Madeira Oil Terminal: sustainability assessment of remedial options

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Madeira Oil Terminal: sustainability assessment of remedial options

Overview

- Background to site and context of sustainability assessment
- Assessment process
- Application of URS tool
- Results & conclusions

Background

- Facility operated from 1962 to 2007 as a marine distribution terminal
- Site ceased operation in 2007 and operational infrastructure subsequently decommissioned and demolished
- Redevelopment plan in place to create a new hotel and agreed with relevant stakeholders
- Remedial action plan identified excavation and thermal treatment as favoured approach – driven largely by timescale available for remedial works
- Redevelopment plan suspended on account of economic conditions

➢ *Removal of time constraints associated with the previous remedial plan presented opportunity for review of alternative and potentially more sustainable remedial approaches*

Shell's Corporate Policy – Key Elements

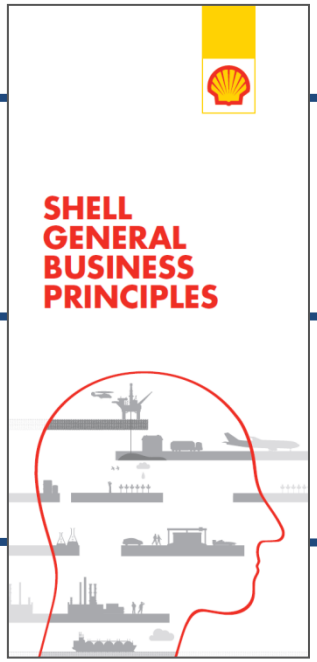
Shell's view of sustainable development encompasses:

- Balancing short- and long-term interests in a way that allows integration of economic, environmental and social considerations into business decisions

"Long-term profitability is essential..."

"...balancing short and long term interests..."

"...integrating economic, environmental and social considerations into business decision-making..."



"...reduce the environmental impact of our operations, products and services..."

"...be good neighbours... manage the social impacts of our activities... enhance benefits to local communities..."

"...regular dialogue and engagement with our stakeholders is essential..."

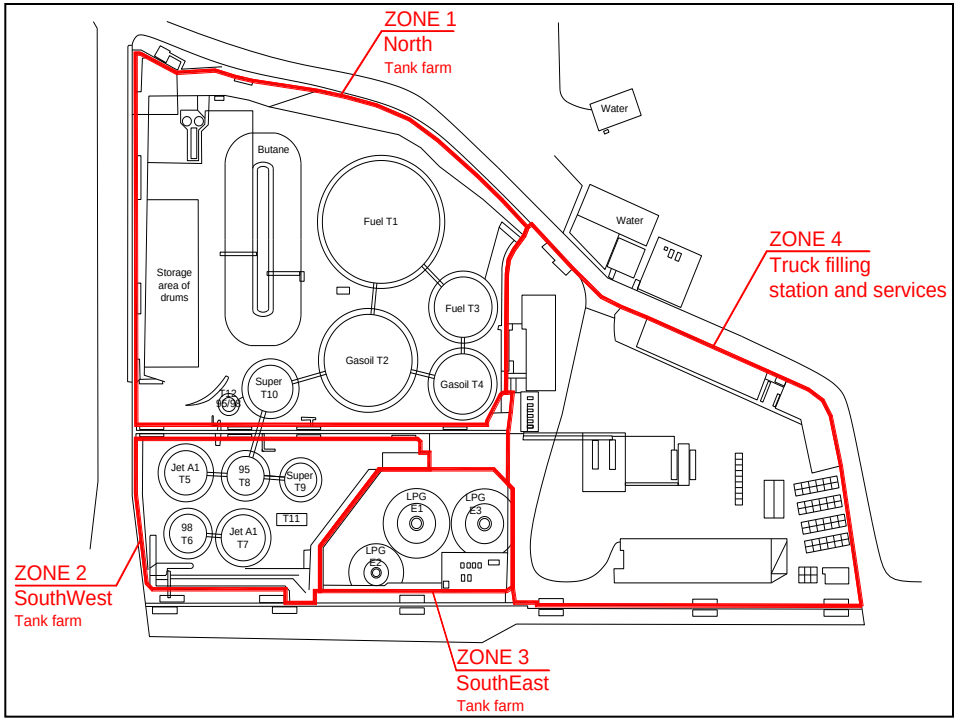
Objective of Study

To review a range of alternative remedial options, taking greater account of sustainability factors, thereby identifying whether an alternative approach to thermal treatment may have more favourable economic, environmental and social impacts

