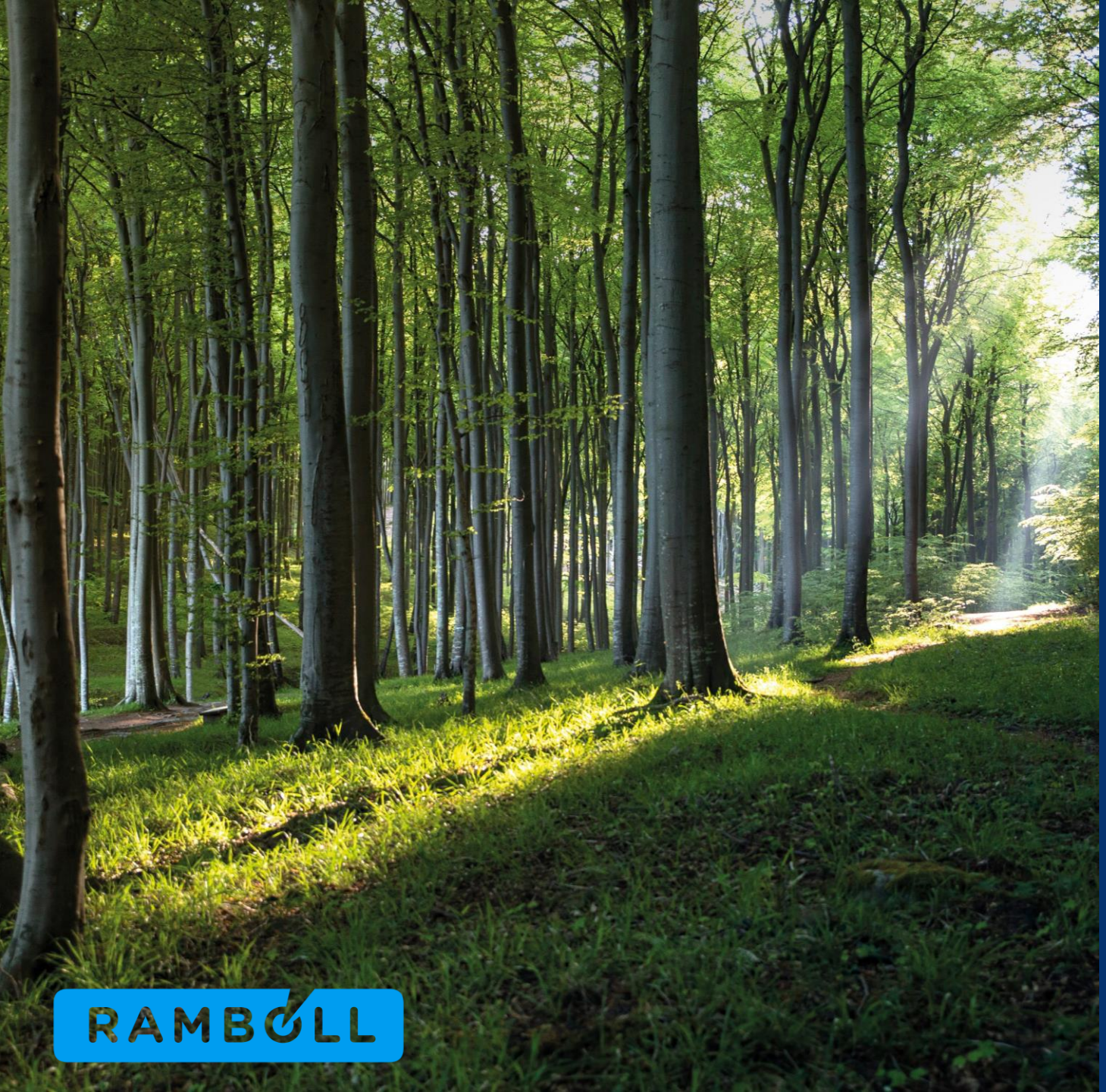


# Social, miljømæssig og økonomisk bæredygtighed

## *En indflyvning*

Gitte Lemming Søndergaard

ATV møde
30. januar 2024

# Hvordan bliver vi mere bæredygtige i vores arbejde med forurenet jord og grundvand?

- Forureningsundersøgelser
- Afværge af forurening
- Drift af afværge

# Hvad har vi kurs mod?

- En fælles **forståelse** af hvad vi mener med bæredygtighed når det gælder undersøgelser og afværge af forurenet jord og grundvand
- Et overblik over hvad vi har af **metoder i værktøjskassen** til at vurdere bæredygtigheden
- Hvor mangler vi værktøjer?

# ISO standard for bæredygtig afværge
## ISO 18504:2017

- Definitioner
- Terminologi
- Overordnede rammer og principper for bæredygtighedsvurderinger

## Sustainable Remediation Forum UK (SuRF UK)

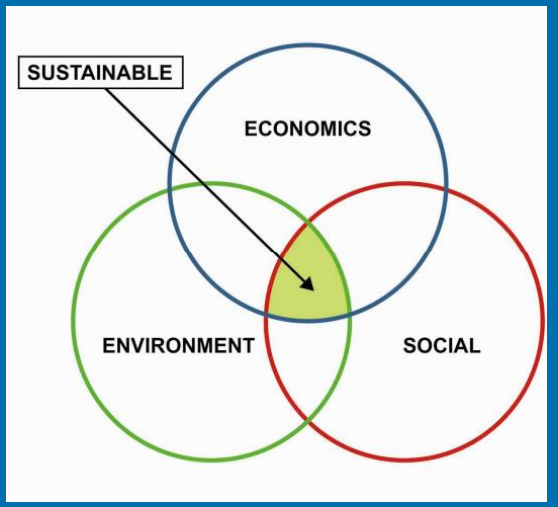
- SuRF UK framework document 2010
- Opdateret indikatorsæt 2020

# DEFINITION

## BÆREDYGTIG AFVÆRGE

”Elimination og/eller kontrol af uacceptable risici på en sikker og rettidig måde mens den **miljømæssige, sociale** og **økonomiske** værdi af arbejdet optimeres

ISO 18504:2017




*Figur fra SurF UK (2010)*

# Hvordan "måler" vi bæredygtighed?

**Bæredygtighedsindikator**

"En enkeltstående **størrelse** eller et **karaktertræk**, der repræsenterer en bæredygtighedseffekt, som kan være enten positiv eller negativ, og som kan sammenlignes på tværs af alternative afværgestrategier for at evaluere deres relative præstation".

