RP 549: Planning the Processing of Waste arising from a Marine Oil Spill:

Part 3: Post Incident Planning

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ABBREVIATIONS, ACRONYMS AND GLOSSARY OF TERMS

ADR	European Agreement concerning the international carriage of Dangerous goods by Road
API	American Petroleum Institute
BOSCA	British Oil Spill Control Association
BRGM	Bureau de Recherches Géologiques et Minières
BSW	Bottom Sediment and Water
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CAPEX	Capital expenditures
CCW	Countryside Council for Wales
Cedre	Centre de documentation, de recherche et d'expérimentations sur les pollutions accidentelles des eaux
CM	Centimetre
DARD	Department of Agriculture and Rural Development
DDE	Direction Départementale de l'Equipement
DEFRA	Department for Environment, Food and Rural Affairs
DIREN	Direction Régionale de l'Environnement
DM	Decimetre
DOE (NI)	Department of the Environment (Northern Ireland)
DRIRE	Direction Régionale de l'Industrie, de la Recherche et de l'Environnement
DS	Dry Sediment
DTLR	Department for Transport, Local Government and the Regions
EA	Environment Agency
EC	European Commission
EG	Environment Group
EIA	Environmental Impact Assessment
ELO	Environment Liaison Officer
EU	European Union
EWC	European Waste Catalogue
FT	Feet
GC / MS	High resolution Gas Chromatography and Mass Spectrometry
GT	Gross Tonnage

HazMat	Hazardous Materials
HC	Hydrocarbon
HDPE	High Density Polyethylene
HNS	Hazardous and Noxious Substances
HTTD	High Temperature Thermal Desorption
HWIP	Household Waste Incineration Plant
IMO	International Maritime Organisation
IOPC	International Oil Pollution Compensation Funds
ITOPF	International Tanker Owners Pollution Federation Limited
JNCC	Joint Nature Conservation Committee
LDPE	Low Density Polyethylene
LTTD	Low Temperature Thermal Desorption
M^3	Cubic metre
MCA	Maritime and Coastguard Agency
MEIR	Marine Emergencies Information Room
MM	Millimetre
MRC	Marine Response Centre
MS	Matière sèche (Dry sediment – DS)
NCP	National Contingency Plan
NCV	Net Calorific Value
NE	Natural England
NIEA	Northern Ireland Environment Agency
NNR	National Nature Reserve
NOSCP	National Oil Spill Contingency Plan
OECD	Organisation for Economic Co-operation and Development
OMT	Oil Spill Management Team
OPEX	Operational expenditures
OPRC	Convention Oil Pollution Preparedness, Response and Co-operation Convention 1990
OSW	Oil Spill Waste
OSWM	Oil Spill Waste Management
OSWMP	Oil Spill Waste Management Plan
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCPSO	Principal Counter Pollution and Salvage Officer
PCT	Polychlorinated Terphenyl
POLREP	Pollution Report

PPB	Part per billion (= 0,001 mg/ kg)
PPE	Personal Protective Equipment
PPM	Part per million (= 1 mg/ kg)
PVC	Polyvinyl chloride (a type of plastic)
REMPEC	Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea
SAC	Special Area of Conservation
SCU	Salvage Control Unit
SEEEC	Sea Empress Environmental Evaluation Committee
SEERAD	Scottish Executive Environmental & Rural Affairs Department
SEPA	Scottish Environment Protection Agency
SFI	Sea Fisheries Inspectorate
SI	Statutory Instrument
SITREP	Situation Report
SNH	Scottish Natural Heritage
SOLAS	Safety of Life at Sea Convention
SOSREP	Secretary of State's Representative for Maritime Salvage and Intervention
SPM	Suspended Particle Matter
SRC	Shoreline Response Centre
SSSI	Site of Special Scientific Interest
STOp	Scientific, Technical and Operational Guidance Notes
T	Tons
TG	Technical Guidelines
THC	Total Hydrocarbon Content
UKHMA	UK Harbour Masters Association
UKMPG	UK Major Ports Group
UNCLOS	United Nations Convention on the Law of the Sea 1982
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
VHOC	Volatile Halogenated Organic Compounds
VOC	Volatile Organic Compounds
WGS 84	World Geodetic System 1984

WTS	Waste Tracking Sheet

1 INTRODUCTION

1.1 Project Background and Terms of Reference

The Maritime and Coastguard Agency (MCA) is the competent U.K. authority that responds to pollution from shipping and offshore installations. The MCA is regularly called upon to react to a wide range of maritime incidents and has developed a comprehensive response procedure to deal with any emergency at sea that causes pollution, or threatens to cause pollution.

As part of its contingency planning role, the MCA has produced a number of documents which set out the basis on which the UK deals with a marine oil spill. Details of these documents are contained in Part 1 of this report. In 2004, the MCA commissioned BMT Cordah to undertake four tasks which together comprised the "Development of a Protocol for the Treatment and Disposal of Oily Waste in the UK". The overall project objective focused on the management and infrastructure in place to deal with oily waste resulting from a marine spill in the United Kingdom. This project was reported in 4 volumes, addressing each of the four main tasks which formed the overall project brief. The report on Task 4 "Designing infrastructure for the handling of large quantities of oily waste"[1] included brief references to treatment techniques and other considerations, but did not address detailed procedures for selecting appropriate treatment processes.

MCA considered that more detailed information on the availability and selection of treatment processes would be advantageous and in 2009, commissioned SLR Consulting Ltd (SLR) to provide this through the undertaking of a desktop study to develop a comprehensive technical and logistics plan for dealing with large quantities of solid and liquid oily waste which could arise from the spilling of oil into the maritime environment from tanker, fixed offshore development or production rig or onshore facility.

1.2 Structure of Outputs from Study

The results of this study have been compiled into four separate parts:

Part 1 – Local Authority Guidance – providing an overview of the management of oil spill waste and identifying the steps Local Authorities need to take to ensure they have effectively planned for an oil spill incident

Part 2 – Contingency Planning – this provides a step-by-step guide to how Local Authorities or other emergency planners can prepare an outline plan in advance of an incident using the best available data – particularly with respect to temporary storage

Part 3 – Post Incident Planning – this provides a step-by-step guide to the means by which appropriate treatment solutions can be identified and implemented once an incident has occurred.

[1] MCA/BMT Cordah Ltd 2007

Part 4 – Information and Data – this section acts as a source of information and data relevant to the selection and implementation of waste processing solutions and the regulatory framework.

1.3 Part 3 Report Structure

This section of the study report has been structured as follows

Section 1 - Introduction

Section 2 - Scope and Purpose of Part 3

Section 3 – Process Overview – Steps Required

Section 4 - Technologies used for Oil Spill Waste Processing

Section 5 – Development of Decision-making Guide

Section 6 – The Decision-making Process – Step-by-step Guide

Appendices

1.4 Overview

The term waste is defined as "any substance or object the holder discards, intends to discard or is required to discard" under the Waste Framework Directive Waste Framework Directive (European Directive 2006/12/EC. Once a substance or object has become waste, it will remain waste until it has been fully recovered and treated and no longer poses a potential threat to the environment or to human health. Annex 1 of the Directive refers to "materials spilled, lost or having undergone other mishap, including any materials, equipment, etc., contaminated as a result of the mishap" (category Q4).

Processing of waste generated following a major oil spill involves a complex range of activities. Selection of the optimum solution depends on a large number of factors.

Figure 1-1 below indicates the types of waste which are likely to be generated by a marine oil spill.

Figure 1-2 shows the wide variation in volumes and characteristics of waste produced by historic oils spills.

The objective of strategy development is to develop a solution which achieves the best possible compromise between these factors, as indicated in the diagram in Figure 1-3, below, to achieve the optimum solution, taking all the factors into account.

Figure 1-1 : Types of waste generated by a marine oil spill[2]

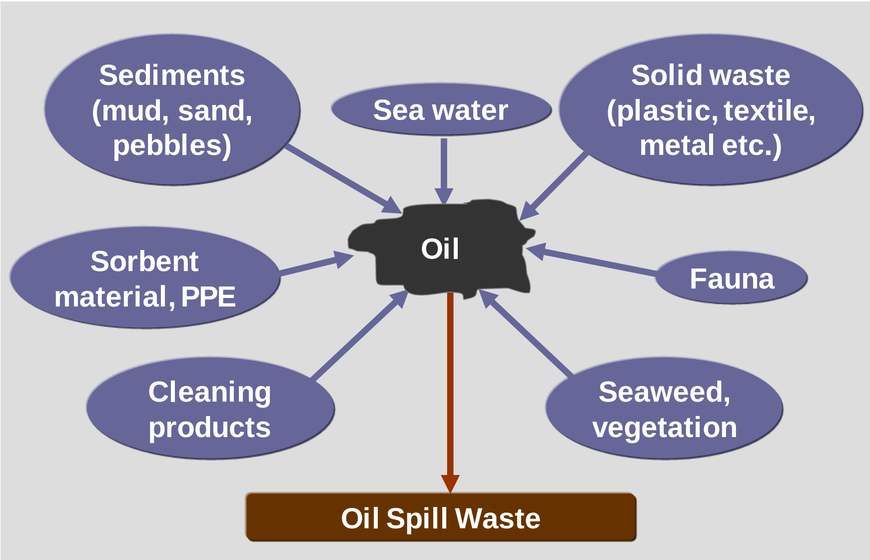
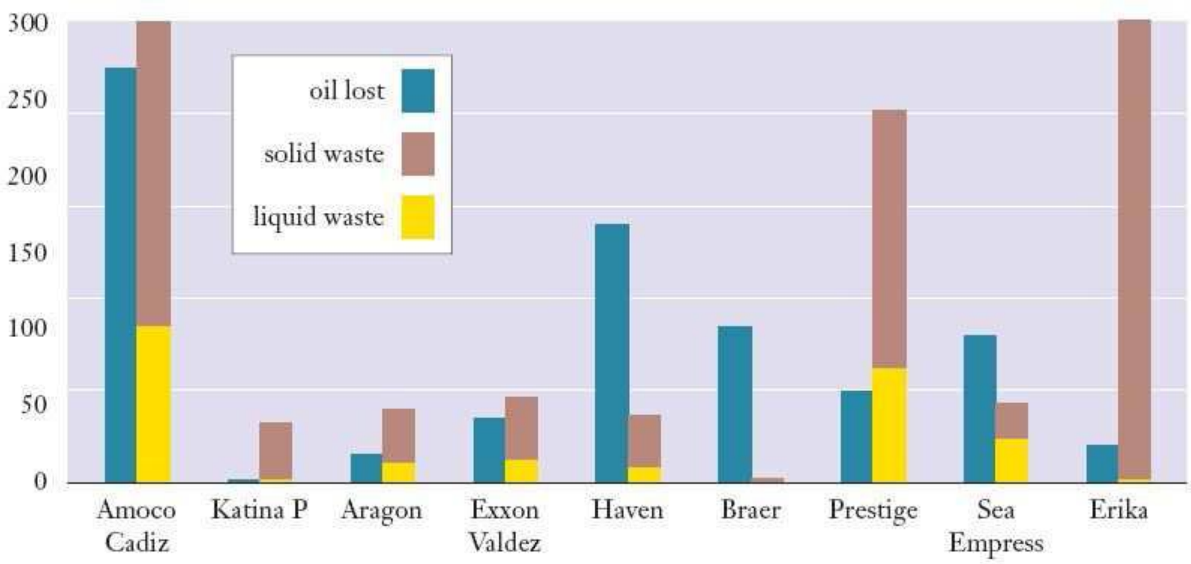


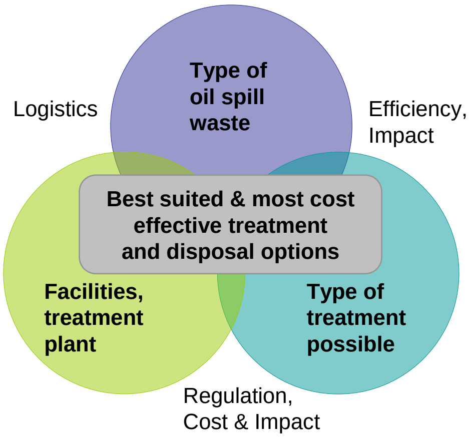
Figure 1-2 Waste generated during historical oil spill incidents – in 1,000 tonnes[3]



[2] Source - REMPEC

[3] (Source: IPIECA, Guidelines for Oil Spill Waste Minimization and Management, Report Series, Vol. 12).

Figure 1-3 : The Optimum Solution



The study has developed a process which can be followed to enable decisions to be made about the choice of the most appropriate technologies and/or facilities to use to treat waste materials arising from the response to an oil spill landfall incident in the UK.

The main difficulties associated with providing guidance on the planning of oil spill waste (OSW) processing are:

- the vast range of volume, type, characteristics and location of the waste generated;
- the equally wide range of technologies available with which the waste could be processed;
- the need for rapid response to mitigate initial environmental and commercial impacts;
- the different and possibly remote (from the spill) geographical location of potential treatment facilities;
- the unpredictability of the market and availability of potential outlets for processed materials;
- the very complex inter-relationship between political, regulatory, technical, logistical, environmental and commercial elements;
- the extensive range of stakeholders and other interested parties

The essence of the challenge faced by the authors in developing guidance on the steps to follow when choosing an appropriate strategy and/or technology for dealing with the waste arisings from a marine oil spill was to try to distil into a clear, logical and easily followed approach the thought processes and knowledge acquired by process engineers over many years undertaking similar projects. To achieve this, the approach adopted has been to produce a step-by-step methodology which starts with the spill, then at each stage identifies the critical information which would be required and on which an appropriate decision would be based. The guide then endeavours to indicate the responses which an experienced process engineer would develop with the benefit of this information – ultimately leading to a conclusion as to what to do.

Ideally, technical, regulatory, political and legal experts would be involved in all decision making processes, but the potential urgency of the situation being considered means that it may be necessary to start the process (or even complete it) without direct input from such experts. This tool is intended to inform such deliberations.

2 SCOPE AND PURPOSE OF PART 3

2.1 Purpose

The decision making guide and model have been developed to set out a process which can be used to inform decisions about the choice of technologies to be used to clean up waste materials arising from the response to an oil spill landfall incident in the UK. It is intended to be used and integrated with existing plans and procedures which have been developed to manage oil spill incidents which may have an impact on UK shores. Details of these and related parties are included in Part 1 of the output.

The guide considers the processing of waste arising from all possible oil spill types and magnitudes. Where small quantities of oil have been spilt and the areas impacted are limited, simple approaches including the employment of a relevantly experienced contractor with appropriate permits and equipment will often be the most effective and expedient means of managing the problem. In other instances, where thousands of tonnes of oil have been deposited and many kilometres of coastline affected, considerable planning and logistical effort will be required in addition to the selection of appropriate treatment methods. The documents endeavour to provide guidance on the approach which can be used in all instances.

