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Analysis of the Economic, Environmental and Social Sustainability of Soil Remediation Technologies with AECOM's Sustainable Remediation Tool

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Delivering a better world

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Agenda

01 Why Sustainability Analysis

02 AECOM Sustainable Remediation Tool®

03 Case Studies

Scope of Work

- Economic, Environmental and Social Sustainability Analysis performed by implementing the AECOM *Sustainable Remediation Tool*® during the decision-making process of different technological solutions within Environmental Remediation Projects.

- introduce the use of the AECOM *Sustainable Remediation Tool*® as a Multi-Criteria Decision Analysis (MCDA) based on sustainability indicators, weights and measurement criteria to be performed as a sustainability assessment of different remedial technologies.

AECOM | ESG (Environmental, Social, Governance) Commitment

1. What is AECOM's Sustainable Legacies strategy?

Our Sustainable Legacies strategy encompasses how we are integrating ESG factors into everything we do.

2. What is AECOM doing to decarbonize?

SCOPE X ™
Incorporating an ESG action plan for reducing by least 50 percent on all major projects (our «ScopeXTM» service)

OPERATIONAL NET ZERO
by **2021**

SCIENCE BASED NET-ZERO
by **2030**, which includes:

BUSINESS TRAVEL EMISSIONS
50%
50 percent reduction in business travel emission by 2030, compared with 2018

VEHICLES AND ENERGY
Decarbonizing all fleet vehichles and switching to renewable energy tariffs

OFFSETTING
Offsetting residual carbon, including through creating our own nature-based solution projets

SUPPLY CHAIN
Developing carbon reduction targets in partnership with our supply chain

3. What is AECOM doing to increase social value and social impact?

PARTNERING WITH THE SME'S
Partering with small and medium-sized enterprises to deliver social value through community investment, positively impacting clients, communities and society

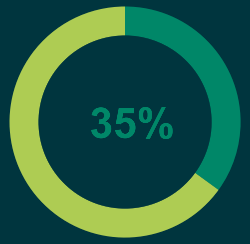
CAM TARGETS
Embedding net-zero, resilience, and social value targets into our client account management program and the work we bid for

MEASURING KEY IMPACTS
Measuring key impacts such as carbon emissions, climate resiliance and social value on major projects

4. What is AECOM doing to advance equity, diversity and inclusion?

SOCIAL EQUITY, DIVERSITY AND INCLUSION
Ensuring that our work with clients and communities promotes social equity, diversity and inclusion

DIVERSITY
Ensuring our project teams reflect the diversity of the clients and communities we serve



WOMEN IN SENIOR LEADERSHIP
We have set an industry-leading, near-term target of women comprising at least 20 percent of senior leadership roles and at least 35 percent of the overall workforce

5. What are we doing to enhance our governance to deliver sustainable legacies?

ASSESSING RISK
Developing and enterprise framework to assess ESG risk in potential projects

ACCOUNTABILITY AND ADVOCACY
To drive leadership accountability and advocacy thorugh specific ESG goals/metrics in annual goals.

TRACKING AND REPORTING
Tracking and reporting on ESG performance targets in line with leading industry benchmarks (i.e., Sustainability Accounting Standards Board [SASB] and Task Force on Climate-related Financial Disclosures [TCDF])

01

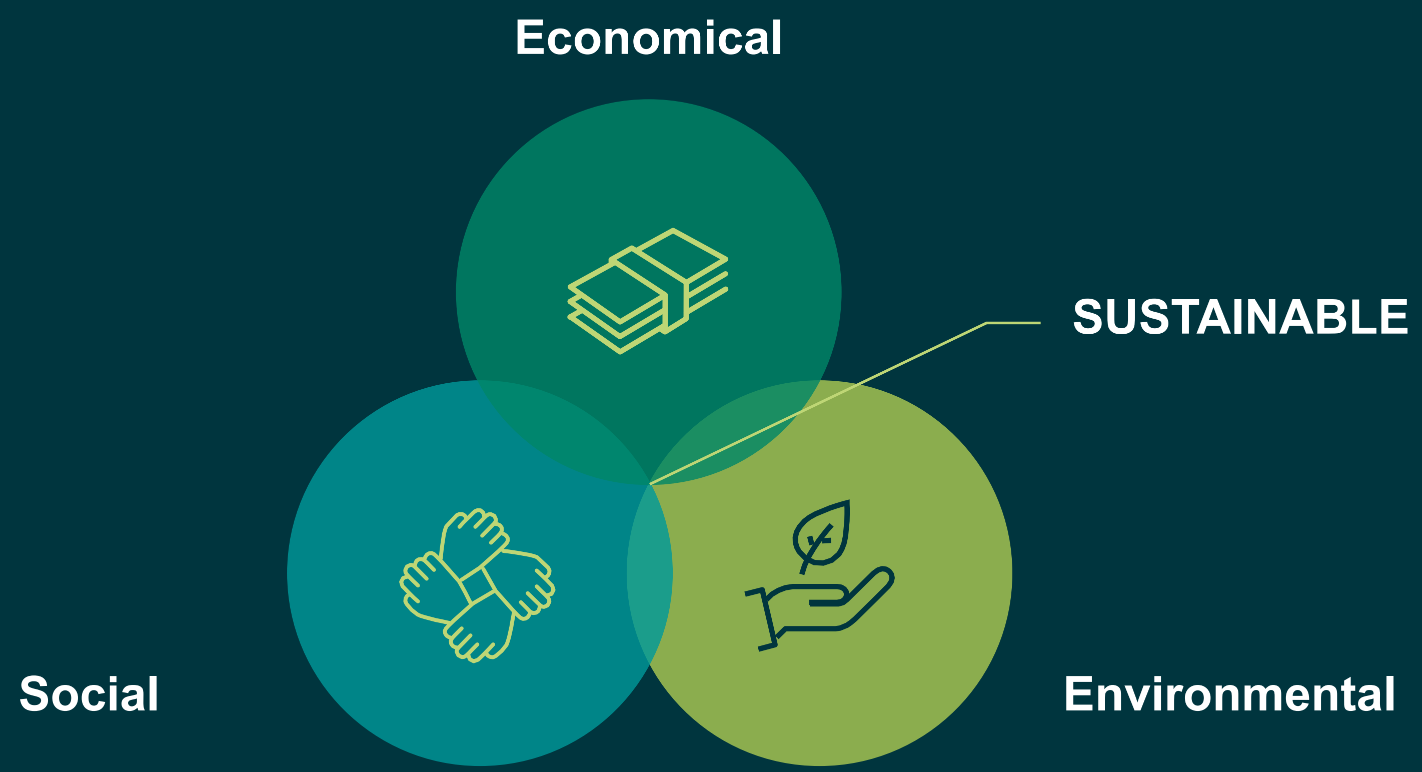
Why Sustainability Analysis

Goals of the Sustainability Analysis in Environmental Remediation
Why Sustainability Analysis in Environmental Remediation?
When Sustainability Analysis in Environmental Remediation?