ISO 18504:2017

Indikatoroverskrifter *ISO* 18504:2017

| Økonomi | Samfund | Miljø |
|---|---|---|
| Direkte omkostninger og gevinster | Sundhed og sikkerhed | Luft |
| Indirekte omkostninger og gevinster | Etik og lighed | Jord og terræn |
| Beskæftigelse og beskæftigelseskapital | Lokalområde | Grundvand og overfladevand |
| Afledte omkostninger og gevinster | Lokalsamfund og involvering | Økosystemer |
| Projektets levetid og fleksibilitet | Usikkerhed og evidens | Ressourceforbrug og affald |

**Eksempler på indikatorer**

Omkostninger

Kr.

Gener for lokalsamfund

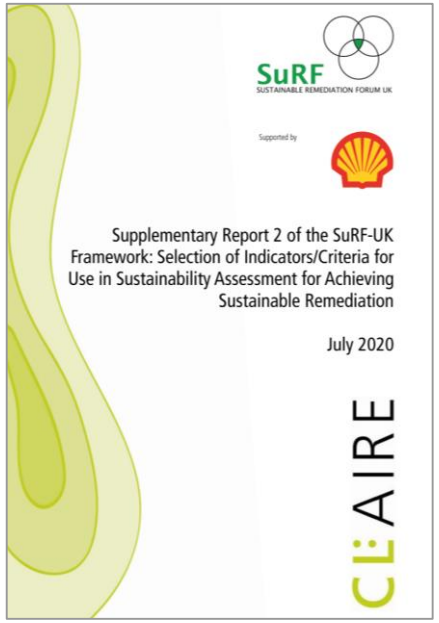
Drivhusgasemission

Kg $CO_2$-ækv.

# Valg af bæredygtighedsindikatorer

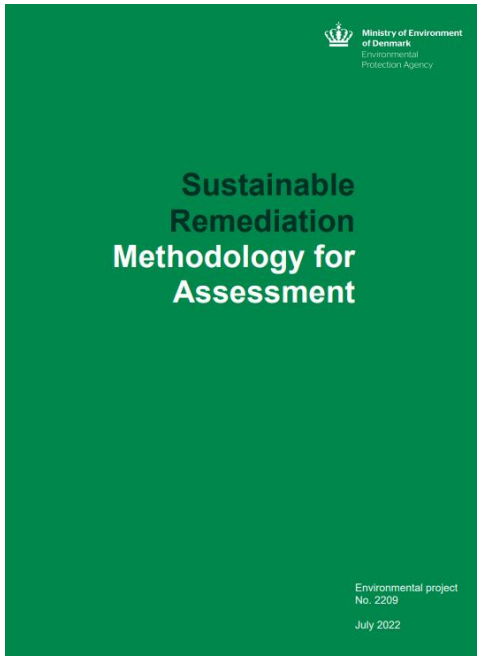
- ✓**SURE by Rambøll**: >70 indikatorer fordelt på de 3 dimensioner kan tilvælges i det online værktøj.
- ✓Indikatorer fra SuRF UK (2020)
- ✓Fleksibelt - indikatorer kan til- og fravælges

https://sure.ramboll.com/




SuRF UK (2020): Supplementary Report (SR2)

- ✓**Miljøprojekt 2209:** Metodebeskrivelse og udarbejdelse af to indikatorsæt:
  - ✓ Indledende vurdering: 21 udvalgte indikatorer
  - ✓ Detaljeret vurdering: 49 udvalgte indikatorer
- ✓Projektet har involveret 3 danske regioner



