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SUSTAINABLE REMEDIATION FORUM UK

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A Framework for Assessing the Sustainability of Soil and Groundwater Remediation

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CONTAMINATED LAND: APPLICATIONS IN REAL ENVIRONMENTS

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A Framework for Assessing the Sustainability of Soil and Groundwater Remediation

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A Framework for Assessing the Sustainability of Land and Groundwater Remediation

Sustainable Remediation Forum-UK (SuRF-UK)

September 2009

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Executive Summary

This document presents a framework for assessing the sustainability of soil and groundwater remediation, and for incorporating sustainable development criteria in land contamination management strategies.

Sustainable remediation is defined by SuRF-UK as 'the practice of demonstrating, in terms of **environmental**, **economic** and **social** indicators, that an acceptable balance exists between the effects of undertaking remediation activities and the benefits that those activities deliver'. The SuRF-UK framework recognises two main stages where sustainable remediation decision-making is applied: Firstly at the project/plan design stage when some of the most influential decisions about the remediation solution can be embedded into a wider sustainable project design; and secondly at the point of remediation selection and implementation when the decision is about selecting the optimum remedial strategy or technique.

This document is the first to provide a framework for assessing the sustainability of soil and groundwater remediation in the UK. While legislation and good practice guidance have encouraged remediation to contribute to sustainable development goals, no formal and authorative framework has previously been published to guide such an assessment. This document, which was drafted by a team comprising regulators, industry, consultants and CL:AIRE, provides assessors with a means to undertake a sustainability assessment of remediation, and to ensure that the remediation industry can directly and measurably contribute toward sustainable development goals.

The framework described in this document complements existing UK good practice guidance, such as the *Model Procedures for the Management of Land Contamination* - but is sufficiently generic to be applied elsewhere and under different regulatory systems. SuRF-UK hopes that its publication and use will lead to more sustainable remediation practice in the UK and elsewhere.

1. Introduction

1.1 Purpose and objectives of the document

This document presents a framework for managing land and groundwater contamination in a manner compatible with sustainable development principles. It has been developed to help assessors take account of relevant sustainable development criteria in selecting the optimum land-use design, determining remedial objectives for contaminated land and groundwater, and in selecting an optimum remediation strategy and technique.

The SuRF-UK framework identifies two fundamental stages at which sustainability can be considered: Firstly plan/project design stage and, secondly, remediation implementation. The framework is flexible so that it can be applied to various decision-making scenarios within a property lifecycle and for different sizes of project or site.

The framework is sufficiently generic that it can be applied to remediation decision-making within any regulatory system. However, in a UK context it has been drafted so it can be applied within planning and contaminated land legislation within England, Wales, Scotland and Northern Ireland, and alongside the UK Government's recommended approach to the assessment and management of land contamination, set out in the Model Procedures for the Management of Land Contamination (CLR11) (Environment Agency & DEFRA, 2004). At the simplest tier a sustainability assessment should require only limited additional effort.

This document has been developed by the Sustainable Remediation Forum-UK (SuRF-UK) under the co-ordination of CL:AIRE and with funding from the Homes and Communities Agency (HCA). It has been subject to wide remediation industry and regulator consultation. The framework presented is intended to be a voluntary initiative, but one that has regulator support. It is hoped that publication and use of this framework will lead to more sustainable land and groundwater remediation in the UK and elsewhere.

This document is the first product of an on-going initiative co-ordinated by CL:AIRE, which will involve further research and guidance development.

1.2 Target audience

The intended audience for this document includes anybody who is involved with, or affected by, the selection, design, implementation and monitoring of soil and groundwater remediation strategies or schemes, including site-owners and their consultants, remediation contractors, planners, environmental regulators, and other interested parties, such as site neighbours and local residents.

The document describes anybody who is involved in the process of evaluating the sustainability of remediation options as a 'assessor'.

1.3 Report structure

The report is structured as follows:

- Chapter 1 - Overview and introduction to sustainable development and remediation;

- Chapter 2 - Legislative and regulatory context in the UK, setting out when sustainable remediation assessment may be applied in regulatory processes;

- Chapter 3 - The SuRF-UK framework for assessing sustainability of soil and groundwater remediation – what the framework looks like;

- Chapter 4 - Applying the SuRF-UK framework. How to assess sustainability of remediation options;

- Chapter 5 - Recording decision. Describes the importance of ensuring the process, assumptions and decisions are documented;

- Chapter 6 – Brief overview of other international sustainable remediation initiatives;

- Glossary and references; and

- Appendices – Giving examples of sustainable remediation assessments to illustrate the text in main document.

1.4 Overview of sustainable development

Sustainable remediation forms one part of a much broader sustainable development agenda. Sustainable development was defined by the World Commission on Environment and Development (1987), (commonly known as 'the Brundtland Commission'), and is concerned with the optimisation of environmental, social and economic benefits in human activities. This framework takes its definition of sustainable development from 'the Brundtland report', which is "*development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs*". This definition forms the basis for much of the UK government's policy on sustainable development (Her Majesty's Government et al. 2005) and is commonly interpreted as those actions that, taking account of environmental, social and economic factors, optimise the overall benefit (Figure 1.1).

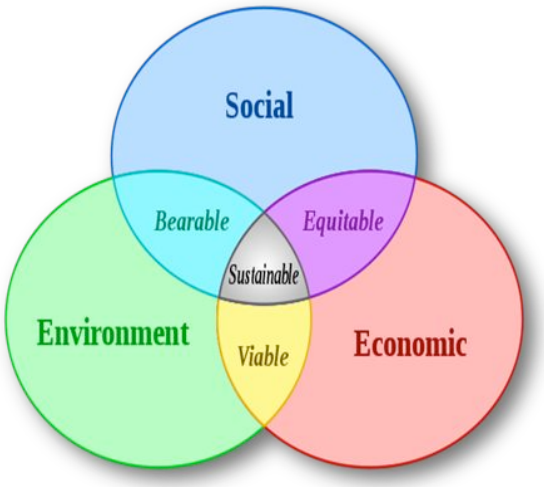

Figure 1.1: Sustainable development is a balance between environmental, social and economic factors

Sustainable development appraisals are commonly undertaken for large and extensive (in spatial and temporal scale) developments. Remediation activities are often just one component of a wider redevelopment project, but one that is commonly overlooked during initial planning and sustainable development appraisals. SuRF-UK believes that consideration of remediation issues alongside other relevant factors in wider sustainable development appraisals will result in projects that are 'better by design'. The framework is based on current practice regarding sustainability assessments (i.e., after the principles set out in the Brundtland report), however more recent concepts, such as assessment and protection of ecosystem goods and services, and consideration of environmental capacity and resilience provide complimentary concepts that may need to be considered.

1.5 Role of remediation within sustainable development

The three elements of sustainable development (environment; society; economy) can be considered when assessing the likely benefits of undertaking any scheme, including remediation. Remediation is defined here as actions to assess or break a source-pathway-receptor linkage and thereby manage risks associated with the presence of contaminants in the environment.

The overall significance of soil and groundwater remediation to the sustainability of a scheme can vary depending on its relative contribution to an overall project. The earliest influence on the property lifecycle considered in this framework is regional spatial planning. At this stage remediation-related considerations are only one small component of a spatial strategy for a region. For example, demographics, flood-risk and transport are also factors. Therefore the impact of sustainable remediation decisions may have a relatively minor impact on the sustainability of a scheme. At this stage it must be recognised that on occasions decisions will be made that appear to be non-optimum with regard to remediation because other factors are more influential in optimising the overall (environmental, social and economic) benefits of a scheme. The framework does,

however, allow reconsideration of overarching project principles and objectives through a feedback loop in instances where non-optimum remediation would result.

At a site-specific level, such as a brownfield redevelopment, the remediation process becomes more significant in the overall project sustainability, and during the remediation of operational land (i.e. where there is no change of use proposed) the sustainability of the remediation defines the project sustainability.

2. Legislative and regulatory context in the UK

The UK approach to the management of historic land and groundwater contamination is founded on a risk-based 'suitable-for-use' philosophy. Two principal regulatory regimes apply to land contamination: the Planning regime and the Contaminated Land regime, as set out for each country in Table 2.1.

Table 2.1: Planning and contaminated land legislation in parts of the UK

Country	Planning legislation	Contaminated land legislation
England	• Town and Country Planning Act 1990 (as amended) • Planning and Compulsory Purchase Act 2004	• Environmental Protection Act 1990, Part 2A • The Contaminated Land (England) Regulations 2000 (SI 2000, No 227) • The Contaminated Land (England) Regulations 2006 (SI 2006, No 1380)
Wales	• Town and Country Planning Act 1990 (as amended) • Planning and Compulsory Purchase Act 2004	• Environmental Protection Act 1990, Part 2A • The Contaminated Land (Wales) Regulations 2001 (Welsh SI 2001, No 2197) • The Contaminated Land (Wales) Regulations 2006 (Welsh SI 2006, No 2989)
Scotland	• Town and Country Planning (Scotland) Act 1997 (as amended) • Planning and Compulsory Purchase Act 2004	• The Contaminated Land (Scotland) Regulations 2000 (Scottish SI 2000, No 178) • The Contaminated Land (Scotland) Regulations 2005 (Scottish SI 2005, No 658)
Northern Ireland	• Planning (Northern Ireland) Order 1991	• Waste and Contaminated Land (Northern Ireland) Order 1997, Part 3 • The Contaminated Land (Northern Ireland) Regulations (DRAFT)

In each case remediation requirements should remove unacceptable risks to human health and the environment, and should contribute to broader sustainable development goals. The key legislation that supports or drives a sustainable approach to remediation of land and groundwater in the UK is summarised below:

2.1 Planning regime

Planning Policy Statements 1 (PPS1) and 23 (PPS23) apply in England and cover requirements for sustainable development and dealing with contamination through the planning system.

PPS1, which provides statutory guidance for the Town and Country Planning process on 'delivering sustainable development' states that *"sustainable development is the core principle underpinning [land-use] planning"* and that *"planning should…promote sustainable patterns of … development"* (ODPM 2005a). PPS1 applies, in England, to the whole planning process, for which remediation activity is one small contributory part.

PPS23, Annex 2, on the 'development of land affected by contamination' (in England) states that consideration of *"... contamination issues can help in locating development that is less sensitive to contamination on areas where the contaminated state of land is … more difficult to address"* and that planning authorities should *"take into account issues of sustainability … which might arise from the contamination."* (ODPM 2004).

In Wales, sustainable development principles are embedded in the planning system through Planning Policy Wales (WAG 2002), which responds to the duty imposed on Welsh Ministers to promote sustainable development under the Government of Wales Act 2006. Similar principles are enshrined in Scotland by the Planning Policy Scotland (The Scottish Government, 2008) and in Northern Ireland by Northern Ireland Planning Policy Statement 1 (NIPS, 1998).