Ideally, technical, regulatory and legal experts would be involved in all decision making processes, but the potential urgency of the situation being considered means that it may be necessary to start the process (or even complete it) without direct input from such experts. This document is intended to inform such deliberations. It is clear that this guide cannot act as a substitute for the appropriate application of the multi-disciplinary skills identified above, and that those using it must be aware of the limitations inherent in the development of such a tool. However, it is believed that the guide can provide a useful addition to the armoury of those faced with the impacts of a marine oil spill, and to assist in speeding decision making even for those who possess the necessary expertise to make decisions themselves.

The primary purpose is to allow a non-expert to quickly come to sensible conclusions about technologies which might be appropriate to the particular spill (or part of a spill) under consideration. The approach is a technical one, and only those logistical or legal considerations directly impacting on the selection process are considered. Simplicity is hence gained at the expense of specificity, and the use of this document is therefore not intended to fully replace the use of experts, but is intended to be entirely compatible with the use of such advisors.

This part of the output from the study provides a guide to the processes which need to be followed to develop and implement a detailed plan covering the processing of the waste arising from shoreline clean up of an oil spill – in this part once an incident has occurred.

2.2 Scope of Project

There is a very large amount of literature in existence relating to the management of marine oil spills. This has been produced by an equally wide range of authors and sponsors. However, study of this literature identifies the common theme of three interconnected strands which have to be pulled together to reduce the complexity of the decision-making processes involved. These are:

A. Decisions about how to treat the area where oil has landed;
B. Decisions about how to treat wastes arising from this operation, and
C. Compliance with the prevailing logistical and legal constraints.

This project focused on addressing B and C above.

2.3 Overall Strategy

If sufficient information and resources could be made available, the most comprehensive strategy would be as follows:

I. To develop an overall Contingency Plan (or a series of alternative plans) in advance of any spill, using the guide and model described in Part 2 of this report based on assumptions of what might be spilt, or repeating the assessments for a range of alternative scenarios and creating an "envelope" of possible outcomes. This approach is described in more detail in Part 2 of the reporting.
II. To repeat the above as soon as the spill has been notified and modelling to identify probable points of landfall has been completed (referred to in Part 4, using the process described in Part 2)
III. When contamination has reached the shoreline and can be examined and classified (Part 3)
IV. By examination and analysis of material actually deposited in storage areas (either temporary or intermediate), as shown in Part 3.

2.4 Scope of this Part 3

This part of the report provides an explanation of the overall waste management process, then provides a summary of the technologies which can be used to process oil spill waste. A summary of how the decision-making guide was developed in then presented followed by a step-by-step guide with a worked example.

A spreadsheet model is being developed to assist in the planning process, and the final section of the report describes the use of this model in its current state of development.

The Appendices contain detailed information on the technologies which can be applied, and information on possible UK and European sources of such equipment, as well as basic data such as European Waste Codes. Examples of useful forms are also provided. This data and extensive information on UK facilities where waste could be processed constitute Part 4 of the report.

2.5 Areas not Addressed in the Project

Whilst it is recognised that the tighter the control of beach cleanup operations, the lower the yield of waste, and the more readily the wastes are treatable, detailed consideration of how to carry out these operations is outside the scope of this document, although reference must be made to this element of the response and information on the techniques being used and the data generated is essential.

The document does not address issues associated with the initial identification, transfer of waste and compliance with relevant waste management legislation at the shoreline (See MCA Manual on Oil Spill Response).

3 PROCESS OVERVIEW - STEPS REQUIRED

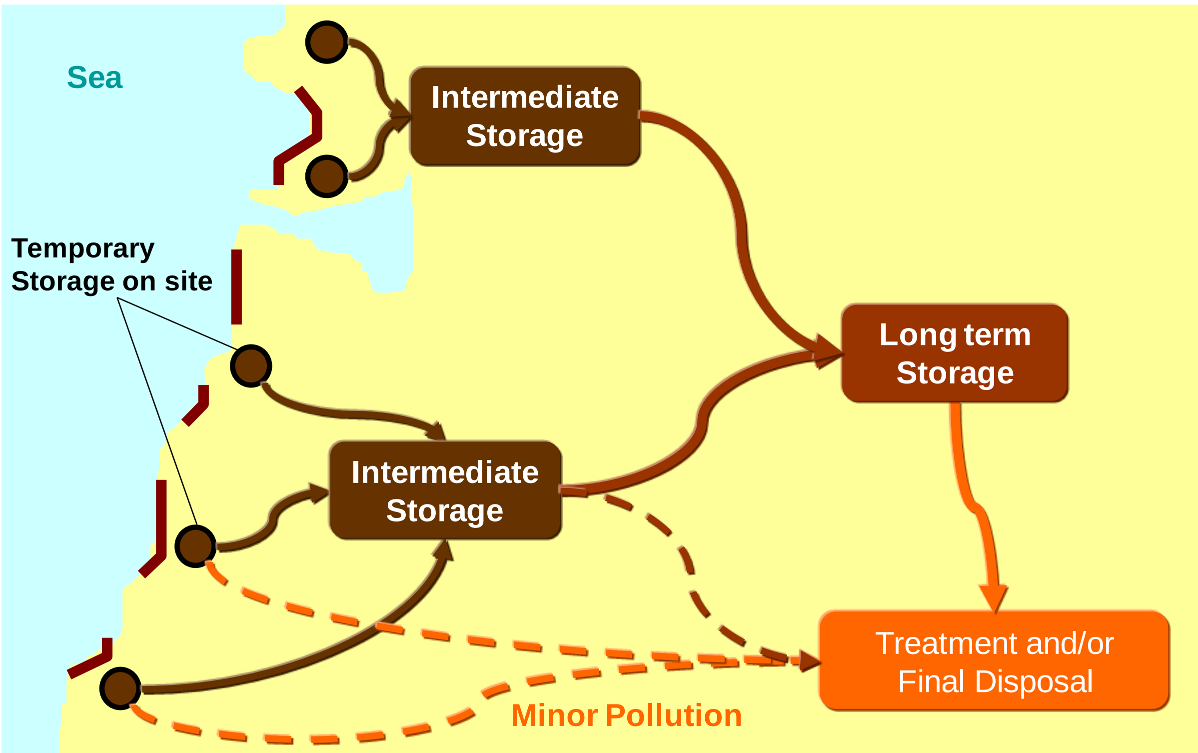
3.1 Overview of Waste Management and Processing Activities

Historical data show that oil spills impacting the shoreline can in extreme cases produce up to 30 times more waste than the volume originally spilled while small spills have also sometimes created large amounts of waste. However, this varies depending on the characteristic and behaviour of the oil, response techniques and management. It is essential to reduce the amount of waste, thus limiting the difficult problem of dealing with the quantity of waste generated in a very short period, and limiting environmental and economical impacts (Source: IPIECA guidelines).

In order to develop a guide to how to determine the appropriate strategy for processing waste arisings from an oil spill, it is necessary to first define general principles. The objective of any oil spill clean-up operation is to recover, treat, recycle or dispose of the oily waste in the most efficient and environmentally sound manner. The disposal option chosen will depend upon the amount and type of oil and contaminated debris, the location of the spill, environmental and legal considerations and the likely costs involved.

The overall process is shown schematically in Figure 3-1 below (source Draft Oil Spill Waste Management Decision Support Tool", REMPEC 2010)

Figure 3-1 - Schematic of Typical Oil Spill Waste Processing



Waste minimization must be a permanent objective during the cleanup operations and in situ handling of OSW. Expert advice should be sought for the selection of the best technical choices for cleanup. Emphasis should be put on methodical management of clean-up sites to avoid spreading and secondary contamination of unaffected sites and also by choosing the recycling options for the oiled equipment

Most oil spill management plans are based on the following overall principles. Flow charts 3-1 to 3-4 below describe the process:

1) Containment and recovery of as much oil and oil/water as possible from the sea (this includes the use of dispersants and in-situ burning where permitted, and the collection of liquid phases from the surface and immediate sub-surface of the sea. (See for example, MCA Manual of Oil Spill Response, MCA Marine Pollution Clean-up Manual, various ITOPF reports)
2) Cleaning of the shoreline using whatever equipment and resources can be most effectively and efficiently applied. Recovery of as much oil as possible, and minimisation of the waste generated consistent with achieving required objectives. The tighter the control of these operations, the lower the yield of waste, and the more readily the wastes produced are treatable (See for example, MCA Manual of Oil Spill Response; Draft Oil Spill Waste Management Decision Support Tool", REMPEC 2010; Guidelines for Oil Spill Waste Minimization and Management, IPIECA 2004). Waste minimization must start with the first response operations on the site and remain a permanent effort. Information and control of the personnel and companies working on site is essential. Other important elements are:
   i) Use appropriate cleanup techniques to minimise the volume of sediments collected.
   ii) Prefer in situ washing techniques instead of the removal of oiled sediment (e.g. surf washing, sand flushing, etc.).
   iii) Avoid additional contamination:
      a) Prevent soil contamination by using liners under drums, tanks and at bottom of storage pits, and
      b) Control the accesses to the cleanup sites and protect them using lining and/ or geotextiles
3) If the shoreline cannot be cleaned in situ sufficiently to require no further treatment (including allowing wave action to complete an initial clean up), collect affected materials and transfer to a local, temporary storage area to remove them from the immediate area and allow the clean up/beach restoration process to continue. Wastes produced should be segregated into similar materials and stored separately at the temporary storage location. (See for example, MCA Manual of Oil Spill Response; Draft Oil Spill Waste Management Decision Support Tool", REMPEC 2010; Guidelines for Oil Spill Waste Minimization and Management, IPIECA 2004). (See section 3.3 for further information on storage).
4) Use the facilities at the temporary storage site to separate liquids from solids (ie by settlement and decanting of the liquids), and to separate oil from water as much as is practicable.
5) If feasible, permitted and viable, treat the wastes produced by this action at the temporary storage location sufficiently to allow direct usage/disposal or transfer to existing (permitted) waste processing facility. Transfer the "treated" material to its appropriate destination in compliance with regulations
6) If not feasible, permitted and viable, transfer to second (intermediate) storage location where processing can take place – again to allow direct usage/disposal or transfer to existing (permitted) waste processing facility. This will probably include consolidation

of waste from a number of different temporary sites to a common intermediate storage site.

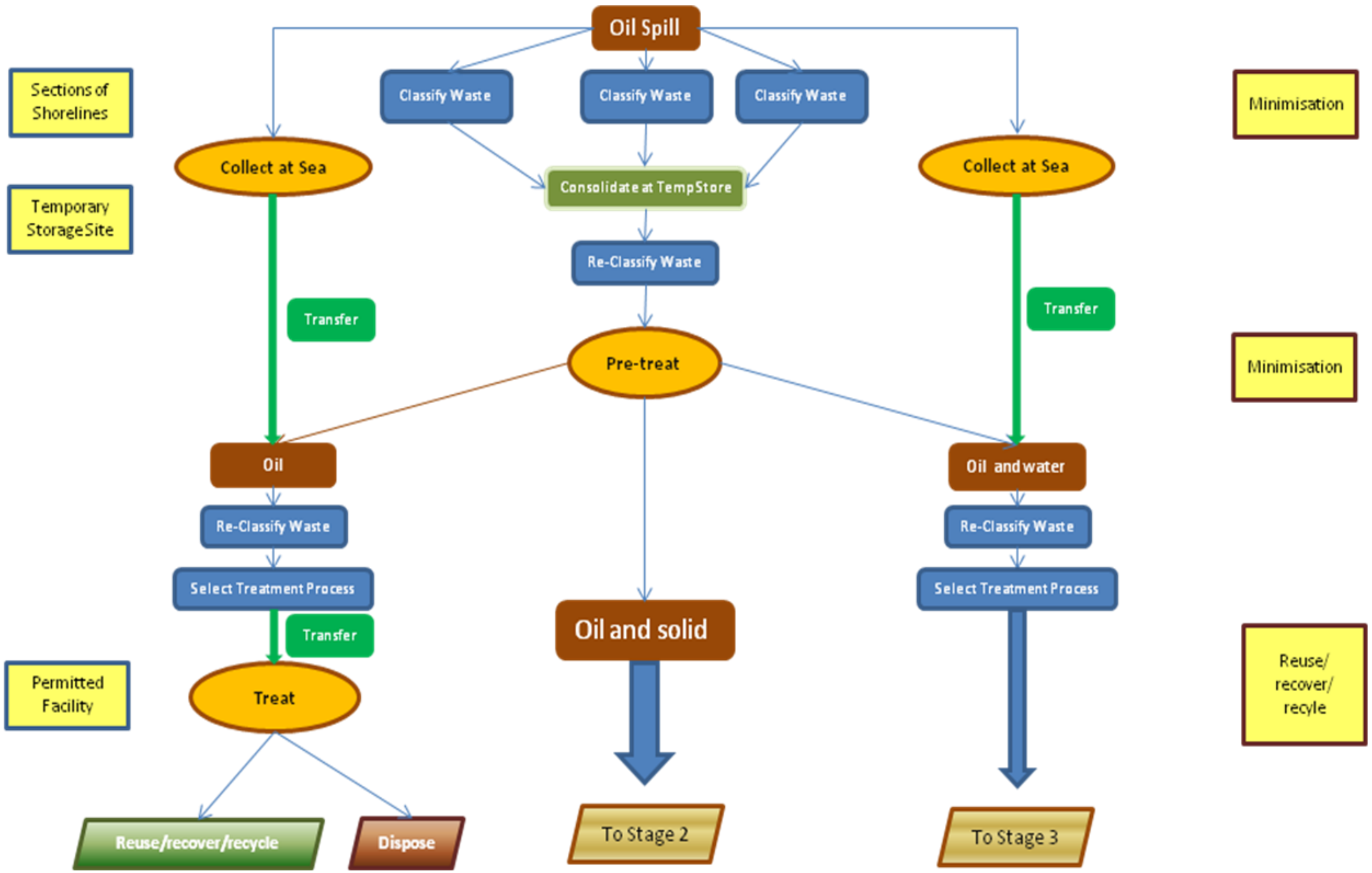
7) When treatment is complete, transfer the “treated” material to its appropriate destination.
8) If any residual waste exists after stage 7 which, with further treatment could be rendered suitable for usage/disposal or transfer to existing (permitted) waste processing facility, but the treatment for which cannot be provided at the intermediate storage location, transfer this to a third location, where such treatment can be undertaken.
9) If necessary, waste material may also be stored at other locations pending treatment, subject to compliance with appropriate regulations.