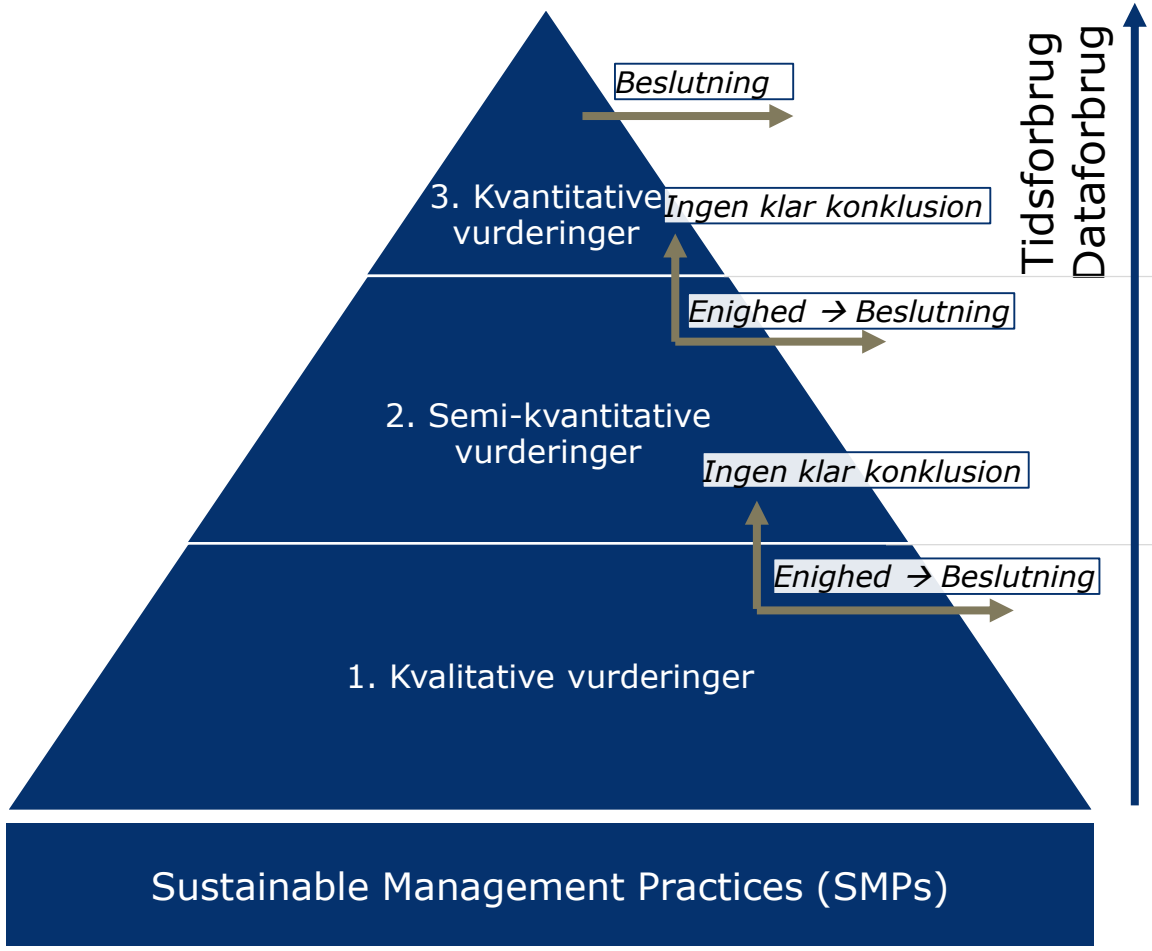

Miljøprojekt 2209. Sustainable Remediation. Methodology for Assessment

# Metoder og værktøjer ifølge ISO

- ISO anviser *ikke* specifikke værktøjer
- Beskriver en række principper for vurdering og trin der skal gennemgås

# Kvalitative, semi-kvantitative eller kvantitative vurderinger

Start simpelt ud




*Modificeret efter Bardos et al. (2016) samt SuRF UK (2020)*

3. **Kvantitative vurderinger:** fysiske opgørelser (f.eks. kg $CO_2$-eq.), livscyklusvurderinger, cost-benefit analyser

2. **Semi-kvantitative vurderinger**: Kvalitative udsagn udtrykt som score

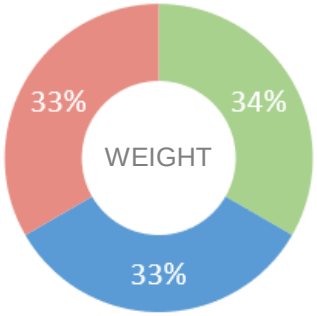
1. **Kvalitative vurderinger:** baseret på kvalitative udsagn


| | Environ-ment | Economy | Social |
|---|---|---|---|
| Remediation alternative 1 | | | |
| Remediation alternative 2 | | | |
| Remediation alternative 3 | | | |

# Multikriterievurderingsmetoder

- *Relativ* sammenligning af alternativernes bæredygtighed baseret på et antal bæredygtighedsindikatorer
- Semi-kvantitative og kvantitative vurderinger kan kombineres

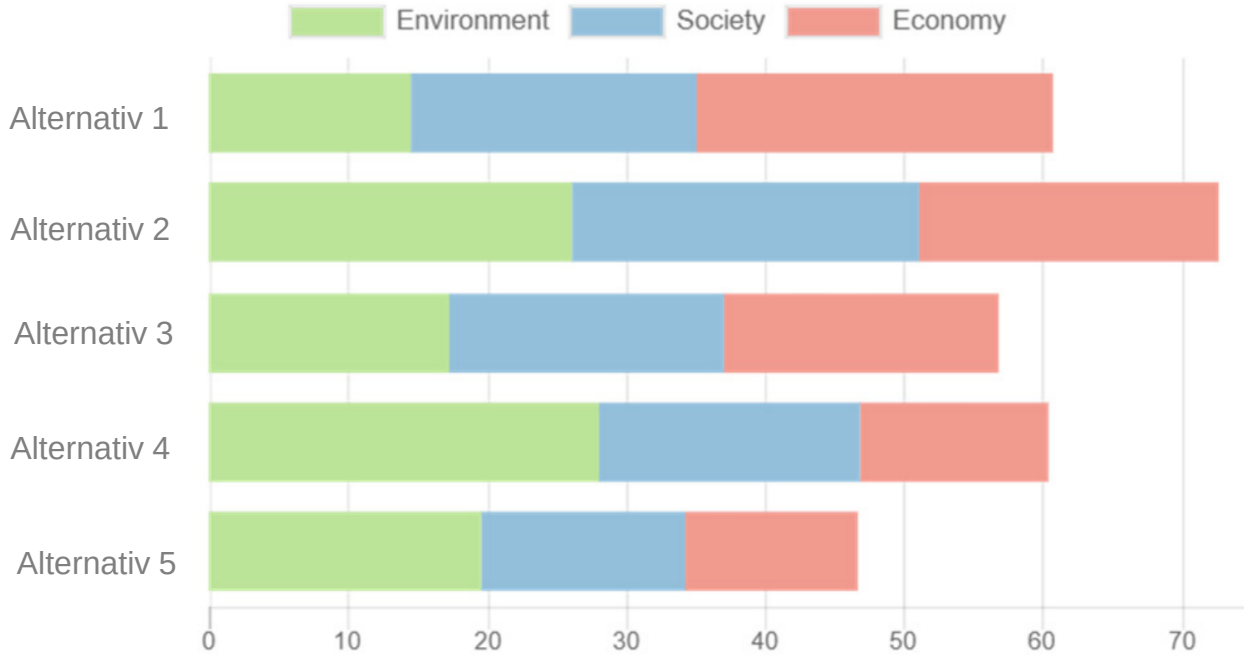
- Hvor godt klarer alternativerne sig for hver bæredygtighedsindikator? **Score**
- Hvor vigtig er den enkelte indikator? **Vægt**




**Samlet bæredygtighedsscore**

$$v(\boldsymbol{x}) = \sum_{i=1}^{n} w_i v_i(x_i)$$

$v(\boldsymbol{x})$ = Total bæredygtighedsscore
$\boldsymbol{x}$ = Alternativ
$v_i$ = Normaliseret score for indikator $i$
$W_i$ = Vægt af indikator $i$
$n$ = Antal indikatorer



# Værktøjskassen

# Værktøjskassen

## Multikriterievurderingsmetoder

**Værktøjer**

- SuRF UK tool — EXCELVÆRKTØJ: 15 indikatorkategorier
- SURE by Ramboll — ONLINE VÆRKTØJ: > 70 indikatorer fordelt på 15 indikatorkategorier
- Bæredygtig afværge (Søndergaard et al. 2014) — EXCELVÆRKTØJ: 15 indikatorer
- SCORE tool (Rosén et al. 2015) — 14 indikatorer + CBA
- Miljøstyrelsen (2022). Sustainable Remediation. Methodology for assessment — Metode og indikatorlister