2.2 Contaminated land regime

The contaminated land regimes (Table 2.1) require local authorities to identify and designate contaminated land in their areas. Remediation Notices must be served by local authorities and/or the environment agencies on the appropriate persons who are responsible for the contaminated land, and requires that remediation is 'reasonable', which includes an assessment of the costs and benefits.

2.3 Other relevant duties on the environment agencies to consider sustainable development

Section 4 of the Environment Act 1995 requires each of the environment agencies to 'contribute to the goal of achieving sustainable development' in undertaking its activities.

Section 39 of the Environment Act 1995 requires each of the environment agencies to take account of the likely costs and benefits in deciding whether and how to exercise its statutory powers (e.g. by serving a notice to require remediation under the Anti-pollution Works Regulations 1999).

2.4 Technical guidance on land and groundwater remediation

Overarching technical guidance on managing risks at sites affected by land contamination is provided in Contaminated Land Report 11: Model procedures for the management of land contamination (CLR11, EA & Defra, 2004). CLR11 already makes reference to the need for sustainable remediation (Figure 2.1). The SuRF-UK framework for assessing sustainable remediation has been designed to fit within and complement

the tiered approach to risk-assessment and management described in CLR11. Key assessment points lie within the existing CLR11 'risk-assessment', 'options appraisal' and 'implementation' tiers as described in Chapter 4. In addition, the SuRF-UK framework provides a means of taking sustainability into account when comparing different land uses for brownfields, based on the wider impacts and benefits of their consequent risk management requirements.

The SuRF-UK framework also extends into wider considerations not explicitly considered in CLR 11 that relate to integration of remediation with non-risk based aspects of project design. These include, for example, whether efficiencies can be gained by integrating remediation with wider sustainable development intentions, such as:

- Construction and remediation processes for waste minimisation purposes;
- Integration of a remediation scheme with renewable energy such as ground source heating and cooling;
- Linkage of remediation work with sustainable drainage and flood protection measures.

These are not intended to be prescriptive examples, but rather to illustrate the wide scope of possibilities that might be made possible by taking a more holistic overall project design approach.

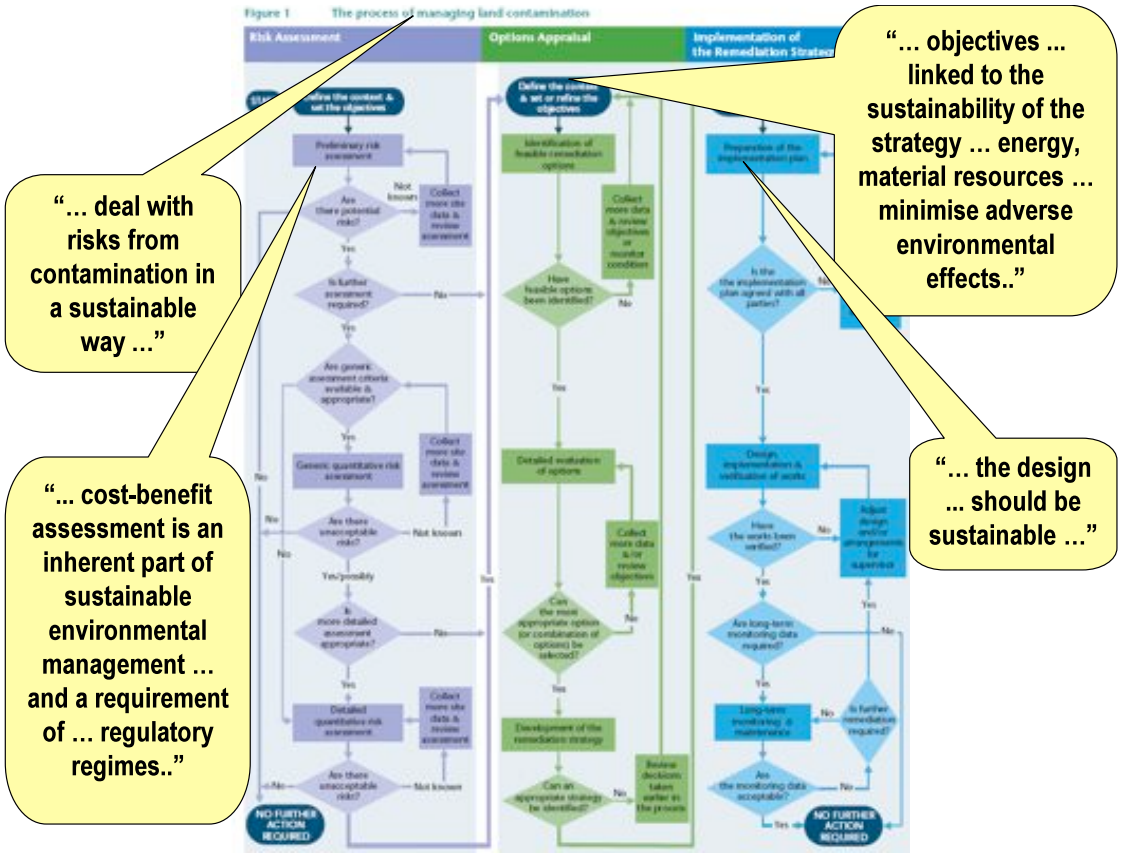

Figure 2.1: SuRF-UK sustainable remediation assessment is aligned to the CLR11 framework

Furthermore the Environment Agency's guidance on assessing risks to the water environment from land contamination (EA 2006a) describes a framework that seeks to establish risk-based remedial goals that are achievable, reasonable, and which takes into account the relative costs and resources needed to meet those goals and the environmental benefits provided. These principles sit within overarching policies on protection and remediation of contaminated sites and the water environment (DoE-NI 2006; EA 2006b; Scottish Executive 2006; SEPA 1997, Welsh Local Government Association et al. 2006).

The techniques that are identified for assessing the sustainability of different remedial strategies and technologies also draw on existing published guidance, including Environment Agency research and development reports on assessing the costs and benefits of land remediation (EA, 1999a), groundwater remediation (1999b, 2000a, 2001), and the wider environmental benefits of remediation (EA, 2000b). The SuRF-UK framework, therefore, draws on existing methods with the aim to develop a robust and streamlined framework for assessing sustainable remediation that is compliant with legislative requirements, complementary to current UK good practice (CLR11), practicable to implement, and will achieve industry-wide acceptance including, critically, by the relevant regulatory authorities.

3. The SuRF-UK framework for sustainable remediation

3.1 Introduction and definition of sustainable remediation

SuRF-UK was established in 2007, under the co-ordination of CL:AIRE, to develop a framework for taking account of sustainable development principles in land and groundwater remediation. The goal of SuRF-UK was to 'develop a framework to embed balanced decision-making in the selection of a remediation strategy to address land contamination, as an integral part of sustainable development', and the framework presented is the output of the first phase of work. During the SuRF-UK meetings it became clear that there were a wide range of views and expectations of sustainable remediation, from a strategic framework to a technology-specific accreditation scheme. This document sets out the consensus achieved during the SuRF-UK fora on where sustainability issues should be considered in land contamination risk-management decisions.

The SuRF-UK framework has been developed to complement existing good practice guidance (e.g. Planning Policy Statements; CLR11) and to be suitable for use under the range of regulatory regimes in the UK. It is sufficiently generic for use in other situations where assessment of sustainability (or simply costs and benefits) associated with remediation is required. Although drafted for a UK regulatory frame, it may have application in a wider European or international context.

Sustainable remediation is defined by SuRF-UK as the practice of demonstrating, in terms of environmental, economic and social indicators, that an acceptable balance exists between the effects of undertaking remediation activities and the benefits that those activities will deliver.

3.2 Key principles of sustainable remediation

SuRF-UK identify a number of key principles that are associated with sustainable remediation, and which should be considered by assessors in the design, implementation and reporting of sustainable remediation schemes. These are:

Principle 1: Protection of human health and the wider environment. Remediation should remove unacceptable risks to human health and the environment, and give due consideration to the costs, benefits and technical feasibility.

Principle 2: Safe working practices. Remediation works should be safe for workers on-site, local communities and the environment.

Principle 3: Consistent, clear and reproducible evidence-based decision-making. Sustainable remediation decisions are made having regard to environmental, social and economic factors, and to current and future implications. A sustainable remediation solution optimises the benefits achieved[2].

Principle 4: Record keeping and transparent reporting. Remediation decisions, including the assumptions and supporting data used to reach them, should be documented in a clear and easily understood format in order to demonstrate to interested parties that a sustainable (or otherwise) solution has been adopted.

Principle 5: Good governance and stakeholder involvement. Remediation decisions should be made having regard to the views of stakeholders and following a clear process that they can participate in.

Principle 6: Sound science. Decisions should be made on the basis of sound science, relevant and accurate data, and clearly explained assumptions. This will ensure that decisions are based upon the best available information and are justifiable and reproducible.

3.3 The structure of the SuRF-UK framework

The SuRF-UK framework recognises two fundamental stages at which sustainability can be considered: A) plan/project design and B) remediation implementation (Figure 3.1).

[2] In certain projects it is recognised that non-optimum remediation decisions may be made because other factors are more influential in optimising the benefit from a development scheme. Considering regulatory implications and recording why such a decision was taken should be a minimum requirement for any decision making process.

