groups to consider the different social, environmental and economic indicators and to score each remediation option accordingly.
8.	**Feedback & Discussion** The attendees fed back that the sustainability assessment was much harder than they thought it would be. Feedback sheets were completed and are attached as part of these notes. General comments were as follows: **Environmental Indicators**: It took longer to assess the impacts as it was easy to stray into other factors. The group felt that scoring was difficult and felt ranking would be easier for environmental indicators. **Social Indicators**: Dependent on the stakeholders each can have quite divergent views relating to the different indicators. For example a LA would want to employ local labour on a regeneration scheme as part of the contract however a Private Company may specify that the project is to use company trained staff. It is therefore important to scope the study first to help set the boundaries. It was felt that perhaps it could be good to weight factors. **Economic:** The group found the task difficult. They focussed on definitions rather than scoring. They decided to take the clients position when considering the indicators. They felt that "Induced Economic Benefit" was a better definition to" Gearing". The group felt that some form of weighting was more important than scoring. The group wondered "How robust

	was a sustainability assessment to climate change impacts?". It is important to have a common understanding before undertaking a sustainability assessment to define boundaries before you undertake the process. Perhaps a client and consultant should try first?
9.	**Closing** JS concluded the meeting and thanked everyone for attending. JS reiterated that the SuRF-UK Steering Group would take away the attendees thoughts and they would be circulating notes from the meeting. JS also asked for case studies that can be shared on the SuRF-UK website and any additional thoughts that people may have after the event to forward to Nicola Harries.

SuRF-UK Phase 2 Workshop objectives

Nicola Harries

19th January 2011

SuRF SUSTAINABLE REMEDIATION FORUM UK

SuRF-UK Phase 2 project objectives

1. To develop ***worked examples*** to illustrate how the SuRF-UK framework may be applied to a ***range of (re)development scenarios, contaminant types and remediation technologies/techniques***.
2. To develop a ***structured checklist of practical sustainability indicators*** for use in a SuRF-UK sustainable remediation assessment.
3. To ***test the practicability of the above indicators*** during real sustainability assessment negotiations.
4. To ***consult with a wide range of stakeholders*** across the contaminated land and brownfield sector ***to validate the indicator checklist***, provide opportunities for external evaluation and case studies, and provide a ***platform for an influential sustainable remediation assessment approach in the UK***.

www.claire.co.uk/surfuk

SuRF SUSTAINABLE REMEDIATION FORUM UK

Objectives this workshop

- Overview of the framework
- Explore how the Framework works with real sites
  - 2 short case-study presentations
- Interactive study
- Give Steering Group direction to refine and develop the supporting elements to the Framework

SuRF SUSTAINABLE REMEDIATION FORUM UK

SuRF-UK Framework for Evaluating Sustainable Remediation Options

Introduction and Benefits

Richard Boyle – HCA

19th January 2011
SuRF UK Phase 2 Workshop Meeting 3

Contents

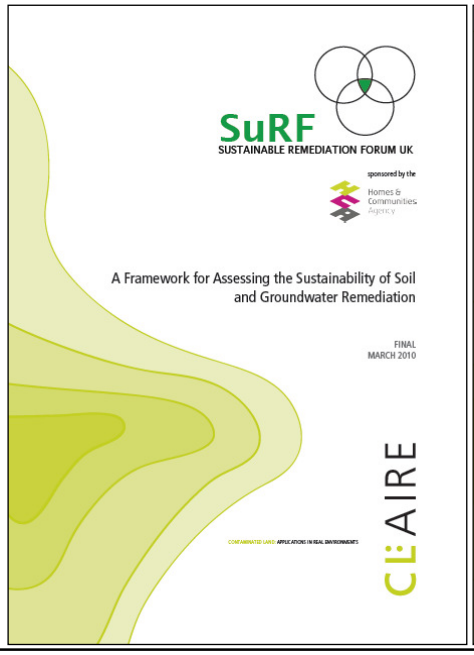
SuRF-UK Constituency

- Established in 2007, following the lead of SuRF (US).
- UK-based collaboration of regulators, industry, academics and consultants. Open forum meetings.
- Independent co-ordination by CL:AIRE (www.claire.co.uk/surfuk).
- Funded by HCA.
- Focus on holistic sustainability assessment of
  - Remediation input to high-level land-use planning
  - Remediation input to overall site / project design ('Better by Design')
  - Remedial strategy selection and remediation technology selection
  - Remediation implementation and verification
- Goals
  - A framework for assessing sustainable remediation
    - Effective, practical, regulatory acceptance
  - Sustainability indicator review

Drivers

- Industry (SAGTA)
  - Good practice, business ethics, sustainable procurement, CSR
- Regulatory (and indeed cross-sectoral)
  - Appropriate and reasonable solutions
  - Planning and Contaminated Land Regimes
  - Water Framework Directive (Soil Framework Directive)
- Planning
  - Sustainability tests in planning applications
  - Sustainability criteria in spatial planning
- Cross-sectoral backing in the UK
- Also response to worldwide interest:
  - EU (NICOLE, SuRF-UK, SuRF-NL?, EURODEMO+)
  - USA (e.g. SuRF, US EPA "green remediation", ASTM)
  - Canada, Australia

SuRF-UK Documents www.claire.co.uk/surfuk



5

Regulatory Acceptance: Foreword to Report

John Palfalvy
Policy Advisor, Brownfield Land
Department of Communities and Local Government

Tom Coles
Contaminated Land Policy Team
Department for Environment, Food and Rural Affairs

Trevor Beattie
Director Strategy, Performance, Policy & Research
Homes and Communities Agency

Gareth Hall
Director General, Department for the Economy and Transport
Welsh Assembly

Sheena Engineer
Land Quality Policy Manager
Environment Agency

Calum MacDonald
Director of Environmental and Organisational Strategy
Scottish Environmental Protection Agency

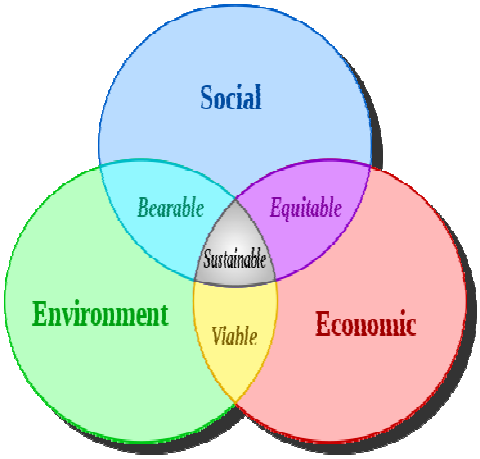
Theresa Kearney
Principal Scientific Officer
Northern Ireland Environment Agency within the Department of the Environment

www.claire.co.uk/surfuk

SuRF
SUSTAINABLE REMEDIATION FORUM UK

6

Defining Sustainability…



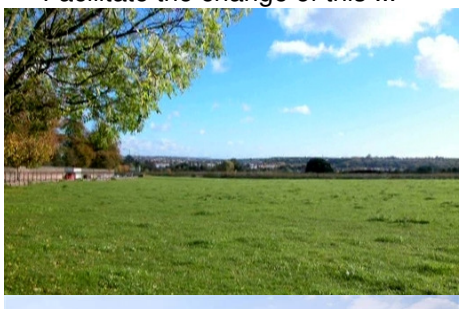
'Development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (1987, Brundtland)

Sustainable Remediation: SuRF-UK Definition

- Sustainable Remediation is '*the practice of demonstrating, in terms of **environmental**, **economic** and **social** indicators, that the benefit of undertaking remediation is greater than its impact and that the optimum remediation solution is selected through the use of a balanced decision-making process*'

SuRF UK Aim

Facilitate the change of this ...



… into this ... but doing it better!

SuRF SUSTAINABLE REMEDIATION FORUM UK

9

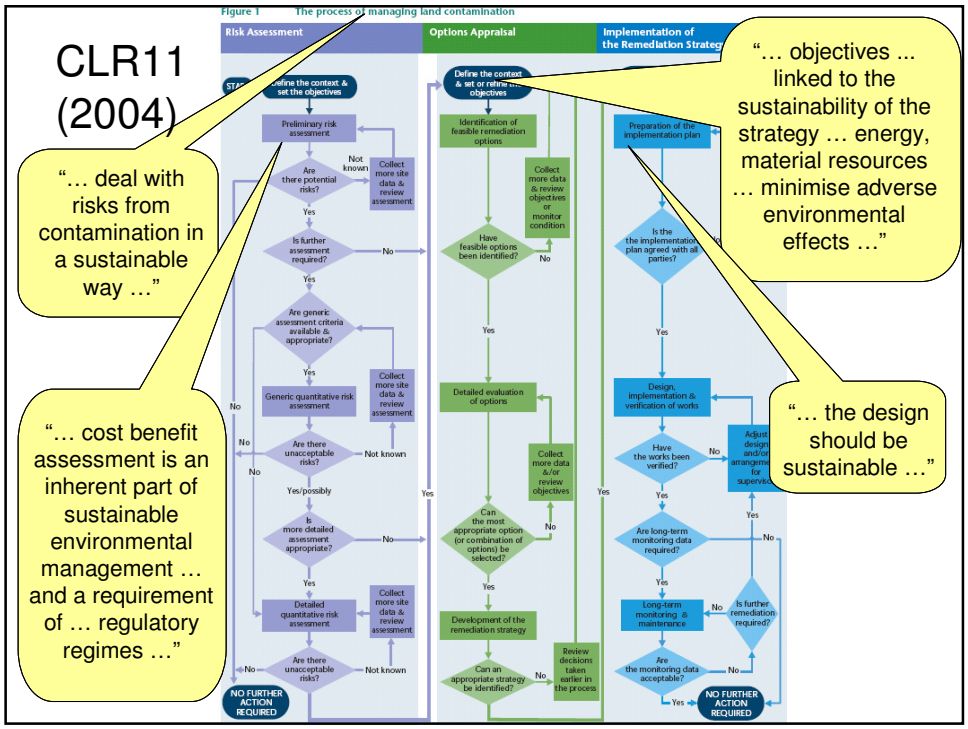
But … Three Common Responses

- Can we *use* Sustainable Remediation?
  - Yes!
  - Regulations and guidance are already written in a way to embrace sustainable remediation concepts and arguments
- What is the *point* of Sustainable Remediation?
  - Makes compliance with regulations easier
  - Makes discussions and communication with stakeholders easier
  - Makes planning applications stronger
  - Introduces a balanced way to bring in financial arguments
- Isn't this a lot *more* work / cost?
  - Not really!
  - Probably doing most of it already.
  - Most sustainability assessments are likely to be straight forward

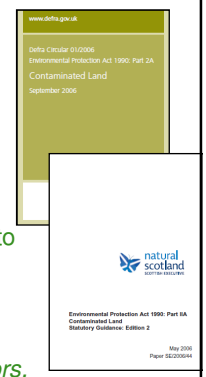
www.claire.co.uk/surfuk

SuRF SUSTAINABLE REMEDIATION FORUM UK

10



Future Regulatory Issues



- Part IIA Consultation for England and Wales
  - Objectives stated from outset *"To ensure that the burdens faced by individuals, companies and society as a whole are proportionate, manageable and **sustainable**."*
  - Section 4(2) "Local Authority summary of its understanding" to show *"Would intervention be **sustainable**? Would non-intervention be more **sustainable**?"*
  - Section 6(d) "Reasonableness of remediation". *"In deciding what is reasonable, the authority must consider various factors, having particular regard to:*