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**Case studier**

- Concawe Report 11 (2023): 10 case studier med bæredygtighedsvurdering af afværge

# Værktøjskassen

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**Case studier**

- Concawe Report 11 (2023): 10 case studier med bæredygtighedsvurdering af afværge

## Miljø

**Værktøjer/tilgange**

- Livscyklusvurdering (LCA):
  - Miljømæssige påvirkninger fra jordforureningsundersøgelser (igangværende)
  - RemS (Screening-LCA for udvalgte afværgemetoder)
  - US EPA Footprint tool
- Kvalitative vurderinger

## Samfund

**Værktøjer/tilgange**

- Kvalitative vurderinger
- Input fra interessenter

## Økonomi

**Værktøjer/tilgange**

- Life cycle cost (LCC)
- Cost-benefit analyse (CBA)
- Kvalitative vurderinger

# Concawe
## Eksempel på case studie

**Kvalitativ vurdering**

**Table 4: Qualitative assessment summary.**

| Indicator Category | Attenuation Based | Dual Phase Extraction |
|---|---|---|
| Environmental | Better | Worse |
| Social | Equal | Equal |
| Economic | Better | Worse |
| Overall | Better | Worse |

| Assessment Criteria | SuRF-UK Category Code | Remediation Options for Assessment | | Justification |
|---|---|---|---|---|
| | | Attenuation Based | Dual Phase Extraction | |
| *Environmental* | | | | |
| Emissions to air | ENV1 | Better | Worse | Emissions to air will be greatest for dual phase extraction given the more intensive installation, commissioning and Operation & Maintenance regime required compared with an 'attenuation-based' approach. |
| Soil and ground conditions | ENV2 | Equal | Equal | Both options expected to have comparable impact on soil quality. Neither is expected to significantly impact geotechnical quality of soil as ground disturbance will be minimal under either approach. |
| Groundwater and surface water | ENV3 | Equal | Equal | Dual phase extraction will require groundwater abstraction. It is considered unlikely this would have an impact on the aquifer beyond the site footprint. Treated water could be discharged via existing site drainage facilities. Both approaches will result in long-term improvement in groundwater quality within the aquifer. |
| Natural resources and waste | ENV5 | Better | Worse | Resource consumption is an aspect where 'attenuation based' approaches are always likely to rank more favourably against alternatives. Waste generation will also be reduced. |
| *Social* | | | | |
| Human health and safety | SOC1 | Better | Worse | Health and safety represents a key priority for all stakeholders given the operational nature of the facility. An 'attenuation based' approach will inherently offer a lower level of site exposure during its deployment, compared to an approach requiring a greater degree of Operation & Maintenance. |
| Neighbourhoods and locality | SOC3 | Equal | Equal | Both options represent relatively low intensity remedial solutions and against the baseline of existing site operations, as such the impact of these to local communities is considered likely to be negligible. |
| Uncertainty and evidence | SOC5 | Worse | Better | NSZD represents a novel remedial option with a limited track record as an applied remedial solution, particularly in the UK. Regulatory support to continue the assessment was obtained following the initial trial however, it is acknowledged that a formal 'attenuation based' approach carries a higher degree of uncertainty, compared to a more established approach. |
| *Economic* | | | | |
| Direct economic costs and benefits | ECON1 | Better | Worse | 'Attenuation based' approaches represent a relatively low cost solution providing they can achieve the necessary soil and groundwater quality improvements. |
| Indirect economic costs and benefits | ECON2 | Better | Worse | Indirect economic benefits associated with NSZD include the lack of disruption to routine site operations and the ability for the site owner to redeploy financial resources (due to the lower cost profile highlighted in ECON1), into other site wide improvements. |
| Project lifespan and flexibility | ECON5 | Worse | Better | An NSZD based approach requires a significant timespan. The technical feasibility of the approach depends on the continuing satisfaction of a number of boundary conditions. Key amongst these for this project are the absence of a change in land use within or adjacent to the study area, as well as the conceptual site model continuing to support the strategy. A significant phase of data gathering was required to establish, with sufficient confidence (for both the client and regulator) that NSZD was a viable potential remedial option. It is anticipated that collection of such a supporting dataset would continue to be a key focus for all stakeholders on other such projects. |

*Reference: Case Studies and Analysis of Sustainable Remediation Techniques and Technologies. Concawe report no. 11/23*

# Concawe
## Eksempel på case studie

Semi-kvantitativ vurdering

Table 1: Tier 1 Sustainability Assessment Indicators and Scoring (Output of the SuRF-UK Tier 1 Sustainability Assessment Tool).

| Technology | | Sheen Mitigation - Remediation Technologies | | | | |
|---|---|---|---|---|---|---|
| | | Groundwater pumping and treatment of LNAPL | Sheen capture (installation of temporary sorbent booms | OBB to capture, retain and degrade sheen | ISS | Excavation and disposal of impacted soils |
| **Social Indicators** | | | | | | |
| Human Health and Safety | Long Term | No Risk to Human Health Receptors based on existing Conceptual Site Model | | | | |
| | Short Term, e.g. site workers | 2 | 2 | 2 | 1 | 1 |
| Ethics and Equity | | 1 | 2 | 3 | 1 | 2 |
| Neighbourhood and Locality | | 2 | 2 | 3 | 2 | 1 |
| Communities and Community Involvement | | 2 | 2 | 2 | 2 | 2 |
| Uncertainty and Evidence | | 2 | 2 | 2 | 2 | 3 |
| **Social Score** | | **9** | **10** | **12** | **8** | **9** |
| **Economic Indicators** | | | | | | |
| Direct Economic Costs and Benefits | | 1 | 2 | 2 | 1 | 1 |
| Indirect Economic Costs and Benefits | | 1 | 1 | 3 | 3 | 3 |
| Employment & Employment Capital | | 3 | 2 | 3 | 3 | 3 |
| Project Lifespan | | 2 | 2 | 2 | 3 | 3 |
| Project Flexibility | | 2 | 3 | 3 | 2 | 3 |
| **Economic Score** | | **9** | **10** | **13** | **12** | **13** |
| **Environmental Indicators** | | | | | | |
| Air Quality / Climate Change | | 2 | 3 | 3 | 3 | 2 |
| Soil and Ground Conditions | | 1 | 1 | 2 | 2 | 3 |
| Groundwater and Surface Water | | 3 | 2 | 3 | 2 | 2 |
| Ecology | | 2 | 2 | 2 | 1 | 1 |
| Natural Resources and Waste | | 2 | 3 | 3 | 1 | 0 |
| **Environmental Score** | | **10** | **11** | **13** | **9** | **8** |
| **Overall Summary** | | | | | | |
| **Overall Score** | | **28** | **31** | **38** | **29** | **30** |