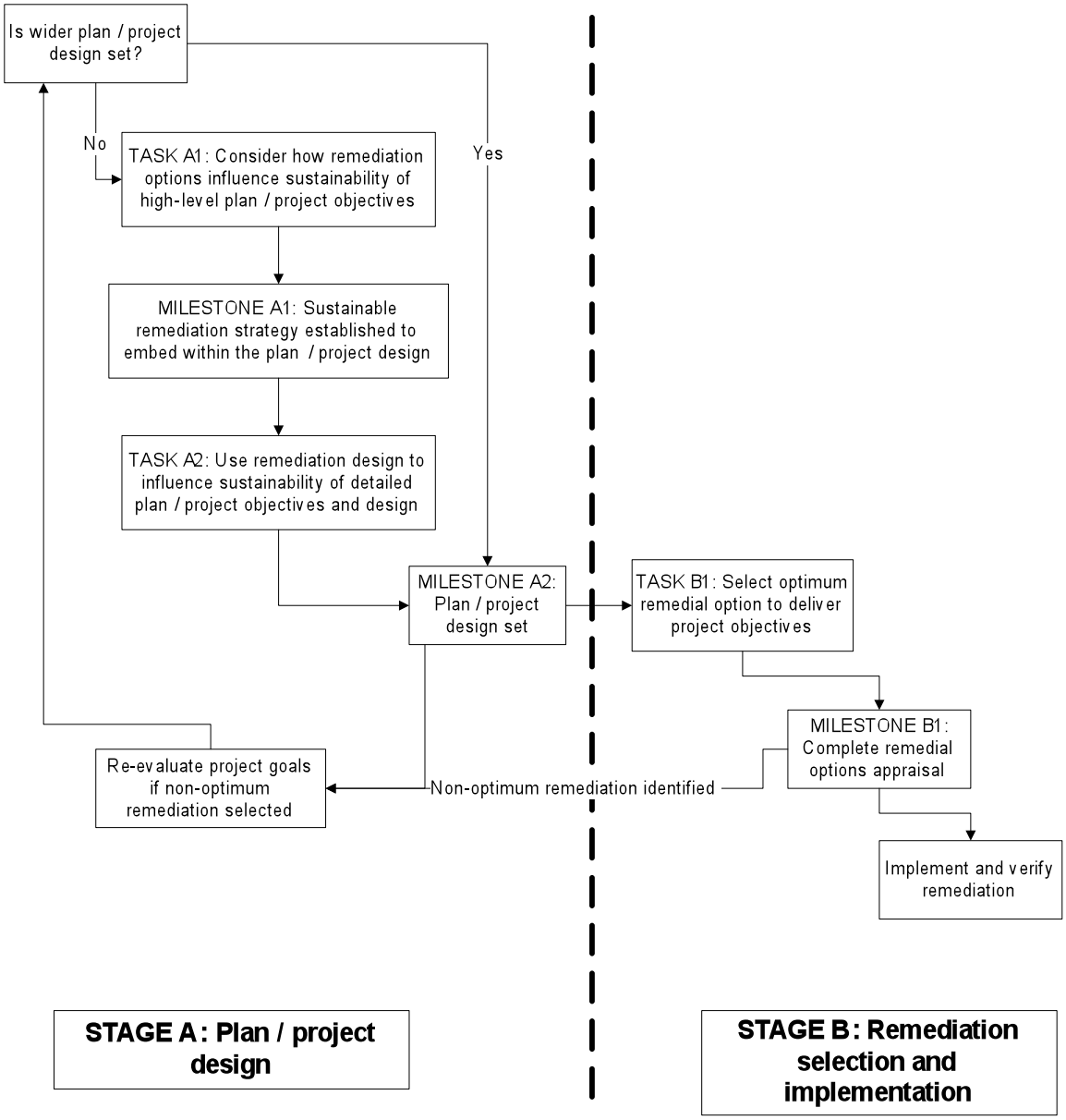

Figure 3.1: The SuRF-UK Framework

The framework recognises a clear break-point between the Stage A 'design' phase and Stage B 'remediation selection and implementation' phase.

Within Stage A (project design) there is an opportunity (Task A1) to embed a sustainable remediation strategy into the wider project/plan design[3]. This stage is considered a relatively flexible stage, permitting several design iterations in an effort to integrate the optimum remediation strategy into the wider project (Milestone A1).

[3] This stage is where the 'core aspects' of a project are set (as referenced in EA, 2000b)

Invariably completion of Stage A delivers a milestone related to an agreed and final project design or plan (Milestone A2). Once the broader project frame is established the main influence that can be achieved by a sustainable remediation assessment is to identify the optimum remediation that will facilitate delivery of the project design or plan[4].

Conceptually, within any scale of site (be it a regional plan, industrial mega-site or small site) or any type of project (brownfield redevelopment, operational site remediation) the same rules of the framework govern the approach:

- There is a starting point at which the project design or plan layout is under consideration. If remedial strategy factors are considered at this stage then there is a task (Task A1) that involves developing and embedding a sustainable remediation strategy in the wider project/plan design. The first milestone (A1) is this embedded remedial strategy that feeds into the second milestone (A2), which is the final project/plan design.

- At the completion of Milestone A2 there is typically a point of limited return (the break-point). This occurs because, for example, contracts, regulatory agreements, conditions of a permit or a planning consent are finalised. In contractual terms, the break-point often is the point of signing a contract, irrespective of the form of agreement under consideration. It may also be the point at which remediation practitioners first become involved.

- After this point, the project design is set and the only relevant task (Task B1) is to select the most sustainable remediation option. The third milestone (B1) is a completed remedial options appraisal, which results in selection of a preferred remediation solution that can be implemented and subsequently verified.

The framework identifies a break-point between these two stages because the opportunity to revisit the design once the design milestone has passed is often limited.

3.4 The use of the framework in different remediation scenarios

The framework is sufficiently flexible that it can be applied to various decision-making scenarios within a property lifecycle, and to different sizes of project or site. Figure 3.2 illustrates how it can be applied to different remediation scenarios by using one or both stages of the framework. Further, Stage A can be 'recycled' as stages A1 and A2 within a brownfield site assessment that is taken through design stages, firstly at regional-scale planning and then at a site-specific level.

[4] These are the 'non-core aspects' of a project (as referenced in EA, 2000b)

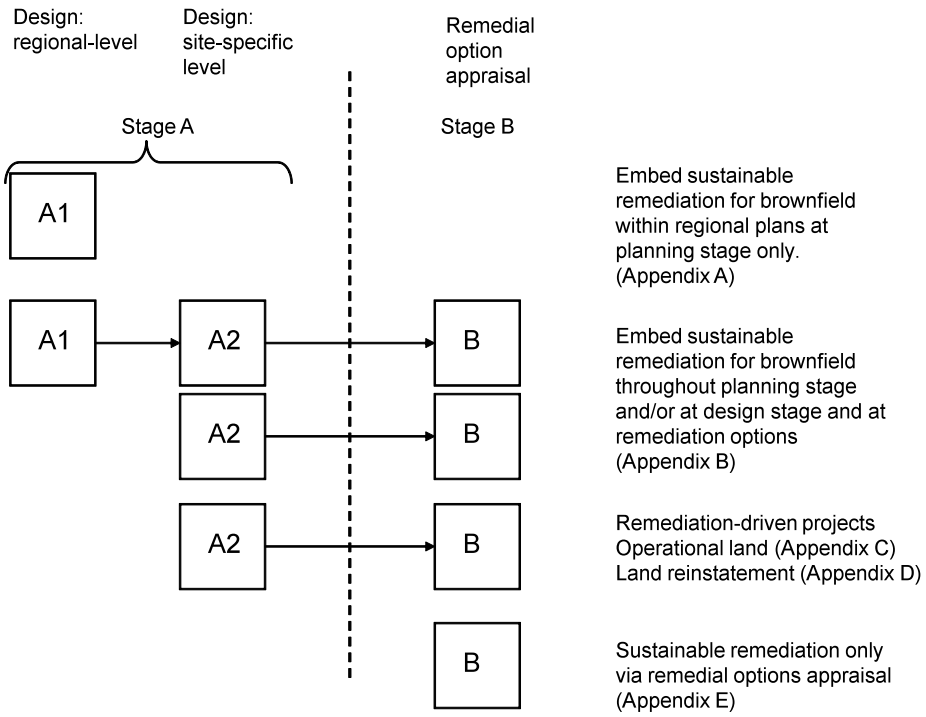

Figure 3.2: Use of the SuRF-UK framework for different remediation scenarios

These remediation scenarios are briefly described in sections 3.4.1 to 3.4.5 and are supported by further explanation in appendices A - E

3.4.1 Regional spatial planning

In the UK, the Town and Country planning process develops regional spatial strategies (at the regional level) and at the local level, local spatial plans which formally allocate land for different uses (e.g. employment, residential, retail etc.). Sustainable development is a core principle of this process, indeed it is a statutory requirement that plans contribute to sustainable development.

Remediation requirements represent one of the factors that can be considered when developing the optimal mosaic of land-uses and site-specific designation. This is essentially a Stage A SuRF-UK framework process only, with knowledge of the likely remediation requirements of various sites influencing their land-use designation. In Figure 3.2 it is shown as a Stage A process. Supporting data is presented in Appendix A. It is not linked to Stage B remediation implementation since it is exclusively a decision-making process at a regional planning level and the final milestone is a regional strategy.

It is presented in this document to highlight the potential contribution that a sustainable remediation assessment can make in regional spatial planning decisions.

3.4.2 Land changing use

A parcel of land for development may be subject to two phases of design, firstly at local-scale planning with a land-use determination and then at site-specific level, arguably with a break-point between them. This concept is presented on Figure 3.2 as two phases A1 and A2 and is supported by Appendix B. However, an alternative and perhaps more common option in practice for brownfield land is that the local plan is set and only the site-specific design issues will be considered.

Site-specific design examples of sustainability considerations might include:

- Location of different land-use types in a mixed-use scheme, given different risk-based remediation criteria and a heterogeneous distribution of contaminants across a site (e.g. locate most vulnerable receptors and land-uses away from most contaminated areas);

- Considerations for basement parking related to remediation requirements (e.g. avoid excavating clean soil to create basements while at the same time remediating other soils *in-situ*);

- Location of sustainable drainage system (SUDS) (CIRIA 2004) attenuation tanks related to remediation requirements (e.g. locate SUDS percolation areas in areas of clean soil to prevent leaching of contaminated materials); and

- Considering use of vapour membranes to intercept a potential 'pathway' rather than excavating and disposing of large volumes of soil (providing risks to other receptors, such as groundwater, are also appropriately protected).

In terms of any brownfield development scenario, Stage A design commonly links directly to Stage B implementation, with the pre-'break-point' milestone invariably being the granting of planning permission.

3.4.3 Land continuing in current use

Remediation work on operation land (e.g. where there is no change of use and remediation is part of a liabilities management programme) invariably drives the sustainability of the project, since the remediation work is the project. This scenario is shown as two stages on Figure 3.2 and is supported by Appendix C. In this case establishing a sustainable remediation strategy to embed within the plan/project design and agreeing the overall project design are part of the same milestone.

3.4.4 Land restoration for 'soft' end-uses

Remediation work as part of land restoration projects also normally represents one of the main drivers of the sustainability of the project since the remediation work is a significant part of the project together with non-remediation earthworks.

Unlike brownfield redevelopment the subsequent life-time impacts of the scheme are commonly less. This scenario is shown as two stages on Figure 3.2 and is supported by

Appendix D. Often, establishing a sustainable remediation strategy to embed within the plan/project design and agreeing the overall project design is the same milestone.

3.4.5 Remediation implementation only

In many circumstances, a practitioner does not have an opportunity to influence the design work. They may only be asked to implement a selected remediation strategy, in order to deliver the design requirement. This represents a Stage B framework process as shown on Figure 3.2 and is supported by Appendix E.

At this stage the remediation options appraisal can only seek to influence the technologies or techniques used to achieve risk-based remedial objectives and also optimise the net (social, environmental and economic) benefit provided by the operation of the remediation.