Goals of the Sustainability Analysis in Environmental Remediation

“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”

Sustainable Remediation Forum in the UK (SuRF-UK)



Why Sustainability Analysis in Environmental Remediation?

Application of ESG policies:

- Awareness of the need for sustainable approaches, *proven through dedicated analysis*;
- Implementation and application of our clients' ESG policies.

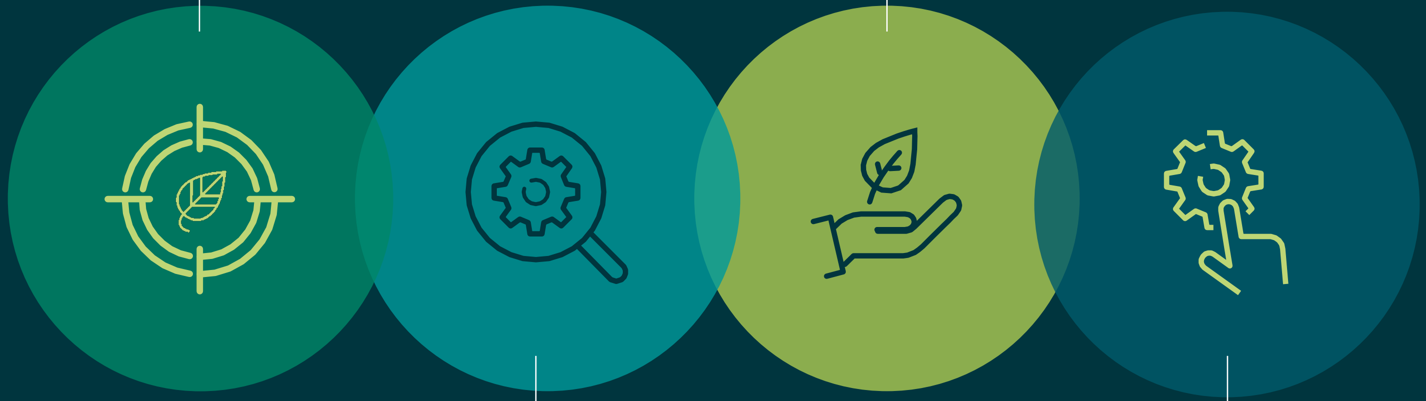
Application of National Guidelines :

- D.D. 137/2021: as part of remediation project design *“The assessment of the effectiveness of each technique, from the point of view of the achievement of objectives and relative environmental, economic and social sustainability […]”*.

When Sustainability Analysis of Environmental Remediation?

Remediation goals
The HHRA sets the site-specific remediation goals (CSR) for the different environmental media

Sustainability of solutions
Evaluation of the economic, environmental and social sustainability for each intervention scenario



Technologies definition
Combination of different technological solutions to achieve the HHRA objectives

Selection of technology
Selection of the best technological combination from an economic, environmental and social perspective

When Sustainability Analysis of Environmental Remediation?

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The HERRA sets the remediation goals (CSR) for the different environmental media

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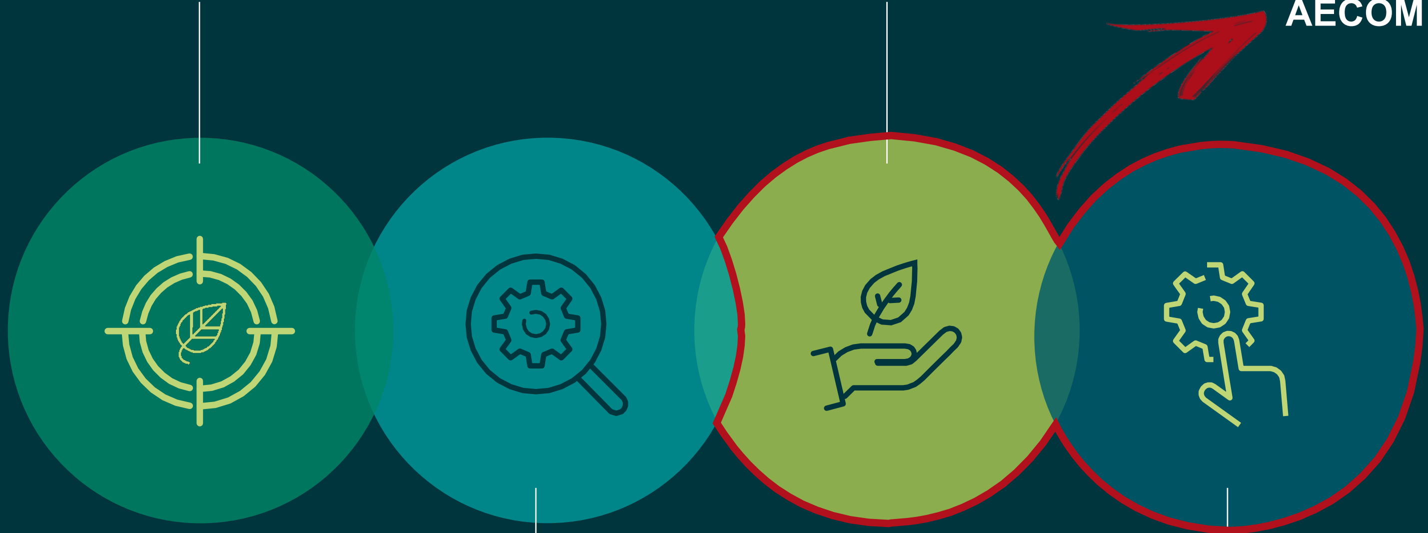
Evaluation of the economic, environmental and social sustainability for each intervention scenario

AECOM *Sustainable Remediation Tool*®



Technologies definition
Combination of different technological solutions to achieve the HERA objectives

Selection of technology
Selection of the best technological combination from an economic, environmental and social perspective