Aerial Photograph of the Site

Conceptual Site Model and Risk Assessment

- Contamination predominantly heavy fuel oil (TPH>C22) with some middle distillates
- Required treatment standard varies according to redevelopment scenario



Assessment Process

- **Task 1** - Initial collation of relevant site and project data including views of external stakeholders
- **Task 2** - Workshop attended by the project team
- **Task 3** - Collation of additional data required to complete the assessment and development of options
- **Task 4** - Completion of the assessment
- **Task 5** - Reporting

Task 1 – Initial Collation of Relevant Site Data

- Summarising of business/site objectives
- Identification of relevant stakeholders
- Collation of site investigation data and other relevant documentation

Task 2 – Initial Workshop Attended by Project Team

- Workshop attended by:
  - **Shell (S&GW technical specialists and site program manager)**
  - **URS (existing project team and sustainability assessment specialists)**
- To establish context, objectives and boundaries of assessment
- To consider views of relevant stakeholders
- To identify end use scenarios
- To agree upon remedial options
- To identify / agree on relevant categories of indicators (assessment criteria) for economic, environmental and social aspects and associated weighting
- To determine the nature (format and tier) of assessment

Task 2 – Establishment of Boundaries of Assessment

- Time – duration of the remedial works
- Spatial – limited to the island itself
- Lifecycle – mobilisation and demobilisation of specialised equipment to the site

Task 2 – Consideration of Stakeholders Views

- Shell
- Madeira Regional Environmental Agency (MREA)
- CMF (local government)
- Surrounding neighbours (adjacent hotel to the east, beach users, some adjacent residents believed to be on Shell-owned land to the north, and a number of food vendors to the west)
- Buyer/developer (not identified at the present time)

(Views of above wider stakeholders well known to project team and hence not directly consulted during this assessment)

Task 2 –Identification of Scenarios to be Included

End use	Duration of Remediation Programme	
	<18 months	5 years
In line with existing site master plan	Scenario 1	Scenario 2
Unrestricted end use	Scenario 3	Scenario 4
Updated site master plan	Scenario 5	Scenario 6

Task 2 – Agreement upon Remedial Options

- Application of in-situ approaches discounted
- Focus of the assessment upon options for the treatment/disposal of excavated material
- 5 soil treatment/disposal options were identified
  - *Thermal desorption*
  - *Land farming*
  - *Enhanced bioremediation*
  - *Soil washing*
  - *Excavation and disposal*

Task 2 – Agreement on Relevant Assessment Criteria and Associated Weightings

Theme	Assessment Criteria	Assigned Weighting	Key Relevant Indicators	Additional Notes / Justification
Economic	Direct Economic Costs and Benefits	5	Direct financial benefits of remediation for organisation	- Key factors to client are the cost of remediation works and maximising sale value of site
	Project lifespan and Flexibility	3	Ability of project to respond to changing circumstances (incl. discovery of additional contamination, different soil materials, different timescales)	- Focus within this criterion is the potential influence of changing circumstances upon overall cost (approaches with lower unit rates likely to be favoured) - For short remediation period scenarios (<18 months) there may be limited flexibility regardless of approach
Environmental	Impacts on Air	5	Greenhouse gases (CO_2, CH_4, N_2O) VOCs	- Note potential conflict of CO_2 emission and VOC emission (less intensive approach may have lower carbon footprint, however give rise to greater VOC emission) - Greenhouse gases arising from burning of fossil fuels
	Natural Resources and Waste	5	Impacts on waste resources (e.g. landfill space) Handling of materials on-site, off-site and waste disposal sources Water abstraction, use and disposal	- Potential existence of suitable landfill facilities on the island
Social	Human Health & Safety	5	Can unacceptable risks be mitigated? Extent of risks to site workers (from bio aerosols, allergens, particulate matter , etc.) 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, excavation etc.)	- Criteria relates specifically to site workers and intruders. If a risk to off-site receptors exists, then the approach will not be undertaken - The period of remedial works is important and lower duration alternatives will be favoured - Note that it is assumed that hydrocarbon vapour emissions may be controlled within acceptable limits with all options
	Neighbourhood and Locality	5	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	- The period of remedial works is important and lower duration alternatives will be favoured.
	Compliance, Uncertainty and Evidence	1	Compliance of the work with policies, regulatory standards and good practise set out by the local authority and nationally 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	- Client will comply with policies, regulatory standards etc. - Consider the extent to which the plans may cope with variation. Flexible options will be favoured - Consider potential consequences of a change in the current CSM identified through further investigation