Overarching the whole process are the most fundamental elements of the management of spill response which can be summarised as follows:

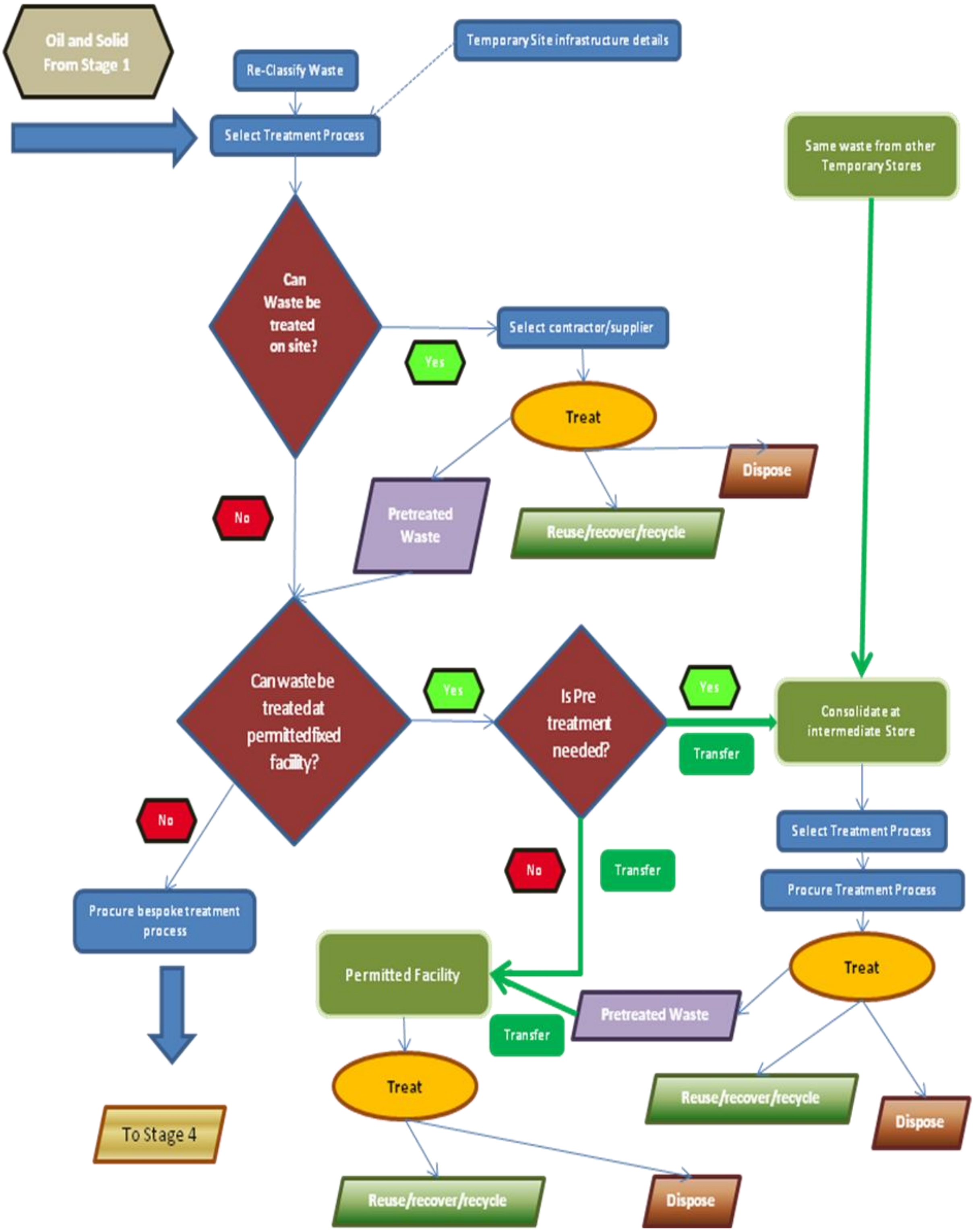
- Solutions need to be proportionate, pragmatic, timely and deliverable under difficult circumstances – for example the “ideal” process may not be available or sufficient access to deliver it may not exist and an alternative which is adequate may have to be used for expediency.
- Deployment of the most appropriate technology will often be secondary to the risk of environmental damage, necessitating the taking of actions which may render waste less easily treatable than in its “original” form.
- Political pressure (from local or national organisations) applied by interested groups, some of whom may have only superficial knowledge of the difficulties involved may need to be managed and the profile of actions may need to be high
- Solutions need to fit within the existing regulatory framework - whilst contingencies are built into the legislation to allow for actions taken in an emergency (providing these actions can be shown to be taken to protect human health and minimise pollution), all other activities must comply with the relevant legislation – for example, the “waste hierarchy”, the use of permitted processes and facilities etc.

The variety of treatment processes which may be required and the inherent complexity of selection which this entails is shown in Figure 3-2, which is a typical oil spill treatment flow sheet.

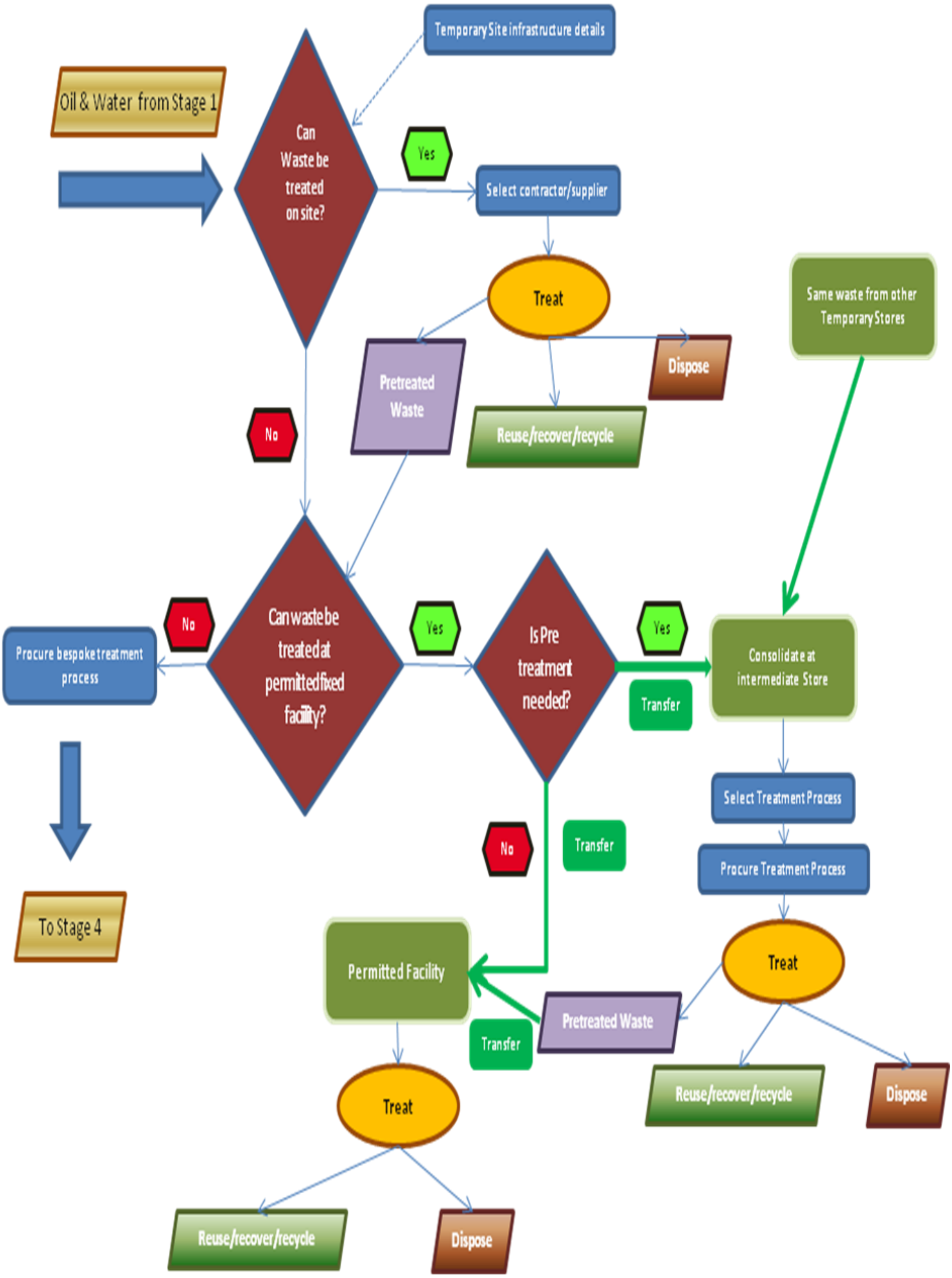
Flow Chart 3-1 - Stage 1 of Waste Treatment Process



Flow Chart 3-2 - Stage 2 of Waste Treatment Processing



Flow Chart 3-3 - Stage 3 of Waste Treatment Processing



Flow Chart 3-4 - Stage 4 of Waste Treatment Processing

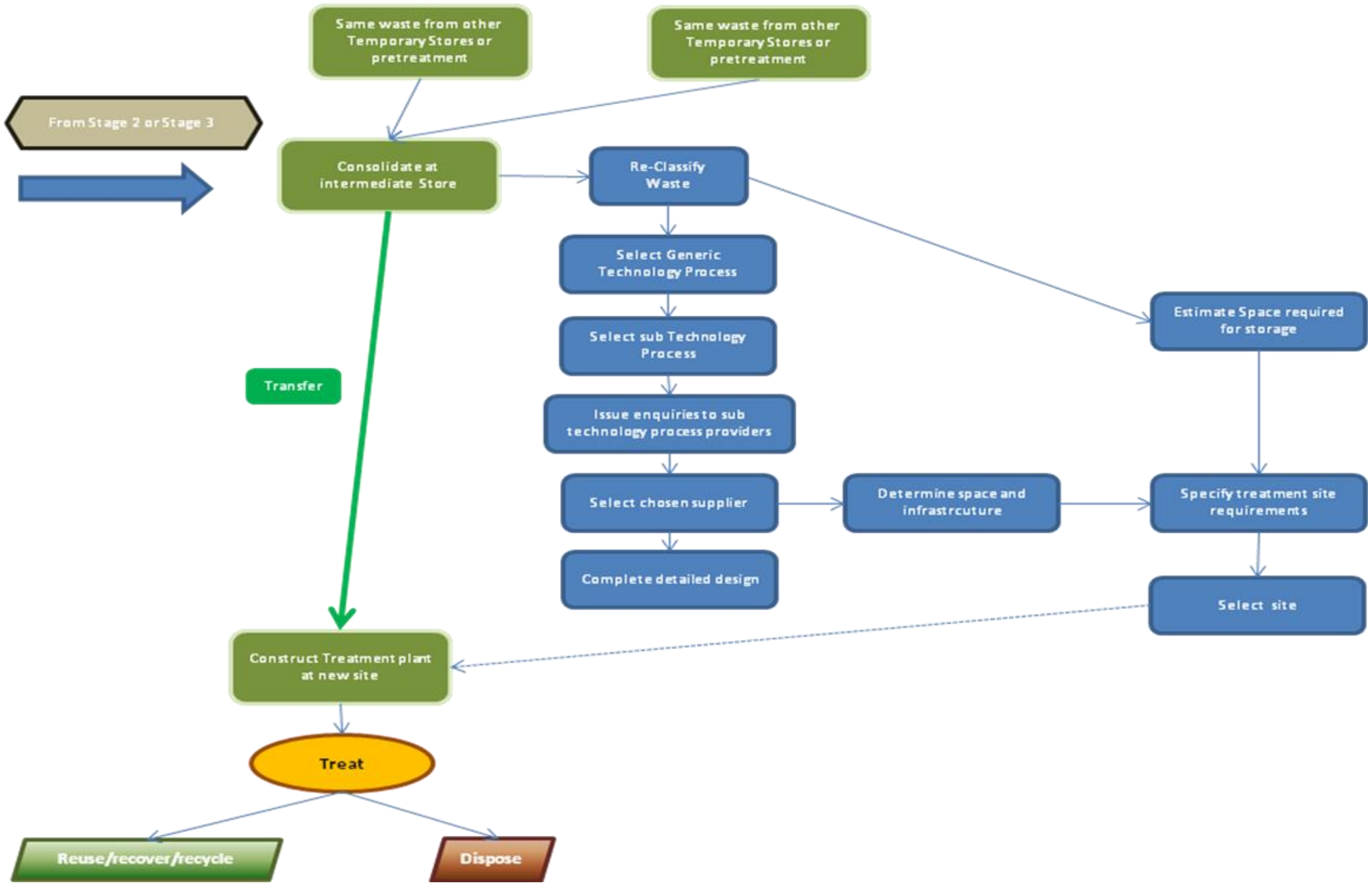
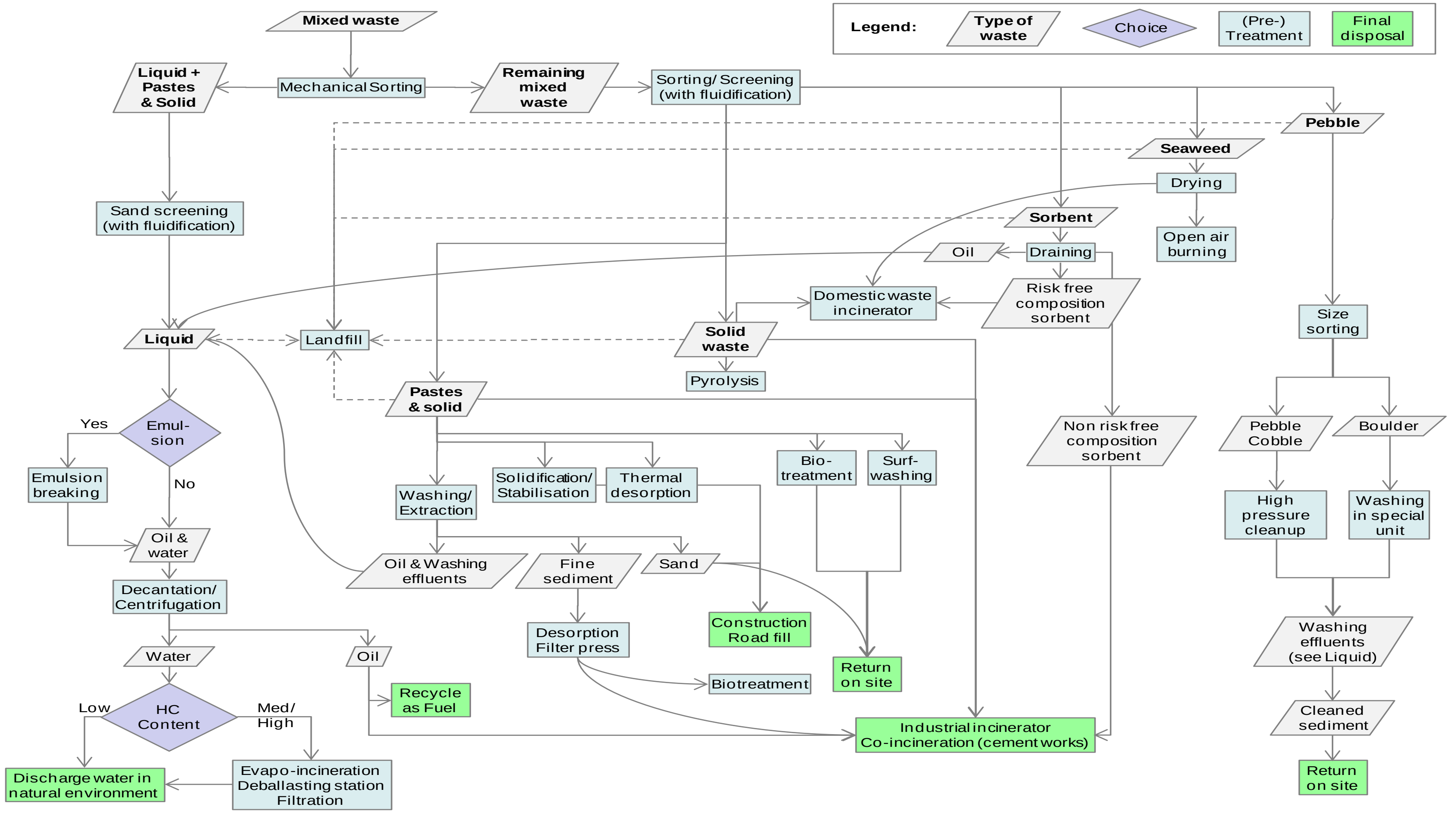