*Reference: Case Studies and Analysis of Sustainable Remediation Techniques and Technologies. Concawe report no. 11/23*

# Trinvis tilgang

## Miljøprojekt 2209: Sustainable Remediation. Methodology for Assessment

### Prerequisites for the sustainability assessment

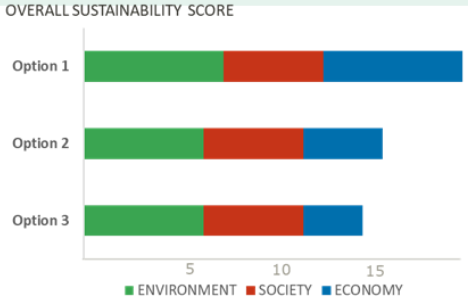
- The site has been prioritized for a remedial action/risk reducing action
- A remedial target/risk reduction target has been defined
- Two or more alternatives for remediation/risk reduction that comply with the remedial targets have been selected

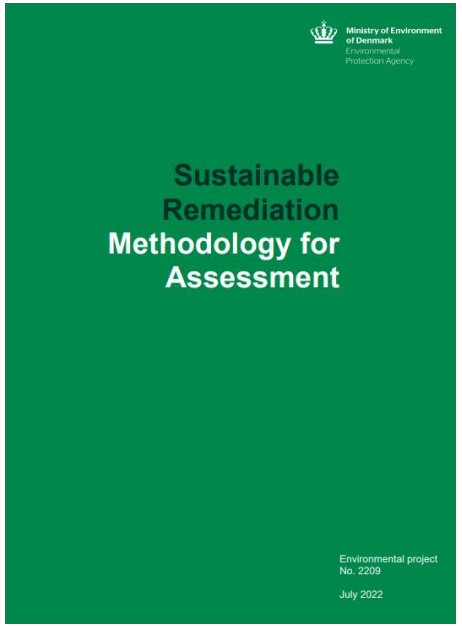
### TIER 1: Initial sustainability assessment

- Qualitative or semi-quantitative assessments
- Limited time use
- Relevant for smaller remediation projects, e.g. during a first screening of remediation alternatives

### TIER 2: Detailed sustainability assessment

- Semi-quantitative or quantitative assessments (LCA, CBA etc.)
- Stakeholder involvement
- More time consuming
- Relevant for larger remediation projects




Miljøprojekt 2209. Sustainable Remediation. Methodology for Assessment

# Indledende afklaringer ved bæredygtighedsvurdering

**Formålet**
Hvilket spørgsmål skal vurderingen bringe svar på?

**Interessenter**
Identificér relevante interessenter

**Alternativer**
Kan alle alternativer opnå det formål, der er med afværgen?

**Projektets afgrænsninger**
Tid, sted, og livscyklusafgrænsninger

**Bæredygtighedsindikatorer**
Enighed blandt interessenter

**Metode**
Fastlæg hvordan hver indikator vurderes



*ISO 18504:2017*

# Interessentinddragelse

## Et nøgleaspekt ifølge ISO 18504:2017


En ***interessent*** kan direkte eller indirekte påvirke, eller blive påvirket af afværgeaktiviterne

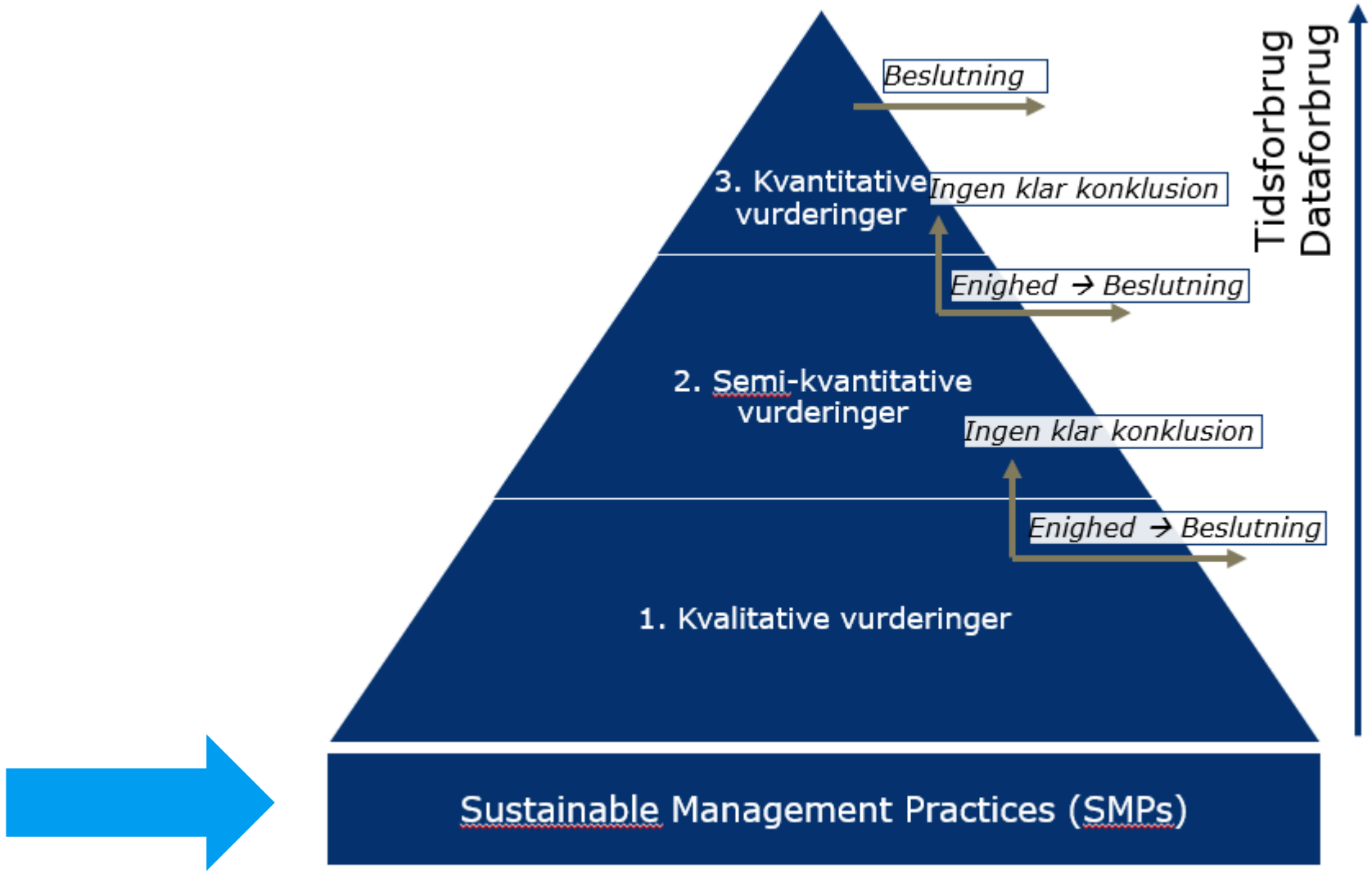
f.eks. grundejer, myndigheder, beboere, naboer, lokalsamfund, interesseorganisationer, lokale virksomheder