    *(a) the **practicability**, **effectiveness** and **durability** of remediation; (b) the **health** and **environmental** impacts of the chosen remedial options; (c) the **cost** which is likely to be involved; and (d) the **benefits** of remediation with regard to the seriousness of the harm [to HH] or pollution of controlled waters."*
- Part IIA Consultation for Scotland considering similar issues
- Soil Framework Directive
  - Heavily focussed on sustainable remediation

www.claire.co.uk/surfuk

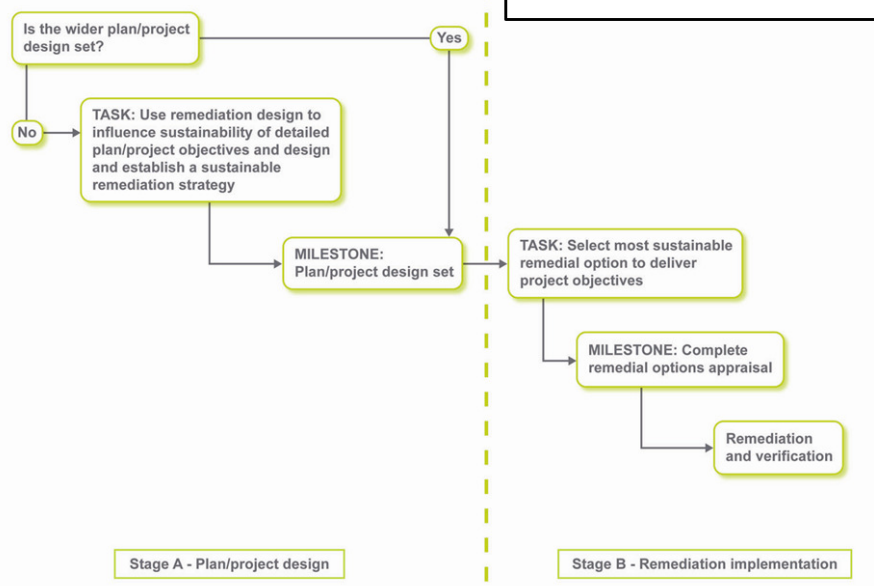
SuRF SUSTAINABLE REMEDIATION FORUM UK

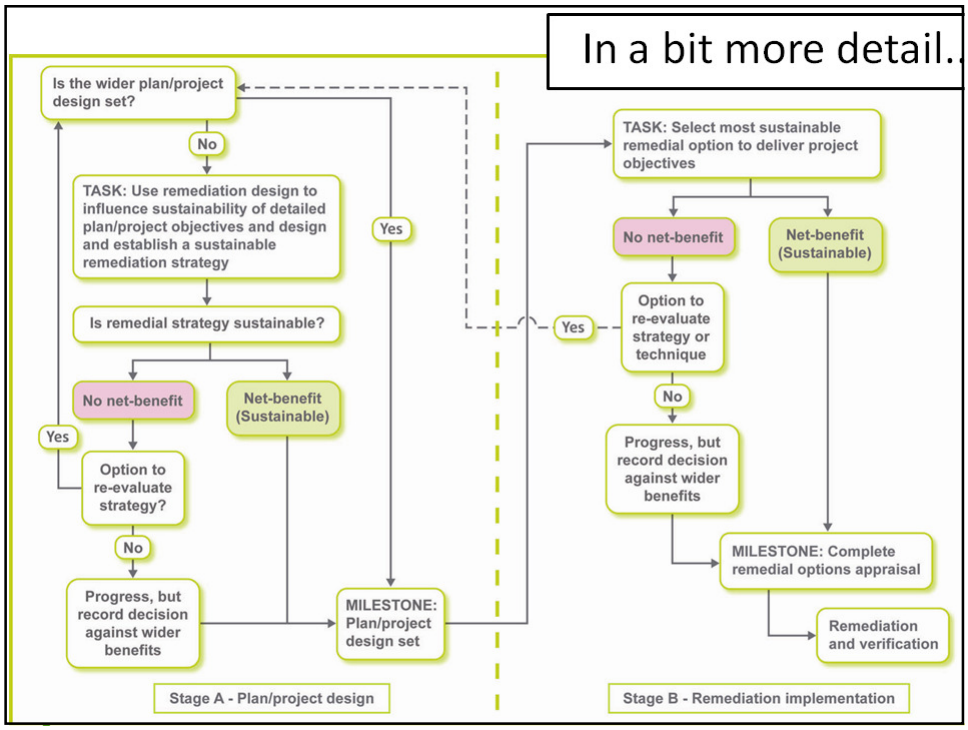
12

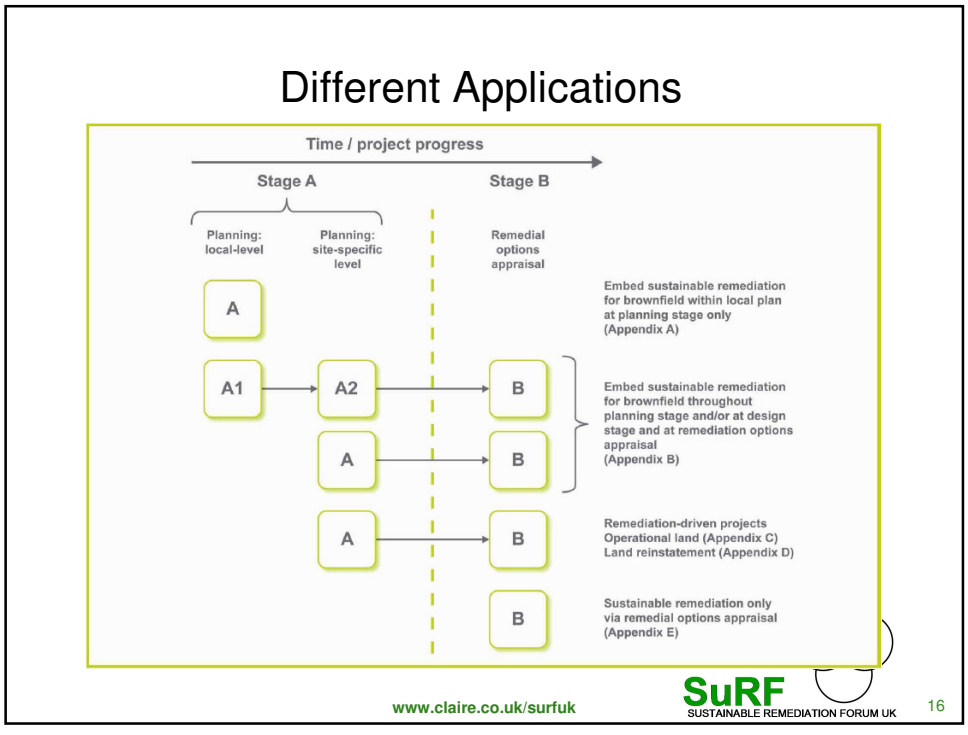
SuRF-UK: Key Principles

- Optimise risk-management based on consideration of social, environmental and economic factors, but always ensure:
  - **Principle 1:** Protection of human health and the wider environment
  - **Principle 2:** Safe working practices
  - **Principle 3:** Consistent, clear and reproducible evidence-based decision-making
  - **Principle 4:** Record keeping and transparent reporting.
  - **Principle 5:** Good governance and stakeholder involvement
  - **Principle 6:** Sound science

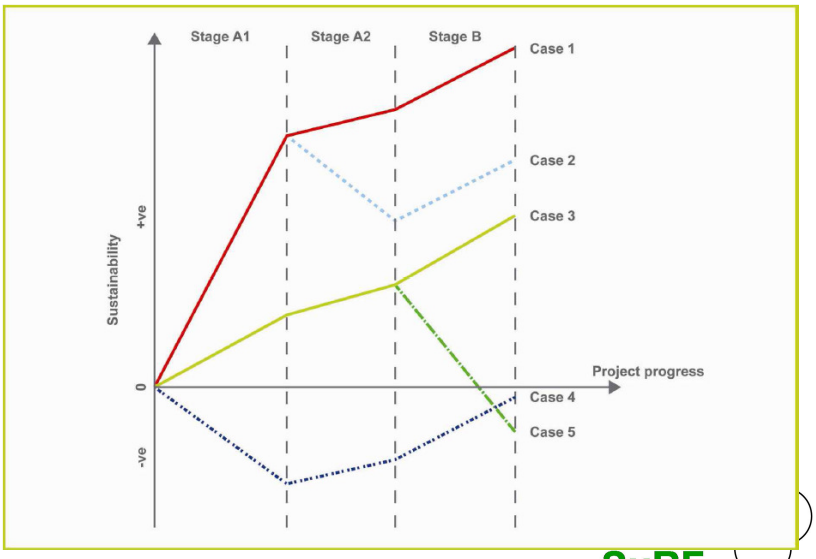
SuRF-UK framework







Benefits of Early Consideration

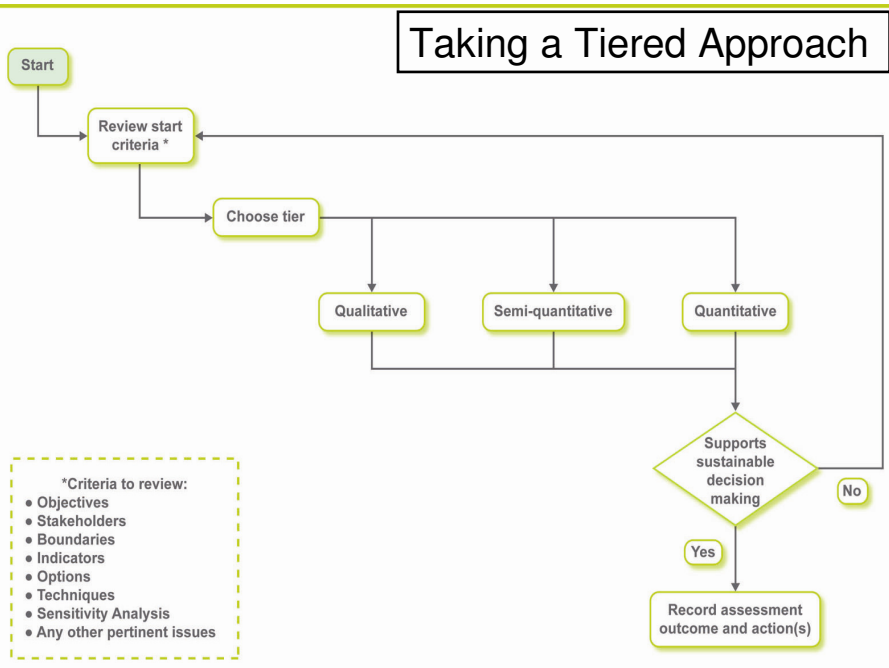


www.claire.co.uk/surfuk

SuRF SUSTAINABLE REMEDIATION FORUM UK

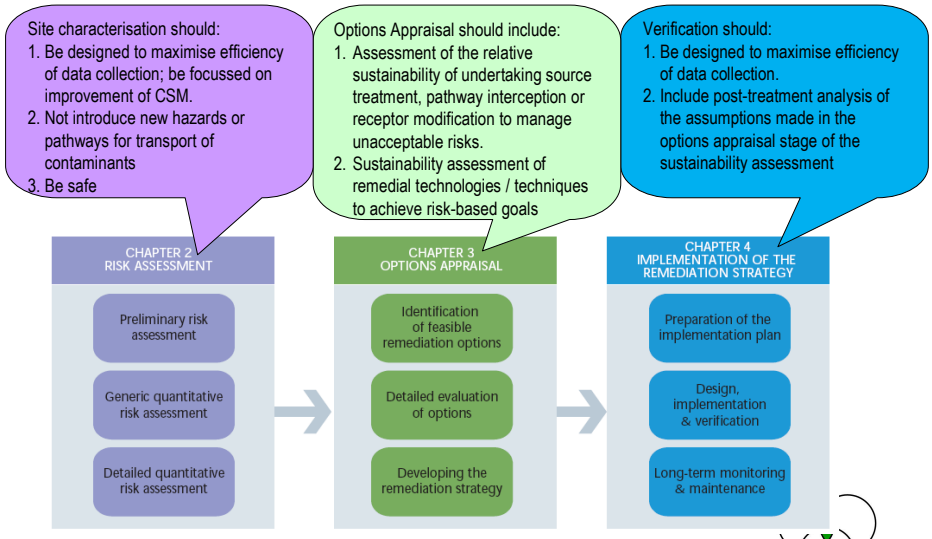
17

Taking a Tiered Approach



www.claire.co.uk/surfuk

CLR11 & SuRF-UK Framework



SuRF SUSTAINABLE REMEDIATION FORUM UK

19

Stages in A Sustainability Assessment

- Agreeing objectives
  - What is being compared and why
- Agreeing which stakeholders to engage with
  - Reviewing objectives accordingly
- Determining boundaries (e.g. project scope)
- Agreeing what sustainability is (which indicators)
- Agreeing how these indicators will be assessed and an overall "picture" of sustainability brought forward (and verified in due course)
- Executing the comparison
- Interpreting findings and carrying out sensitivity analyses

www.claire.co.uk/surfuk

SuRF SUSTAINABLE REMEDIATION FORUM UK

20

SuRF-UK Sustainability Indicators (in Development)

Environmental	Social	Economic
1. Impacts on air (including climate change; 2. Impacts on soil; 3. Impacts on water; 4. Impacts on ecology; 5. Use of natural resources and generation of wastes; 6. Intrusiveness.	1. Impacts on human health and safety; 2. Ethical and equity considerations; 3. Impacts on neighbourhoods or regions; 4. Community involvement and satisfaction; 5. Compliance with policy objectives and strategies; 6. Uncertainty and evidence.	1. Direct economic costs and benefits; 2. Indirect economic costs and benefits; 3. Employment and capital gain; 4. Gearing; 5. Life-span and 'project risks'; 6. Project flexibility.

www.claire.co.uk/surfuk

SuRF SUSTAINABLE REMEDIATION FORUM UK

21

SuRF-UK Framework

- First Framework to set out what sustainable remediation is and how to use it
  - Based upon consensus of views from range of stakeholders
  - Wide acceptance by stakeholders and regulators
- Framework:
  - Complements sustainable development goals of planning and shows where gains can be made
  - Puts in place a mechanism to comply with regulations / adhere to guidance
  - Can save money, minimise environmental and social impacts of remediation
  - Facilitates communication with stakeholders over complex issues
- Arguably, not that more than done now, but people have never expressed it in terms of sustainability
- Shows how things can be done better and why

www.claire.co.uk/surfuk

SuRF SUSTAINABLE REMEDIATION FORUM UK

22

Benchmarking Sustainable Remediation Decision-Support Tools for Use in a Tiered Assessment Framework

Jonathan Smith, Gavin Kerrison & Curt Stanley
Shell Global Solutions – HSE Services

Disclaimer

The companies in which Royal Dutch Shell plc directly or indirectly owns investments are separate entities. In this presentation the expressions "Shell", "Group" and "Shell Group" are sometimes used for convenience where references are made to Group companies in general. Likewise the words "we", "us" and "our" are also used to refer to Group companies in general or those who work for them. The expressions are also used where there is no purpose in identifying specific companies.