4. Applying the SuRF-UK framework

4.1 A tiered approach to assessing sustainability of remediation activities

Sustainable remediation requires an assessment of the environmental, social and economic aspects associated with land and groundwater remediation, in order to ensure that the net benefit is optimised, and that the benefit exceeds the (economic, social and environmental) cost of undertaking remediation. Sustainable remediation can involve decisions on an optimum remedial strategy at a number of points in a site's (re)development or risk-management process (Table 4.1). Aligned to the relevant regulatory process the principal points at which a formal assessment may be made are:

1. Spatial (land-use) planning: consideration of the impact of remediation alongside other relevant criteria on the sustainability of different land-use allocations during regional spatial planning and redevelopment activities;

2. Site specific master-planning to ensure the allocated use of the site is set out in the most appropriate and efficient manner;

3. Remedial strategy design: selection of a remedial strategy (i.e. source treatment, pathway interception or receptor modification) that optimises the net benefits of risk-management actions;

4. Remediation technology selection: selection of a remedial technology or technique that achieves risk-based remedial goals in the most sustainable manner.

In addition, consideration of sustainability criteria is recommended at the following points:

5. Design of site characterisation strategies (e.g. by focusing site characterisation to improve understanding of plausible source-pathway-receptor linkages to improve a conceptual site model; minimising journeys to site for numerous poorly-planned phases of site investigation; waste minimisation; use of non-intrusive technologies,

and design of site characterisation to prevent new contamination by, for example drilling through low-permeability confining layers);

6. Design of remediation verification strategies (similar issues to site characterisation);

7. Collection of data to verify a sustainability assessment.

The assessment points for site-specific assessments are summarised in Figure 4.1 and Table 4.1. No flowchart is provided for the spatial planning process. SuRF-UK recommends that consideration of remediation issues is included alongside other relevant considerations in a sustainability appraisal undertaken as part of spatial planning activities. The potential implications take two primary forms:

- Firstly, allocating land for new potentially contaminating activities in low-sensitivity locations (e.g., remote from sensitive environmental receptors), in order to minimise potential damage and need for remediation in the event of a release close to potential receptors; and

- Secondly, allocation of existing areas of brownfield land for continued potentially contaminating activities in preference to more sensitive end-uses in order to i) avoid new potentially contaminating activity on greenfield sites and ii) minimise remediation requirements to make the land 'suitable for use'.

In the first of these stages, the sustainable remediation assessment may form part of an *Strategic Environmental Assessment* (SEA) or *Environmental impact assessment (EIA).*

Strategic Environmental Assessment is a systematic decision support process aiming to ensure that environmental and possibly other sustainability aspects are considered effectively in *policy, plan and programme making* (ODPM 2005b). In Europe, Strategic Environmental Assessment is undertaken to meet the requirements of European Directive 2001/42/EC. Key principles in Strategic Environmental Assessment include the promotion of sustainable development.

Environmental Impact Assessment is a procedure to make a structured appraisal of a broad range of environmental effects of a particular *project*. In the EU, EIA is subject to Directive 85/337/EEC. EIA affects projects beyond a certain size, and not all remediation projects will trigger the need for an EIA in their own right. EIA could also be triggered for remediation as part of a larger development project. Environmental impact assessment does not consider the full range of factors that would be considered in a full sustainability appraisal. However, it may be beneficial to carry out sustainability appraisal if the EIA requirements have been triggered to provide a balanced comparison of available options.

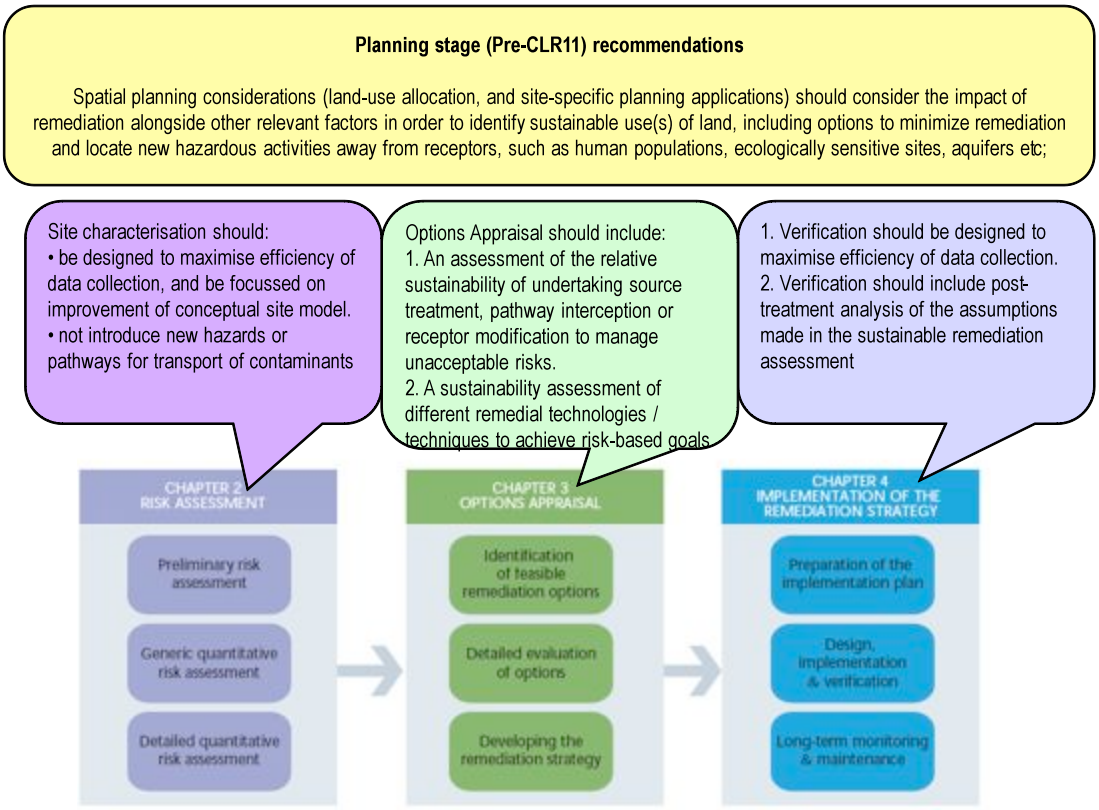

Figure 4.1: SuRF-UK sustainable remediation assessment points aligned to planning decisions and the CLR11 process

Table 4.1: Summary of site-specific SuRF-UK assessment points aligned to the CLR11 process

	Risk Assessment	**Options Appraisal**	**Implementation of Strategy**
End point	Robust conceptual model, risks and uncertainties understood. Decision of need for remedial works, based on risk assessment.	Remedial options reviewed. Preferred strategy identified.	Remedial action complete and verified. Possible long-term monitoring.
SuRF-UK formal assessments	Remedial options assessed: a) Optimum remedial strategy (i.e. source pathway or receptor treatment to achieve risk-based remedial goals); b) Technology selection		None
SuRF-UK optional assessments	Ensure site characterisation: a) Is designed to ensure efficient data collection, focused on improvement of conceptual model b) Prevents new hazards or S-P-R linkages	None	Ensure verification: a) Is designed to ensure efficient data collection, focused on improvement of conceptual model, b) Verifies sustainability assessment assumptions

At each SuRF-UK assessment point the environmental, social and economic costs and benefits associated with the available options that could achieve the redevelopment/risk-management objectives should be assessed. This can be based on qualitative or quantitative methods, and is illustrated, for a quantitative cost-benefit analysis in Box 1.

Box 1. Example of a quantitative approach to sustainable remediation assessment

The assessment should consider how the balance of costs and benefits for the available remedial strategies/techniques compares, and whether the benefits of the preferred remediation option exceed the costs.

$$SR = \sum_{1}^{j}\left(\left(Benefit_{environment} - Cost_{environment}\right) + \left(Benefit_{society} - Cost_{society}\right) + \left(Benefit_{economic} - Cost_{economic}\right)\right)$$

where:

SR is the sustainable remediation score for each of the *j* remedial options
$Benefit_x$ is the benefit associated with each factor (environment, society or economy) for each remedial option (net present value)
$Cost_x$ is the cost associated with each factor (environment, society or economy) for each remedial option (net present value)

The optimum remedial option achieves:

SR ≥ 0;
SR is the maximum for the feasible remedial options 1 to *j;*
A fair distribution of the costs and benefits amongst the affected parties

A hierarchy of suitable sustainability indicators that are relevant to remediation activities are described in the next section. A range of techniques is available to undertake the sustainability assessment. SuRF-UK recommend a tiered approach using simple qualitative approaches (or simply a conversation with affected stakeholders) where this is adequate to reach a justifiable decision, semi-quantitative multi-criteria analysis and monetised cost-benefit analysis for more complex and difficult site assessments (Figure 4.2).

SuRF-UK considers that the specific tool used for a sustainable remediation assessment is less important than the process and thought that goes into an assessment. An assessment that considers environmental, social and economic factors from various stakeholder perspectives and which reaches a management decision based on a transparent and documented process is likely to be more acceptable than one which uses a sustainability assessment tool as a 'black box' and which fails to properly consider or justify input data and assumptions. Sustainability assessment tools should help evaluators undertake an assessment and make a management decision, not be the assessment.

A range of tools and methods are available for undertaking a sustainability assessment (or components of a sustainability assessment) as set out in Table 4.2, but in essence they all seek to achieve the same goal: to assess the environmental, social and economic benefits and disbenefits (or costs) for a range of suitable options that meet a

project goal. The assessment methods measure the benefits and costs in some way (often financial cost, but could be any form of 'currency') and seek to identify:

- whether the overall benefits (of remediation) exceed the overall costs of doing the work;

- for those methods where benefit exceeds cost, the method or methods that offers the optimum overall benefit.

An ideal sustainability assessment tool allows assessors to evaluate the environmental, social and economic factors in transparent and robust manner, using data and knowledge that is readily available and which is easily communicated to interested parties.