Interessentinvolvering er en central del af en bæredygtighedsvurdering
- vigtig kilde til information
- nødvendig for at sikre en valid proces iflg. ISO

Graden af involvering afhænger af projektets størrelse:

- **Små og simple projekter:** Grundejer, rådgiver og lokale myndigheder
- **Større og mere komplekse projekter**: Bredere interessentgruppe og dialog

# Sustainable Management Practices




*Modificeret efter Bardos et al. (2016) samt SuRF UK*

# Sustainable Management Practices Spreadsheet

## SURF UK 2021

Sustainanable management practices for forskellige projektfaser: planlægning, forureningsundersøgelse, afværge, moniteringsfase osv.

| SUSTAINABLE MANAGEMENT PRACTICE | | Sustainability Indicators | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Remediation Construction and Operation | ECON1 | ECON2 | ECON3 | ECON4 | ECON5 | ENV1 | ENV2 | ENV3 | ENV4 | ENV5 | SOC1 | SOC2 | SOC3 | SOC4 | SOC5 |
| Identify stakeholders most likely to be impacted by the activity and engage and minimise the impact on them. | √ | X | | | | | | | | | | | X | | X | X |
| Minimise vehicle miles | √√ | X | | | | | X | | | | X | X | | X | | |
| Plan to re-use boreholes through each phase of investigation, remediation and long-term monitoring | √ | X | | | | | | | | | X | X | | X | | |
| Reduce, reuse and recycle where possible. Plan your activities to reduce waste. | √√ | X | | | | | | | | | X | | | | | |
| Select suitably sized plant and equipment | √√ | X | | | | | | | | | X | | | X | | |
| Specify electronic data transfer from laboratories | √√ | X | | | | | | | | | X | | | | | X |
| Avoid drilling in the road or busy access areas where possible | √√ | | X | | | | | | | | | X | | X | | |
| Avoid drilling through confining layers without appropriate protection to prevent cross-contamination | √√ | | X | | | | | | X | | | | | | | |
| Consider self-inspection/audit procedures to ensure that permit/consent conditions are being complied with | √√ | | X | | | | | | | | | | | | | |
| Develop an Ecology Management Plan to identify and manage impacts on areas of ecological interest before disturbing the site | √ | | X | | | | | | | | | | | | | |

Ideer til at forbedre bæredygtigheden af den valgte afværge- eller undersøgelsesmetode



https://www.claire.co.uk/component/phocadownload/category/16-surf-uk-bulletins?download=818:surf-uk-smps-2021

# US EPA (2016)

## Green Remediation Best Management Practices. Site Investigations and Environmental Monitoring

**Et par eksempler**

- Reducér kørsel ved at vælge lokale entreprenører, leverandører, analyselaboratorier og jordmodtagere
- Brug undersøgelsesteknologier, der er mindre invasive:
  - f.eks. geofysiske metoder, trækerner mv.
- Reducér antallet af boringer
  - Genbrug undersøgelsesboringer ved senere afværge
  - Horisontalt boringsnetværk som alternativ til mange vertikale boringer
  - Anvende multi-level sampling
  - Anvende direct push sonderinger eller soniske boringer i det omfang det er muligt (mindre invasive, mindre opboret jord, mindre tidsforbrug)

Fokus på miljømæssig bæredygtighed

EPA United States Environmental Protection Agency

Office of Land and Emergency Management (5203P)
EPA 542-F-16-002 September 2016 Update

**Green Remediation Best Management Practices: Site Investigation and Environmental Monitoring**

*A fact sheet about the concepts and tools for using best management practices to reduce the environmental footprint of activities associated with assessing or remediating contaminated sites*

www.cluin.org/greenremediation



The U.S. Environmental Protection Agency (EPA) *Principles for Greener Cleanups* outline the Agency's policy for evaluating and minimizing the environmental footprint of activities involved in cleaning up contaminated sites.[1] Best management practices (BMPs) of green remediation involve specific activities to address the core elements of greener cleanups:

- Reduce total energy use and increase the percentage of energy from renewable resources.
- Reduce air pollutants and greenhouse gas emissions.
- Reduce water use and preserve water quality.
- Conserve material resources and reduce waste.
- Protect land and ecosystem services.

Materials & Waste, Energy, Land & Ecosystems, Core Elements, Air & Atmosphere, Water

### Overview

The need for site investigation is common to cleanups under any regulatory program. Investigative activities can occur at all points in the cleanup process, from initial site assessment through waste site closeout. A site investigation generally is undertaken to:

- Confirm the presence or absence of specific contaminants.
- Delineate the nature and extent of environmental contamination.
- Identify contaminant sources.
- Provide data for assessing potential risk to human health or the environment.
- Gather data for determining if a remedial or removal action should be taken.
- Identify site characteristics affecting remedial design, construction or operation.