Shell Global Solutions is a network of independent technology companies in the Shell Group. In this presentation the expression 'Shell Global Solutions' is sometimes used for convenience where reference is made to these companies in general, or where no useful purpose is served by identifying a particular company.

The information contained in this presentation contains forward-looking statements, that are subject to risk factors which may affect the outcome of the matters covered. None of Shell International B.V., any other Shell company and their respective officers, employees and agents represents the accuracy or completeness of the information set forth in this presentation and none of the foregoing shall be liable for any loss, cost, expense or damage (whether arising from negligence or otherwise) relating to the use of such information.

The information contained in this presentation is intended to be general in nature and must not be relied on as specific advice in connection with any decisions you may make. Shell Global Solutions is not liable for any action you may take as a result of you relying on such material or for any loss or damage suffered by you as a result of you taking this action. Furthermore, these materials do not in any way constitute an offer to provide specific services. Some services may not be available in certain countries or political subdivisions thereof.

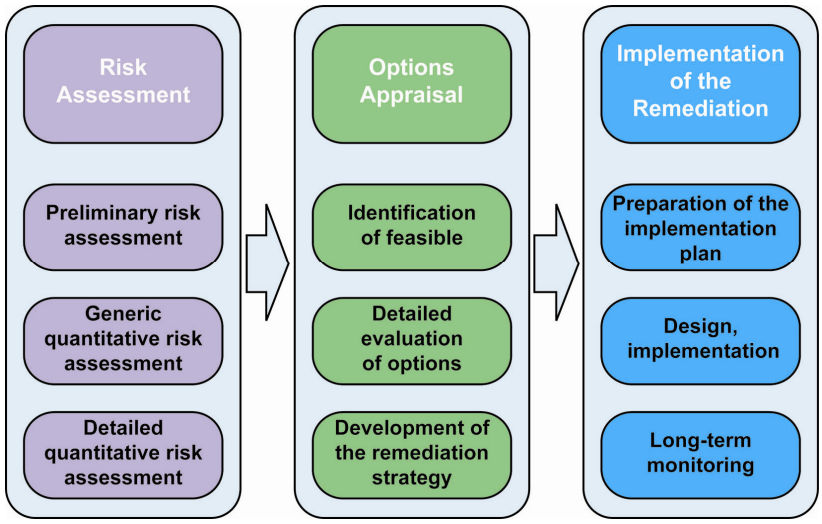
TAKE-AWAY MESSAGE

- Benchmarking shows simple and rapid sustainability assessments can result in robust remediation decisions

PROJECT OBJECTIVES

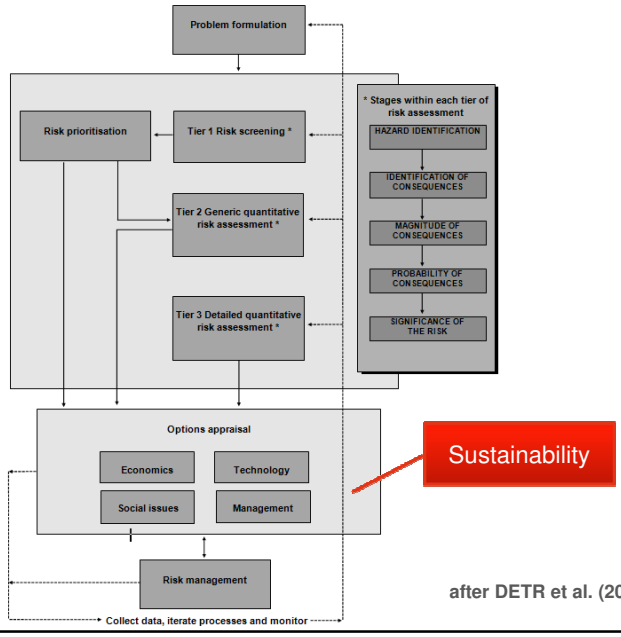
- To 'road-test' the SuRF-UK sustainable remediation framework
  - Retail filling station in UK
  - Within CLR11 process – Options Appraisal stage [SuRF-UK Stage B]
- To compare a single remediation project using different sustainability appraisal tools (SuRF-UK tier 1-3)
  - Ease of application, and assessor/auditor skill requirement
  - Cost and time
  - Data requirements
  - **Consistency of resulting environmental management decision**
- To collect evidence to inform selection of an appropriate tier of sustainability assessment

CLR11 CONTEXT



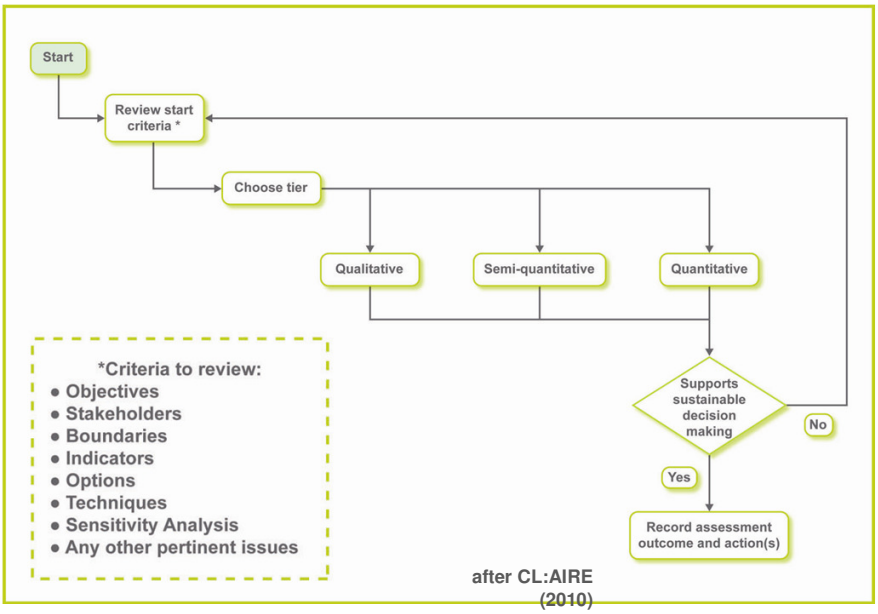
5

RISK-ASSESSMENT / RISK-MANAGEMENT



after DETR et al. (2000)

SuRF-UK TIERED ASSESSMENT FRAMEWORK



after CL:AIRE (2010)

SCOPE OF SUSTAINABILITY APPRAISAL

- Sustainability appraisal objectives
- Stakeholders
- Boundaries
  - Spatial
  - Temporal
  - Life-cycle
- Sustainability indicators

SuRF-UK SUSTAINABLE REMEDIATION INDICATOR CATEGORIES

Environmental	Social	Economic
1. Impacts on air (including climate change; 2. Impacts on soil; 3. Impacts on water; 4. Impacts on ecology; 5. Use of natural resources and generation of wastes; 6. Intrusiveness.	1. Impacts on human health and safety; 2. Ethical and equity considerations; 3. Impacts on neighbourhoods or regions; 4. Community involvement and satisfaction; 5. Compliance with policy objectives and strategies; 6. Uncertainty and evidence.	1. Direct economic costs and benefits; 2. Indirect economic costs and benefits; 3. Employment and capital gain; 4. Gearing; 5. Life-span and 'project risks'; 6. Project flexibility.

9

BENCHMARKING APPROACH

- Sequential process. Start simple, progress through tiers
- Qualitative
  - A 'round-table conversation'
  - High/Medium/Low rating for each factor
- Semi-quantitative – Multi-Criteria Analysis
  - Spreadsheet-based
  - Scoring and weightings applied
- Quantitative – Cost-Benefit Analysis
  - Environmental Economic consultancy undertook detailed CBA
  - CBA considered and used to inform a decision by assessors

Battelle Chlorocon May 2010 10

SITE HISTORY

- Petrol filling station, tanks installed 1989
- January 2002: Reported loss of unleaded petrol
- Site characterisation
  - January 2002 – Tier 1 risk assessment
  - July 2002 – Tier 2 risk assessment
- 2002:Tanks decommissioned; new tanks and lines installed
- Remediation
  - DPVE – March to September 2003: ca. 8600 litres recovered
    - Verification: August 2004 – Boundary site investigation
  - SVE – February to July 2006: ca 400 litres recovered
    - Verification: July 2006 (Terravac)
    - Post treatment: January/May/June 2007 – GW monitoring
- Cost-benefit assessment: May - August 2008
- Post-treatment GW monitoring: Jan 2009

11

SITE LOCATION

12

HYDROGEOLOGICAL CONCEPTUAL MODEL

Potential compliance / receptor location (for existing releases)

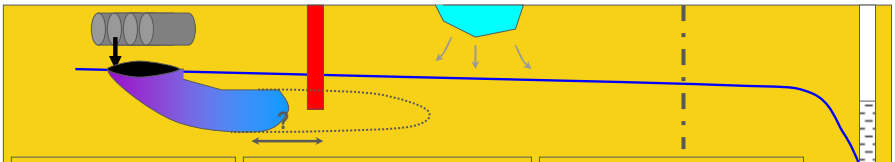
GW abstraction → 2500m

SPZ 2 boundary (P20) → 760m

River → 180m

GW resource (P20) → 50/100m

Target Conc. 1 µg/l benzene DWS; 140 µg/l aromatic C8-10 (WHO)



Biodegradation:

- ✓ Oxygen depletion
- ✓ Nitrate depletion
- ✓Increased Fe (II)
- ✓Increased Mn (II)
- ✓ Bacterial counts

Retardation:

- TSS Foc ~ 0.0002
- Koc (benzene) – 135 l/kg
- ⇒ Kd ~ 0.027 ; Rf ~ 1.27
- Koc (TPH C8-10 aromatic) = 1584 l/kg, Rf ~ 3.53

GW Transport:

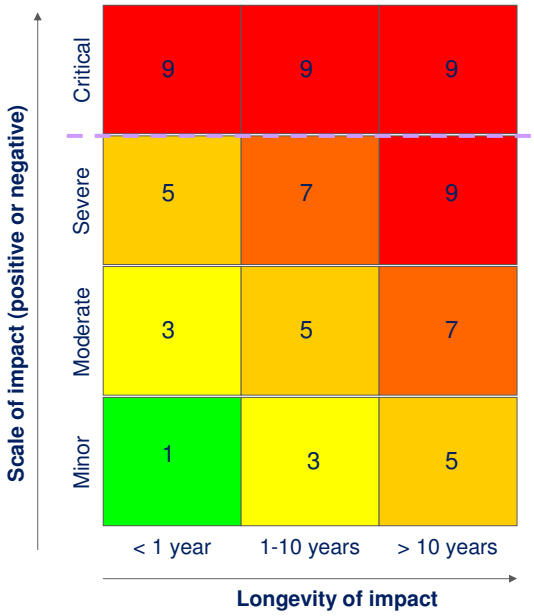
- K ~ 4 md^{-1} , i ~ 0.0055, n_e ~ 0.25
- ⇒ v ~ 32 m/yr
- ⇒ u_{benz} = 26 m/yr
- ⇒ $u_{TPH:C8-10}$ = 9.1 m/yr