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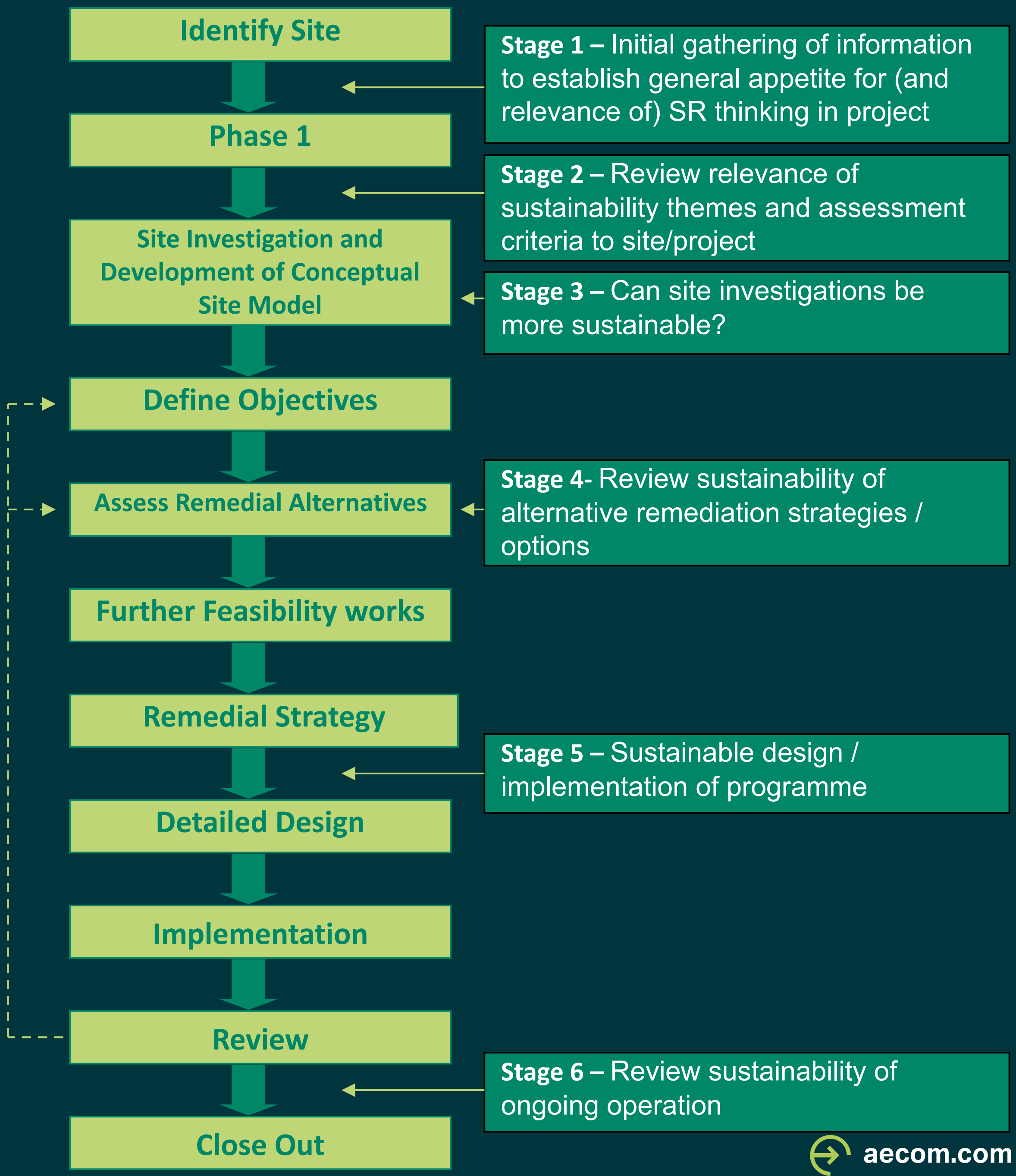
02

AECOM Sustainable Remediation Tool®

Why AECOM *Sustainable Remediation Tool*®
Aim of the tool
Tool description

Why AECOM *SRTool*®

- Allows the evaluation of the economic, environmental and social sustainability of different technological solutions identified for land or groundwater remediation to be assessed through a tiered analysis;
- Is versatile and can be applied in a timely manner to several and different remediation projects;
- Shows how assessing the sustainability of remediation significantly influences the selection of applicable technologies, **providing added value for a sustainable approach to remediation**;
- Applicable to the entire remediation process: from the design through implementation, to the verification of the achievement of the remediation objectives;
- Different levels of assessment complexity, from qualitative to quantitative;
- User friendly: contained within an xls sheet.



Scope of the Tool

1

To be able to **include** the most **sustainable** technologies within environmental remediation projects

2

Making the most **sustainable** solutions **relevant** when **selecting** the technology to be used

3

Formalising an **existing** process carried out during the *best practice* decision-making phase

Tool Description

Opportunity to engage different stakeholders (e.g. local authorities, ARPA, new owners, etc.) while assigning weight to each evaluation criteria

1

Stage 1
Gathering of relevant and sensitive information (e.g. Client's sustainability policies, stakeholders, business and project objectives, land use, etc.).

2

Stage 2
Initial review of the various sustainability issues (economic, environmental and social), **evaluation criteria and site/project indicators.**

3

Stage 3
Evaluation of the *best practices* for initial remedial activities.
How can implementation be more sustainable?

4

Stage 4
Qualitative analysis of technologies carried out by assigning a weight to the evaluation criteria based on and the score assigned to each technology for that criteria.

5

Stage 5
Identify actions to make the selected option more sustainable

6

Stage 6
Quantitative analysis: GHG evaluation.
The emissions can then be compared with the annual costs incurred in relation to the mass of contaminants removed.

Tool Description

1

Stage 1
Gathering of relevant and sensitive information (e.g. Client's sustainability policies, stakeholders, business and project objectives, land use, etc.).

GENERAL CLIENT SUSTAINABILITY POLICY QUESTIONS	Answer	Detailed Response
Does the client have a sustainability policy that must be adhered to?	Yes	
Does the client company have any sustainability targets that must be adhered to?	Yes	
Do the policy or targets influence the methods of site investigation or remediation that should be used?	Yes	
In the client's view, how relevant is sustainability in terms of the remediation method decision making process?	Relevant	
SITE SPECIFIC QUESTIONS		
Site Objectives		
Client business objectives		Bonifica dei suoli contaminati superficiali e profondi e della faldadel S
Is site to be redeveloped?	Yes	Destinazuone d'uso industriale
Remediation objectives		Obiettivi CSR per terreni superficiali e profondi, CSC ai POC
Is there scope to influence either business or specific remediation objectives based upon sustainability considerations?	No	
Stakeholders		
Are there multiple stakeholders	Yes	
Who are the stakeholders (name/body, role, potential influence on decision making process)		AA
Specific Site Conditions		
Is site located within sensitive environmental area (e.g. SSSI, coastal location)	No	
Is site located close to areas of sensitive residential and/or commercial properties	Yes	
Are there any other site factors relevant to sustainability assessment		No