Table 4.2: Selected decision support techniques with relevance to sustainable remediation assessments (indicating coverage of the environmental, economic and social elements of sustainable development; whether techniques are quantitative or qualitative; and whether contaminated site management (CSM) applications are known to exist at present)

	Environment	Economy	Society	Type	CSM
Scoring / ranking systems (including multi-criteria analysis)	Narrow to Wide	Narrow to Wide	Narrow to Wide	Qual	Yes
Best Available Technique (BAT)	Narrow to Wide	Narrow	-	Qual	Yes
Carbon footprint ("area")	Narrow	-	-	Quan	Yes
Carbon balance (flows)	Narrow	-	-	Quan	
Cost benefit analysis	Narrow to Wide	Narrow to Wide	Narrow to Wide	Quan	Yes
Cost effectiveness analysis	Narrow to Wide	Narrow to Wide	Narrow to Wide	Qual	Yes
Eco-efficiency	Narrow	-	-	Quan	?
Ecological footprint	Narrow	-	-	Quan	
Energy / intensity efficiency	Narrow	-	-	Quan	Yes
Environmental risk assessment	Narrow to Wide	-	-	Quan	Yes
Human health risk assessment		-	Narrow		Yes
Environmental impact assessment / Strategic environmental assessment	Narrow to Wide	-	-	Qual	Yes
Financial risk assessment	-	Narrow	-	Quan	Yes
Industrial ecology	Narrow to Wide	Narrow to Wide	-	Quan	
Life Cycle Assessment (based)	Narrow to Wide	-	-	Quan	Yes
Quality of life assessment	Wide	Wide	Wide	Qual	

Noets:
Qual = Qualitative
Quan = Quantitative

- The table describes each technique in terms of its *typical* coverage of particular aspects of sustainability. For example, a carbon footprint appraisal focuses on a "narrow" segment of environmental sustainability issues (ignoring for example soil functionality, biodiversity and landscape impacts), whereas all of these aspects could be considered by a cost-benefit analysis, providing it was suitably specified.
- A dash (-) means that the technique has no coverage.

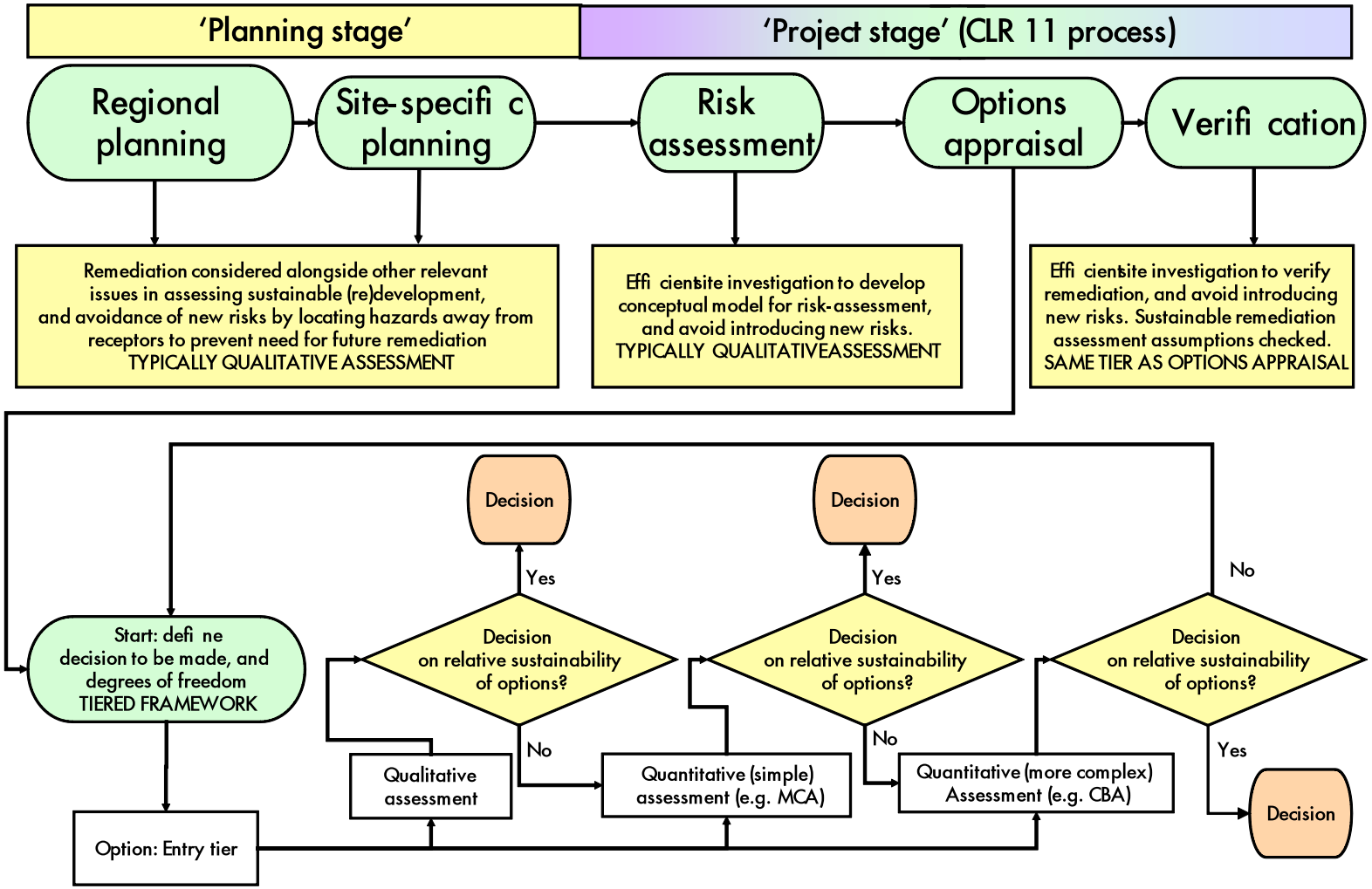

Figure 4.2: Tiered approach to assessing the sustainability of remediation in spatial planning decisions and risk-assessment/management (CLR11-aligned) stages

4.2 Sustainability indicators for remediation

Sustainable remediation assessment is generally based on an assessment of the performance of different remediation options against a list of sustainability indicators. Relevant assessment criteria fall under three headings: environmental, social and economic. For example, assessment criteria for remediation technology selection might cover the broad issues presented in Table 4.3. These 18 categories have been found to include a wide range of indicators found in the international peer-reviewed literature on sustainability appraisals (CL:AIRE, 2009).

Table 4.3: Overarching categories of indicators for sustainability assessment of remediation options

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.

Sustainability assessment techniques employ some means of aggregating individual assessments of indicators to provide an overall understanding of "sustainability". Qualitative or quantitative approaches may be used in sustainability assessments. In general quantitative approaches are limited to particular aspects of sustainability, but may be useful for gathering evidence as part of an overall appraisal.

A system of scoring the relative importance or benefit/cost that each remediation option provides against other alternatives is needed. The Environment Agency's guidance on cost-benefit assessment for groundwater remediation describes how such analysis may be performed by monetizing the costs and benefits that each remedial option incurs against relevant sustainability indicators. However at the simpler assessment levels a non-monetized approach is typically used, such as 'a score out of ten' or high-medium-low ranking.

Indicators are integral to the communication of sustainable development[5]. They help assessors review progress objectively, they highlight where the challenges are, and they help people to understand what sustainable development means globally, nationally, locally and for them as individuals. Indicators appear to serve two broad functions.

Policy orientated indicators that are linked to specific policy goals, often with some threshold or target for "acceptability" included, for example the England Sustainable Development Policy: Framework Indicators (Defra 2005a, 2005b) of guidance on determining Regional Development Strategies (ODPM 2005b). Alternatively indicators

[5] http://www.defra.gov.uk/sustainable/government/progress/index.htm

may be orientated towards consistent reporting of sustainability effects, independent of particular regional, national or international policy goals, such as the Global Reporting Initiative (www.globalreporting.org). Obviously factors being considered will overlap, for example perhaps carbon or energy intensity, or impacts on water quality may be common to a number of different indicator sets for either function. However, on the whole indicator sets developed for specific policy goals tend to be more directed in their coverage.

Therivel (2004) provides a detailed review of the qualities of, and uses for, sustainability appraisal indicators. Further detailed review of sustainability indicators application to land and groundwater remediation projects is presented in CL:AIRE (2009).

5. Recording decisions

Clear recording of decisions and of the assumptions made in reaching decisions on sustainable remediation is an important aspect of the SuRF-UK framework. Good communication, an open and honest approach, reliance on sound science and documented decisions are fundamental to reaching an outcome that all parties recognise as being reasonable and equitable. A template for documenting decisions and assumptions leading to a decision on sustainable remediation is provided in Appendix F. It is recommended that this (or an equivalent document) is prepared as part of all sustainable remediation assessments.

Sustainable remediation should achieve risk-management objectives, whilst having due regard to the costs and benefits associated with the available remediation strategies and techniques. As part of this process, it must be recognised that on occasions (particularly where remediation is a part of a wider redevelopment project) non-optimum remediation decisions will be made because other factors are more influential in optimising the overall benefits of a scheme. Such consideration may include, for example, demographic factors, flood-risk management and transport (CL:AIRE 2009).

How these decisions are recorded in the context of the SuRF UK framework is shown in Figure 5.1.