NA shown to be effective. BTEX half-lives 90 – 200 days

TIERED SUSTAINABILITY ASSESSMENT

- Scoring system
- Link out to spreadsheets
  - Qualitative
  - Semi-quantitative
- Sustainability metric definitions

SCORING MATRIX PROVIDED TO ASSESSORS



TIER 1 APPRAISAL

		Remediation option: Soil										
		Base case	Source treatments						Pathway interception			
	Sustainability criteria	Do nothing	Excavation & disposal	Dual-Phase Vapour Extraction	Soil Vapour Extraction	In-situ soil bioremediation	Ex-situ soil bioremediation	Encapsulation (low-K cap / barriers)	Pump & Treat	Air-Sparge	MNA	In-situ biore (e.g. relea
	1. Costs of undertaking remediation											
	Environment											
	Impact on the environment by remediation	0	3	1					3			
	Social											
	Social impact of remediation	0	3	1					2			
	Economic											
	Direct costs and direct economic cost	0	2	1					2			
	2. Benefits of undertaking remediation											
	Environment											
	Benefit to the environment	0	3	2					2			
	Social											
	Benefit to society	0	1	1					1			
	Economic											
	Economic benefit	0	3	2					2			
	Net environmental benefit	0	0	1	0	0	0	0	-1	0	0	
	Net social benefit	0	-2	0	0	0	0	0	-1	0	0	
	Net economic benefit	0	1	1	0	0	0	0	0	0	0	
	Overall net-benefit (Sustainability)	0	-1	2	0	0	0	0	-2	0	0	
	RANK	2	19	1	2	2	2	2	20	2	2	

Tier 1 (Qualitative) assessment

TIER 2 APPRAISAL

9					Remediation option: Soil							
10		Boundary Condition and/or Clarification			Base case			Source treatments				
11					1			2				
12		Sustainability criteria			Do nothing			Excavation & disposal				
13					score	matrix	comment	score	matrix	comment	sco	
14												
15		1. Costs of undertaking remediation										
16	C	*Environment*		Weighting								
17	C	Impact on water	GW & SW considered (only one ranked).	1	9	>10yrs/sev	Defined as severe, if impact defined as could reach abstraction bore. Loss of Gwresource. No connection to SW tho'.	1	<1yr / minor	some water/surface water management		
18	C	Impact on soil	need to define what functions we would want expect from the land use. For on-going s/stn just geotech properties chosen.	1	0		Could be 5 based on >10yr and minor. But assume 0 if connected to on-going s/stn I.e geotech only. HC not effect structures.	1	<1yr / minor	Low value use as ongoing s/stn and will be replaced with clean fill. Geotech only, if not could be 9 as complete removal!		
19	C	Impact on air	Direct and in-direct emmisions.	1	0			3	<1yr / moderate	Emissions/odour during excavation & energy use dig & transport (how much soil?)		
20	C	Impact on ecology	On-site and immediate surrounds only - assume NO surface water body connection	1	5			3	<1yr / moderate	ground disturbance / habitat loss assume minimal for s/stn. If any quick recovery		
21	C	Natural resource use and waste generation	Resources & water use. Waste gen counted here and not in inclusiveness (as per note). Fossil fuels counted in air based on emissions.	1	0			9	<1yr /critical	clean fill inport & soil export to L/fill		
22	C	Intrusiveness	footprint /visual / dust / odours - Nuisance	1	0			9	<1yr / critical	Waste gen, disposal, noise, dust etc..		
23	C											
24	C	*Social*										
							some safty/exposure connected with excavation			Excavation & transport high safety risk inc. road safety		

SUSTAINABILITY APPRAISAL OUTCOME (SELECTED)

Rank	Tier 1 (Qual.)	Tier 2 (MCA)	Tier 3 (B/C ratio) (CBA)
1	A, B, C	B	A (1.27)
2		A	B (1.09)
5		C	C (0.97)
8		D	F (0.86)
11	E		D (0.8)
14	D, G	E, G	E (0.58)
15	F	F	G (0.4)

A	DPVE
B	DPVE+MNA
C	In situ bioremediation
D	P&T
E	Excavate & dispose
F	Receptor treatment
G	Do nothing

FINDINGS #1

	Qualitative	Semi-quantitative	Quantitative
Time/effort	0.5 – 1 day	1 – 3 days	~1 week
Data	Generic data generally adequate		Site-specific valuation necessary
Practicability: Individual assessor	OK. Sufficiently simple ranking	Difficult to represent range of views	OK – relies on external valuation data
Practicability: Stakeholder group	OK. Sufficiently simple ranking. Enjoyable process!	OK. Considerable debate on scores	OK – debate centred on assumptions embedded in CBA
Summary	Able to differentiate between different types of remediation option. Not able to resolve subtlety. Quick, easy.	Added numbers to qualitative assessment, but debateable whether added robustness. Difficult with a single assessor.	Able to resolve subtlety . Full CBA data hungry – use partial CBA where difference between options. Not all valuation data

FINDINGS #2

- Objectives of sustainability assessment must be clear
  - Scope of assessment must be clear, and agreed, by all parties
- Sustainability factor definition is critical
  - All parties need to be clear what they are scoring/valuing
  - Care needed to avoid double counting, or omission
- Remediation selection

CONCLUSIONS

- Ranking of remediation options is similar in all 3 tiers
  - Management decision was very similar at all tiers
- Clear rules, definitions and participant understanding are critical
- Tiers
  - Qualitative assessment successfully distinguishes between groups of options
  - Quantitative assessment necessary to distinguish subtly different options
  - Start simple, and quantify only where needed to resolve complexity
- For 'simple' remediation decisions (e.g. an operational site, no land-use change), a low-tier assessment was robust

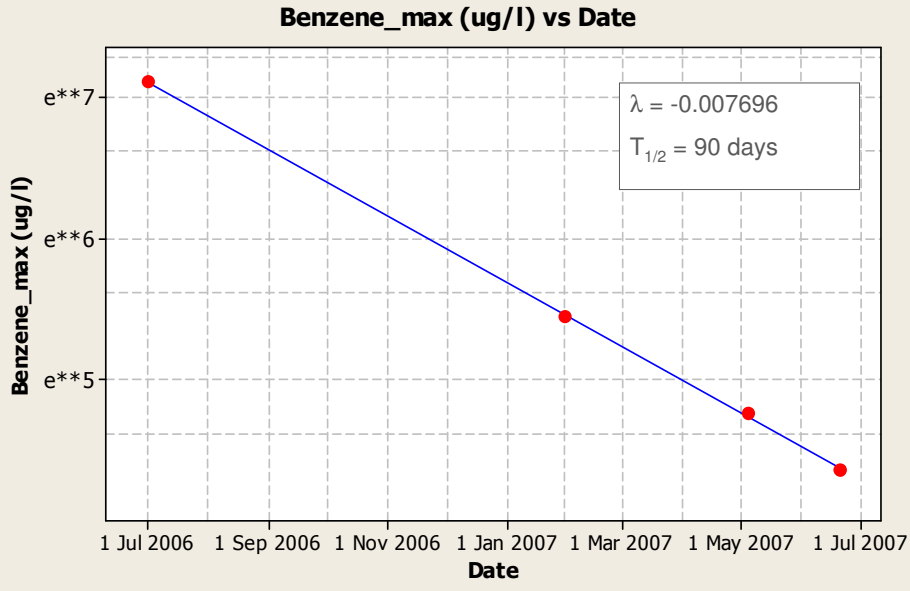
Hydrogeology

- Triassic Sherwood Sandstone: Principal Aquifer
  - Resource Protection Zone (SPZ 3),
  - PWS 'A' 2.5 km to north east (down hydraulic gradient)
  - PWS 'B' 2km to south west (up hydraulic gradient)
  - SPZ 2 boundary of PWS 'A' ~ 0.75 km north east
  - Data
    - Local hydraulic test pumping: K ~ 4 m/d, n_e ~ 0.25
    - Regional GW gradient through site ~ 0.0055
- Alluvial clays, silts and gravels (≤ 3 m)
- Surface water bodies
  - River, 180m, no hydraulic continuity GW→SW

MNA assessment (following R&D P95)

- Source removal:
  - Tanks decommissioned (2002)
  - LNAPL removed by DPVE (2003)
  - SVE / bioventing of unsaturated zone impact (2006)
- NA Lines of Evidence: Primary
  - Concentration (or toxicity, flux, mass) decrease over time
- Secondary
  - Geochemical species (electron acceptor depletion)
- Tertiary
  - Microbial evidence

25



26

Measured degradation rates, 2006-07: summary

	Max. plume conc.		Mean plume conc.	
Compound	**Rate, λ**	**Half-life (days)**	**Rate, λ**	**Half-life (days)**
TPH (C_{8-10} aromatic)	0.00641	108	0.003177	218
Benzene	0.007696	90	0.006346	109
Toluene	0.006509	106	0.00558	124
Ethylbenzene	0.003596	193	0.002182	317
Xylene	0.001637	423	0.002256	307

Initial Sustainability Assessmentof a C-CURE biochar application

Paul Bardos, r3 environmental technology ltd
www.r3environmental.com

SuRF SUSTAINABLE REMEDIATION FORUM UK

Acknowledgements

- SURF-UK Steering Group
- C-CURE
  - Tony Hutchings, Forest Research; tony.hutchings@forestry.gsi.gov.uk
  - Frans de Leij, University of Surrey

SuRF SUSTAINABLE REMEDIATION FORUM UK

Contents

- Risk Management Problem
- Remedial Options
- Sustainability assessment approach
  - Objectives and stakeholders
  - Scope, boundaries and technique
  - Sustainability assessment findings
  - Sensitivity analyses
- Conclusions

Risk Management Problem

- Parys Mountain is a historic copper mining area near Amlwch in Anglesey
- On the site are a number of sediment settlement ponds. These are dry for part of the year

Some important features of the site

- Contamination: mainly cationic heavy metals
- Major interest in preservation of landscape (heather), but settlement ponds are too toxic / acidic for heather in their current condition
- Major interest in preserving archaeological features and built remnants
- Assume a preference against imported fill materials
- Relocation of householders not possible, and risk reduction therefore very important
- First possible application of a new technology (biochar)
- Limited site access, narrow roads, open access to site
- The settlement ponds have been subject to annual flooding by acidic leachate form the rest of the mine site; this will be diverted away from the settlement ponds

Aims

- 'Development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (1987, Brundtland)
  - Risk management goal: protection of householders from dust blow from the Parys Mountain settlement ponds
  - Sustainability management objective: compare sustainability (qualitatively) of remedial alternatives identified for this goal

Remedial Options Under Consideration

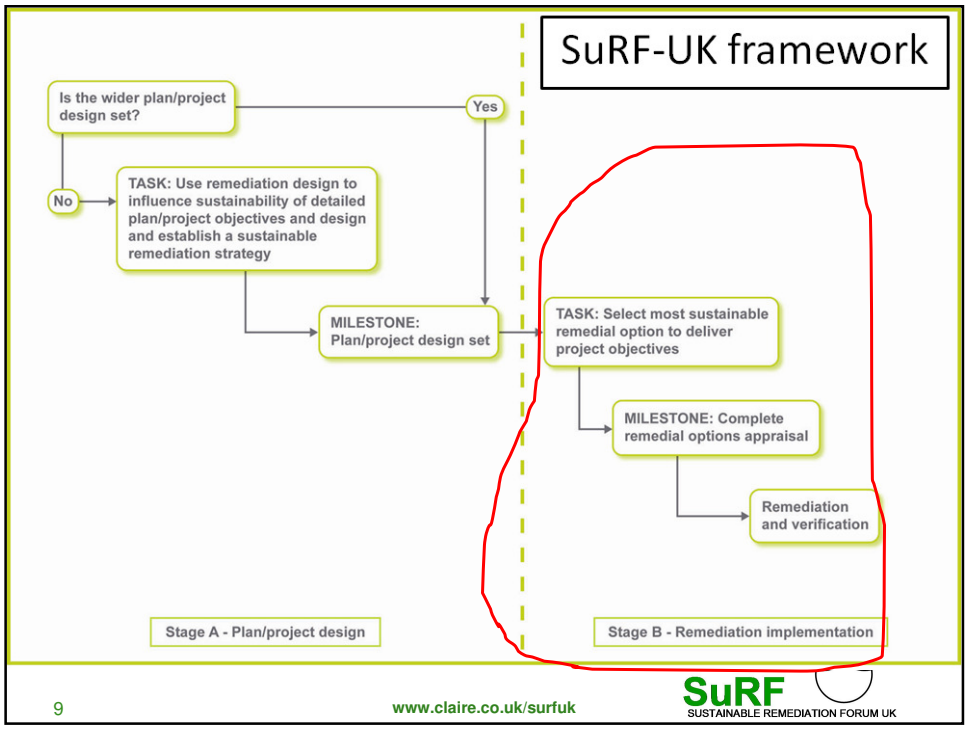
- Treatment with biochar
  - 2% amendment by mass of surface layers, production by-product from renewable energy from waste biomass (e.g. agricultural wastes), low bulk density, incorporation by conventional agricultural techniques (e.g. at this scale rotavating), high sorption of cations, high pH buffering capacity
  - New technology, first application, supported directly by C-CURE
  - Stabilise sediment pond surface by revegetation to reduce dust blow
- Treatment with agricultural lime ($CaCO_3$)
  - 5% amendment by mass of surface layers, produced from a primary resource, energy intensive, neutralisation releases CO_2, incorporation by conventional agricultural techniques , operates by neutralising pH and precipitating cations
  - Established technique for mitigating metal availability
  - Stabilise sediment pond surface by revegetation to reduce dust blow