Task 3 – Development of Options

Consideration	Option					*Relevant Pillar*
	1	2	3	4	5	
Likely origin of treatment plant						*Environmental*
CO_2 emissions						*Environmental*
Fugitive vapour emissions						*Environmental*
Water consumption						*Environmental*
Wastewater disposal						*Environmental*
Reuse of treated material on site						*Environmental*
Fugitive vapour emissions						*Environmental and Social*
Likely unit treatment cost range						*Economic*
Labour requirements						*Economic*
Potential programme cost range						*Economic*
Indicative programme duration						*Social*
Likelihood of achieving SSTLs						*Various*
Treatment plant footprint						*Various*
Processing rate						*Various*
Other factors						*Various*

Task 3 – Development of Options - Example

	On site thermal desorption	On site bio treatment (simple land farming approach)	On site bio treatment (more intensive approach)	On site soil washing	Disposal of soils at facility off the island	***Relevant Indicators***
Likely origin of treatment plant	Northern Europe (assumed distance 2000 - 2500 nautical miles and 250 - 500 land miles)	Equipment for treatment process sourced locally	Northern Europe (assumed distance 2000 - 2500 nautical miles and 250 - 500 land miles)	Northern Europe (assumed distance 2000 - 2500 nautical miles and 250 - 500 land miles)	Northern Europe (assumed distance 2000 - 2500 nautical miles and 250 - 500 land miles)	*Environmental - Impacts on Air*
Water consumption	High water consumption required for cooling of treated soils. Estimated water consumption 5 - 20 m3/hour.	Periodic moisture addition required. (10,000 m3/year)	Initial and periodic moisture addition required. Estimated over 10.000 m3 per year.	Likelihood of water recycling during the process. Estimated water consumption 2 - 10 m3/hour.	No water consumption	*Environmental - Natural Resources and Waste*
Wastewater disposal	Dependent upon scenario and associated depth of excavation	Dependent upon scenario and associated depth of excavation	Dependent upon scenario and associated depth of excavation	Dependent upon scenario and associated depth of excavation	Dependent upon scenario and associated depth of excavation	*Environmental - Natural Resources and Waste*
Reuse of treated material on site	Yes	Yes	Yes	Yes (some material taken off site)	No	*Environmental - Natural Resources and Waste*
Solid waste generation	Minimal	Minimal	Minimal	Yes (filter cake material)	Yes	*Environmental - Natural Resources and Waste*
Fugitive vapour emissions	Rate and pattern of excavation can be controlled to minimise vapour emission	Significant, given large surface area of treatment bed	Emission likely associated with mixing and stockpiling operation	Rate and pattern of excavation can be controlled to minimise vapour emission	Rate and pattern of excavation can be controlled to minimise vapour emission on site. Stockpiling at port facility would require management to minimise potential associated emission	*Environmental - Impacts on Air Social - Neighbourhood and Locality*

Task 3 – Screening of Scenarios to be Included

	Scenario					
	Existing site masterplan		Unrestricted end use		Updated site masterplan	
	<18 months	<5 years	<18 months	<5 years	<18 months	<5 years
	1	2	3	4	5	6
Remedial Option						
Thermal desorption	Y	Y	N	N	Y	Y
Land farming	Y	Y	N	P	Y	Y
Enhanced Bioremediation	Y	Y	P	Y	Y	Y
Soil Washing	Y	Y	N	N	Y	Y
Excavation and disposal	N	N	N	N	Y	Y

Key

Y	Yes - Likely to be applicable
P	Possible - Some uncertainty / constraints
N	No - Not applicable