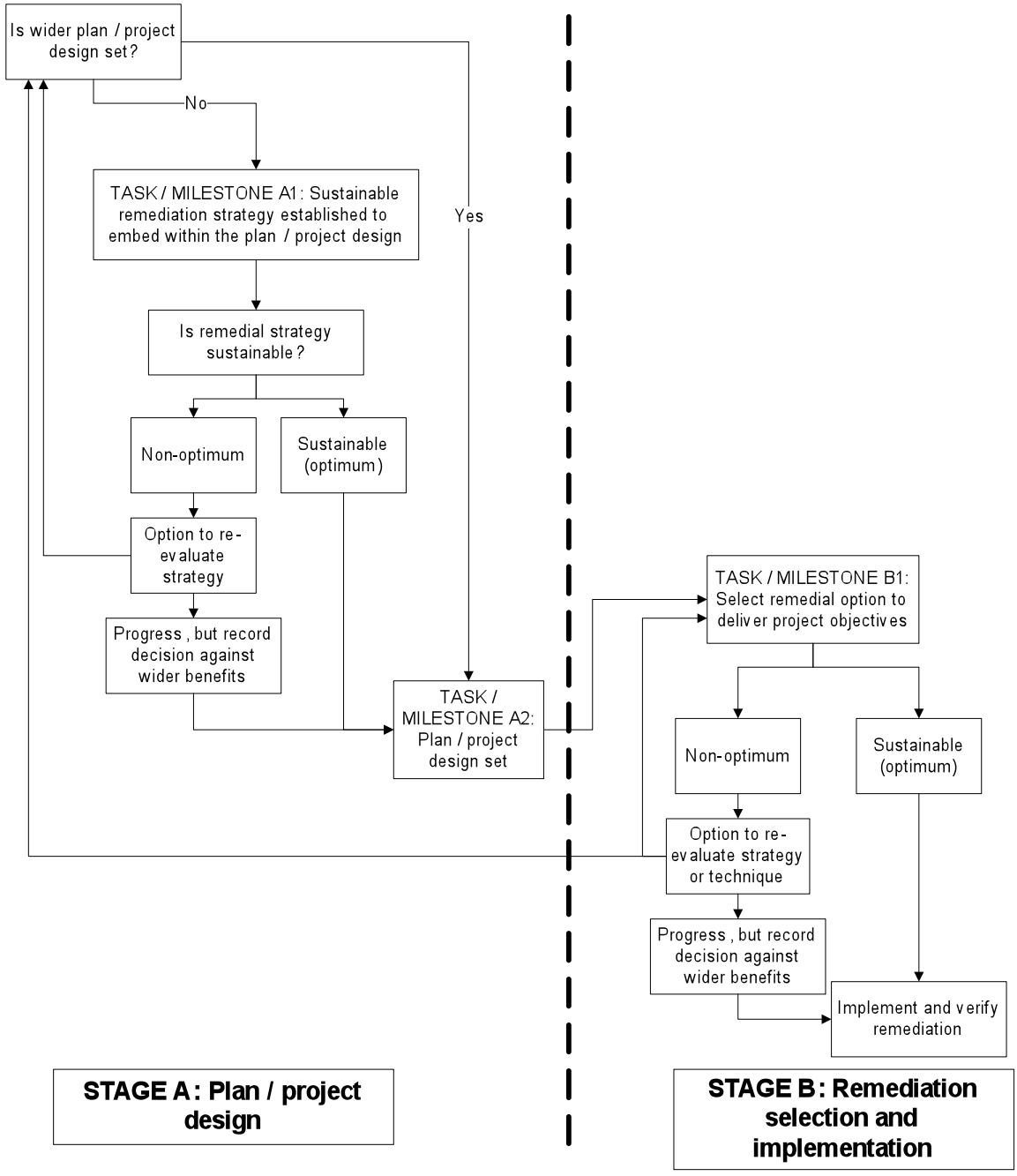

Figure 5.1: Recording non-optimum ('unsustainable') decisions with the SuRF-UK context

6. Interactions of SuRF-UK with other sustainable remediation initiatives

Sustainable remediation is a rapidly developing research and environmental management topic internationally. This report is the first phase of work by SuRF-UK, and further work on sustainability indicators, metrics and tools is planned. A number of other

initiatives are currently active, and are summarised below. There is a) discussion between initiatives, b) participation of SuRF-UK steering group members on other initiatives and c) joint work on specific tasks.

6.1 SURF

The Sustainable Remediation Forum (SURF, www.sustainableremediation.org) was the first SURF initiative, based in the USA. It is a collaborative initiative of industry and consultancy members, with United States Environmental Protection Agency (USEPA) participation, that seeks to develop understanding and methods for sustainable remediation principles that are relevant in a US policy and regulatory context. A thorough overview of SURF activity and progress is presented in SURF (2009).

SURF's stated working concept is:

- *In fulfilling our obligations to remediate sites to be protective of human health and the environment we will embrace sustainable approaches to remediation that provide a net benefit to the environment.*

- *To the extent possible, these approaches will:*

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

6.2 NICOLE

NICOLE (www.nicole.org), the Network of Industrially Contaminated Sites in Europe, has a working group on sustainable remediation which seeks to establish a framework for sustainable remediation applicable across Europe. NICOLE is comprised dominantly of private-sector organisations and the approach largely reflects the views of industry and consultants. SuRF-UK steering group members are working with NICOLE to ensure consistency of approaches where appropriate.

NICOLE's working definition of sustainable remediation is:

"a "framework in order to embed balanced decision making in the selection of the strategy to address land [and/or water contamination] as an integral part of sustainable land use".

Any definition must allow ability to:

- *Make risk based decisions*
- *Consider [and define] boundaries in time and space*
- *Ensure a balance of outcomes can be achieved*
- *Consider land [and water] use first as part of the process*

The basic decision making rationale behind contaminated land management is a basis in risk assessment. However, the means of achieving risk management must in itself not

place unreasonable demands on the environment, economy and society, the three key elements of sustainable development", (Bardos 2008).

6.3 USEPA Green Remediation

'Green Remediation' as defined by the USEPA (2008) is an initiative to encourage the use of renewable energy in remediation activities, and the avoidance of unnecessary use of natural resources and waste generation. It is anticipated to lead, in due course, to development of an American Society for Testing and Materials (ASTM) standard. A key difference between Green Remediation and the SuRF-UK approach is that SuRF-UK seeks to consider remediation activities as part of the broader sustainable development objectives of the project, rather than simply to select the most 'environmentally-friendly' technology to achieve a given remedial objective. SuRF-UK recognises that certain remedial activities and objectives may be 'unsustainable' regardless of the energy source used to achieve them. In these circumstances SuRF-UK recommends reconsideration of the fundamental remedial objectives, which is beyond the scope of Green Remediation. Nevertheless, lessons learned through the Green Remediation initiative may be extremely valuable at the SuRF-UK technology selection stage.

The USEPA define 'green remediation' as "*the practice of considering all environmental effects of remedy implementation and incorporating options to maximise net environmental benefit of cleanup actions.". Green remediation considers a range of impacts: air pollution caused by toxic or priority pollutants such as particulate matter and lead; water cycle imbalance within local and regional hydrologic regimes; soil erosion and nutrient depletion as well as subsurface geochemical changes; ecological diversity and population reductions; and emission of carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and other greenhouse gases contributing to climate change*. (USEPA 2008).

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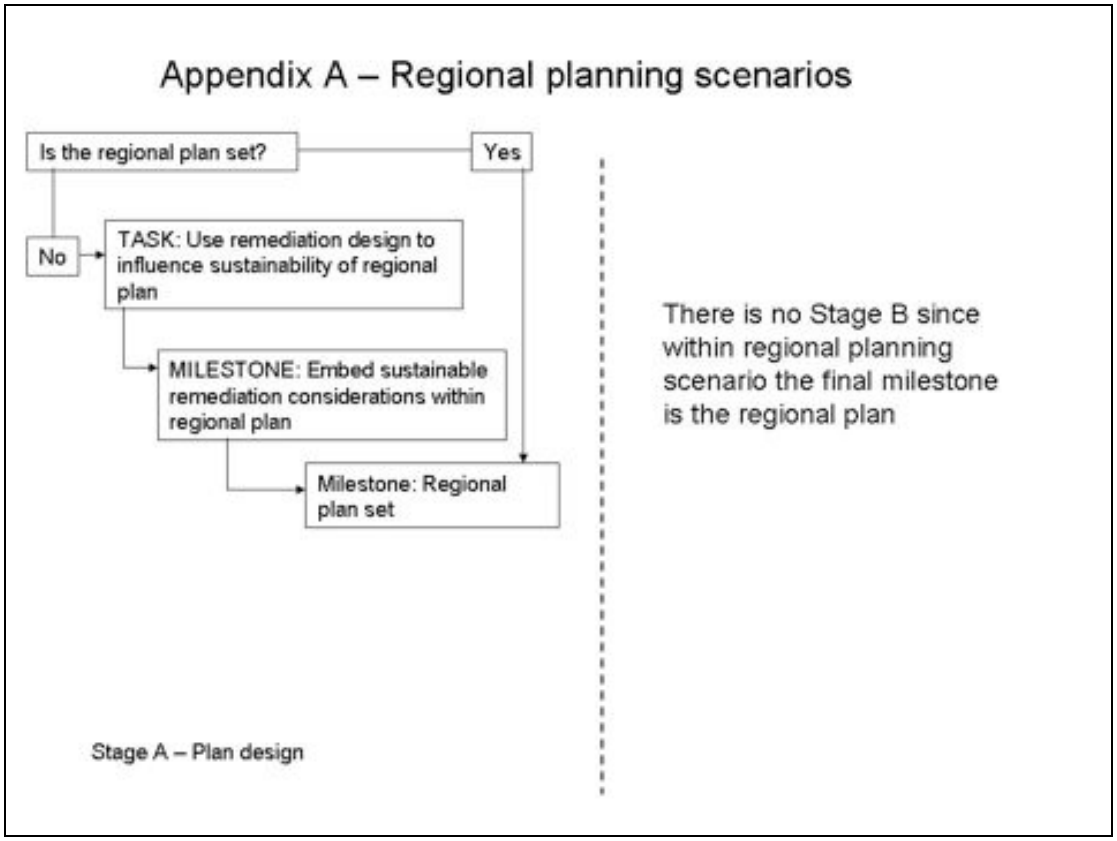
Glossary

Appendix A: (Town and Country) Regional planning scenarios

Within the UK, the Town and Country planning process develops local spatial strategies and formally allocates land for different uses (e.g. employment, residential, retail etc.). Sustainable development is a core goal of this process.

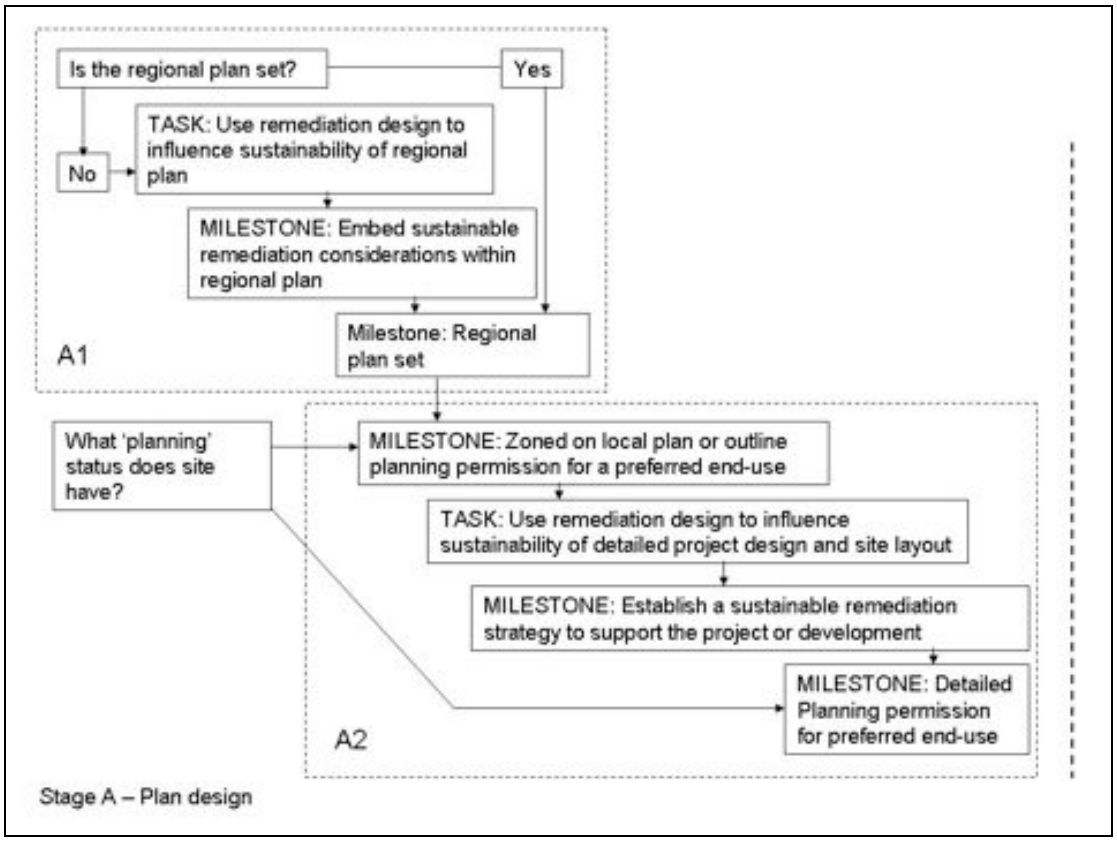
Remediation requirements represent one of the factors that can be considered when developing the optimal mosaic of land-uses and site-specific designation.