SuRF SUSTAINABLE REMEDIATION FORUM UK

Remedial Options Under Consideration

- Excavation and removal
  - Remove sediment (which has no archaeological value) and refill ponds
  - Established approach
  - Excavation and removal off site (off island)
- No intervention
  - Take no action
  - “Control”

SuRF SUSTAINABLE REMEDIATION FORUM UK



Sustainability Assessment Approach

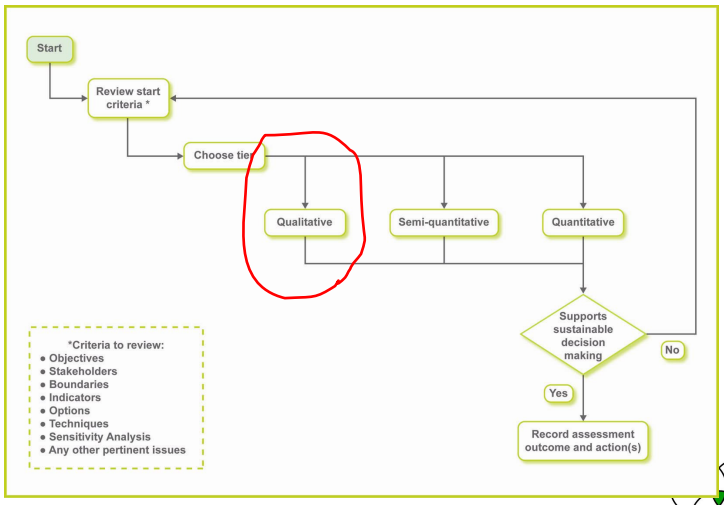
Based on NICOLE and SURF-UK assessment suggestions, with a bespoke approach to comparison and visualisation

Qualitative

1. Setting objectives / identifying stakeholders
2. Agreeing scope, boundaries and sustainability assessment methodology
3. Execution and sensitivity analyses

- All underpinned by stakeholder engagement

SuRF-UK



SuRF SUSTAINABLE REMEDIATION FORUM UK

Objectives

- Project (system) being assessed
  - Remediation work for the mitigation of human health risks to the residential property adjacent to disused sediment ponds.
- Alternatives considered:
  - C-CURE biochar stabilisation in situ; lime stabilisation in situ; excavation and removal to landfill with replacement by clean fill; and no intervention
- Aims of the assessment
  - To identify the most sustainable remediation approach from the options available across a holistic and broad view of sustainable development, (based on the draft headline indicator categories from SURF-UK)
- Consequences of the assessment
  - Determination and selection of most sustainable approach

SuRF SUSTAINABLE REMEDIATION FORUM UK

Stakeholders Involved in the Assessment

- Narrow basis
  - Service provider and technology vendor
- Ideally wide ranging
  - Client, regulator, householder, other interested parties
- This was not possible in 2009 because:
  - This was a "scoping study", since then a lot has changed, including the remedial alternatives under consideration
  - Of commercial considerations
- Narrow basis → "scoping study" rather than a full sustainability assessment (will not be unusual in projects)
- Wider stakeholder engagement → validation of the sustainability assessment

Boundaries and scope

- Boundaries
  - System: delivery of the risk management and its impacts whether local or distant, temporary or permanent
  - Life cycle: consumption by the project, but not the impacts of producing capital equipment (like a digger etc)
  - Proximity: operational area of the project = local
  - Permanence: duration of the project = temporary
- Scope: break out SuRF-UK headlines to full indicator set
  - Individual indicators (similar to your hand out today, but earlier thinking)
  - Decide relevance to the project and just use those relevant (record all decisions)

SuRF-UK Overarching Headline Categories

Environmental	Social	Economic
➢ impacts on air – including climate ➢ impacts on soil ➢ impacts on water ➢ impacts on ecology ➢ use of natural resources and generation of wastes ➢ intrusiveness.	➢ impacts on human health and safety ➢ ethical and equity considerations ➢ impacts on neighbourhoods or regions ➢ community involvement and satisfaction ➢ compliance with policy objectives and strategies ➢ uncertainty and evidence	➢ direct economic costs and benefits ➢ indirect economic costs and benefits ➢ employment and capital gain ➢ gearing ➢ life-span and 'project risks' ➢ project flexibility

1 www.claire.co.uk/surfuk

SuRF SUSTAINABLE REMEDIATION FORUM UK

Approach to Comparison for Each Indicator

- Used rankings
  - to avoid arbitrary scoring arguments
  - to avoid separate considerations of how to score pros vs. cons
- Used categories
  - high, medium, low importance to avoid weightings and associated arguments
  - local / distant and temporary / permanent to allow us to distinguish effects only taking place over the project, and effects only taking place within the project area
- But rankings to not show "scale of difference", so
  - Identified "stoppers", i.e. a condition on an indicator that means a remedy cannot go ahead
  - Identified "outliers"
- Rankings for relevant indicators
  - what gets closest to the ideal condition?

16 www.claire.co.uk/surfuk

SuRF SUSTAINABLE REMEDIATION FORUM UK

For instance: headline = Environmental →Intrusiveness

Indicator						
Aesthetic impact on landscape						
Impacts on archaeology						
Impacts on built environment						
Impacts of light						
Etc etc						

SuRF SUSTAINABLE REMEDIATION FORUM UK

For instance: Environmental →Intrusiveness

Indicator	Rel'ce					
Aesthetic impact on landscape	Yes					
Impacts on archaeology	No					
Impacts on built environment	Yes					
Impacts of light	No					
Etc etc						

Considered already under built environment

Daylight operations only expected

SuRF SUSTAINABLE REMEDIATION FORUM UK

For instance: Environmental →Intrusiveness

Indicator	Rel'ce	Ideal				
Aesthetic impact on landscape	Yes	In keeping				
Impacts on archaeology	No	-				
Impacts on built environment	Yes	None				
Impacts of light	No	-				
Etc etc						

SuRF SUSTAINABLE REMEDIATION FORUM UK

For instance: Environmental →Intrusiveness

Indicator	Rel'ce	Ideal	Biochar	Lime	Landfill	No action
Aesthetic impact on landscape	Yes	In keeping	1	1	1	4
Impacts on archaeology	No	-	-	-	-	-
Impacts on built environment	Yes	None	2	2	4	1
Impacts of light	No	-	-	-	-	-
Etc etc						

SuRF SUSTAINABLE REMEDIATION FORUM UK

For instance: Environmental →Intrusiveness

Indicator	Rel'ce	Ideal	Biochar	Lime	Landfill	No action
Aesthetic impact on landscape	Yes	In keeping	1	1	1	4
Impacts on archaeology	No	-	-	-	-	-
Impacts on built environment	Yes	None	2	2	4	1
Impacts of light	No	-	-	-	-	-
Etc etc						

No heather for no intervention

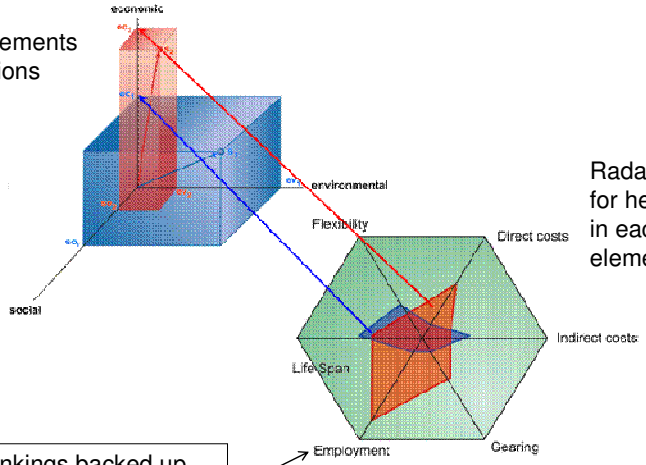
Risks of damage from disturbance, greatest for removal to landfill, nonexistent for no intervention

For instance: Environmental →Intrusiveness

Indicator	Rel'ce	Ideal	Biochar	Lime	Landfill	No action
Aesthetic impact on landscape	Yes	In keeping	1	1	1	4
Impacts on archaeology	No	-	-	-	-	-
Impacts on built environment	Yes	None	2	2	4	1
Impacts of light	No	-	-	-	-	-
Etc etc						
Average			**1.8**	**1.6**	**3.2**	**2.2**

Technique – aggregation & visualisation

Plotting 3 elements in 3 dimensions



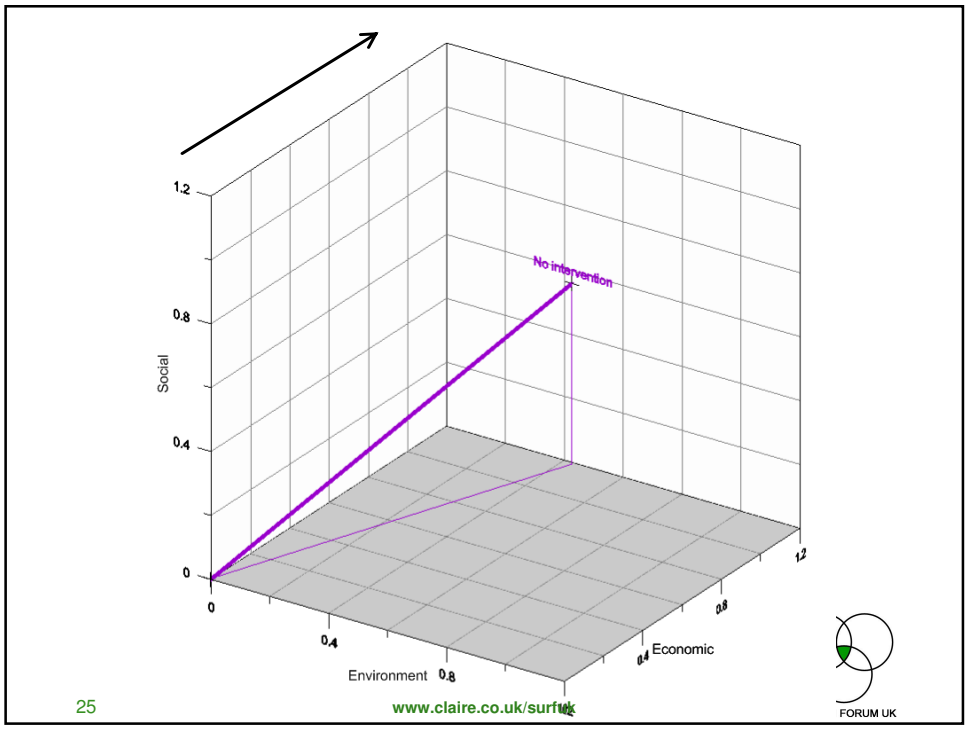
Radar plots for headlines in each element