The likely importance of sustainable remediation at this site is:	Important

Tool Description

			Explanations
Economic	Direct Economic Costs and Benefits	Direct financial benefits of remediation for organisation	-
		Consequences of capital and operation costs and sensitivity to alterations of: operations and ongoing monitoring	Will the cost of the works be negatively or positively affected if changes are made to operations and ongoing monitoring plans?
		Consequences of capital and operation costs and sensitivity to alterations of: Regulator costs	Will the cost of the works be negatively or positively affected if changes are made to regulator costs?
		Consequences of capital and operation costs and sensitivity to alterations of: Planning	Will the cost of the works be negatively or positively affected if changes are made to the lan use plans?
		Consequences of capital and operation costs and sensitivity to alterations of: Permit licences	Will the cost of the works be negatively or positively affected if changes are made to the permit licences?
		alterations of: Uplift in site value to facilitate future development or divestment	Will the works negatively or positively affect the price of the land, taking into account future development or land sale?
		Consequences of capital and operation costs and sensitivity to alterations of: Liability discharge	Will the cost of the works be negatively or positively affected by any changes in liability discharge?
	Indirect Economic Costs and Benefits	Long term or indirect costs and benefits: Financial debt	Will the works result in, or affect any financial debts held by the company?
		Long term or indirect costs and benefits: Allocation of financial resources internally	Will the works positively or negatively affect the allocation of financial resources internally?
		Long term or indirect costs and benefits: Changes in site / local land / property values	Could the works positively or negatively affect si / land / property values?
		Long term or indirect costs and benefits: Fines and punitive damages (following legal action so includes solicitor and technical costs during defence)	Is there potential for the works to reduce or increase the risk of having to pay fines or punitive damages?
		Long term or indirect costs and benefits: Financial consequences of impact on corporate reputation	Could the works enhance or damage the client's reputation?
		Long term or indirect costs and benefits: Consequences of an area's economic performance	Could the works enhance or damage the area's economic performance?)
		Long term or indirect costs and benefits: Tax implications	Are there any tax implications of carrying out the works vs. not carrying out the works?
	Employment and Employment Capital	Potential for creation of jobs (short term)	-
		Potential for creation of jobs (long term)	-
		Extent of improvement in skill level of client's employees during	-
		Extent of opportunities created for employee education and	-
		Innovation and new skills	What is the extent of opportunity for innovation and development of new skills for the client company as a result of remediation works?
	Induced economic costs and benefits	Extent of opportunity to create inward investment	-
		Extent of opportunity to make use of funding schemes	-
		Ability of the client to affect other projects in order to increase economic value	-
	Project Lifespan and Flexibility	Duration of the benefit of the remediation	Is the remediation method a short term fix or will i have long term benefits?
		Factors affecting the chances of success of the remediation works and issues that may affect works (incl. community, contractual, environmental, procurement, technological risks)	-
		discovery of additional contamination, different soil materials, different timescales)	-
		Ability to respond to changing regulation and its	-
		Robustness of solution to climate change effects	-
		Robustness of solution to altering economic circumstances	-
		Requirements for ongoing institutional controls	-

Impacts on Air	Greenhouse gases (CO_2, CH_4, N_2O)	Could the remediation works lead to increases (or decreases) in ...?
	NOx	
	SOx	
	Particulates	
	O_3	
	VOCs	
	Ozone depleting substances	
Soil and Ground Conditions	Soil quality (chemistry)	Could remediation positively or negatively effect...?
	Water filtration and purification processes	
	Soil structure (including organic matter content/quality)	
	Erosion and soil stability	
	Geotechnical properties	
	Compaction/other damage to soil structure	Could remediation result in compaction or any other damage to soil structure?
	Impacts on geological SSSIs and geoparks	Could remediation have an impact on a SSSI or geopark?
Groundwater and Surface Water	Release of contaminants (including nutrients)	Are there any circumstances in which remediation could affect groundwater or surface water in terms of...?
	Dissolved organic carbon or silt/particulates	
	Affect suitability of water for potable or other uses	Are there any circumstances in which remediation could affect the suitability of water for drinking or other uses?
	Water body status (under WFD) and other legislative water quality objectives	Could legislative water quality objectives be breached by remediation on the site?
	Biological function (aquatic ecosystems) and chemical function	Are there any circumstances in which remediation could affect groundwater or surface water in terms of...?
	Mobilisation of dissolved substances	
	Effects on water abstraction - lowering river levels, water table, potential acidification	Could the remediation have an effect on water abstraction (in terms of lowering water levels and acidification)?
Ecology	Direct consequences for flora (particularly protected species, biodiversity and impacts on SSSIs)	-
	Direct consequences for fauna (particularly protected species, biodiversity and impacts on SSSIs)	-
	Introduction of alien species	-
	Significant changes in ecological community structure or function	-
	Impacts of light on ecology	-
	Impacts of noise on ecology	-
	Impacts of vibrations in ecology	-
Natural Resources and Waste	Impacts on land	These need to be thought of in terms of the availability of natural resources and waste disposal as a result of the remediation works
	Impacts on waste resources (e.g. landfill space)	
	Use or recycled / reusable resources in stead of primary resources	
	Use of renewable energy / fuels	
	Potential to generate energy on site	
	Handling of materials on-site, off-site and waste disposal	
	Water abstraction, use and disposal	

Social	Human Health & Safety	Can unacceptable risks be mitigated?	-
		Extent of risks to site workers (from bioaerosols, allergens,	-
		Extent of risks to site neighbours (from bioaerosols, allergens,	-
		Extent of risk to the public (from bioaerosols, allergens, PM10,	-
		Extent of risk to site workers (from operating machinery, traffic movements, evacuations etc)	-
		Extent of risk to site neighbours (from operating machinery, traffic movements, evacuations etc)	-
		Extent of risk to the public (from operating machinery, traffic movements, evacuations etc)	-
	Ethics and Equality	Extent to which social justice and / or equality is addressed	-
		What is the duration of the remedial works and are there issues of intergenerational equity (extent to which the transfer of contamination impacts to future generations will be avoided)	-
		Is the "polluter paid" principle being upheld with regard to the distribution of impacts and benefits?	-
		Extent to which the works are disproportionate to, or more beneficial towards, certain groups	-
		To what extent will carrying out the remediation avoid transfer of contamination impacts to future generations	-
		Extent to which businesses involved are operating ethically (open procurement process etc)	-
		Does the treatment raise any ethical concerns to stakeholders (e.g. use of genetically modified organisms etc)	-
	Neighbourhood and Locality	Impacts on local community: Dust	-
		Impacts on local community: Light	-
		Impacts on local community: Noise	-
		Impacts on local community: Odour	-
		Impacts on local community: Vibrations	-
		Extent of potential for anti-social use of site	-
		Impacts on the local culture, vitality and built environment (architectural conservation, archaeological conservation)	-
	Communities and Community Involvement	Impacts of works on public access to: Commercial services	-
		Impacts of works on public access to: Residential services	-
		Impacts of works on public access to: Educational services	-
		Impacts of works on public access to: Leisure services	-
		Impacts of works on public access to: Amenities	-
		Extent of community involvement in decision making	-
		Transparency and involvement of the local community (directly or through representative bodies)	-
	Compliance, Uncertainty and Evidence	Compliance of the work with policies, regulatory standards and good practise set out by the local authority and nationally	All of these should be considered in terms of compliance, and not in terms of economic gain or loss.
		Compliance of the work with requests made by the community	
		Extent to which work is in line with industry working practices and expectations	
		Quality of investigation, assessment and plans for implementation of remediation process	
		Extent to which the remediation plans can cope with variation	
		Accuracy of record taking and data storage with regard to sustainability assessment	
		of remediation progress (including sustainability assessment) will be met	