Site investigation as well as long-term environmental monitoring typically involve a range of technologies and techniques to gather field measurements and collect analytical samples of soil and groundwater and often surface water, sediment, soil gas or indoor air. Investigation also may involve searching for underground storage tanks, drums or other buried objects, or evaluating demolition material containing asbestos, lead-based paint or other toxic products. Many of the same techniques and technologies may be used in later stages of a cleanup to evaluate ongoing performance of a remedy; determine the need for any modification to a remedial system; or track factors influencing anticipated closeout of a cleanup project. At certain points, site investigation and environmental monitoring both rely on data analysis or verification conducted by offsite laboratories.

Water monitoring at the New Idria Mercury Mine Superfund site in California involves use of time-interval sampling devices powered by solar energy. Collected sampling data are transmitted via satellite to a website accessible by project staff. This approach supplies a renewable source of onsite energy and reduces the frequency of staff visits to this remote site. Ongoing investigation of this site led to removal actions in 2011 and 2015.

### Project Planning

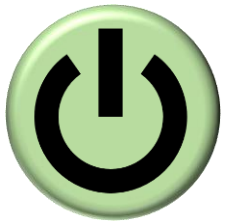
Integration of green remediation BMPs early during the project design phase will help reduce cumulative environmental footprints of a cleanup. The BMP integration process involves selecting BMPs most suitable for the site's unique contamination scenario, potential remedies and anticipated site reuse. BMPs to be considered when planning a site investigation include:

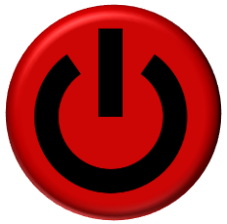
- Schedule activities for suitable seasons to reduce the amount of fuel needed for heating or cooling equipment and supplies.
- Select service providers, product suppliers and analytical laboratories from the local area and consolidate the service and delivery schedules.

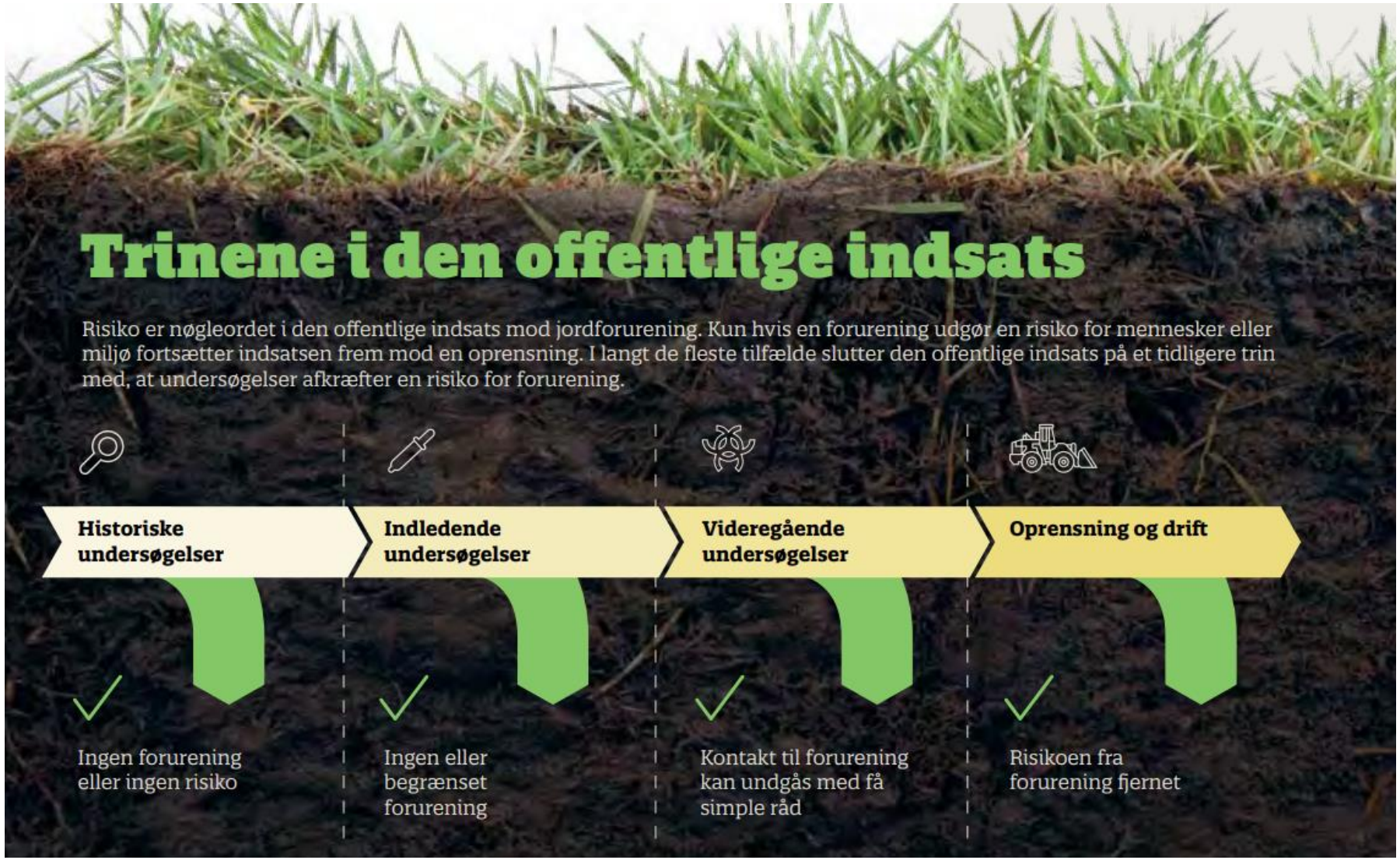
The ASTM *Standard Guide for Greener Cleanups* outlines a process for identifying, screening and selecting BMPs to minimize the environmental footprint of site-specific cleanup activities.[2]

# Risikovurdering er central!

- Hvornår er afværge nødvendig?
- Hvornår kan afværge stoppes?