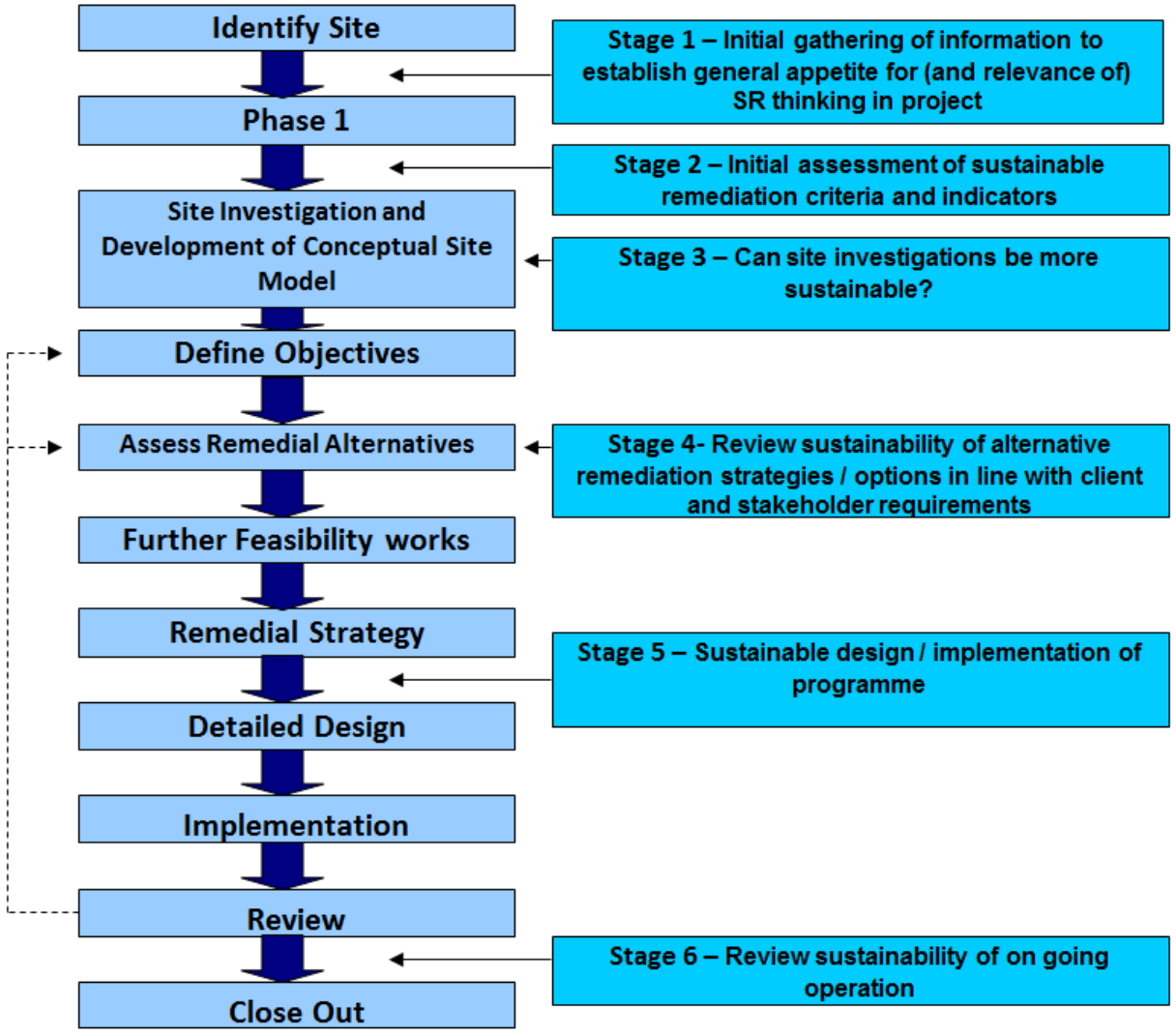
- Remedial options were reviewed against each scenario
- Limited options for Scenarios 3 and 4 so they were not included in the assessment
- Scenario 1, 2, 5 and 6 were included in the assessment

Task 4 – Completion of Assessment

- Application of URS tool
- 'Tier 1'* assessment agreed to be appropriate at initial project workshop
- Process involved a series of further workshops
- Subjectivity / sensitivity analysis