Individual rankings backed up by an evidence table, averaged for each headline

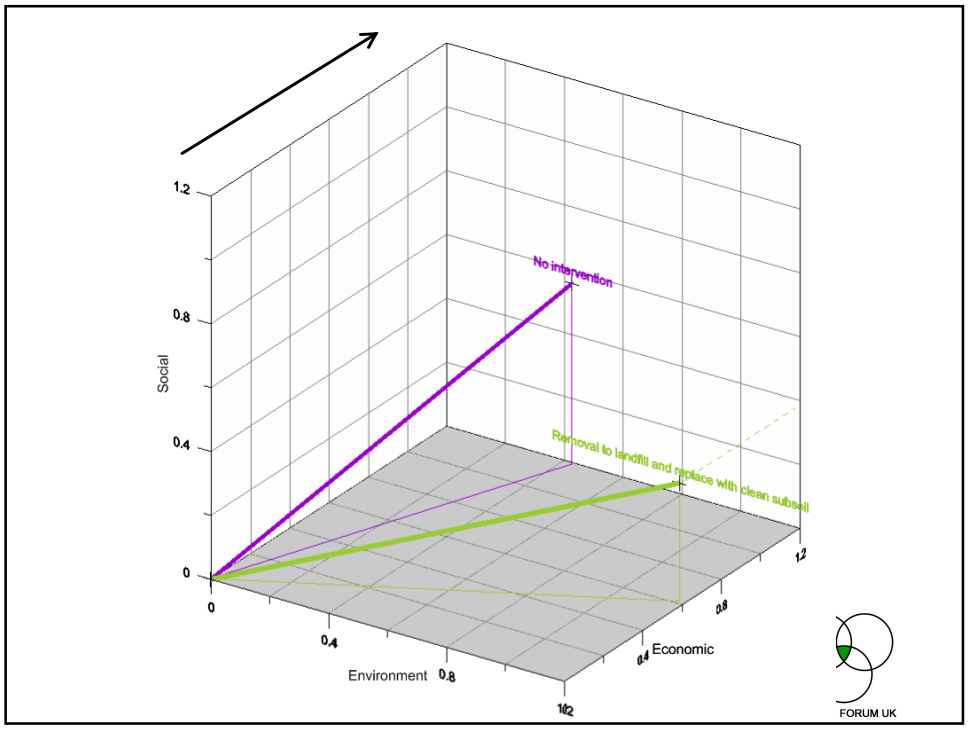
SuRF SUSTAINABLE REMEDIATION FORUM UK

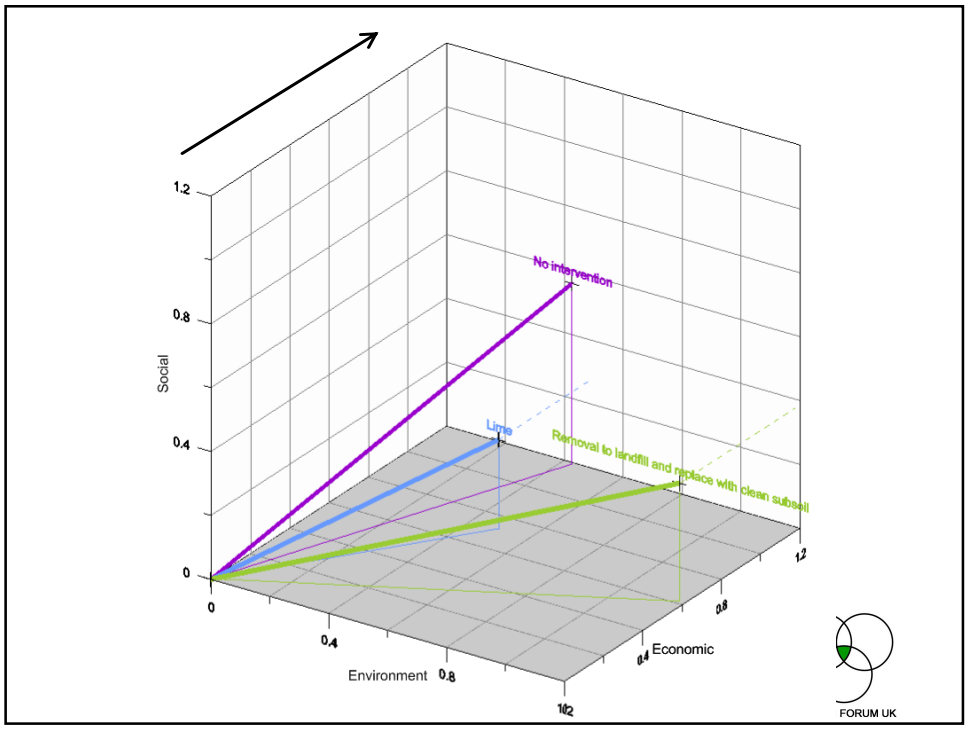
Findings

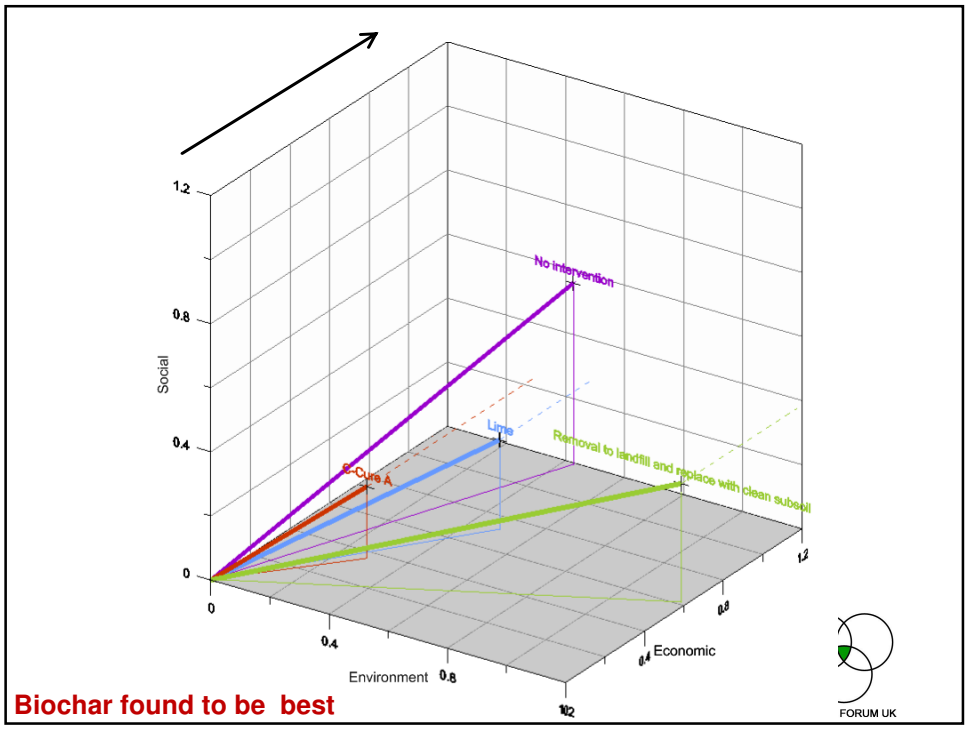
SuRF SUSTAINABLE REMEDIATION FORUM UK



25 www.claire.co.uk/surfuk





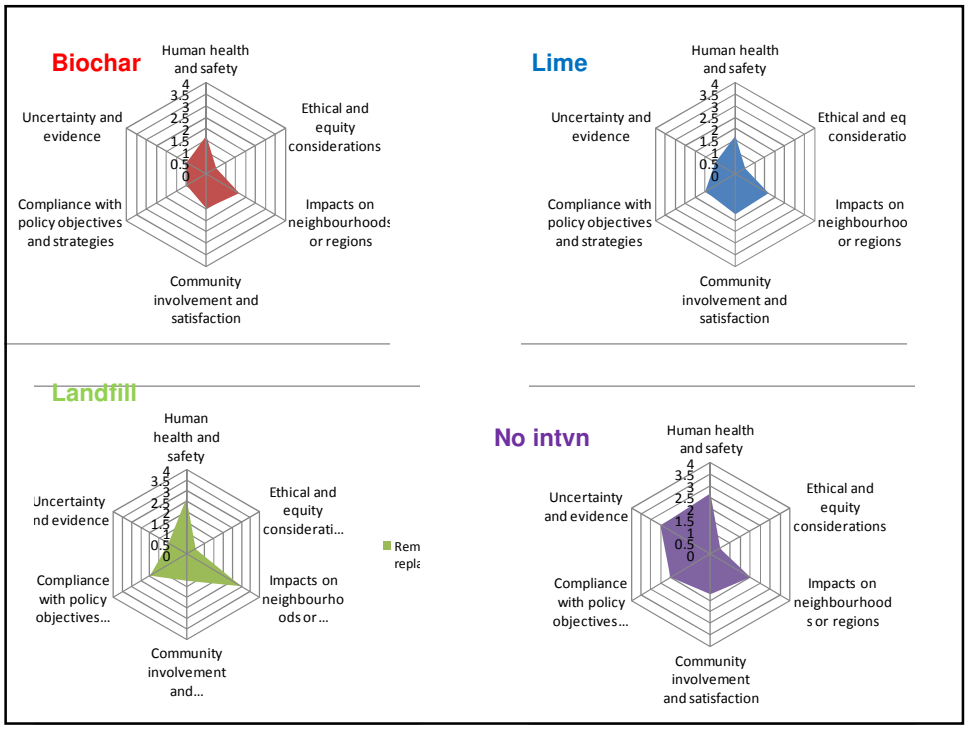


Biochar found to be best

Case Study 2
Initial Sustainability Assessmentof a C-CURE biochar application

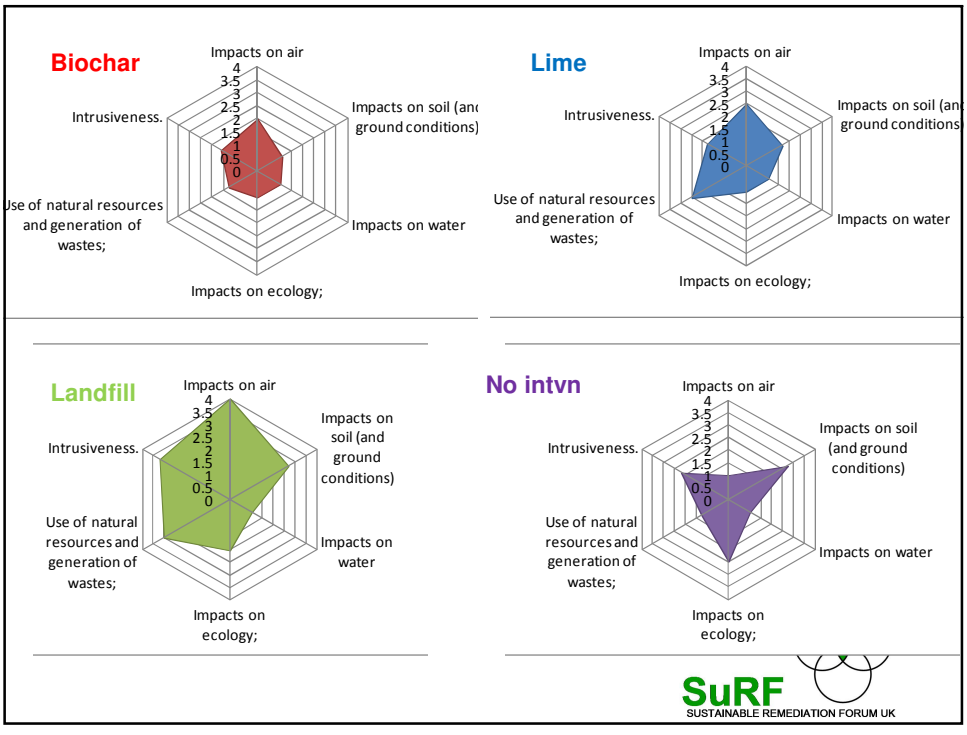
Social element in detail (includes human health impacts)

SuRF SUSTAINABLE REMEDIATION FORUM UK



Environmental element in detail

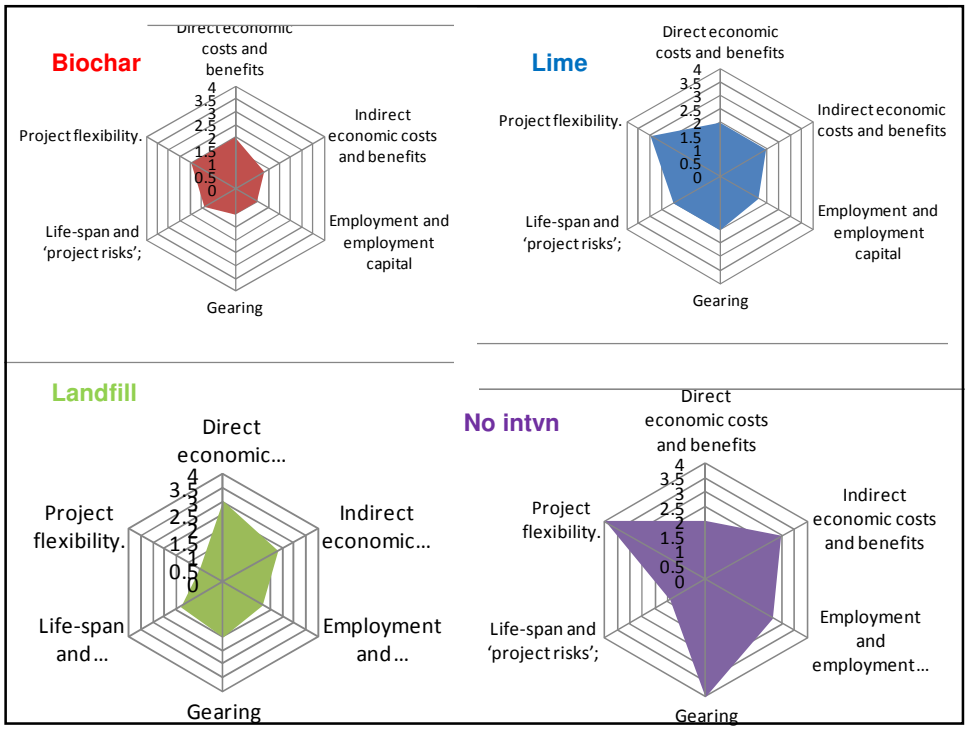
SuRF SUSTAINABLE REMEDIATION FORUM UK



SuRF SUSTAINABLE REMEDIATION FORUM UK

Economic element in detail

SuRF SUSTAINABLE REMEDIATION FORUM UK



Sensitivity analyses – are we sure biochar is best?