Figure 3-2 Typical Oil Spill Treatment Flow Sheet[4]



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4 Source REMPEC

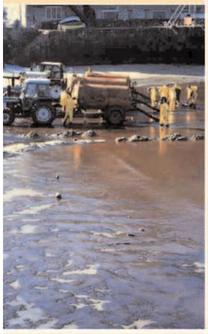
3.2 Waste Generated

The various processes outlined above will produce different types of waste, as shown in Figure 4-3 below (source “Guidelines for Oil Spill Waste Minimization and Management”. International Petroleum Industry Environmental Conservation Association, London, Report Series Vol. 12, IPIECA 2004)

The characterisation of waste volumes and types is critical to the selection of processing techniques and is discussed in more detail in Section 6.

Figure 3-3 - Primary Clean-up Techniques and Waste Generated

Clean-up technique		Effect on waste stream	Type of waste generated
Dispersant application 	Dispersant chemicals are used to break down the oil slick into small droplets so that the diluting effect of the ocean is better able to reduce hydrocarbon concentrations. This strategy will not work with all oils and is not appropriate for use in certain environments.	Waste concentrations are minimal as the oil is suspended in the water column and allowed to biodegrade naturally.	• No hydrocarbon waste is generated. • PPE • Empty dispersant drums/considerations
At sea response operations 	Recovery devices, e.g. booms and skimmers, are deployed from ships or small craft to recover oil from the sea surface. Suitably sized storage systems may be needed which, in the case of highly viscous or waxy oils, will require heating elements. Transfer systems and reception facilities will also be needed to sustain operations over the long term.	Recovery operations will potentially give rise to a large quantity of waste oil and water for treatment. The volume of the storage systems available must be consistent with the recovery capacity of the skimmers. The type of oil spilled will have an effect on the resultant waste; viscous and waxy oils in particular will entrain debris and can create large volumes of waste. They can also present severe handling difficulties.	• Oiled equipment/vessels • Oiled PPE and workforce • Recovered oil • Oily water • Oiled vegetation • Oiled sorbent materials • Oiled flotsam and jetsam • Animal carcasses

Shoreline clean-up 	Oils are recovered from shorelines either using mechanical or manual means. Manual recovery is the preferred method because it has the effect of minimizing the amount of waste generated. Machines can be used to transport the waste from the shoreline to the primary storage site. Portable tanks or lined pits can be used to consolidate recovered oil at the operating site. The shoreline type, and degree of access to it, will dictate the types of strategies used which, in turn, will determine the amount of waste recovered.	The type of spilled oil will often have a profound effect on the amount of oily waste generated. Waste segregation and minimization techniques are critical to ensure an efficient operation. These should be established at the initial recovery site and maintained right through to the final disposal site otherwise waste volumes will spiral out of control. Waste sites should be managed in such a way as to prevent secondary pollution.	• Oiled equipment/vessels
			• Oiled PPE and workforce
			• Recovered oil
			• Oiled vegetation
			• Oily water
			• Oiled sorbent materials
			• Oiled beach material:
			  • sand
			  • shingle
			  • cobbles
			• Oiled flotsam and jetsam
			• Animal carcasses
			• Oiled transport

In-situ burning 	This involves a strategy of burning spilled oil using fire booms to thicken the oil layer to sustain combustion. Weathering and emulsification of oil will inhibit the process. The strategy cannot be used on all oil types or in all environments. The resultant air pollution and the production of viscous residues can limit the application of the strategy.	*In-situ* burning can reduce the amount of oil in the environment. However, the remaining material may be more persistent.	• Burnt oil residues • Oiled/fire damaged boom • Oiled vessel • Oiled PPE

Figure 3-4 below shows examples of typical waste in the above categories (source Draft Oil Spill Waste Management Decision Support Tool”, REMPEC 2010)

Figure 3-4 - Examples of Different Types of Waste

Liquids	 (source : Cedre)
Pastes & solids (sand...)	 (source : Cedre)

Polluted pebbles & stones

(source: Cedre)

Polluted sorbent

(source : OTRA)

Polluted sea weed

(source : OTRA)

Polluted solid waste	 (source : OTRA)
Polluted fauna	 (source : OTRA)

3.3 Storage Requirements

3.3.1 Temporary Storage Sites (TSS)

A critical element of the waste treatment process is the provision of safe storage for waste which is constructed and configured to minimise environmental impact. Details of this are beyond the scope of the document, and are extensively addressed in the MCA Document "Development of a Protocol for the Treatment and Disposal of Oily Waste in the UK - Task 4: Designing Infrastructure for the Handling of Large Quantities of Oily Waste" to which it is recommended that reference be made. However it is felt that providing some general information about temporary storage sites is useful in setting some of the later elements of this guide in context, and these are described in the following paragraphs.

Information is provided on various types of storage facilities indicating their advantages and disadvantages.

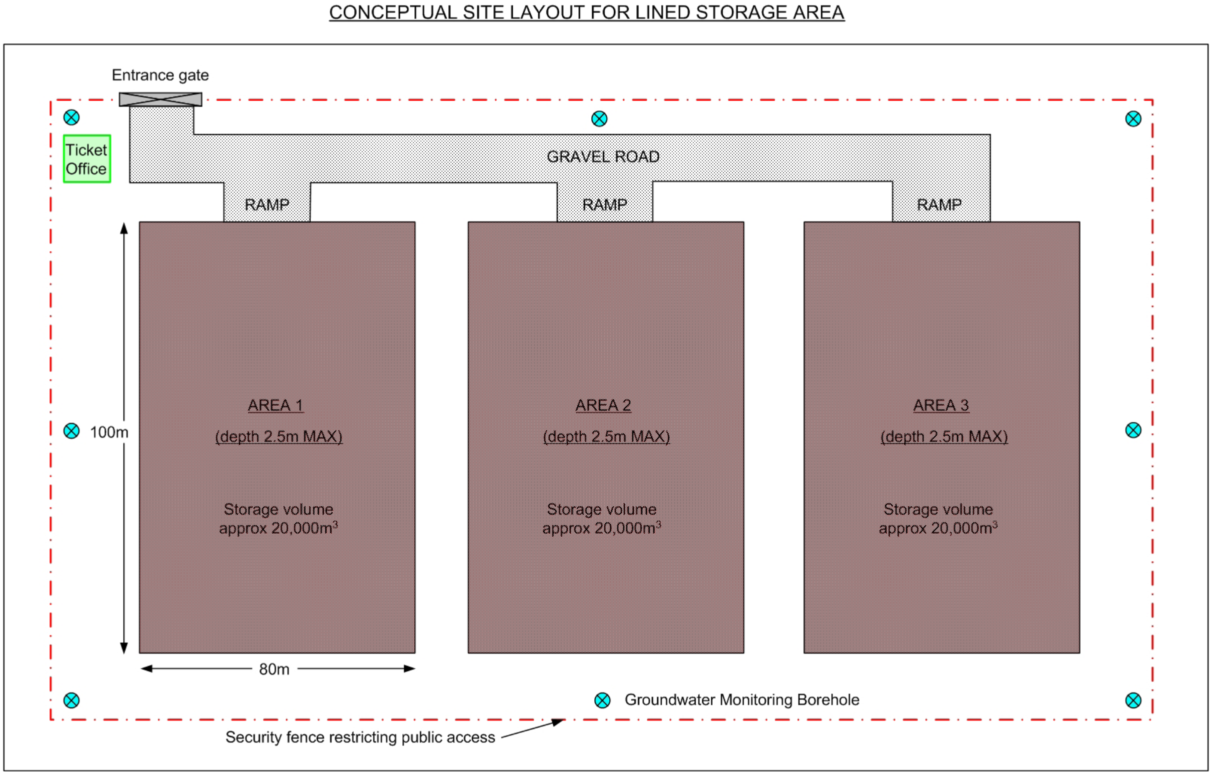
The planning, design, construction, operation and eventual decommissioning of temporary facilities for the storage and handling of oily wastes must comply with UK national legislation and regulations, including duty of care, health and safety, waste oil storage and treatment, movement and management of oily waste and environment and planning.

The aims of such an arrangement of temporary waste storage facilities are to:

i. Provide “buffer” capacity so that the beaches can be kept clear to allow cleaning and restoration activities to proceed as quickly as possible.
ii. Minimise the need to handle/transport waste repeatedly, thus maximising the economics of transportation and reducing the associated nuisance and disturbance this may cause.
iii. Provide facilities in which wastes can be progressively segregated, and pre-treated if appropriate.
iv. Provide facilities for reducing the bulk of waste material. Settlement ponds, for example, can promote the separation of oily water so that oil may be skimmed off and sent for recycling, and the water can be discharged back to the environment.
v. Provide a flow of waste material into the ultimate treatment and/or disposal facilities that can be controlled and adjusted to match the processing capacity of the disposal site(s).
vi. Monitor, track and record all the different types and amounts of waste that are recovered.

Figure 3-5 below shows the arrangement of a typical temporary storage area (source MCA, 2007. RP 549: Development of a Protocol for the Treatment and Disposal of Oily Waste in the UK - Task 4: Designing Infrastructure for the Handling of Large Quantities of Oily Waste)

Figure 3-5 Typical Temporary Storage Area



Criteria for site selection are outlined below (sources: IPIECA, IMO, Cedre, ITOPF):

- close proximity to the site of clean-up,
- good access to roads for heavy trucks (unpaved track may require to be reinforced and restored afterwards),
- sufficient space to ensure segregation of various waste is possible and, if necessary, storage of machinery unsuitable for roads,
- be at a distance from natural sensitive area (or with additional containment measures if it is unavoidable to locate the storage in a sensitive area), and
- agreement of the site owner and/ or local authority.

Management of the site must ensure:

- correct labelling for each waste category,
- quantification of waste by category,
- security to prevent unauthorized dumping, and
- complete removal of oil and restoration of the site at the end of operation

It is probable that some temporary storage facilities will not have the necessary space or infrastructure to enable pre-treatment to be carried out. It is also likely that in some instances, pressure to "clean up" the shoreline will result in ineffective sorting and segregation of waste types. In these cases, waste will need to be transferred to intermediate storage facilities with greater space and/or infrastructure for processing. If space and infrastructure can be provided to enable preliminary treatment to be carried out at the temporary site, however, this will be of benefit in the overall processing plan and will comply with the requirements of the Waste Hierarchy and environmental regulator preference.

3.3.2 Intermediate and Long-Term Storage

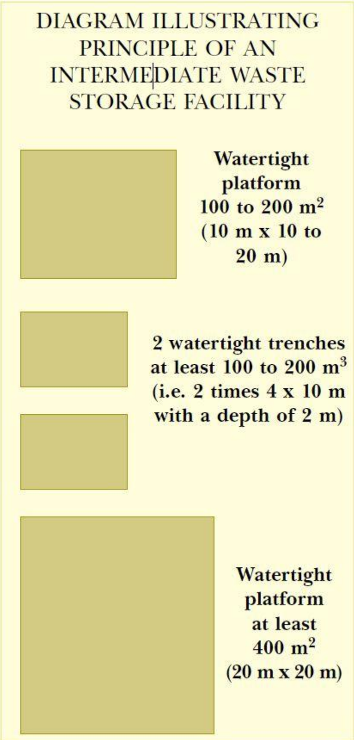
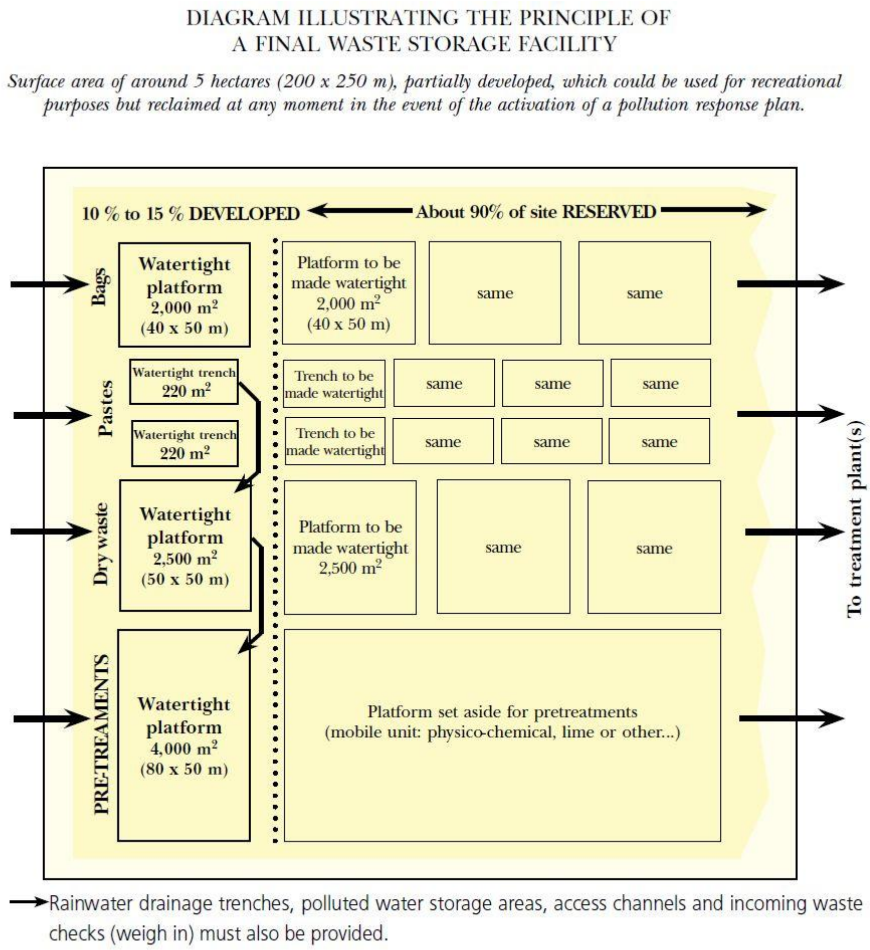
The table below provides considerations and criteria for intermediate and long term storage (source Draft Oil Spill Waste Management Decision Support Tool", REMPEC 2010)