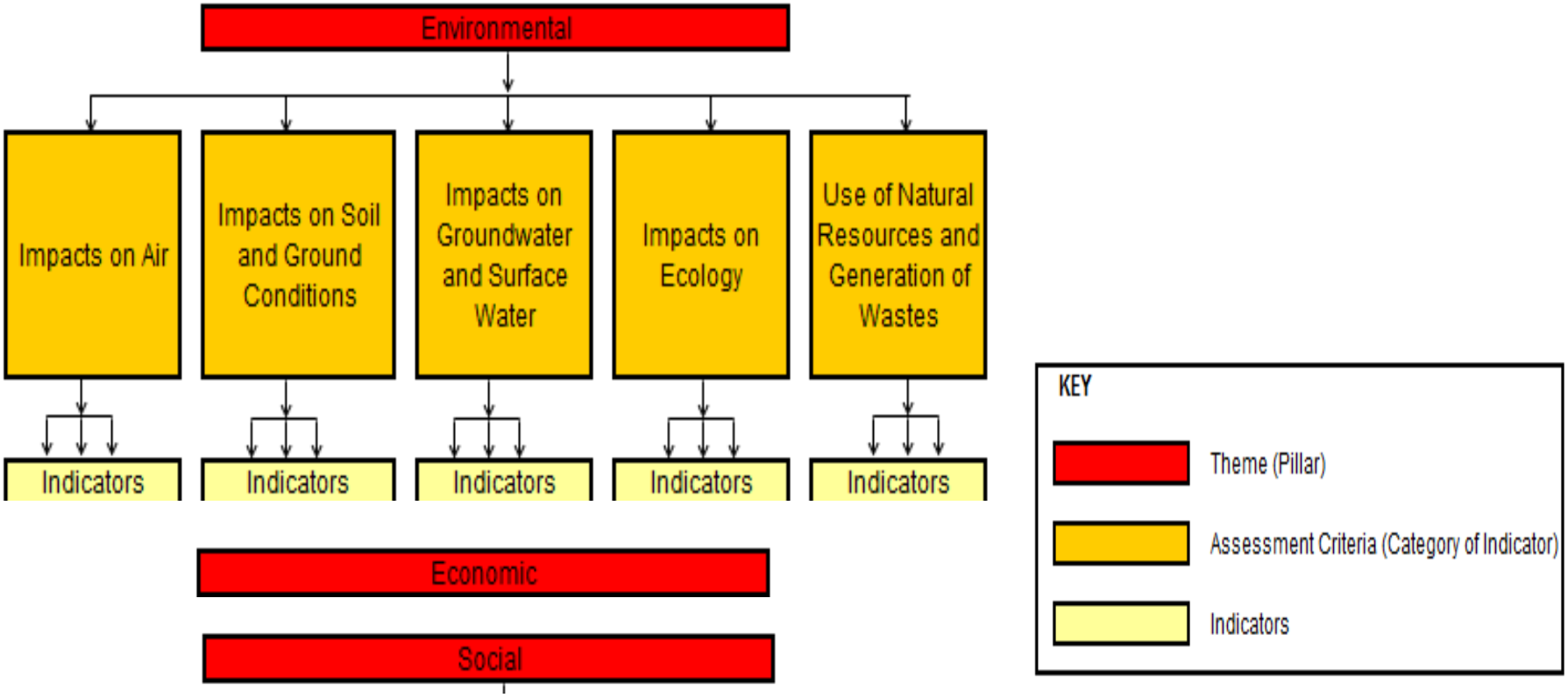
**URS nomenclature = Semi-quantitative based on Criteria (holistic)*

Illustrating the URS Tool



URS Tool – Stage 4: Semi-Quantitative Weighting

- Assessment criteria weighted according to client / stakeholder preferences and requirements
- Options scored according to the criteria ('Tier 1')