This is essentially a Stage A SuRF-UK framework process only, with knowledge of the likely remediation requirements of various sites influencing the land-use designation. It is not linked to Stage B remediation implementation since it is exclusively a decision-making process at a regional planning level and the final milestone is the regional plan.



Appendix B: Brownfield land redevelopment

A parcel of brownfield land may be subject to two phases of design, firstly at local-scale planning level (as per Appendix A) and then at the site-specific level.



In terms of the SuRF-UK framework a parcel of brownfield land could go through two cycles of the design stage: A1 at regional-level and then A2 at a site-specific level.

However, in practice the more frequent use of the SuRF-UK framework for brownfield land will be at a site-specific level where the local plan is set and only the site-specific design issues remain to be considered.

Site-specific design examples of sustainability considerations might include:

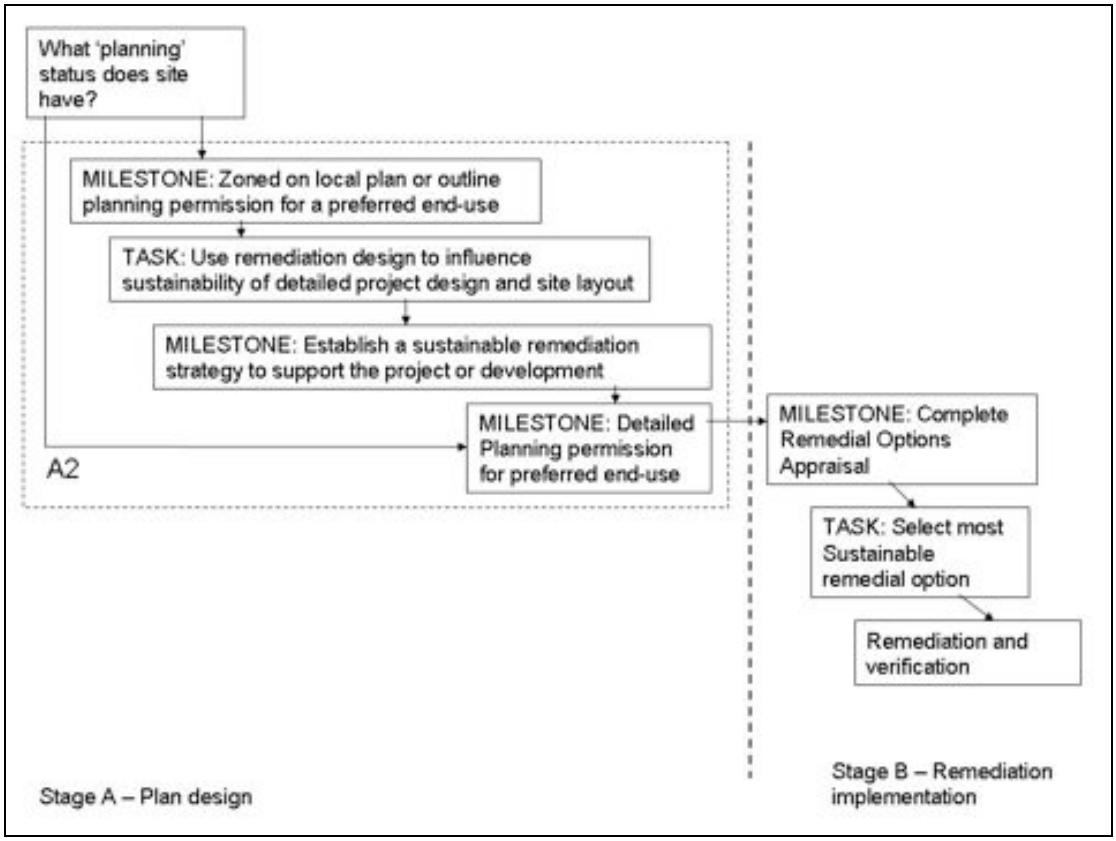
- Location of different land-use types in a mixed-use scheme, given different risk-based remediation criteria and a heterogeneous distribution of contaminants across a site (e.g. locate most vulnerable receptors and land-uses away from most contaminated areas);

- Considerations for basement parking related to remediation requirements (e.g. avoid excavating clean soil to create basements while at the same time remediating other soils *in-situ*);

- Location of sustainable drainage system (SuDS) (CIRIA 2004) attenuation tanks related to remediation requirements (e.g. locate SuDS percolation areas in areas of clean soil to prevent leaching of contaminated materials); and

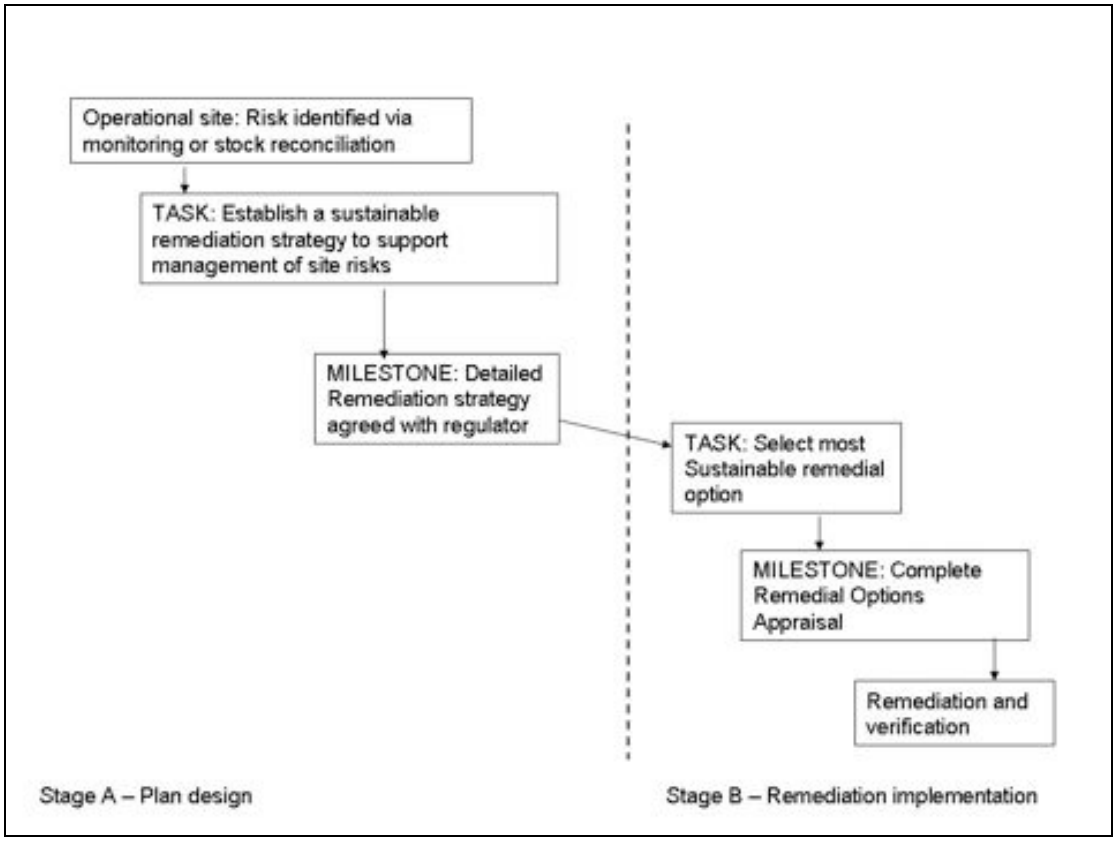
- Considering use of vapour membranes to intercept a potential 'pathway' rather than excavating and disposing of large volumes of soil (providing risks to other receptors, such as groundwater, are also appropriately protected).

In terms of any brownfield development scenario Stage A design will link to Stage B implementation, with the pre-break point milestone frequently being the granting of planning permission.



Appendix C: Remediation of operational land (no change of use)

Remediation work on operational land invariably drives the sustainability of the project since the remediation work is the project. Normally, establishing a sustainable remediation strategy to embed within the plan/project design and agreeing the overall project design are the same milestone.

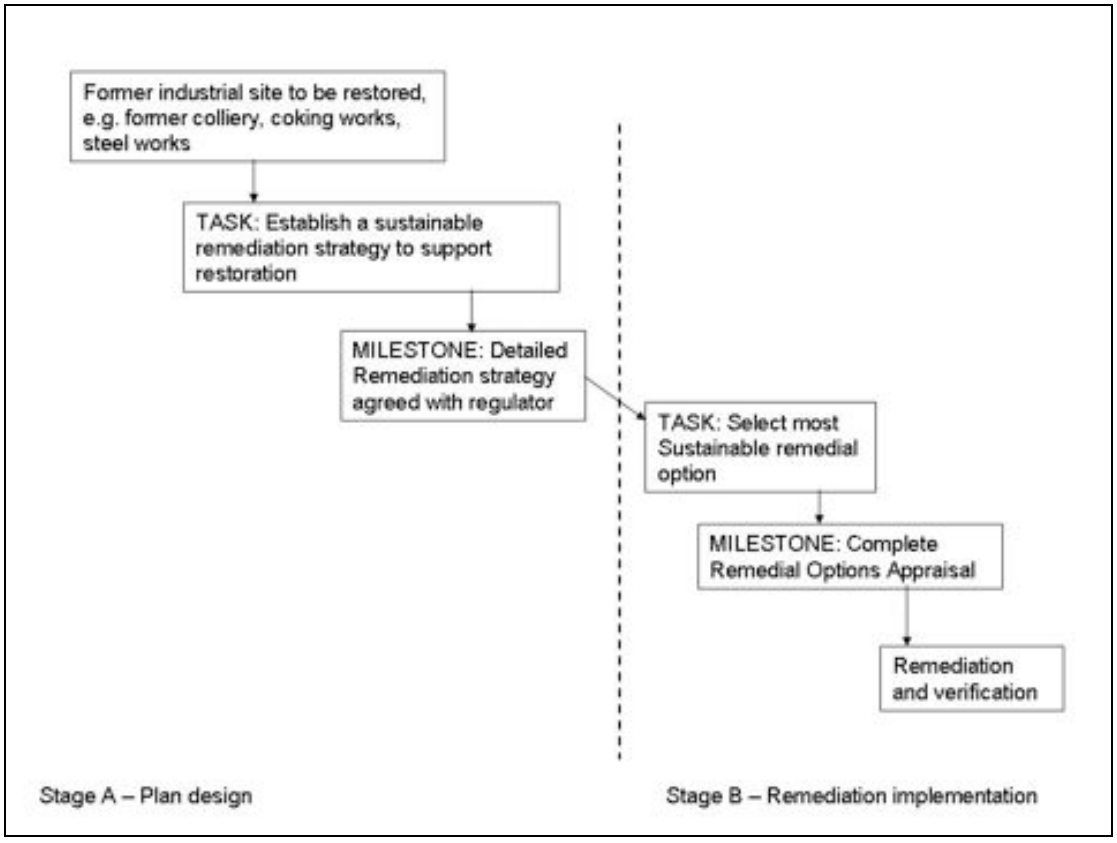


Appendix D: Land restoration schemes

Remediation work as part of land restoration projects invariably represents one of the main drivers of the sustainability of the project since the remediation work is a significant part of project together with non-remediation earthworks

Unlike brownfield development the subsequent life-time impacts of the scheme will be much less. Often, establishing a sustainable remediation strategy to embed within the plan/project design and agreeing the overall project design is the same milestone.