Table 3-1 - Criteria for Intermediate and Long Term Storage

Criteria	Intermediate storage	Long Term storage
Occupancy	•Plan on occupying for 0 to 1 year (more in extreme cases).	•Plan on occupying for up to 5 years. •There may be legal restrictions.
Example of storage capacities	•1,500–3,000 m2 surface area. •Storage pits (100–200 m3). •Storage for debris, bags, barrels, tanks etc.	•20,000–100,000m2 surface area. •Storage pits (1,000–10,000 m3). •Sorting, pre-treatment, stabilization.
Distance from recovery/ transfer sites	•Not more than 5 km if possible, 30 to 50 km maximum.	•Not more than 50 to 100 km; or one hour by road from previous storage.
Land conditions	•Flat and graded to accommodate settling tanks. •Rain runoff collection facilities may be required.	•Flat and graded to accommodate settling tanks. •Build appropriate rain runoff facilities.
Access and earthworks	•Access by heavy lorries necessary, plan for decontamination areas for the vehicles.	
Regulatory requirements	•Comply with local land occupation and environmental regulations. •Plan for long term availability and potential occupation.	
Hydrogeological conditions	•Load-bearing capacity must be adequate. •Impermeable subsoil, either naturally or artificially. •Avoid groundwater systems.	
Environmental conditions	•At a safe distance from populated areas (50 m or more). •Beware of the impacts of lorries. •Avoid protected areas, cultural or archaeologically sensitive sites.	
Management and maintenance conditions	•Supervise all traffic on site. •Track all waste. •Sort waste. •Assess quantities. •Organize final disposal contracts. •Water management. •Security to prevent unauthorized dumping. •Site restoration.	

Figure 3-6 below shows typical layout arrangements for intermediate and long-term storage sites (source Draft Oil Spill Waste Management Decision Support Tool", REMPEC 2010)

Figure 3-6 Examples of Arrangements at Intermediate and Long-term Storage Sites

<table>
<tr><th>Example of set up of intermediate storage sites</th><th>Example of set up of long term storage sites</th></tr>
<tr><td>
</td><td>
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3.3.3 *Intermediate Storage Sites*

Criteria for intermediate storage site selection are:

- be located close to the coast, and of easy access;
- be pre-identified and listed in the relevant contingency plan. The proposed intermediate sites should be approved by the environmental regulator and permitted where appropriate
- have no legal issues. All required authorizations should be obtained prior to their use.

The set-up of intermediate storage sites will depend on the volume and nature of waste collected in each region, and to be stored (e.g. simple storage place for containers and bags, or specifically built pits). The intermediate sites should be separated into different areas, one for each type of OSW requiring storage. Particular attention will be given to limit and recover any run-off water or leachate (liquid that drains or 'leaches" from a landfill and/ or a waste storage).

Intermediate storage requires continuous management during all operations:

- competent supervisors on site,
- continuous recording of lorries incoming and leaving the site,
- health and safety management (suited PPE for the personnel on site, clear marking of the different areas on site, limitation of the traffic, limitation of the spreading of the pollution, etc.),
- environmental sound management (leak proof container, ground and soil protection, monitoring of leachate, management of run-off water, waste handling, etc.),
- identification of the waste stored on site and continuous tracking of the waste entering and leaving the sites (at least volume/ weight, nature, packaging, producer, origin etc.),
- up to date documentation on all the waste transferred by the site, and
- complete rehabilitation of the site once all waste has been evacuated.

3.3.4 Long-term Storage

Intermediate storage is not recommended for long periods (from an environmental point of view). It is recommended that material be transferred to “long term storage” when required, for example:

- If the total volume of waste exceeds the treatment capability in the country;
- If installations have to be adapted (or built) to provide the necessary pre-treatment or treatment depending on the type of waste and treatment chosen;
- When negotiating contracts for the treatment (or the export of waste) may be a lengthy process.

Long term storage enables:

- the storage of waste for year(s) in a secured and environmentally suited location,
- time for the treatment and final disposal facilities to be completed for all the categories of waste collected,
- the further sorting of the waste (once the treatment options are finalized), and
- supplying waste to the treatment installations at a rate matching their treatment capability.

Long term storage sites should be pre-identified during the planning process and be officially approved by the environmental regulator. Large areas will be required to receive waste from major pollutions. Due to the potentially large amount of waste that may be stored on the site for a long period, a risk assessment should be carried out to choose a site where potential infiltration of oil and oily water into the ground would have the least impact.

The Long term storage sites will have to be set up and managed accordingly to the long period of use of the site. Reception facilities will be manned and secured on a 24/7 basis during the cleanup operations. A complete waste tracking system during the operations, i.e. waste movement on site, and environmental site monitoring system must be implemented. Once reception of waste is completed, the site must be checked regularly, with regular analysis of the soil and ground water quality.

The final rehabilitation of the site will be carried out after a complete environmental assessment of the impacts of the waste storage and should include soil and ground water remediation if necessary.

3.4 Regulatory Framework

The planning, design, construction, operation and eventual decommissioning of temporary and permanent facilities for the storage and processing of oily wastes must comply with UK national legislation and regulations. The handling of waste oil products is carefully controlled and enforced in England and Wales by the Environment Agency (EA), in Scotland by the Scottish Environment Protection Agency (SEPA), and in Northern Ireland by the Environment and Heritage Service (EHS) and the NIEA.

The object of the Regulators is to:

- Minimise the amounts of hazardous/special waste that are generated.
- Control and track the movement of hazardous/special waste, from the time of its collection to its final disposal, by means of a consignment note system.
- Institute licensing and inspection controls for carriers of waste and operators of transit sites.
- Regulate industrial processes and waste handling sites (including landfills and storage facilities) through the Integrated Pollution Prevention Control (IPPC) regime.

The regulatory framework embraces the vast majority of actions and activities relating to the management and processing of oil spill waste and it is therefore essential that those involved in the decision-making process are aware of the relevant legislation and consult with and liaise constantly with the relevant regulator's representatives.

More details on the regulatory framework are contained in Part 1 of this report.

3.4.1 The Role of the Environmental Regulator

The EA has produced its own internal operational instruction, entitled "Waste Management during Major Marine Pollution Incidents, a copy of which is included in Appendix. This sets out the approach the regulator is expected to take during the management of an oil spill. A Liaison Officer is appointed, who will provide advice and support on regulatory matters through the Waste Management sub group of the Shoreline Response Centre.

The liaison office will provide advice on:

- Segregating and minimising the amount of waste produced
- Developing recovery plans or clean up plans that have a net benefit to the environment

- Planning the temporary storage of contaminated material pending treatment
- Designing and locating the temporary storage and recovery areas
- Understanding the waste regulations, including issues relating to hazardous waste and waste carriers
- Managing the final recovery or disposal of the contaminated waste

The EA has “enforcement positions” on various relevant aspects of OSW management, including:

- Enforcement and Prosecution Policy
- Environmental Permits
    - acts done in an emergency
    - enforcement action when the statutory defence no longer applies
- Identifying temporary sites
- Hazardous waste regulations
    - acts done in an emergency
    - enforcement action when the statutory defence no longer applies
    - recording movements of hazardous waste
- The use of registered waste carriers
- Recording regulatory decisions

These are published as internal documents to guide the regulator’s staff. Copies should be made available to all parties involved in the management of OSW.

3.4.2 Acts Done in an Emergency

The Hazardous Waste Regulations (2005) anticipate that there may be unusual or exceptional circumstances where it is not immediately possible to comply with the Regulations as a result of an emergency or grave danger. An emergency or grave danger is defined by Regulation 61(2) as “*a present or threatened situation arising from a substance or object which is, or which there are reasonable grounds to believe is, hazardous waste, and the situation constitutes a threat to the population or the environment in any place”*.

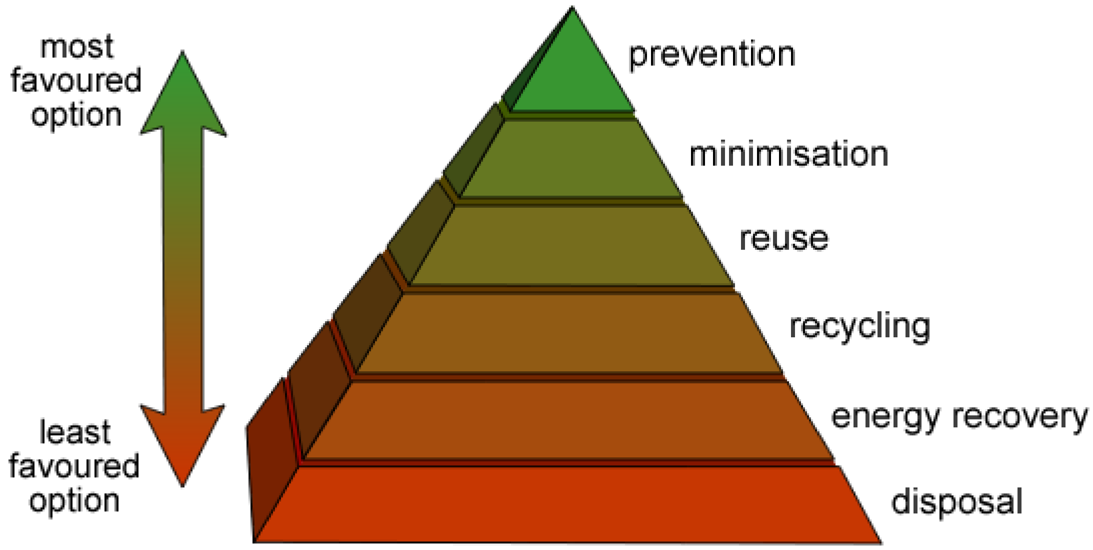
Where there is a risk to the environment or health because of the release of hazardous waste such as a spillage or chemical leak of hazardous waste or a spillage of hazardous waste at a road traffic accident, which is likely to cause harm to human health and/or pollution of the environment, there would generally be an emergency or grave danger. Regulation 40 of the Environmental Permitting Regulations provides a defence for actions taken in an emergency, providing these are:

- Steps taken to minimise pollution
- The EA is notified of the acts as soon as is reasonably practicable.

3.4.3 Waste Hierarchy

The waste hierarchy aims to encourage the management of waste materials in order to reduce the amount of waste produced, and to recover maximum value from the wastes that are produced. It is not applied as a strict hierarchy as many complex factors influence the optimal management for any given waste material. However, as a guide, it encourages the prevention of waste, followed by the reuse and refurbishment of goods, then value recovery through recycling and composting.

The next option is energy recovery, an important level in the hierarchy as many materials have significant embedded energy that can be recovered. Waste prevention, reuse, recycling and recovery are collectively defined by the Organisation for Economic Co-operation and Development (OECD) as waste minimisation. Finally, waste disposal should only be used when no option further up the hierarchy is possible.



In the case of oil spill waste, the "prevention" element of the process is addressed by design and contingency planning for offshore installations and shipping. Minimisation of waste starts as soon as the waste is spilled and is a critical aspect of all elements of OSW planning.

4 TECHNOLOGIES FOR OIL SPILL WASTE PROCESSING

4.1 Overview

The choice of an oil spill waste treatment method depends on:

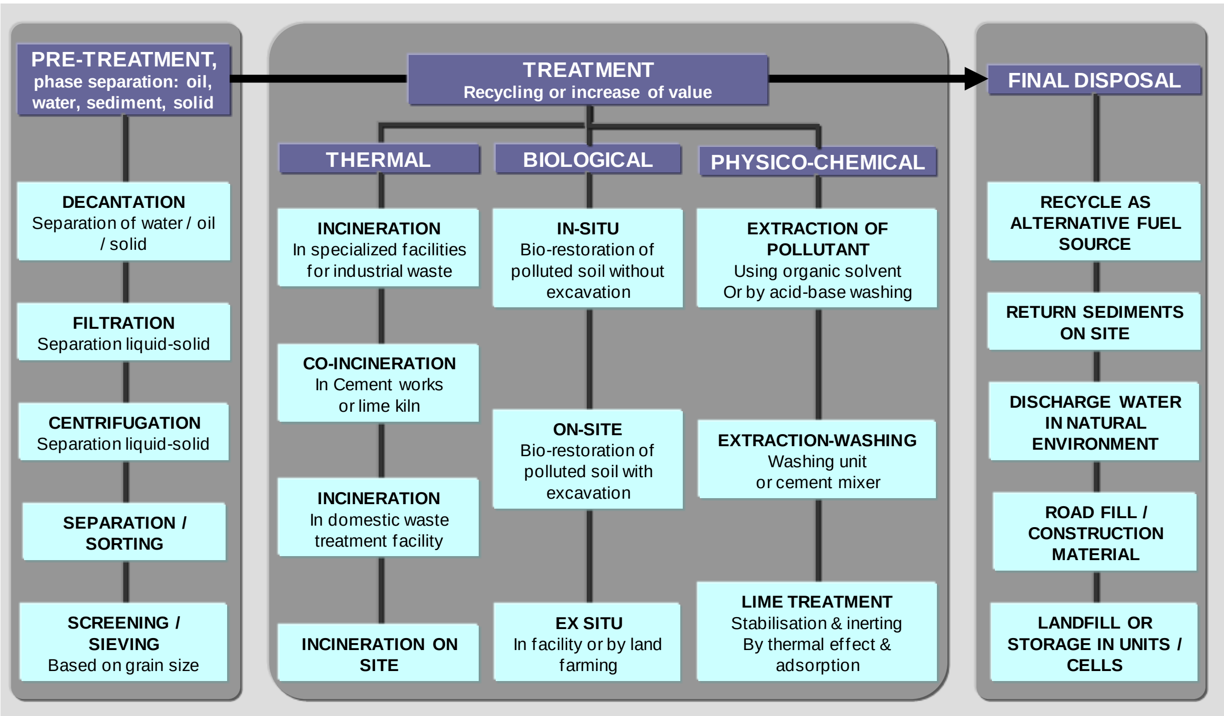
- the type and volume of waste, and
- the facilities and treatment techniques available
- their rate of processing capability

Each spill involves a particular type of oil, which will undergo weathering, and be recovered on various shoreline locations, thus producing different types of waste.