- Removing presumption against importation of fill materials
- Considering "high" importance indicators only
- Considering "permanent" effect indicators only
- Considering "local" effect indicators only
- Different ways of aggregating social headline categories
- C-CURE biochar remained best in all sensitivity analysis scenarios
- In some scenarios the positions for "no intervention", "lime stabilisation" and "landfill alternatives" changed relative to each other
- Stop conditions on lime stabilisation (reversibility) and no intervention (failure to protect human health)

Conclusions and Next Steps

- In this case biochar stabilisation offers the more sustainable remediation across all elements (social, economic and environmental)
- A simple, cheap qualitative approach yielded clear outcomes (two meetings)
- Sensitivity analysis improved the robustness of findings
- Subject to validation
- Suggested next steps
  - Roll out to a wider stakeholder grouping for the site
  - Examine some aspects in a quantitative way
    - Carbon footprint
  - Hopefully this will then be a SuRF-UK Case Study

Thank you for listening

SuRF
SUSTAINABLE REMEDIATION FORUM UK

Sustainability "vectors"

C-Cure Amendment	$\begin{pmatrix} en.29 \\ so.23 \\ ec.36 \end{pmatrix}$	
Lime Amendment		$\begin{pmatrix} en.50 \\ so.28 \\ ec.72 \end{pmatrix}$
Removal to Landfill and Replacement with Clean Fill	$\begin{pmatrix} en1.2 \\ so.37 \\ ec.61 \end{pmatrix}$	
No intervention		$\begin{pmatrix} en.44 \\ so.57 \\ ec1.2 \end{pmatrix}$

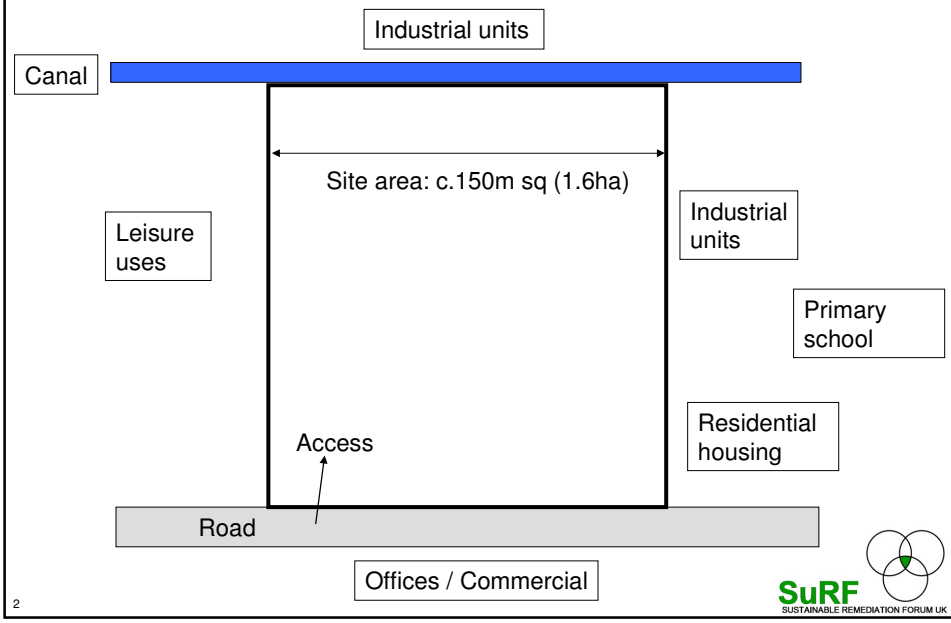
SuRF
SUSTAINABLE REMEDIATION FORUM UK

Developing a Sustainability Assessment on a Brownfield site

Naomi Regan

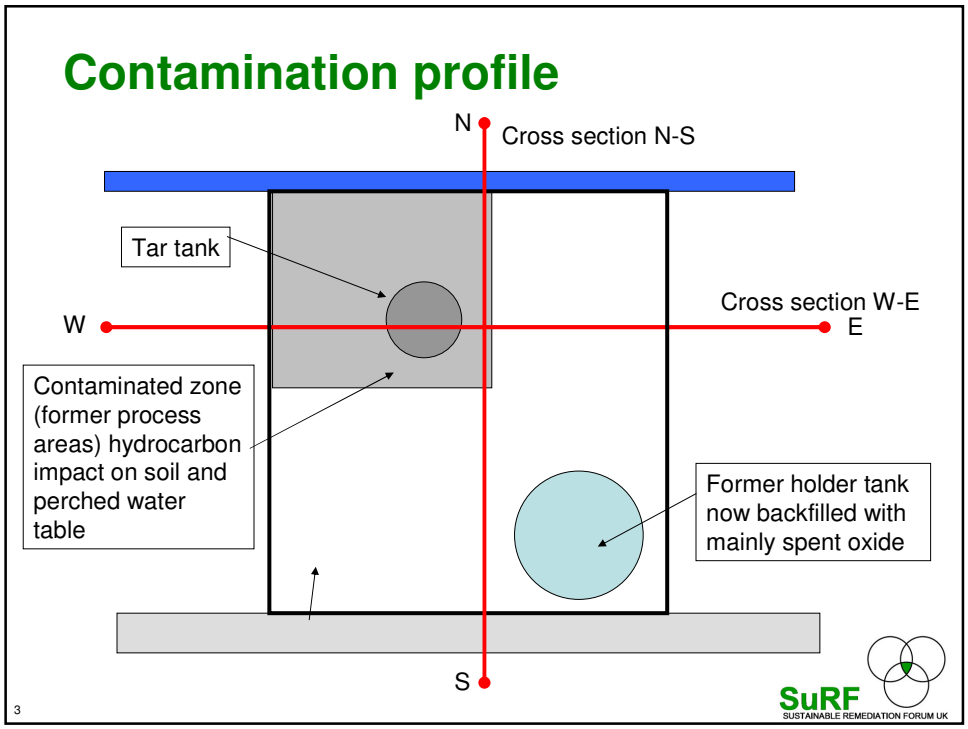
SuRF
SUSTAINABLE REMEDIATION FORUM UK

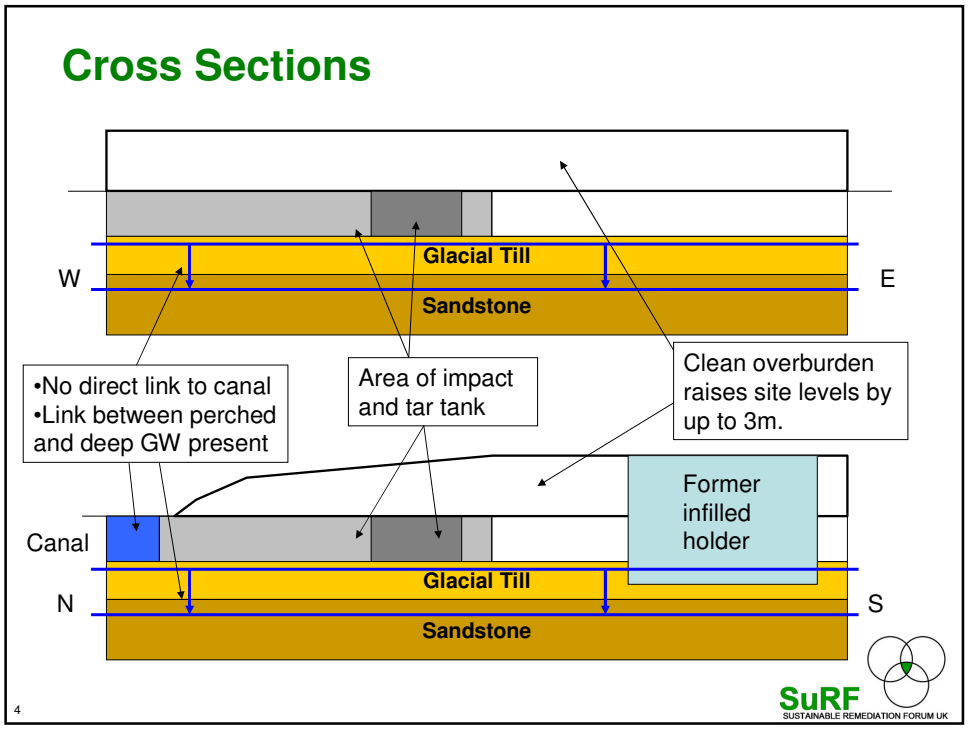
Site: Environmental setting



2

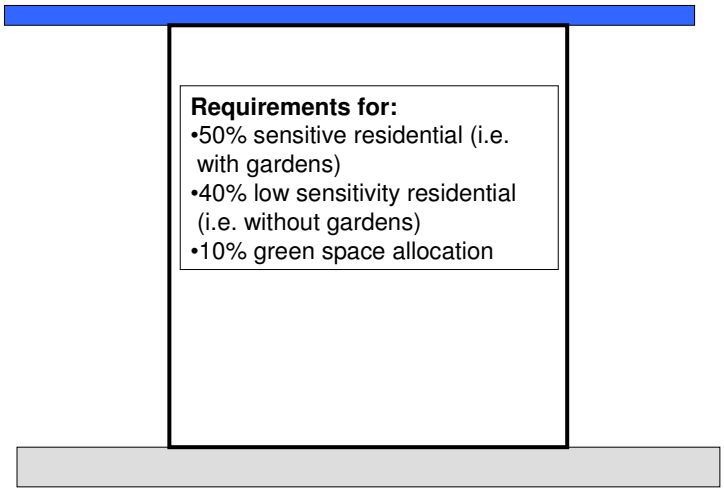
SuRF
SUSTAINABLE REMEDIATION FORUM UK





Group work
Developing a Sustainability Assessment on a Brownfield site

Development requirements:



5

SuRF SUSTAINABLE REMEDIATION FORUM UK

Remediation Design

- Opportunity to develop a sustainable remediation strategy – link to wider development opportunity
- Requirement for green space
- Consider overall site level – no set requirement to leave as existing
- Contamination source is c.8000 m^3:
  - 5500m^3 of spent oxide contaminated materials in former holder
  - 2500m^3 of hydrocarbon-impacted soils, free product and tank structures
- Clean overburden above former process areas – c.6000 m^3

6

SuRF SUSTAINABLE REMEDIATION FORUM UK

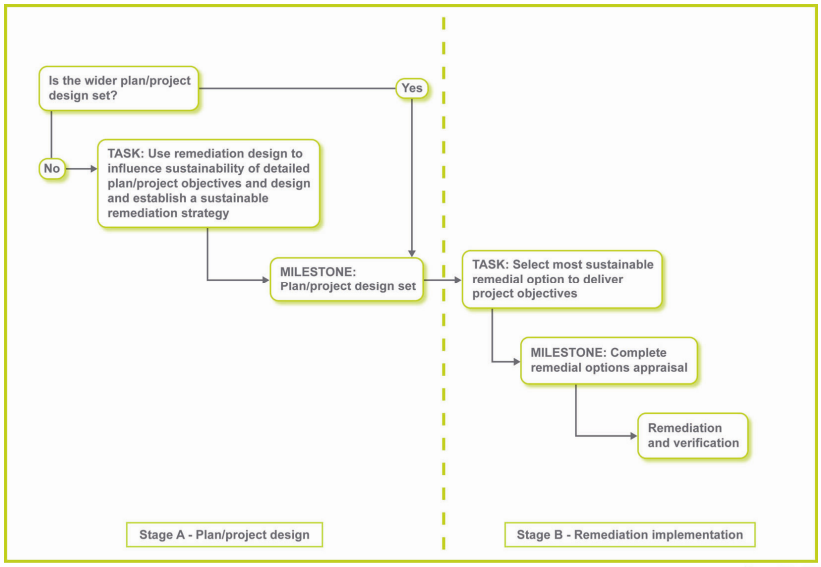
The Brief

- Remediate site to
  - A) remove environmental risk (i.e. all statutory risks)
  - B) allow sale for planned development
- Remediation needs to consider contamination held in structures – i.e. those that have the potential to cause a significant pollutant linkage if the structure is breached
- The remediation solution needs to be 'indefinitely durable' *(i.e. a solution that will ultimately not foreseeably require ongoing monitoring, control and maintenance)*
- Consider the options for remediation tied into the zoning of development supported by sustainability assessment