Results

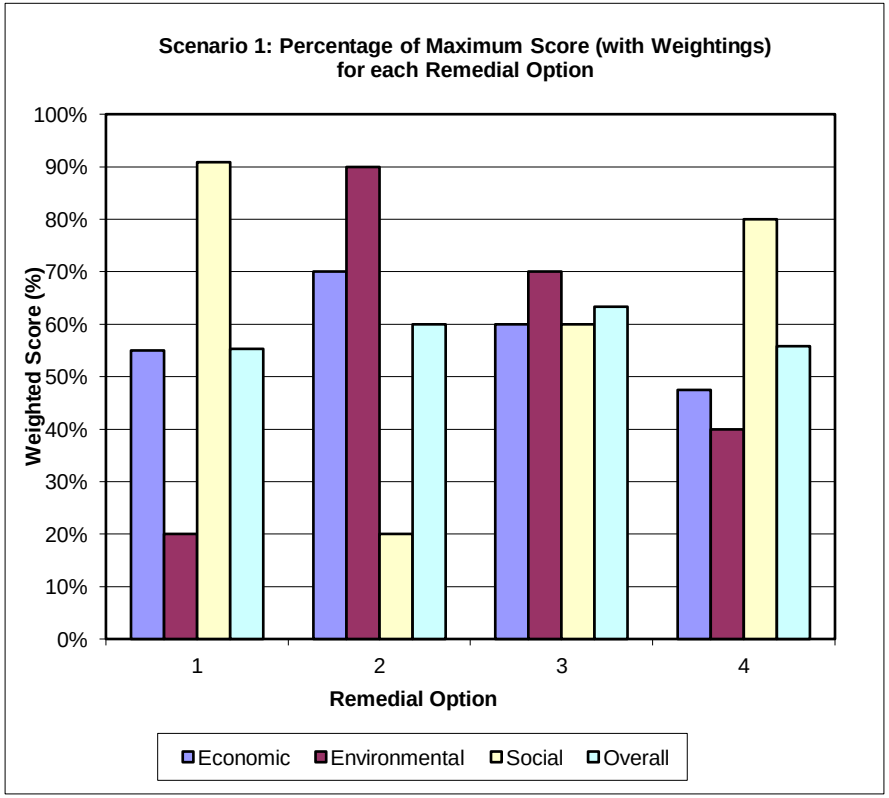
Summary of Scoring for Scenario 1: Existing Masterplan (17,500 tonnes) in less than 18 months

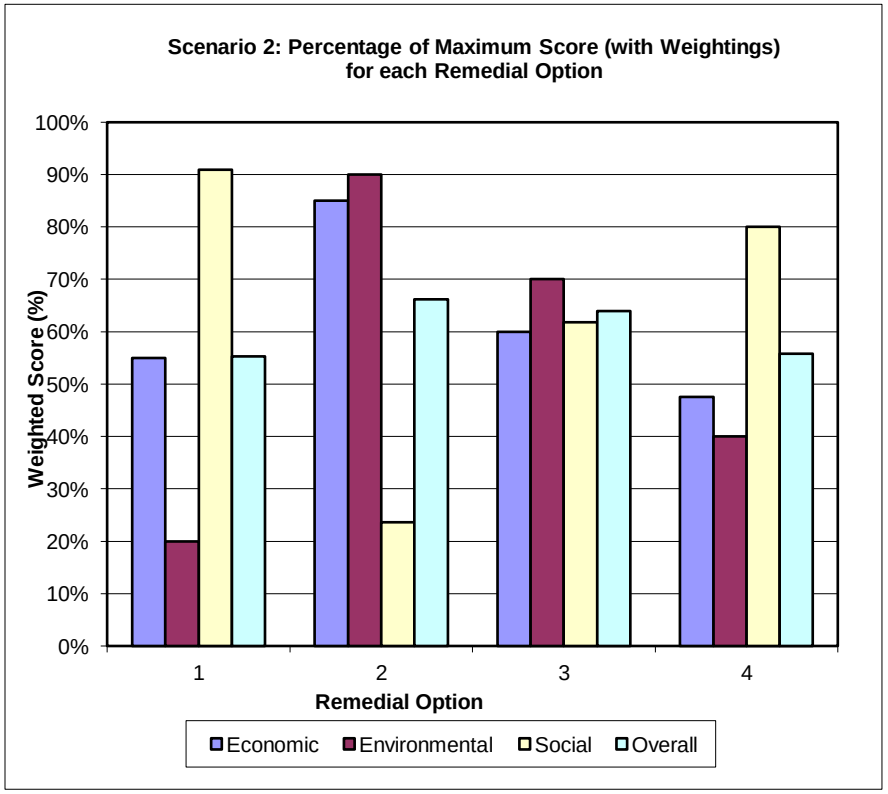
Theme	Assessment Criteria	Weight	Remediation Option*				Justification of Scores
			1	2	3	4	
Economic	Direct Economic Costs and Benefits	5	2	5	3	2	- Based upon cost estimates
	Indirect Economic Costs and Benefits	0	0	0	0	0	
	Employment and Employment Capital	0	0	0	0	0	
	Induced Economic Costs and Benefits	0	0	0	0	0	
	Project Lifespan and Flexibility	3	4	1	3	3	- Rates for thermal and soil washing are broadly similar and both are flexible for changing quantities. As volumes increase, costs will increase. Thermal is the most flexible - Some uncertainty is associated with bio option and higher quantities - Limited flexibility for land farming option given short period available for remediation
Environmental	Impacts on Air	5	1	4	3	2	- Highest CO_2 footprint likely to be associated with thermal approach (followed by soil washing) - Whilst lowest footprint is likely to be associated with land farming, it is likely to give rise to greatest VOC emissions but the overall impact of this is likely to be less than the impact of enhanced bio and soil washing
	Impacts on Soil and Ground Conditions	0	0	0	0	0	
	Impacts on Groundwater and Surface Water	0	0	0	0	0	
	Impacts on Ecology	0	0	0	0	0	