However, based on past experience, spills involving persistent crude oil or refined products usually produce the same main categories of waste. To manage these wastes, various types of treatment may be implemented.

Each main treatment process or facility usually requires a pre-treatment, i.e. a preparation of the waste to ensure that it will be accepted by the treatment facility. Each pre-treatment is specific and depends on the treatment chosen and on the entry criteria of the treatment facility. The figure below was developed by CEDRE to outline the main types of treatment and pre-treatment for oil spill waste.

Figure 4-1 Typical Oil Spill Waste Treatment Processes



(Source: Cedre)

4.2 Classification of Technologies

The MCA guide (MCA 2007) identifies nine “generic” technologies (reprocessing; oil-water separation; emulsion breaking; stabilization; bioremediation; sediment-washing; thermal treatment; heavy fuel use and landfill) which can be used to process all or part of waste from an oil spill.

However, the broad MCA categories contain a number of quite different technologies, with varying constraints of available capacity. For example, “sediment-cleaning” is carried out on quite a small scale (tens of cubic metres per hour of waste) by a small number of specialist refinery waste contractors, but less-sophisticated quarry-type equipment is available which can treat thousands of cubic metres per hour.

Three of the MCA category names have therefore been amended. “Sediment-washing” has been changed to “sediment cleaning” to include some quarry solids handling techniques which go beyond simple washing, and stockpiling has been included along with stabilisation to cover techniques which allow an urgent problem to be set aside for later treatment with no impact on the environment. The “Thermal Treatment” category has been split into two – thermal treatment being used to refer to processes such as thermal desorption, and an additional category “Incineration” created. This has been done because in terms of the treatment process, thermal desorption would be expected to be carried out by bringing a mobile unit to the waste, be that at a temporary or an intermediate storage site, whereas incineration will take place at a fixed location. This makes distinction between certain of the technologies easier.

The revised list of generic technologies used in this guide is therefore:

- Reprocessing,
- Oil-water separation,
- Emulsion breaking,
- Stabilization and stockpiling,
- Bioremediation,
- Sediment cleaning,
- Thermal treatment (desorption),
- Heavy fuel use
- Incineration
- Landfill

Note that stabilisation is not taken to include the processes known as stabilisation which blends solid material with liquid wastes in an attempt to make them suitable for landfill. In terms of this protocol, this process is not differentiated from landfill, and doubt it would be acceptable as a proposal to the UK regulators.

Explanations of what these technologies are, and how they operate are shown in Table 4-1, below. Table 4-2 contains similar descriptions of “sub technologies” of these generic technologies and more detailed information on options may be found in the data sheets included in Appendix C (modified from REMPEC 2009).

Table 4-1 – Generic Technologies for Processing Oily Waste

Generic Technology	General Description
Reprocessing	Oils substantially free of solids and water may be sent to a refinery as a feedstock for reprocessing into fuel
Oil-water separation	Separation of the oil and water phases in a mixture reduces waste volumes. This is usually achieved by gravity settlement, or what might be viewed as enhanced gravity settlement (centrifuges etc.), though flotation may also be used.
Emulsion breaking (oil/water emulsion)	Oil and waste can form an intimate stable mixture known as an emulsion. Emulsions cannot be separated into their components without destabilisation. The use of chemicals, heating, or a number of other techniques can effect this destabilisation
Stabilization/Storage/ Stockpiling	It may be expedient to render oily wastes suitable for longer term storage, or to store those wastes which are already reasonably stable. Mixing with quicklime can render sandy wastes into relatively stable solid form. Extreme conditions can turn some wastes into a glass suited to long-term storage.
Bioremediation	The organic component of wastes (including the oil present) can be food for microorganisms under a range of conditions. Bioremediation processes harness this technique to clean up contaminated materials.
Sediment cleaning	Oils can be washed from the surface of solid materials, and oil soaked into materials can be recovered in this way through size reduction prior to washing. Hot water and solvents can be used to enhance washing processes.
Thermal treatment	Oils can be mobilised, or volatilised by heat. There are a number of processes available to us which can carry out these operations to varying degrees.
Incineration	Oils can be partially or fully oxidized (burnt) by heat. Incineration is taken to include gasification and pyrolysis
(Heavy) fuel use	Oily wastes can be used as fuel and less oily wastes as feedstock in a number of industrial processes such as cement making.
Landfill	Wastes can be deposited at permitted landfills

Table 4-2 – Sub-Technologies for Processing Oily Waste

Generic Technology	Sub Technology	General Description
Reprocessing	None available	
Oil-water Separation	Sedimentation	In a sedimentation or settlement tank, heavy particles sink and light particles float. Techniques exist for enhancing operation of such processes, such as the inclined plates used in the API separator.
	Centrifugation	A centrifuge creates a high gravitational field, separating light and heavy particles in a smaller space than a sedimentation tank. It can potentially separate two liquid phases from accompanying solids in a single stage. It has small passages within it which are unsuited to use with gross solids.
Emulsion Breaking (oil/water emulsion)	Chemical	Alteration of pH and the use of specific surface-active chemicals can destabilise many emulsions.
	Physical	Some emulsions can be broken by heating, and some by vigorous agitation.
	Electrochemical	As the stability of emulsions is based in the mutual electrical repulsion of particles, electrical methods known as electrocoagulation may be used to separate oil and water phases. This technique is less well proven than the others here.
Stabilization/Storage/ Stockpiling	Lime Stabilisation	Quicklime's reaction with siliceous materials can be used to temporarily stabilise wastes with a high solids content. This technique should not be used for liquid wastes.
	Vitrification	Solid wastes, (especially sandy materials) can be turned into a glass by the use of very high temperatures, to produce a highly stable end product.
	Storage	Materials which are naturally stable under environmental conditions, or have been stabilised can be stored. This technique might be expedient if there are larger volumes of waste, and high time pressure.
Bioremediation	In-situ	Bioremediation can be carried out without transporting contaminated materials away from site, with the possible addition of nutrients or oxygenating material.

Generic Technology	Sub Technology	General Description
	Land Farming	The wastes are mixed with soil and additives and spread relatively thinly over the land to promote a fairly low-intensity biological/chemical oxidative degradation of the organic material present.
	Anaerobic Digestion	AD proceeds in the absence of oxygen, using organisms which either do not require it, or are poisoned by it. There are variants which can cope with fairly dry materials, but it is most commonly used with wet wastes.
	Composting	Composting is another aerobic process, involving mixing with soil and additives as with land farming, but with the process intensified by piling up into a static aerated pile, turned windrows, or in an aerated containment vessel.
	Biopile	The Biopile differs from composing in that it represents a further intensification of a static aerated pile by means of containment and controlled irrigation.
Sediment Cleaning	Steam	High-pressure steam jets may be used to remove oil from solid material.
	Flotation	Oil particles tend to float, a tendency which can be enhanced by attaching tiny air bubbles to them via a recycled stream of pressurised, aerated effluent. This process can be used to clean up oil-contaminated sands. Hot water may be used to enhance oil removal.
	Screening	Filters may be used to separate solid particles from liquids. The solids may either be washed on the screen, or as a separate process.
	Sorting	Oil concentrations tend to be higher in the finer sediments. Sorting out larger particles with mineral processing equipment yields a stream of coarser solids with a lower oil content.
	Mills/Shredders/ Shearing Machines/ Crushers	Size reduction equipment, (usually with a minerals processing pedigree) can be used to facilitate washing, or prepare material for further treatment.
	Pressure washing	Hand or automated washing with hot or cold water or solvents under pressure can remove much of the oil from coarse sediments.
Thermal Treatment	Drying	Oily grass and seaweed can be dried to facilitate burning in shallow piles where environmental conditions permit.

Generic Technology	Sub Technology	General Description
	Thermal Desorption	Relatively low temperature heat treatment can be used to remove oils by vaporisation. The technique is most suited to soil decontamination.
Incineration	Gasification/ Incineration	Heating under pressure in the presence of oxygen (in the same way as town gas used to be made) converts organic materials into a mixture of carbon monoxide and hydrogen known as syngas, which can be burned.
	Pyrolysis/ Incineration	Heating under pressure in the absence of oxygen can decompose organic materials present in solid wastes into smaller, more volatile molecules. The resulting gas stream can be burned, but there are additionally liquid and solid wastes produced.
	Incineration: Municipal	Some municipal incinerators can treat a percentage of solid or liquid oily wastes.
	Incineration: Industrial	Commercial incinerators exist to burn more hazardous wastes, in addition to the other industrial uses described in the “heavy fuel use” section. Such commercial incinerators are likely to be more expensive, and have smaller capacities than their municipal equivalents.
	Evapo-incineration	Mixtures of oil and water can be heat treated to evaporate off the water, and the residual oily condensate burned.
(Heavy) Fuel Use	Cement/Lime Kiln	Essentially solid wastes can be used as either mineral feedstock or fuel in cement production, and liquid wastes can be used as fuel. Whilst a wide range of feedstock and fuel can be used, the system has to be set up for each input, and only larger and more homogeneous batches will be attractive to operators.
	Power Plant/Glass Industry/Smelting Industry	Liquid wastes with a high calorific value can be used as fuel in the glass and metals processing industries.
Landfill	None available	There are not so much sub-technologies for landfill as subtypes. Based on physical form and level of contamination, landfilled materials will meet acceptance criteria for inert, non hazardous or hazardous (in increasing order of cost) landfill sites or cells. Liquid wastes may not be landfilled, and some pre-treatment may be required for all types.

5 DEVELOPMENT OF DECISION-MAKING GUIDE

5.1 Approach

The initial stage of the development was to document the process which would be followed in an "ideal" situation. This is shown in Section 5.2 and in Flow Chart 5-1 which follow. Information required to enable this procedure to be followed was assessed, and typical availability of this information in real situations was then determined. Where it was felt unlikely that such information would be readily available, alternative solutions to enable the process to continue were developed and documented. The whole process was then converted into a spreadsheet model to facilitate rapid assessment of different scenarios.

5.2 Strategy Development - all information available

If all necessary information were to be available, the following is the procedure which a process engineer would be likely to follow to establish the best waste processing strategy, assuming the overall strategy follows that described in Section 3.1. This is summarised diagrammatically in Figure 5-1:

1) Determine the magnitude and characteristics of the waste which needs to be processed
    i) From each of the segments of the shoreline affected (will need to be estimated if early in the process)
    ii) At each of the temporary storage facilities to which the waste processed from the shoreline will be (or has been) transferred (derived from information obtained in a above or measured if waste already transferred). The typical temporary storage site layout presented in Figure 3-5 indicates bays for storing segregated classes of waste with dimensions 100 x 80 x 2.5 m, giving capacities up to 20,000 m^3.
2) Consolidate the data to give total volumes of various types of waste
    a) At each temporary storage location
    b) In each local area – ie a number of temporary storage locations together
    c) In a region – ie the total amount of waste in, for example a county
3) The regulatory authority's expressed preference for treatment is that if possible the waste should be processed on the shore; if this is not posssible, and if this is also not posssible at the temporary storage location, the material should be transferred elsewhere for treatment. This document assumes that material has been or will be processed as well as possible on the shore and that treatment is required for the waste arising from this process and that which cannot be treated on the shoreline. To follow regulatory preference, the next stage would be to make an assessment as to whether permitted, mobile equipment exists and is available with which the material at a temporary store could be treated – this will require assessment of:
    a) Which permitted mobile systems could treat the waste (assessed using data from mobile equipment permit holders and analysis of waste)
    b) Which of the treatment systems which could treat the waste is available for immediate deployment?
    c) Whether the necessary facilities/infrastructure exists, or could be provided, at the temporary storage facility to enable the available, permitted equipment to operate satisfactorily (for example, power, effluent disposal etc)
    d) If feasible based on stage 3a), 3b) and 3c) above, whether the impact of use of the necessary mobile unit(s) would be acceptable to the local population and the environmental regulator (noise, odour impact) and whether the processing could take place as quickly as required to have an acceptable (to the local population or politicians) outcome in terms of the time taken to remove the waste

   e) If there are multiple storage locations where the same equipment could be used and its application would be feasible, would the rate of treatment allow the system to treat one site, then move on to the next and still treat all the sites within an acceptable time scale?
   f) The use of non-permitted equipment at the temporary storage location is considered by the EA as being acceptable if this can be demonstrated to have overall environmental benefit - discussions would need to be held with the regulator’s representative to estbalish whether this would be applicable in any specific situation.

4) It is entirely feasible that the process outlined in stage 3 will lead to the conclusion that part of the waste may be treated by mobile units but not all can. If this is the case, plans should be implemented to treat the waste which can be treated as soon as possible.
5) If part or all of the waste cannot be treated with permitted mobile units, the possibilty of treatment at existing, fixed permitted waste facilities should be explored. This follows a similar procedure to that outlined for the mobile units – ie
   a) Which permitted facilities could treat the waste (assessed using data from permitted facilities operators and analysis of waste)?
   b) How much spare treatment (or storage pending treatment) capacity has each of the facilities which could treat the waste available?
   c) The volume of particular types of waste which need treatment (as established at stage 2) could then be compared with the available capacity and geographical locations and a preference list established – ie which facility would be best for disposal of waste from each individual location or a group of locations.
   d) If feasible, arrangements should then be made to transfer the waste to the appropriate facilities.
6) If necessary or considered beneficial, either of the above stages could be implemented by a specialised waste contractor who could take responsibility for the whole process – this would require confirmation of their ability to manage the process and supervision/inspection to confirm compliance with the necessary legal and regulatory framework but would have the advantage that inexperienced personnel within the spill response team would not be required to make decisions outside their knowledge.
7) If neither treatment by a mobile unit nor transfer to and treatment at a permanent facility is feasible, consideration must be given to the specific procurement and deployment of equipment to treat the waste. This process follows a similar pattern to the other two stages:
   a) Review of which processing equipment or combinations of equipment could treat the waste (assessed using data from professional experience, suppliers and analysis of waste) and what would be the “product” streams produced? Consideration should be given at this stage to the possibility of using second hand equipment (modified or as available) to undertake the processing as this is likely to be available much more quickly than new units.
   b) What facilties and infrastructure/space would be required to enable the selected process to operate?
   c) What would be the cost and the delivery time of appropriate equipment?
   d) What “nuisance” levels would be produced (eg noise, odour)?
   e) Using 7a) – 7d), a suitable site would need to be selected (if this has not already been done) where the treatment system could be installed. Arrangements would then need to be made with the landowners to allow the land to be used and for all the necessary infrastructure to be put in place if this does not already exist
   f) Once the treatment system has been specified, an appropriate environmental permit would need to be obtained – this could take place in parallel with the construction of the system. Site options shoud be reviewed and if a single site

cannot be found to accommodate both the treatment facility and the storage of waste pending tretament, a separate stoprage site will need to be located and developed.