2

Stage 2

Initial review of the various sustainability issues (economic, environmental and social), **evaluation criteria and site/project indicators.**

Tool Description

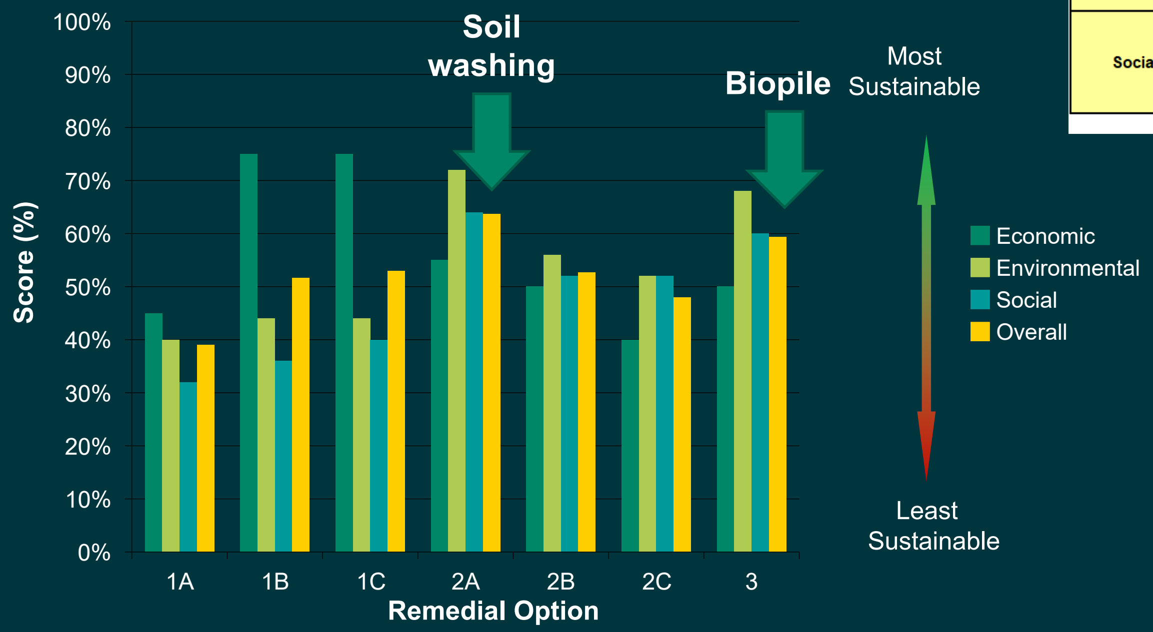
3

Evaluation of the *best practices* for initial remedial activities.
How can implementation be more sustainable?

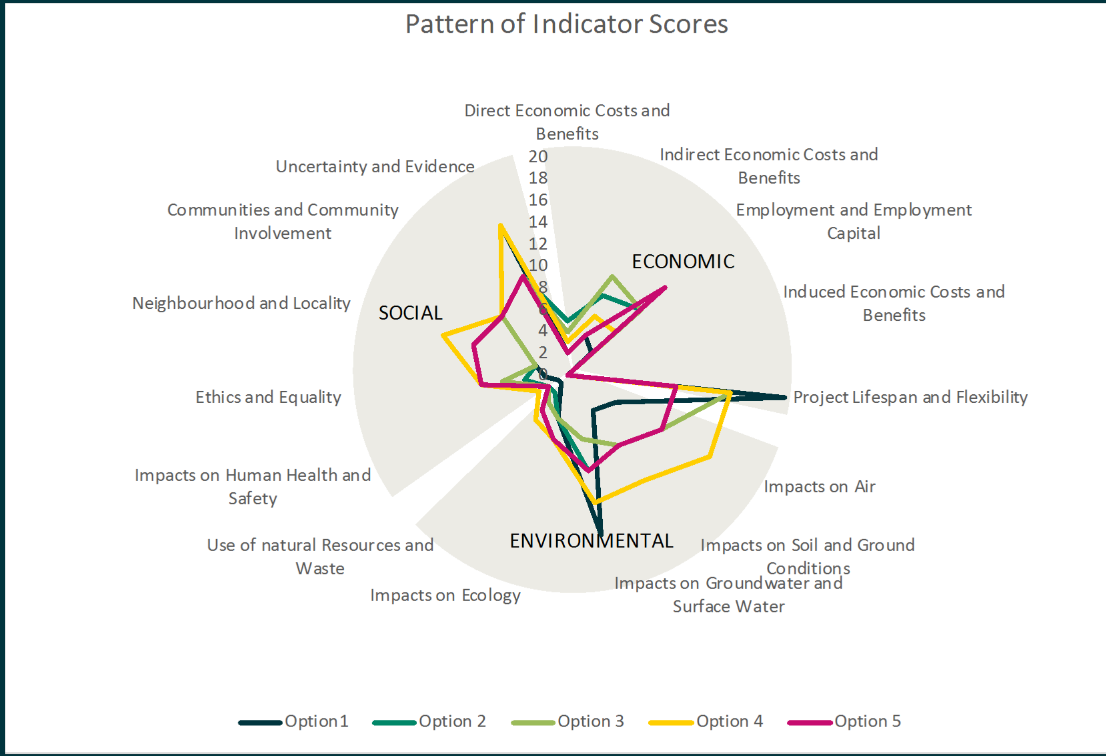
Considerations	Can this be applied to the site?				How can this action be carried out?	Relevant UK Indicator	Benefits	Challenges
	Overall	Economic (Y / N)	Environmental (Y / N)	Social (Y / N)				
Locate pre-design wells in locations that will be useful in subsequent remedy actions	Yes	Y	Y		Posizionamento ragionato di eventuali/ulteriori piezometri di monitoraggio effettuati durante la remedial	SuRF-UK	**Environmental:** Reduces vehicle emissions **Economic:** Reduces costs **Social:** Reduces traffic movement through the community	Some regulations may not permit on-site laboratories without early consensus from regulators.
Use published data rather than field collected data where possible	Yes	Y	Y		Per evitare pilot test rifarsi a case studies di altri siti	GRI Indicator EN5, 8, 18, 28, 29		
Screen samples in the field where possible, instead of sending to lab	No					SuRF-UK		
Make use of on-site or local laboratories, if permitted, where field screening is not possible	Yes	Y	Y	Y	Utilizzare laboratori locali certificati (qualora presenti) o i laboratori più vicini al Sito	SuRF-UK		
Use non-toxic hydraulic fluid in heavy equipment	Yes	Y	Y		Scegliere ditte specializzate all'avanguardia	GRI Indicator EN22, 24		
Use non-intrusive assessment techniques (e.g. GPR) in place of excavation or drilling	Not Applicable to Site					GRI Indicator EN5, 7, 18		
Use direct push rather than rotary drill for well installation	No				Presenza di substrato ciottoloso	SuRF-UK		
Select the most appropriate materials for well installation	Not Applicable to Site					SuRF-UK	**Environmental:** Reduces impacts of virgin material production. Reduces releases of harmful substances. **Social:** Reduces demand for virgin materials	Variances from traditional construction methods and materials may increase project costs.
Specify reusable equipment that can be decontaminated	Yes	Y	Y	Y	Pianificandolo anticipatamente con il Cliente	SuRF-UK		
Include recycled materials in specification and bid documents	Yes	Y	Y	Y	Pianificandolo anticipatamente con il Cliente	SuRF-UK		
Use phosphate-free detergents	Not Applicable to Site					GRI Indicator EN21		
Use soy-based inks, recycled paper, double-sided printing for report purposes	Not Applicable to Site					GRI Indicator EN1, EN2		
Obtain approval to submit deliverables electronically rather than on paper	Yes	Y	Y	Y	Prendendo accordi con Cliente	GRI Indicator EN1, 27		
Reduce or eliminate waste spoils generated during well installation	Not Applicable to Site					SuRF-UK	**Environmental/Economic:** Reduces waste required to be disposed of into	Non-traditional sampling
Use in-situ treatment technologies	Yes	Y	Y	Y	Premendo per una scelta in situ anzichè off-site	SuRF-UK		