	Use of Natural Resources and Waste Generation	5	1	5	4	2	- Thermal approach involves high energy consumption - Land farming requires minimal consumption of fuel and fuel consumption for enhanced bio is also low - Soil washing involves relatively high water and power consumption and generates filtercake which is assumed to go for off site/off island disposal
Social	Impacts on Human Health and Safety	5	5	1	3	4	- Safety of thermal process can be managed with associated process control. thermal approach also minimises time on site so on this basis scores highly - Bio approaches (particularly land farming) involve longer period of works on site, so workers are potentially exposed to higher risk - Safety of soil washing unit can be managed through process control and operating procedures
	Ethics and Equality	0	0	0	0	0	
	Neighbourhood and Locality	5	4	1	3	4	- Dust impacts are likely to be greatest for land farming and (to a lesser extent) enhanced bio approach - Potential odour issue is likely to be greatest with land farming and (to a lesser extent) enhanced bio as a result of large stockpile and bio bed - Daily operations associated with all approaches to be restricted, however thermal and soil washing will have overall shorter programme duration (minimising potential dust, light, noise, vibration issues)
	Communities and Community Involvement	0	0	0	0	0	
	Compliance, Uncertainty and Evidence	1	5	1	3	4	- All scenarios expected to be reasonably flexible to changes in extent - Land farming is the least flexible option given uncertainties of achieving treatment standards within limited available period - Thermal approach most able to deal with changes in contaminant levels