7

SuRF SUSTAINABLE REMEDIATION FORUM UK

Applying the SuRF-UK Framework (A)



8

SuRF SUSTAINABLE REMEDIATION FORUM UK

Group work
Developing a Sustainability Assessment on a Brownfield site

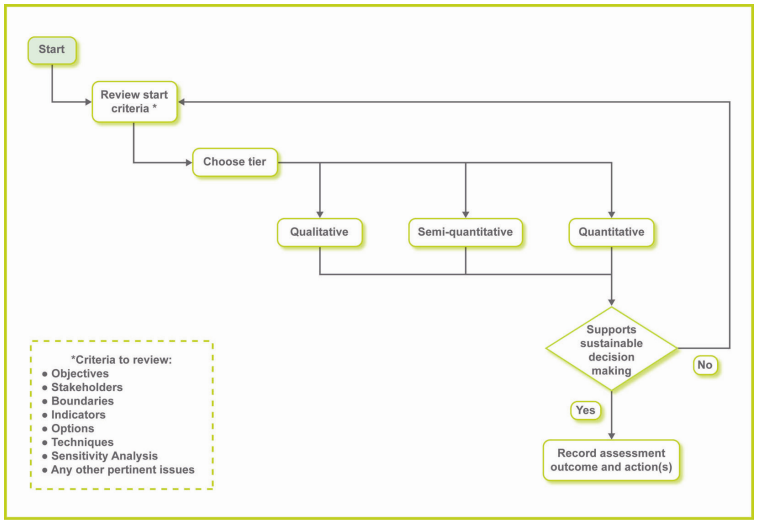
The assessment

- How do we approach sustainability assessment?
- What indicators are considered?

9

SuRF SUSTAINABLE REMEDIATION FORUM UK

SuRF-UK Framework for assessment



SuRF SUSTAINABLE REMEDIATION FORUM UK

Group work
Developing a Sustainability Assessment on a Brownfield site

Before Lunch – Exercise 1

- Split into 2 groups
  - Group 1:
    - Consider who are the relevant stakeholders and come up with a list of around 5 key technical and 5 key non-technical stakeholders
  - Group 2:
    - Consider initial remediation / development options appraisal and come up with 3-4
- Feedback from both groups

SuRF SUSTAINABLE REMEDIATION FORUM UK

Exercise 1 – Consider:

- Group 1:
  - Key stakeholders and their agendas
- Group 2:
  - High level options appraisal – treatment vs disposal options
  - Zoning of future land use based on areas of contamination
  - How overburden can be used

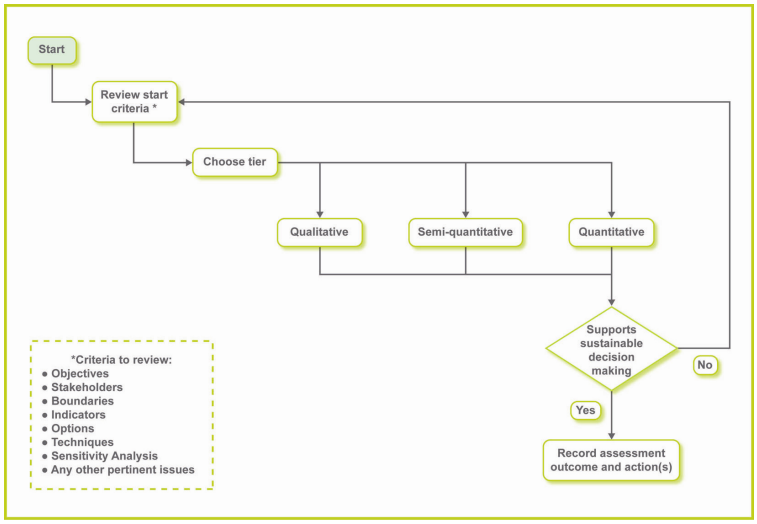
SuRF SUSTAINABLE REMEDIATION FORUM UK

The assessment

- How do we approach sustainability assessment?
- What indicators are considered?

SuRF SUSTAINABLE REMEDIATION FORUM UK

SuRF-UK Framework for assessment



SuRF SUSTAINABLE REMEDIATION FORUM UK

Group work
Developing a Sustainability Assessment on a Brownfield site

After lunch – Exercise 2

- Using stakeholders and options decided in Exercise 1 split into 3 groups to consider indicators:
- Group 1 – Environmental Indicators
- Group 2 – Social Indicators
- Group 3 – Economic Indicators

SuRF SUSTAINABLE REMEDIATION FORUM UK

Exercise 2 – Consider:

- Views for each stakeholder and associated scoring for each remediation option
- Client views have been given – just need to complete scoring
- Scoring rules:
  - No impact = 0
  - Short-term +ive impact = 1
  - Long-term +ive impact = 2
  - Short-term –ive impact = -1
  - Long-term –ive impact = -2

SuRF SUSTAINABLE REMEDIATION FORUM UK

Exercise 1 – Output Reporting-Stakeholders Feedback - Group 1 – Key Stakeholders:

	Technical		**Non-Technical**
1.	Clients Consultant	6.	Client
2.	Local Authority – Planning and Environmental Health Authority	7.	Adjacent Land Users
3.	SEPA/EA – Controlled Waters	8.	Utilities Companies
4.	British Waterways	9.	Developer
5.	Remediation Contractor	10.	Natural/Heritage Agencies
11.		16.	
12.		17.	
13.		18.	
14.		19.	
15.		20.	

Agendas of 10 key stakeholders:

Stakeholder	**Technical / non-technical**	**Agenda**
1.Clients Consultant	Technical	Reputation & Representing Client, Design Costs Optimisation, Maximise Profits, Project PI Insurance, Legal Compliance
2.Local Authority	Technical	LDF/LDP Compliance, Sustainable Development, Project Reputation/Liabilities, Minimise Risks (not Part 11A)
3.SEPA/EA	Technical	Sustainable Development, Project Water Resources, Compliance with Regs/Minimise Risks (Not Part 11A/WFD)
4.British Waterways	Technical	Structural Integrity of Canal, Project Users & Business (Fibre Optics)
5.Remediation Contractor	Technical	Feasible/Practical/Deliverable Option, Maximise Profits, Reputation, Project PI Insurance, Legal Compliance, Project Workers (H&S)
6.Client	Non-technical	Minimise Liability, Minimise Costs, Maximise Sales, Compliance with Legislation/CSR, Reputation
7.Adjacent Land Uses	Non-technical	Nuisance/Impact Neighbourhood, Create Health Risk, H & S Risk, Children Accessing Site, Affecting Business Operations
8.Utilities Companies	Non-technical	Can they supply capacity? Maximise Profits, Minimise risks, can they adaopt? Will it impact their work?
9.Developer	Non-technical	Minimise Costs, Maximise profit, develop desirable development, minimise risk/liability, reputation, minimise unknowns
10.Natural/Heritage Agencies	Non-technical	Ecological/Heritage issues

E**xercise 1 – Output Reporting-Options Feedback - Group 2 – Options:**

	Option
1.	1. Excavate Tar Tank; 2. Bioremediate Oily Soils; 3. Stabilise Spent Oxide; 4. MNA; 5. Reuse Overburden
2.	1. Excavate Tar Tank; 2. Thermal Desorption Oily Soils; 3. Stabilise Spent Oxide; 4. Pump and Treat Water; 5. Reuse Overburden
3.	1. Excavate & Dispose All Contaminated Soils/Tar; 2. Pump & Treat Water; 3. Reuse Overburden
4.	1. Stabilise Oily Soils/ Spent Oxide; 2. Dispose of the Tank; 3. MNA for Water; 4. Reuse Overburden
5.	
6.	
7.	
8.	

ZONE 1 – Open Space – Stabilise Areas, Clean Areas, Replace bioremediated soils
ZONE 2 – Residential Gardens – Clean Space
Zone 3 – Flats – Stabilised Areas, Encapsulated Areas, replace post thermally treated soils

Stakeholder / (+ive/-ive) Views	Direct economic costs and benefits	Indirect economic costs and benefits	Employment and employment capital	(Induced Economic Benefit) Gearing	Lifespan and project risks	Project flexibility
Example - (Stakeholder 1) Client	*Robust and durable solution that cost effectively remediates sources and maximises sale value.*	*Release of need to hold environmental provision. Minimal development abnormals to be deducted. Standard of job maintain corporate reputation.*	*Utilise local workforce and materials wherever possible*	*Utilise Cluster approach where possible. Consider zoning of development early to ensure appropriate remediation*	*Remedial solution is 'indefinitely durable' - ongoing monitoring is minimised. Contamination in structures is addressed as part of this*	*Measures to deal with additional contamination / delays are in place and risk register includes contingency to deal with them*
(Stakeholder 1) clients consultant_____	Robust and durable solution that cost effectively remediates sources and maximises sale value, plus consideration of method & involvement & H & S management	Reputation, insurance and warranty, cost of prosecution	local workforce, education	Cluster/follow on work	PI Liability, reputation	As client must set out project to include contingency
(Stakeholder 2) local authority_____	EHO - No	Reputation, litigation	local workforce, education, local spend	Cluster, local economic benefit	Reputation, litigation, long term liabilities	As client must set out project to include contingency
(Stakeholder 3) SEPA_____	Cost to be assessed against benefit. WASTE MINIMISATION	N/A	N/A	N/A	As above	As client must set out project to include contingency
(Stakeholder 4) British Waterways_____	N/A	Increased land values	N/A	Change value of their property	Risks to their propoerty	As client must set out project to include contingency
(Stakeholder 5) Remediation Contractor_____	Depends onscope assuming specialist contractor not owning landfill, more on site work.	Reputation, insurance warranty, prosecution	Workforce local to contractor unless dictated by client	Cluster, follow on work	Remediation failure, liability, reputation	As client must set out project to include contingency depending on contract
(Stakeholder 6) Client _____						
(Stakeholder 7) Neighbours _____	N/A	uplift in land value	workforce local	local economic benefit	Nuisance, subsidence, ongoing work, traffic	As client must set out to include contingency depending on contract
(Stakeholder 8) Utilities _____	N/A	capacity issues	N/A	N/A	Subsidence, residual contamination, services during remediation	As client must set out to include contingency depending on contract
(Stakeholder 9) Developer_____	Wants as much spent on site as possible	residual risk- environmental provision until houses are built	Local workforce	Enhanced local property values	Removal of all risks	Does not want residual risk
(Stakeholder 10) Natural Heritage_____	N/A	Legal Action	N/A	N/A	Long term liabilities	As client

	Direct economic costs and benefits				Indirect economic costs and benefits				Employment and employment capital				Gearing				Lifespan and project risks				Project flexibility			
Options	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Example - (Stakeholder 1) Client																								
(Stakeholder 1) _____	1	2	1	1																				
(Stakeholder 2) _____	1	1	2	1																				
(Stakeholder 3) _____	1	1	1	1																				
(Stakeholder 4) _____	0	0	0	0																				
(Stakeholder 5) _____	2	2	1	1																				
(Stakeholder 6) _____	0	0	0	0																				
(Stakeholder 7) _____	0	0	0	0																				
(Stakeholder 8) _____	0	0	0	0																				
(Stakeholder 9) _____	1	1	2	1																				
(Stakeholder 10) _____	0	0	0	0																				
Totals	6	7	7	5																				

	Grand Totals
(Option 1) _____	
(Option 2) _____	
(Option 3) _____	
(Option 4) _____	

Rules:
If no impact score = 0
If short term positive impact score = 1
If long term positive impact score = 2
If short term negative impact score = –1
If long term negative impact score = –2

ECONOMIC