Phase 4 | Output

Percentage of Maximum Score (without Weightings) for each Remedial Option



Assessment Criteria		Weight	1A	1B	1C	2A	2B			Justify your scores for each of the assessment criteria
			Remediation Option							
Economic	Direct Economic Costs and Benefits	5	2	5	4	3	2			
	Indirect Economic Costs and Benefits	3	2	4	5	3	2			
	Employment and Employment Capital	2	1	3	3	2	4			
	Induced Economic Costs and Benefits	0								
	Project Lifespan and Flexibility	3	4	3	3	3	2			
		TOTAL	9	15	15	11	10			
Environmental	Impacts on Air	5	1	2	2	3	2			
	Impacts on Soil and Ground Conditions	4	1	2	2	3	2			
	Impacts on Groundwater and Surface Water	4	5	3	2	4	3			
	Impacts on Ecology	2	2	2	2	3	3			
	Use of Natural Resources and Waste Generation	5	1	2	3	5	4			
		TOTAL	10	11	11	18	14			
Social	Impacts on Human Health and Safety	4	1	2	2	3	2			
	Ethics and Equality	4	1	2	3	4	4			
	Neighbourhood and Locality	3	1	1	1	4	3			
	Communities and Community Involvement	2	2	2	2	2	2			
	Compliance, Uncertainty and Evidence	4	3	2	2	3	2			
		TOTAL	8	9	10	16	13			



Evaluations may be updated during the lifetime of the project: after remedial investigation results, after laboratory or pilot tests

Tool Description

5

Stage 5

Identify actions to make the selected option more sustainable

Considerations	Can this be applied to the site?				How can this action be carried out?	Relevant UK Indicator	Benefits	Challenges
	Overall	Economic (Y / N)	Environmental (Y / N)	Social (Y / N)				
ptimise treatment								
Reduce waste generation	Yes					SURF-UK, GRI Indicator EN1, 21, 22, 24	**Environmental:** Reduces water use, energy consumption, waste sent to landfill, production impacts of virgin material **Economic:** Reduces cost of utility bills, increases operational efficiency **Social:** Reduces the use of natural resources, improves landfill longevity	Non-traditional materials may increase project costs and be difficult to source.
Reduce water discharge	Please Select					SURF-UK, GRI Indicator EN21		
Reduce the number of mobilisations	Please Select					SURF-UK, GRI Indicator EN16, 18, 20, SO1		
Use appropriately sized equipment	Please Select					SURF-UK, GRI Indicator EN29, SO1		
Identify opportunities to use recycled materials	Please Select					SURF-UK, GRI Indicator EN2		
Reuse materials on-site	Please Select					SURF-UK, GRI Indicator EN2		
Recycle wastes	Please Select					SURF-UK, GRI Indicator EN2		
Develop an adaptive design to reduce footprint, power and labour as remediation progresses	Please Select					SURF-UK		
inimise Impacts								
Minimise the loss of land function	Please Select					SURF-UK, GRI Indicator EN11	**Environmental:** Provides long term contamination control and reduces local discharge of contaminants **Social:** Integrates with future long term use	The size of the remediation site and other site users (including at-risk populations of protected wetlands) may dictate placement and staging areas. The benefits and costs of the alternative technology must be balanced against the advantages and disadvantages of the technology
Minimise the need for land restoration	Please Select					SURF-UK, GRI Indicator EN11, SO1		
Minimise the loss of aesthetic value	Please Select					SURF-UK, GRI Indicator EN11, SO1		
Minimise disruption to the community due to land use change	Please Select					SURF-UK, GRI Indicator EN11, SO1		
Optimise system design by moving to less energy intensive processes	Please Select					SURF-UK, GRI Indicator EN3, 4, 6, 7		
uture Use								
Match remediation objectives with future land use plans by identifying the future need early in the design process	Please Select					SURF-UK	**Economic/Social:** Maintains focus on future use and stakeholder expectations, promotes stronger local communities.	Long term use may not be established yet. Estimates of job creation can be difficult to obtain.
Consult local planning boards for estimates of job creation resulting from re-development	Please Select					SURF-UK, GRI Indicator SO1, LA1		
aterial Selection								