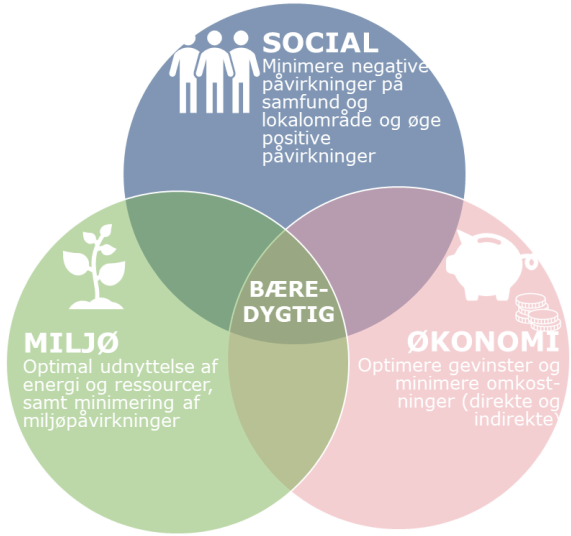

*Figur stammer fra Bevar jordforbindelsen. Regionernes arbejde med jordforurening. Maj 2023*

# Værktøjskassen – hvad mangler vi?

- LCA-screeningsværktøj for afværgeløsninger
- Sustainable Management Practices (SMPs)
  - For danske forhold
  - For den miljømæssige dimension – gerne funderet på LCA

# Opsummering

- Bæredygtighedsvurdering inkluderer en sammenligning af påvirkninger for miljø, samfund og økonomi

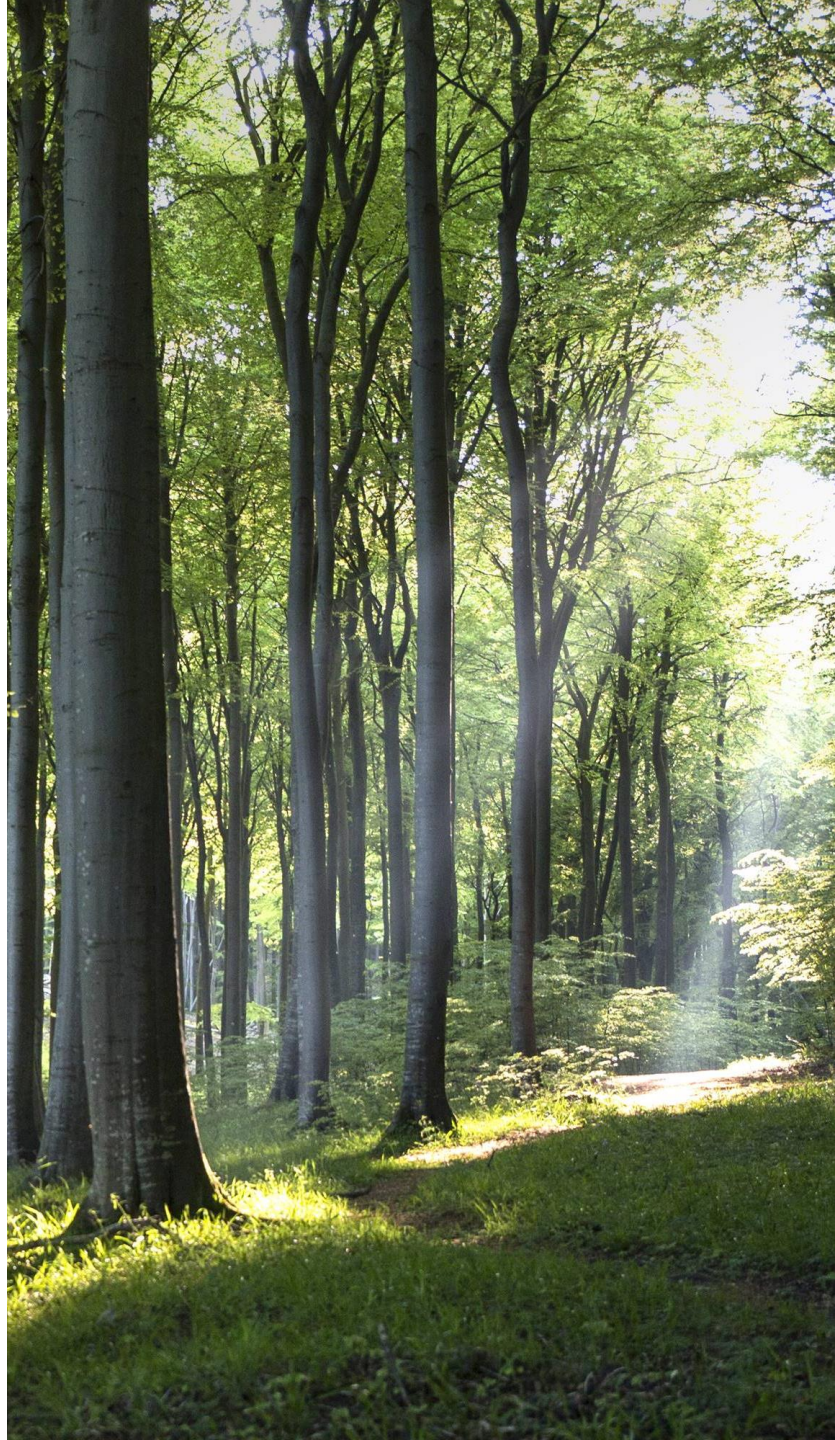



- Interessentinvolvering er et nøgleprincip og vigtigheden øges i takt med projektets størrelse

- Vi har værktøjerne til multikriterievurdering

- Vi mangler et opdateret og standardiseret værktøj til LCA-screening af afværgeteknologier

- Sustainable Management practises



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# Tak for opmærksomheden

*Spørgsmål?*

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RAMBØLL

Bright ideas.
Sustainable change.

# Nøgleprincipper
## ISO 18504:2017

For at kunne hævde at afværgen er så bæredygtig som muligt under de givne betingelser skal følgende principper være overholdt:

- lovmæssige krav ifm. afværge er afklaret

- **uacceptable risici i forhold til menneskers sundhed og økosystemer er ikke tilstede** efter afværgen er udført

- **ingen uacceptable risici forbundet at udføre arbejde eller for det omgivende samfund** skabes af afværgeaktiviteten

- en **transparant beslutningsproces baseret på evidens og videnskab** er udført

- god ledelse og **interessentinvolvering** er anvendt