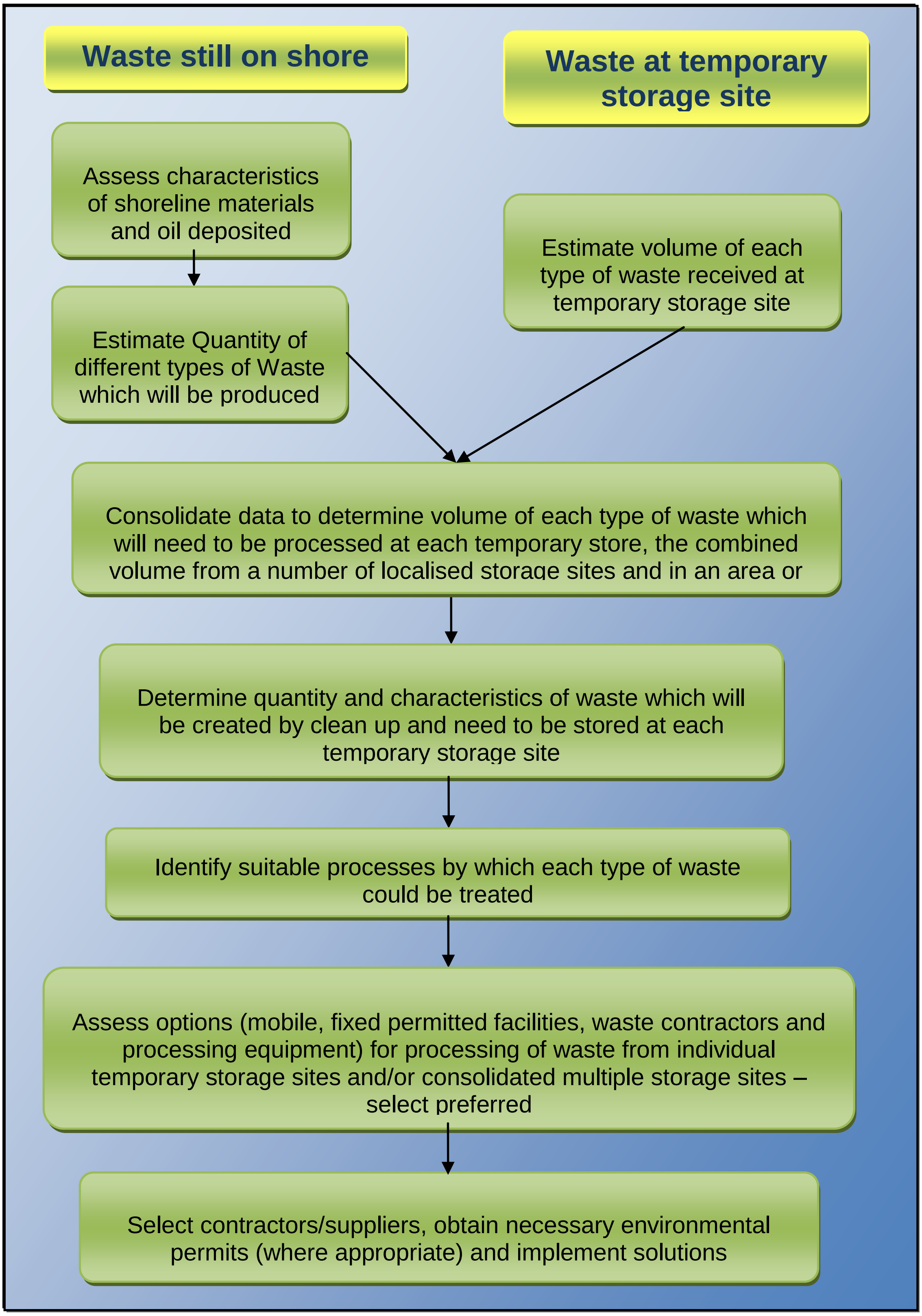
g) When delivered, the equipment would need to be commissioned and operated to process the waste

h) Outlets would need to be found for the “treated” waste streams – these may be either end use or further waste processing dependent on the nature of the produced streams.

i) Consideration should again be given to the employment of an experienced contractor to undertake some or all of the above tasks

Stages 3 a) and b) and 5a) and b) could be preceded by ranking of the candidate proceses as shown in Section 6.6.2.3

Flow Chart 5-1 – Flow Chart of Processing Strategy Development - Idealised



5.3 Information Required to Develop Strategy

The process outlined above depends on the availability of information from a variety of sources. This section outlines the information required.

The various treatment processes which can be used to remove oil from a mixture with water or from deposition on a solid all depend on one or more characteristics of the oil/water or oil/solid mixture to be effective. In order to determine which of the available techniques would be likely to be most effective, therefore, it is necessary to obtain information on the following critical characteristics:

a) Physical/chemical properties of oil on shoreline

b) Physical/chemical properties of materials with which oil has been mixed

c) Degree of contamination of materials impacted

The volume of waste is also clearly a vital component on the process selection procedure.

Because each of the treatment methods also works in different ways, they will each have specific requirements by way of space, power, operating staff, effluent disposal etc.

Combining these factors with the general principles of oil spill management outlined in Section 3 and the idealised process outlined in Section 5.2 above leads to the conclusion that in order to make decisions on an appropriate strategy, information is required on a number of key elements, including:

i) Volumes of waste to be processed

ii) Physical/chemical properties of oil on shoreline

iii) Physical/chemical properties of materials with which oil has been mixed

iv) Degree of contamination of materials impacted

v) Likely collection/consolidation point for waste (on beach, temporary storage location etc)

vi) Technologies or facilities available to process waste

vii) Infrastructure/facilities available at collection/consolidation point

viii) Other locations available to which waste could be transferred

ix) Logistics of transfer

x) Regulatory or other restrictions

With the benefit of appropriate information, the process engineer would then apply his skills and experience to select appropriate solutions, as outlined in Section 5.2.

Under “normal” circumstances, if critical information was not readily available, engineers would request or produce additional data until they had sufficient to enable them to develop a response appropriate to the level of accuracy required for a specific application. In this instance, however, it was clear that not all this data would be quickly obtainable and it was therefore necessary to develop alternative means by which the best possible data could be provided and applied in the real situation when oil has been spilt and no further information is immediately available.

Table 5-1 below identifies the information which is needed, indicates typical sources and availability of this information and possible alternative means by which data could be established or estimated.

Section 5.4 describes how the information is obtained from the primary sources, where they exist and Section 5.5 the methods which have been used in this guide to provide information where primary source data is not readily available.

Section 6.6 describes the process by which a selection of the appropriate technology may be made by those without the benefit of expert knowledge.

Table 5-1 – Information Required and Sources

Information Required	Primary Source	Availability	Possible Alternative Source or substitute data?
Physical/chemical properties of oil on shoreline (after spill)	Inspection – SCAT report	Good when SCAT report completed	Inspection and UFOC Classification
Physical/chemical properties of materials with which oil has been mixed (after spill)	Inspection – SCAT report	Good when SCAT report completed	MAGIC database (not as accurate as inspection)
Volumes of waste to be processed (1) if oily materials still on shoreline	None	None	Estimation of volume from experience and modelling
Volumes of waste to be processed (2) if oily waste has been transferred to storage	Inspect/measure at storage location	Good after inspection	Estimation of volume from experience and modelling
Degree of contamination of materials impacted	Inspection – SCAT report	Good when SCAT report or waste inspection completed	Estimation of volume from experience and modelling
Likely collection/consolidation point for waste (on beach, temporary storage location etc)	Local authority	Not good	Inspection
Selection of technologies suitable to process waste	Knowledge and experience, literature, buyers guides	Good if knowledgeable	Guidance on selection, information from suppliers
Facilities (licensed/permitted) available to recover or process waste	Regulator registers, direct enquiry	List of facilities good from regulators. Information from companies poor	Pressure from regulator or MCA to provide detail. Enquiry when spill occurred and commercial opportunity apparent.
Infrastructure/facilities available at collection/consolidation point	Local authority	Not good	Inspection
Other locations available to which waste could be transferred	Local authority??	Not good	Investigation

Information Required	Primary Source	Availability	Possible Alternative Source or substitute data?
Logistics of transfer	Inspection of sites, routes, etc	Good	Use of proprietary software designed to plan vehicle routes
Regulatory or other requirements and restrictions	Regulator (EA, SEPA, NIEA)	Good	Not necessary
Final disposal options or outlets	Various including regulator	Variable	Waste contractors

5.4 Primary Sources of Information

5.4.1 Waste Characterisation

5.4.1.1 Derivation of Approach

Section 5.3 indicates the key data which it is necessary to possess before reasonable comparisons can be made between alternative processing options. A simple, consistent basis is required to communicate this information. This section explains how this has been derived.

Part 4 of the MCA's Marine Pollution Clean-up Manual (MCA, 2007b) provides overall outline guidance for decontamination of materials arising during shoreline cleanup. It considers reprocessing, oil-water separation, emulsion breaking, stabilization, bioremediation, sediment-washing, thermal treatment, heavy fuel use and landfill technologies, does not consider the interaction of oil type and suitability of technology, and differentiates only to the level of "suitable/unsuitable technology", rather than attempting to rank technologies.

Selection of treatment technology is on the basis of what the oil is mixed with:

- Recovered oil alone
- Oil and water mixtures or emulsions
- Oil and sediment mixtures
- Oil containing organic debris
- Oil and oil-contaminated PPE/ equipment

This categorisation is identical to that used by IPIECA (2004)

What is still missing from the process engineering point of view is consideration of what sort of oil is present, the relative proportions of oil and contaminants, and the required treatment standard for recovered components.

A document which goes further in addressing these missing considerations is the "Guidelines And Strategies For Oil Spill Waste Management In Arctic Regions" EPPR (2009) which adds consideration of substrate (shoreline) type, oil type, degree of oiling (surface oiling category), and shoreline length (optional). It may be seen that the last two categories address the relative proportions and volume categories.

The EPPR also consolidate the commonly used UFOC oil classification categories (Castle, R.W., and Wehrenberg, F. , 1997), into five coarser ones:

- Volatile oils (gasoline products – viscosity like water)
- Light oils (diesel and light crudes – viscosity like water)
- Medium oils (intermediate products and medium crudes)
- Heavy oils (residual products and heavy crudes – viscosity like molasses)
- Solid oils (bitumen, tar, asphalt – does not pour)

(EPPR (2009) Appendix B2)

A document produced by REMPEC (2009) sets out yet another way to categorise waste arising, but it includes no classes not covered by the above combined classification, is less applicable to the process engineer's needs, and less connected to how beach operations are organised.

Having considered all of the available options, integrating the categories used by the EPPR (2009) with those of the MCA (MCA, 2007b) was considered offer the best compromise, in order to define seven waste types produced by the operation:

1. Recovered oil alone
2. Oil and water mixtures or emulsions
3. Oil and sediment mixtures 1- Sand/Mixed
4. Oil and sediment mixtures 2- Coarse Sediment
5. Oil and sediment mixtures 3- Cobble/Boulder
6. Oil containing organic debris
7. Oil and oil-contaminated PPE/ equipment

It has been assumed in producing this table that the EPPR categories "vegetation" and "oiled debris" fall under category 6, that the "bedrock/solid" category yields only mixtures falling under one of the given categories, and that snow/oil mixtures are frozen examples of category 2.

It is also considered that the UFOC classification is too sophisticated for current needs.

The EPPR document provides the best model for this decision-making tool, and its authors have produced a programme which allows the best technology to be identified based upon oil type, shore type, degree of oiling and (optional) length (See section 6.5).

5.4.1.2 Definition of Oily Waste Classifications

Comparing a variety of different guides and assessing the needs of the process engineer resulted in the following definitions which are used in the model and throughout the rest of this document

5.4.1.2.1Physical/ Chemical Oil Properties

These are ranked essentially by viscosity

- "Volatile" refers to gasoline products – viscosity like water
- "Light" refers to diesel and light crudes – viscosity like water
- "Medium" refers to intermediate products and medium crudes
- "Heavy" refers to residual products and heavy crudes – viscosity like molasses
- "Solid" refers to bitumen, tar, asphalt – does not pour

5.4.1.2.2Physical/chemical properties of solid component

- "Oil alone" is a single oil phase, no appreciable solids or immiscible liquids
- "Oil + Water mix" includes emulsions
- "Sand mix" is oil mixed predominantly with sand
- "Coarse mix" is oil mixed predominantly with coarse sediment/pebbles
- "Stone mix" is oil mixed predominantly with cobbles and boulders
- "Organic debris" is oil mixed with animals or plants, or materials derived from them

- “PPE/equipment” oil contaminated equipment requiring disposal

5.4.1.2.3Water type

Whilst in the vast majority of cases it is envisaged that oil will be mixed with seawater, pollution of estuaries and thus possible entrance into essentially fresh water is possible. Definitions based on Total Dissolved Solids (TDS) levels could have been used, but a quick, more generic description has been adopted.

- Fresh- From inland water body or groundwater
- Brackish- From inland bodies of water such as estuaries with significant salt levels
- Salt- Seawater

5.4.1.2.4Relative levels of contamination

Taken from SCAT manual as shown below:

UK SCAT Manual *3.1 STANDARD TERMS AND DEFINITIONS*

Summarising the degree of oiling

Several of the above data can be combined to create indices to rate the degree or relative severity of oiling in a particular segment. Potential indices are depicted in Figures 3.2 and 3.3.

		Width of Oiled Area			
		Wide	**Medium**	**Narrow**	**Very Narrow**
Oil Distribution	**Continuous 91 – 100%**	Heavy	Heavy	Moderate	Light
	Broken 51 – 90%	Heavy	Heavy	Moderate	Light
	Patchy 11 – 50%	Moderate	Moderate	Light	Very Light
	Sporadic 1 – 10%	Light	Light	Very Light	Very Light
	Trace < 1%	Very Light	Very Light	Very Light	Very Light

Figure 3.2 Surface oil cover category (width x surface distribution data)

		Initial Categorization of Surface Oil			
		Heavy	**Moderate**	**Light**	**Very Light**
Average Thickness	**Thick > 1 cm**	Heavy	Heavy	Moderate	Light
	Cover 0.1 – 1.0 cm	Heavy	Heavy	Moderate	Light
	Coat 0.01 – 0.1 cm	Moderate	Moderate	Light	Very Light
	Stain/Film < 0.01 cm	Light	Light	Very Light	Very Light

Section 5.4.2 describes the mechanism for collection of the information described above.