Tool Description

6

Stage 6
Carbon foot print calculator

Work Element	Units	Notes / Further details if applicable	Annual Quantity	Conversion Factor*	CO2e (kg) (=Annual Quantity*Conversion Factor)	Further Comments / Assumptions
Utilities						
Electricity Supply[1]	kWh			0,21233	0,00	
Municipal Water Supply[2]	m^3			0,00032	0,00	
Additional Utilities [3] (please list below)						
-	Please Select			tbc		
-	Please Select			tbc		
-	Please Select			tbc		
Manufacture of Consumables						
Activated Carbon Supply (Vapour Phase)[4]	kg	Please Select		0,00000	0,00	
Activated Carbon Supply (Aqueous Phase)[4]	kg	Please Select		0,00000	0,00	
Additional Consumables [5] (please list below)						
-	Please Select			tbc		
-	Please Select			tbc		
-	Please Select			tbc		
-	Please Select			tbc		
Waste Disposal						
Oil / Liquid Waste Disposal[6]	m^3			tbc		
Waste Water Disposal[7]	m^3			0,42000	0,00	
Solid Waste Disposal[8]	kg			0,62200	0,00	
Additional Waste Disposal [9] (please list below)						
Disposal of solid hazardous waste (to underground deposit)[9,4]	kg			0,18300	0,00	
-	Please Select			tbc		
-	Please Select			tbc		
Travel (for monitoring / maintenance visits)[10]						
AECOM	miles	Select Vehicle Type		tbc	0.00	NOTE: For Vans and HGVs, the CO2e value in column H should be calculated using the following formula: ***Annual quantity*tonnes transported*conversion factor***
Contractor	miles	Select Vehicle Type		tbc	0.00	
Lab couriers	miles	Select Vehicle Type		tbc	0.00	
Additional Travel (please list below)						
Equipment delivery	miles	Select Vehicle Type		tbc	0.00	NOTE: For Vans and HGVs, the CO2e value in column H should be calculated using the following formula: ***Annual quantity*tonnes**

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03

Case Studies

“Final remediation project for both the shallow and deep unsaturated soil and perched aquifer following D.Lgs. 152/2006” – Client Confidential

“Operational Safety Environmental Measures of the unsaturated soil object of to Health and Environmental Risk Assessment following the Ministrial Decree n.123, 2021” – Client Confidential

Case Study 1 | Final Remediation Project of a former Chemical Site

Environmental Framework

- ~ 3.600 m^3 of contaminated (Conc.>CSR) unsaturated shallow soil (0-1 mt b.g.l.);
- ~ 14.500 m^3 of contaminated (Conc.>CSR) unsaturated deep soil (1-5,5 mt b.g.l.);
- ~ 15.500 m^3 of contaminated (Conc.>CSR) saturated soil (shallow and perched acquifer, 5,5-8 mt b.g.l.);
- Confirmed contamination (Conc.>CSR) in the deep main aquifer.

Remedial actions to reduce contaminant migration from the unsaturated soil and shallow aquifer to the deep aquifer

Social, Environmental and Economic Concerns

- Dismantled Chemical Site;
- Redevelopment plan of the Site for industrial use;
- Municipality requires the fully restoration of the Site;
- The Site is located in an urban context (presence of neighbouring residential houses);
- The Site is close to an artificial channel used for agricultural and farming purposes.

Need to identify the most sustainable remediation strategy applicable to the Site

Case Study 1 | Final Remediation Project of a former Chemical Site

Social, Environmental and Economic Concerns

- Dismantled Chemical Site of about 70.000 km^2;
- Redevelopment plan of the Site for industrial use;
- Municipality requires the fully restoration of the Site;
- The Site is located in an urban context (presence of neighbouring residential houses);
- The Site is close to an artificial channel used for agricultural and farming purposes.

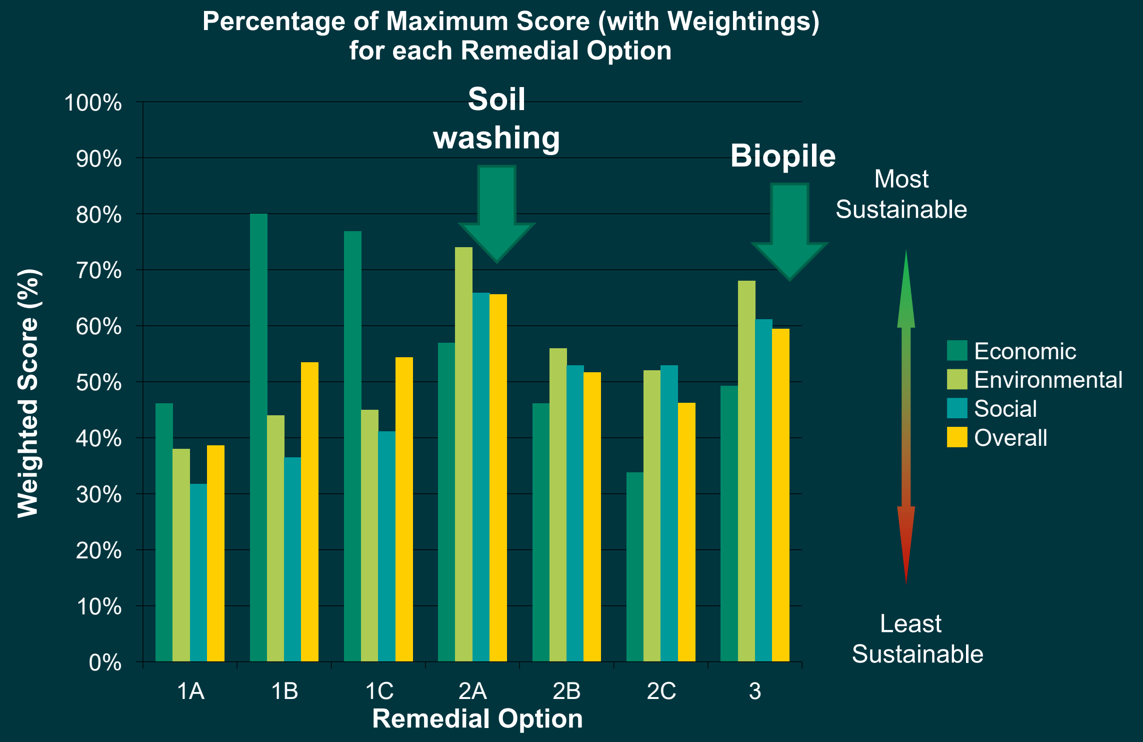
Weighting of the Assessment Criteria

Assessment		Weight
Economic	Direct Economic Costs and Benefits	5
	Indirect Economic Costs and Benefits	3
	Employment and Employment Capital	2
	Induced Economic Costs and Benefits	0
	Project Lifespan and Flexibility	3
		TOTAL
Environmental	Impacts on Air	5
	Impacts on Soil and Ground Conditions	4
	Impacts on Groundwater and Surface Water	4
	Impacts on Ecology	2
	Use of Natural Resources and Waste Generation	5
		TOTAL
Social	Impacts on Human Health and Safety	4
	Ethics and Equality	4
	Neighbourhood and Locality	3
	Communities and Community Involvement	2
	Compliance, Uncertainty and Evidence	4
		TOTAL

Case Study 1 | Final Remediation Project of a former Chemical Site

The sustainability analysis was performed on 7 different scenarios, corresponding to different combinations and applications of one or more remediation technologies for the remediation of both shallow and deep unsaturated soil, and perched aquifer.