It is possible that the remediation design is an integral part of the overall project design, for example where soil materials and organic matter are brought on site both to support the growth of a particular vegetation and as part of a risk management (pathway interception) strategy.

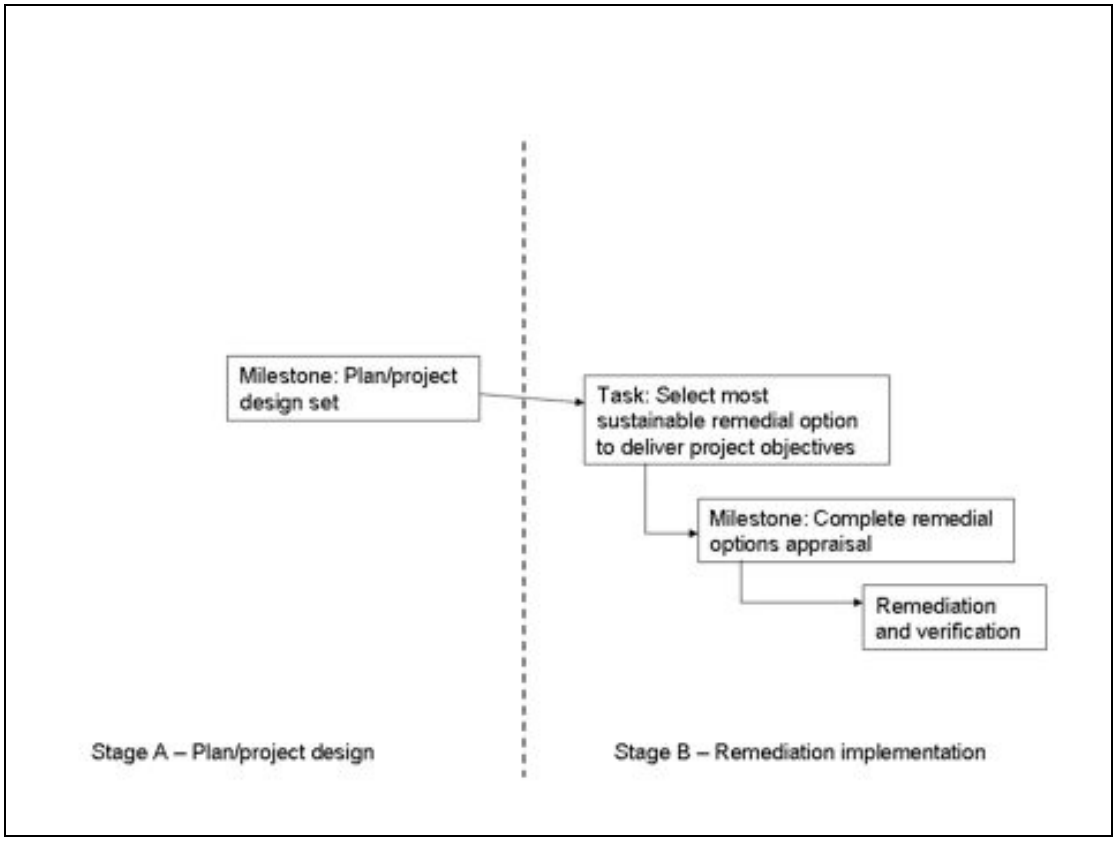


Appendix E: Remediation implementation only

The SuRF-UK framework recognises that in many circumstances, a practitioner does not have an opportunity to influence the design work. They are only asked to implement the remediation solution to deliver the design requirement. This represents a Stage B framework process.

At this stage the remediation options appraisal can only seek to identify the technologies or techniques to achieve risk-based remedial objectives and also optimise the net (social, environmental and economic) benefit provided by the remediation.

Operating with Stage B is effectively the realm of green remediation as described in Chapter 6 of this framework document.



Appendix F: Report headings for sustainable remediation assessments

A typical sustainable remediation assessment report is likely to cover the following aspects. It may form a part of a risk-assessment or remediation options appraisal report. The length and complexity of the report should be proportionate to the complexity of the project, but sufficient to explain the decision made to all stakeholders involved.

1. Project details
    - Name and location of site
    - Name and affiliation of assessor
    - Date of assessment
    - Project reference

2. Project objectives and constraints
    - Outline of the constraints and limitations within which the sustainable remediation assessment is performed:
        i. Project goals e.g., defined end-use
        ii. Regulatory or legislative requirements
        iii. Contractual requirements
        iv. Non-moveable project objectives (e.g., timescale, land-use etc.)
        v. Moveable project objectives (e.g., timescale, land-use etc.)

3. Conceptual site model
    - Summary of conceptual site model, or (ideally) link to a comprehensive conceptual site model report.

4. Sustainability indicators used
    - List of sustainability indicators used and data sources drawn upon

5. Other assumptions
    - Assumptions such as discount rate assumed to calculate net-present values; weighting applied to indicators.

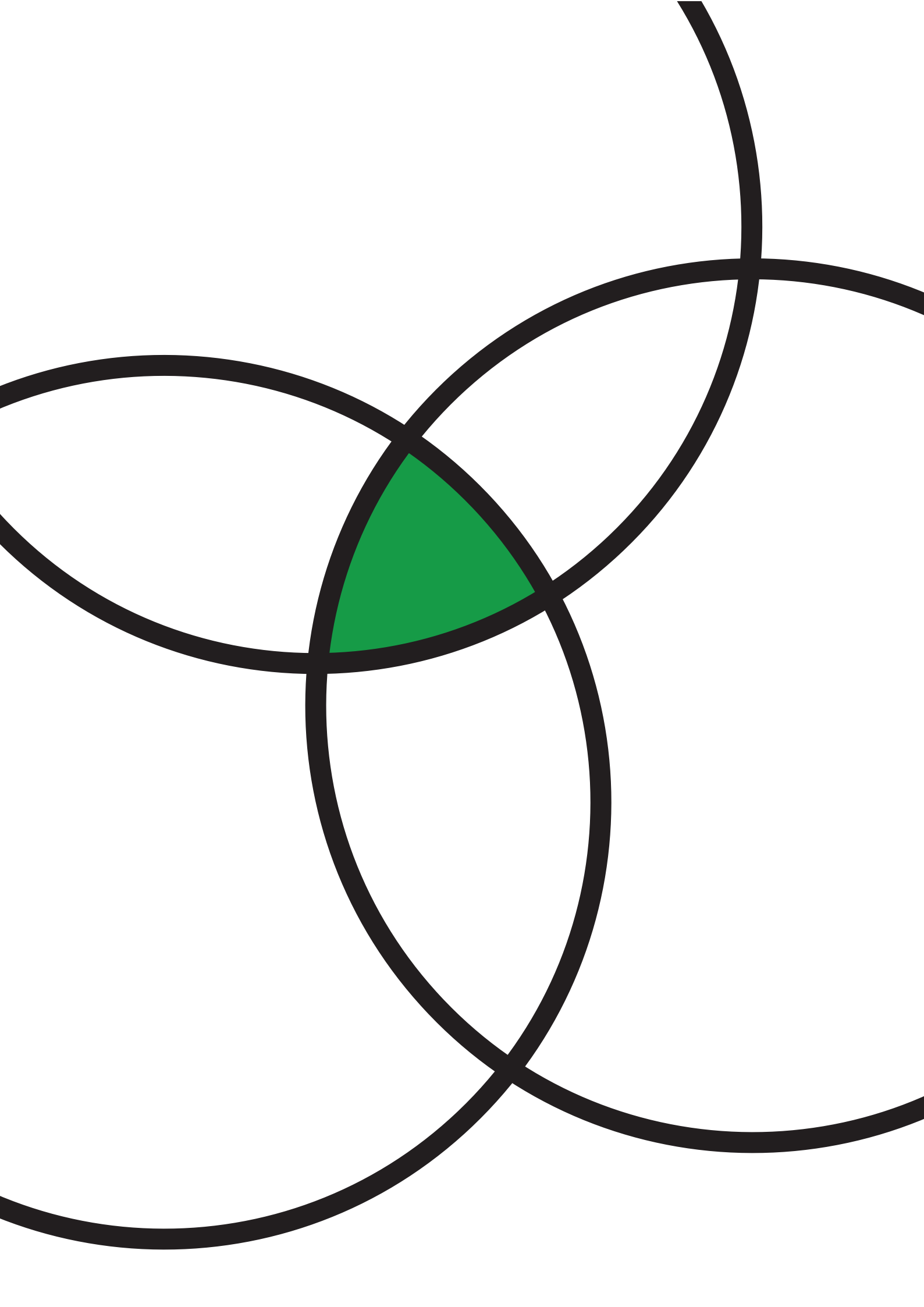
6. Sustainability method/technique used
    - Describe method (e.g. qualitative assessment, multi-criteria analysis, cost-benefit analysis) and/or tool (proprietary or in-house tool) used for assessment. Clarify its linkages with the conceptual site model, indicators and other assumptions, and state the boundaries of the assessment, such as the systems being compared, timeframes, geography and level of detail etc

7. Remedial options considered
    - List method and evidence (if necessary) that each option can meet project goals.

8. Consultation
    - Describe consultation process, list consultees, and indicate degree of consensus achieved through process.

9. Results
    - Description of the relative sustainability of each of the remedial options considered.
    - Statement of the preferred remedial solution and its performance in the sustainability assessment.

10. References and data sources



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