Remediation Options: (1) Thermal Desorption (2) Land Farming (3) Enhanced Bioremediation (4) Soil Washing

Results

- **Scenario 1: Existing Masterplan (17,500 tonnes) in < 18 months: high clean up standards**
- **Scenario 2: Existing Masterplan (17,500 tonnes) in 5 years: high clean up standards**

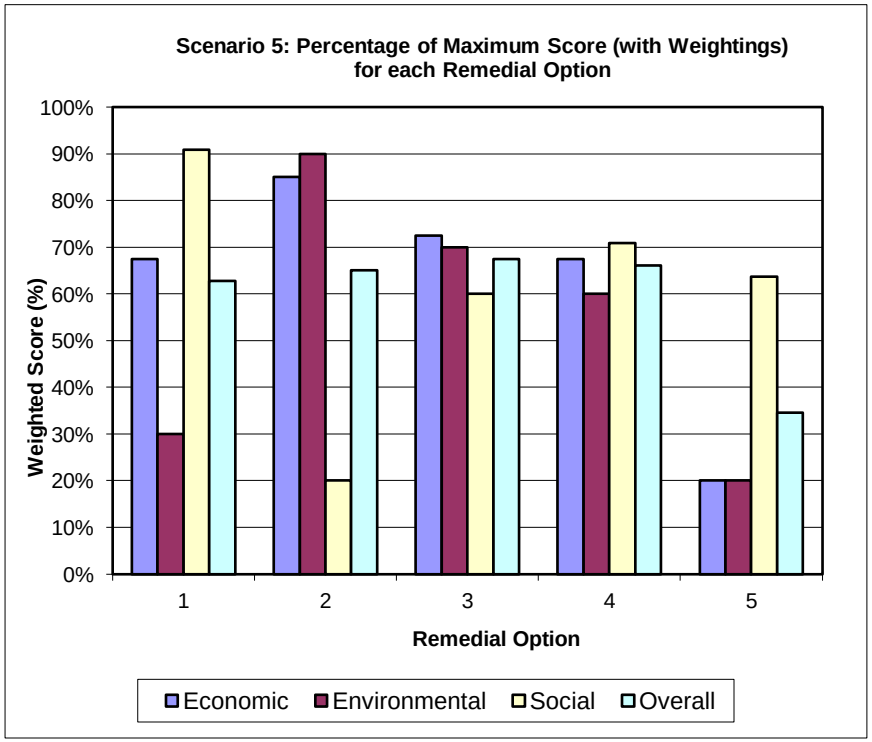


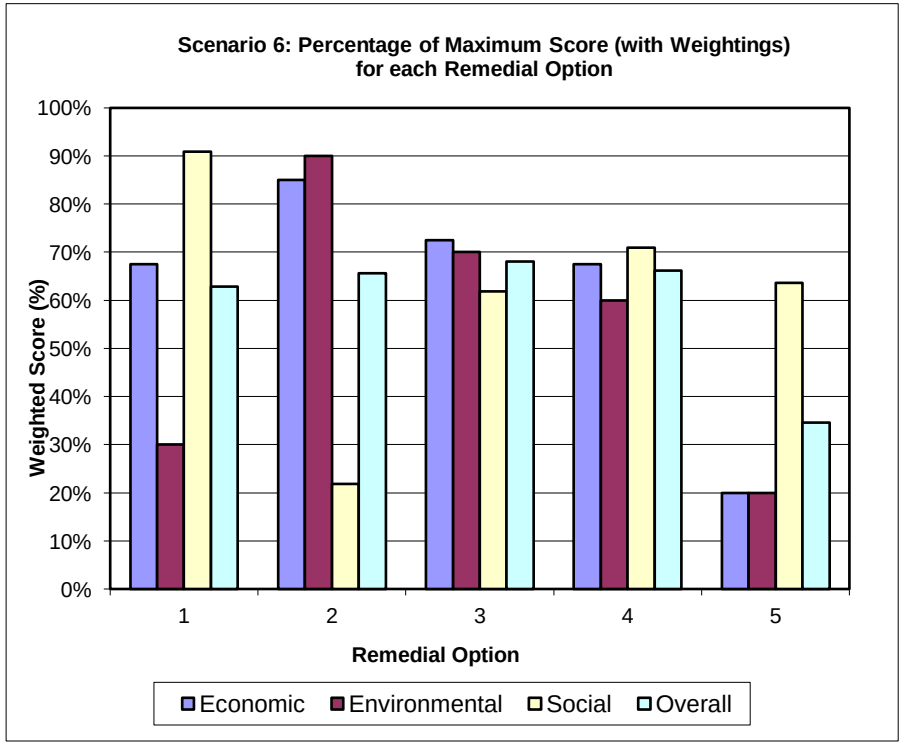


Remediation Options: (1) Thermal Desorption (2) Land Farming (3) Enhanced Bioremediation (4) Soil Washing

Results

- **Scenario 5: Updated site Masterplan (9,000 tonnes) in < 18 months: less onerous clean up criteria**
- **Scenario 6: Updated site Masterplan (9,000 tonnes) in 5 years: less onerous clean up criteria**





Remediation Options: (1) Thermal Desorption (2) Land Farming (3) Enhanced Bioremediation (4) Soil Washing (5) Excavation & Disposal

Task 5: Reporting and conclusions

- Enhanced bioremediation approach likely to represent the most sustainable and appropriate remedial solution for the site

- Adoption of an enhanced bioremediation approach would represent a change of the original strategy – as the original time constraints are no longer applicable, there is an alternative more sustainable solution (economic, environmental, social)

- Assessment also highlighted specific indicators that should be addressed in detailed implementation planning for enhanced bioremediation approach (potential dust and odour issues)

- Identification of uncertainties

Lessons Learnt

This was a pilot project so during the progression of this assessment the following aspects became evident:

- Remedial options should be defined to an appropriate degree before proceeding with the sustainability assessment.
- The context of the assessment should be discussed at an early stage between the project team.
- Benefit could have been gained from further discussion with stakeholders to help to clarify and develop understanding of the 'average' scores given to the social aspects as in the sustainability assessment outcomes section.
- The assessments undertaken illustrate that whilst a given option may score significantly differently on specific indicators or categories of indicators, the overall scores typically illustrate a more balanced picture, with fewer differentials between the options.
- Generation of benefits should be viewed in the context of the regeneration scheme as a whole rather than just remediation alone.

Acknowledgements

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