Num. Technology	Scenarios and technologies description
1A	Off-site dig and disposal (shallow, deep unsaturated and saturated soil)
1B	Off-site dig and disposal (shallow, deep unsaturated) + Soil Mixing / ISCO or ISS for saturated soils
1C	Off-site dig and disposal (shallow, deep unsaturated up to 4m depth), Soil Mixing / ISCO or ISS for unsaturated and saturated soils from 4 to 8m depth
2A	On-site dig and treat with Soil Washing (shallow, deep unsaturated and saturated)
2B	On-site dig and treat with Soil Washing (shallow, deep unsaturated) + Soil Mixing / ISCO or ISS for saturated soils
2C	Dig and on-site treatment with Soil Washing (shallow, deep unsaturated up to 4m depth), Soil Mixing / ISCO or ISS for unsaturated and saturated soils from 4 to 8m depth
3	Dig and on-site treatment with Biopile (shallow, deep unsaturated) + Soil Mixing + ISCO or ISS for saturated soils



Case Study 2 | Operational Safety Environmental Measures (MISO) of an operating Refinery

Environmental Framework

- ~ 175.000 m^2 of contaminated (Conc.>CSR) area;
- ~ 98.000 m^2 of contaminated area accessible for the MISO actions;
- MISO target: 278.000 m^3 of contaminated unsaturated soil.

Project goal: mitigation of the contamination prior the final the remediation project, wich follow the decommissioning of the area

Social, Environmental and Economic Concerns

- Part of the site is located in a natural reserve area;
- Presence of native plant (''*Macchia Mediterranea*'') and species;
- Site located close to the sea and close to the city.

Need to identify the most sustainable remediation strategy applicable to the Site

Case Study 2 | Operational Safety Environmental Measures (MISO) of an operating Refinery

Social, Environmental and Economic Concerns

- Part of the site is located in a natural reserve area;
- Presence of native plant (''*Macchia Mediterranea*'') and species;
- Site located close to the sea and close to the city.

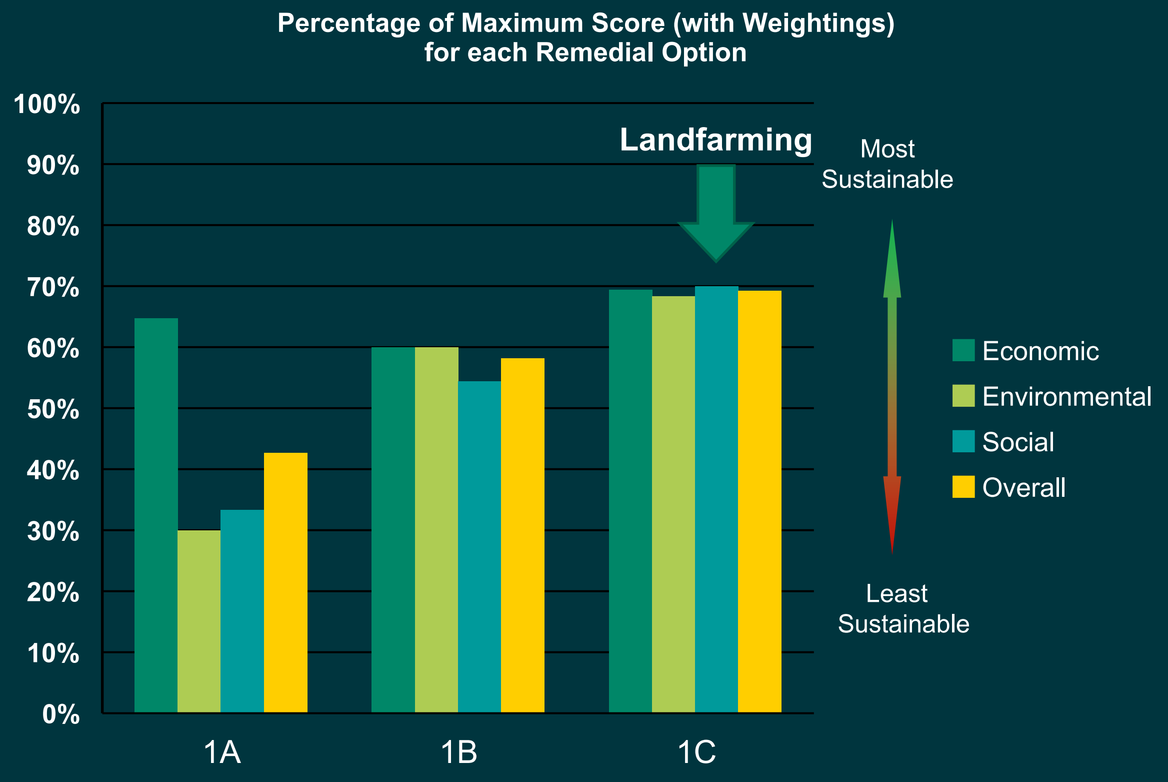
Weighting of the Assessment Criteria

Assessment		Weight
Economic	Direct Economic Costs and Benefits	4
	Indirect Economic Costs and Benefits	4
	Employment and Employment Capital	3
	Induced Economic Costs and Benefits	2
	Project Lifespan and Flexibility	4
		TOTAL
Environmental	Impacts on Air	5
	Impacts on Soil and Ground Conditions	5
	Impacts on Groundwater and Surface Water	4
	Impacts on Ecology	5
	Use of Natural Resources and Waste Generation	5
		TOTAL
Social	Impacts on Human Health and Safety	5
	Ethics and Equality	4
	Neighbourhood and Locality	3
	Communities and Community Involvement	2
	Compliance, Uncertainty and Evidence	4
		TOTAL

Case Study 2 | Operational Safety Environmental Measures (MISO) of an operating Refinery

The sustainability analysis was performed on 3 different scenarios, corresponding to different combinations and applications of one or more remediation technologies for the remediation of the unsatured shallow soil.

Num. Technology	Scenarios and technologies description
1A	Off-site dig and disposal (on all areas up to saturated soil)
1B	Off-site dig and disposal (in localized areas and up to saturated soil) + capping (HDPE+concrete slab)+ MPE/SVE/Bioventing
1C	Off-site dig and disposal (in localized areas and up to saturated soil) + on-site treatment (Landfarmig) + waterproof sealing + MPE/SVE/Bioventing



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