5.4.2 Shoreline Cleanup Assessment Technique (SCAT)

As part of oil spill response, Shoreline Cleanup Assessment Technique (SCAT) teams systematically survey the area affected by the spill to provide rapid accurate geo-referenced documentation of shoreline oiling conditions. This information is used to develop real-time decisions and to expedite shoreline treatment planning and response operations. A SCAT programme includes field assessment surveys, data management, and data application components as part of the spill management organisation. The field survey teams use specific and standard terminology to describe and define shoreline oiling conditions. The systematic approach provides for consistent data collection. This allows a comparison of data and observations between different sites, between different observers, and between the same sites over time. In most surveys, the SCAT teams complete forms and sketches for each segment in the affected area. A SCAT proforma is used for documentation. Segment lengths are small enough to obtain adequate resolution and detail on the distribution of oil, but not so small that too much data is generated. Most segments in oiled areas would be in the range of 0.2 - 2.0 km in length.

The UK SCAT manual (MCA 2007) was adapted (with permission) from the most recent Environment Canada SCAT manual and materials. In particular, modifications were made to make the manual compatible with the UK *National Contingency Plan for Marine Pollution from Shipping and Offshore Installations* (MCA 2006a) and various technical aspects of shoreline classifications in the UK. The primary focus of this manual is on the detailed systematic shoreline assessment surveys that are most effectively carried out when bulk shoreline oil is essentially static. However, shoreline assessment surveys are also required, often daily, during the emergency response phase when oil is still moving around. These surveys are generally simpler and require less training.

SCAT surveys are based on several fundamental principles. These include

- a systematic assessment of all shorelines in the affected area
- a division of the coastline into homogeneous geographic units or segments.
- the use of a standard set of terms and definitions for documentation
- a survey team that is objective and trained
- the timely provision of data and information for decision making and planning

This systematic and well-established approach makes it ideal to provide the fundamental data required by the process engineer to aid his selection process. Table 6-2 below shows an extract from a typical SCAT form:

Table 5-2 - Extract from Typical SCAT Report Form

Segment	Area		Cover/oil distribution		Oil Thickness		Estimated percentage of area necessitating manual removal of waste	Estimated percentage of free oil easily recovered	Oil Characteristics	Oil Type	Tidal Zone	Slope	Substrate / shoreline
	Length (m)	Width (m)	Range	Est %	Range	Est (mm)							
A	200	5	Sporadic (1 - 10%)	5	Pooled (>1cm)	5	5%	5%	SR Surface Oil Residue (non cohesive, oiled surface sediments	Medium	L Lower Shore	F Flat (<5 °)	Sand / mixed sediment
B	100	20	Continuous (91 - 100%)	95	Pooled (>1cm)	3	10%	5%	SR Surface Oil Residue (non cohesive, oiled surface sediments	Medium	L Lower Shore	M Moderate (5 - 30°)	Sand / mixed sediment
C	50	2	Patchy (11 - 50%)	40	Cover (0.1 - 1cm)	0.5	10%	5%	SR Surface Oil Residue (non cohesive, oiled surface sediments	Medium	M Mid Shore	M Moderate (5 - 30°)	Pebbles
D	150	10	Broken (51 - 90%)	55	Coat (0.01 - 0.1cm)	0.01	5%	5%	SR Surface Oil Residue (non cohesive, oiled surface sediments	Medium	U Upper Shore	S Steep (31 - 60°)	Cobbles
E	50	3	Patchy (11 - 50%)	40	Cover (0.1 - 1cm)	0.8	5%	5%	SR Surface Oil Residue (non cohesive, oiled surface sediments	Medium	L Lower Shore	M Moderate (5 - 30°)	Oil debris

5.4.3 Waste Classification at Temporary Storage Location

The SCAT guide provides a widely adopted methodology for classification of wastes arising during oil spill clean-up operations. Ideally all wastes stored at temporary treatment facilities should have been classified and be associated with SCAT forms describing their nature before their arrival at the storage site. The assessment of the volumes and classifications of waste will undoubtedly be more accurate once it has been removed from the shore, allowing improved data to be used, thereby refining the process for selecting appropriate treatments, if time allows. It is also possible that further characterisation is required in order to fit the waste into the framework for waste treatment or landfill, by means of assigning an EWC code (see Appendix A). It is also possible that wastes may have been misidentified, mixed or lost their associated paperwork, necessitating further classification.

If definitive identification is required, reference should be made to the “Manual on Oil Pollution – Section VI, IMO, Guidelines for sampling and identification of oil spills”, 1998 Edition, which gives detailed and illustrated Instructions and recommendations on sampling analysis and reporting methodology. Sampling and analysis by this means gives a more accurate estimate of contamination levels, and may be a requirement of demonstrable due diligence when sending wastes onward to licensed facilities.

For each type of treatment or disposal option, analysis will be desirable to check the compatibility of the waste with the requirements of the process and with the environmental legislation for atmospheric or water releases.

The most frequent analysis conducted to assist in the choice of a treatment or disposal options are:

Total hydrocarbon content (THC): for example when sand contains more than 20% of oil it is possible to recover this oil by washing, as much as 5% of oil concentration is acceptable for composting in biopile treatment but less than 1 to 2% is required for land farming and less than 0,5% of oil is often requested for use as incoming raw material in cement kiln,

- PAHs (Polycyclic Aromatic Hydrocarbons),
- water content and dry matter,
- sand content and grain size,
- organic matter,
- Net Calorific Value,
- chlorine and halogen content are important entry criteria for re-use of oil as energy source in cement kilns,
- sulphur content,
- metals (Nickel, Vanadium), and
- BTEX.

This relatively sophisticated data will need to be interpreted by a qualified process engineer, so if detailed assessment is not required for other reasons, and a process engineer is not available, assessment of the waste in a storage facility should be undertaken in line with the SCAT approach and classification. It is considered that much of the SCAT classification can be generated from waste stored at a temporary storage facility by simple inspection.

Assuming different types of contaminated materials have not been unduly mixed, it should be as easy to visually identify the size distribution and nature of substrates as it would be on the beach.

Distinguishing oil type for oils collected alone by means of a pour test for viscosity is relatively easy, but determining oil type on contaminated materials without a laboratory test is more troublesome. It seems however likely that the type of oil spilled should be well known by the time wastes are in temporary storage.

Whether water within mixed wastes is salt or fresh is likely to be well-known, and is easily measured onsite by a number of means in the unlikely event it is not.

For liquid phases, the concentrations of oil can be roughly measured by taking a few samples and allowing them to settle in a measuring cylinder. One, two or three layers will develop - oil, water and oil/water emulsion. The proportions can be measured for each, averaged across the samples and these ratios applied to the whole volume.

The degree of oiling term will probably prove to be the most problematic, as it is based in the SCAT manual upon assessment of the width of percentage coverage of the oil in a beach environment. Once the material has been dug from the beach and transported to the storage facility, it will not be readily possible to know what its appearance would have been on the beach. The REMPEC guide shows examples of lightly and heavily oiled sediments (Figure 6-1 below) and the differences in oil content are given as 0.5 and 3.4% respectively. A quick analysis might be done to establish oil content as a weight fraction (remove the contamination using a solvent and then measure the weight difference), but it should be noted that “heavy” contamination by SCAT standards equates to only a small fraction on such a basis. The pragmatic approach is to seek the assistance of a SCAT-trained surveyor and seek their view on how they would classify the material.

Figure 5-1 below shows examples of contaminated sands at different levels of contamination (source Draft Oil Spill Waste Management Decision Support Tool”, REMPEC 2010).

Figure 5-1 Examples of Differently Contaminated Sands

Sand and relative hydrocarbon content in oiled sediment samples	
Jieh accident (Lebanon) Coarse sand lightly oiled Total Hydrocarbon content: 5 500 mg/kg dried matter (0,5%)	
Jieh accident (Lebanon) Fine sand heavily oiled Total Hydrocarbon content 34 000 mg/kg dried matter (3,4%)	

Of note in the above photographs is the relatively small visual difference in appearance with respect to oil contamination between the two samples

5.4.4 Estimation of volume of waste

If waste has already been transferred to a temporary storage site, estimation of the volume of the various types of waste should be relatively straightforward. Waste volumes can be estimated by multiplying up the dimensions of the pile of waste, the number of containers of known capacity, or alternatively from the records of the number of transports (each of a known volume). Assuming the storage bays created are of a uniform shape, volumes can be estimated by measuring the length and width of the bay occupied by waste and multiplying it by the estimated depth of waste.

5.4.5 Information on Permitted Facilities and Waste Users

To enable a good comparison to be made between the various treatment options, information is required on the waste processing capability of existing facilities, the key ones being shown below:

- Type of waste managed / treated
- Acceptance criteria
    - Percent solids?
    - Percent liquids?
    - Maximum solid particle size?
    - Maximum oil contamination level that can be treated?
    - Upper viscosity limit of oil spill waste that can be accepted?
    - Facility to handle volatile materials?
    - Maximum degree of water contamination (for two-phase oil/water mixtures and also water-in-oil emulsions) of recovered oil that can be accepted
    - Any other restrictions on the composition of recovered oil that can be accepted (e.g. contamination by dispersants, surfactants or demulsifiers, salt, sulphur etc)
- Pre-treatment required (if any), and capability (please specify if facility has the option of being able to undertake any pre-treatment which may be required to render unacceptable materials acceptable)?.
- Treatment rate (tons of waste per hour/day/ month/ year)?
- Average utilisation (%)?
- Reception facilities:
    - By sea? Max size of vessel? Daily reception capacity?
    - By road? Max size of vehicle? Daily reception capacity?
    - By train? Daily reception capacity?
    - By inland waterway? Daily reception capacity?
- Storage capacity (total, typically available)?
- Energy, water and other input required (nature and typical quantity required per ton treated
- Other constraint?

The EA provided SLR with details of all the permitted facilities in England and Wales, and contact was made with each. After initial screening, those facilities with relevant treatment capability were sent a data sheet (Appendix E6 and asked to complete the appropriate sections and return to SLR. A very poor response was received. Data which was provided has been incorporated into Part 4 of this report. It has been separated from this Part 3 to enable the data to be updated and maintained more easily.

5.4.6 Information on Temporary, Intermediate and Long-term Storage Sites

This information should be collated by the local authority, and should be made available to the response team. It is possible this will not be available, however, and management of this situation is explained in Section 5.5.4.

5.5 Alternative Means of Obtaining Missing Information

The review of available information included in Table 5-1 indicates that there are three major elements where information is unlikely to be readily available. Consideration was given to what possible substitute data could be used, or what alternative approach could be adopted to generate information sufficiently representative to be able to be applied in the decision-making process. The solutions developed are outlined in the following sections.

5.5.1 Volumes of Waste to be Processed – Waste still on Shoreline

The volume of waste to be dealt with is a critical element of the consideration of the optimal means for dealing with it. A review of the literature located the Polaris Applied Sciences/The Oil Spill Training Company (PAS/TOSTC) produced tool which they entitled their "**Waste Management Calculator (WMC)",** published **in** 2009. The Calculator was developed as part of a study undertaken by Polaris Applied Sciences reported as "Guidelines and Strategies for Oil Spill Management in Arctic Regions", undertaken for the Joint Secretariat of the Inuvialuit Renewables Resources Committee in Canada. This study compared available data on the volumes of waste generated from various oils spills throughout the world and developed software which estimates the quantity of waste which will be generated as a result of cleaning up sections of shoreline using various clean up techniques. The correlation between calculated and actual results was demonstrated to be good, especially considering the wide range of types of waste and locations dealt with, and it was therefore concluded that application of this tool would be of great benefit to those developing waste processing strategies, and this has been incorporated into this decision making guide.

The essential first step of a SCAT survey is to divide the coastline into working units called segments, within which the shoreline character is relatively homogeneous in terms of physical features and sediment type. Each segment is assigned a unique location identifier. Segment boundaries are established on the basis of prominent geological features (such as a headland), changes in shoreline or substrate type, a change in oiling conditions, or establishment of the boundary of an operations area.

The WMC is applied to each segment of shoreline and the data obtained used to estimate the volume of each type of material waste which it is anticipated will be generated. The data for each segment can then be consolidated to estimate the volumes requiring treatment within locations, areas and regions (see Section 6 for example of use).

The protocol developed in this project does not consider the processing of materials which are dealt with on the shoreline – for example material which can be cleaned and returned to the surf for polishing. It is anticipated that decisions on this will be made at the time and will depend on a wide range of factors. The Waste Management Calculator incorporates a number of different means by which this can be achieved and takes these into account when determining likely volumes of waste which will require treatment.

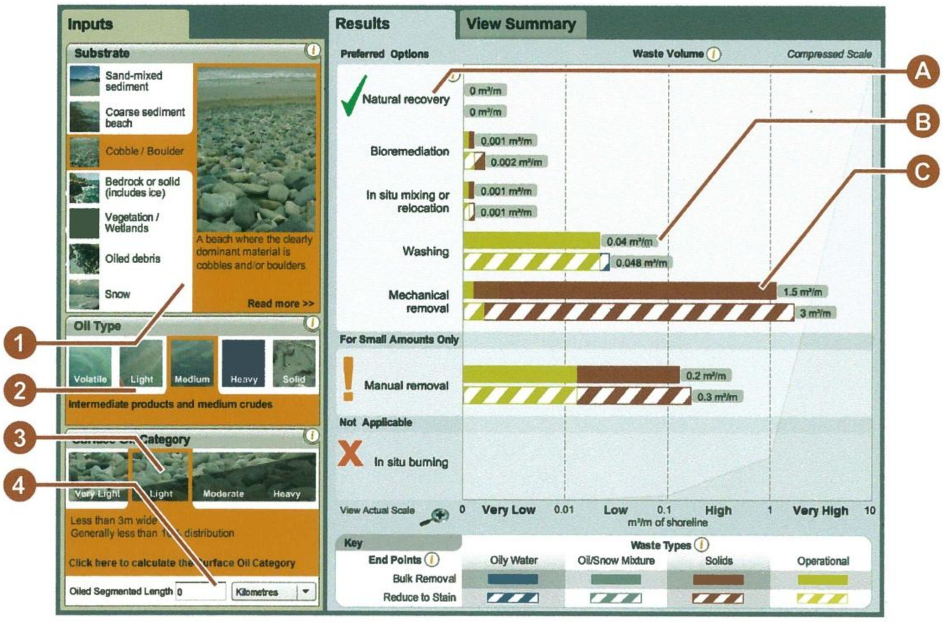
The Waste Management Calculator also enables volumes of spill-derived and "operational" waste to be estimated, based on information derived from visual and some intrusive inspection of the affected shore.

The detail as to how this is used in the decision-making process is described in Section 6, and a copy of the User Guide to this tool is included in Appendix B.

5.5.1.1 Structure and Outline of the Waste Management Calculator

Figure 5-2 - Overview of Waste Management Calculator

The Waste Management Calculator is an interactive, graphic-oriented computer tool for use by non-technical (or technical) managers, decision makers, and planners. This tool can be used to evaluate response options with regards to the types and approximate volumes of wastes that potentially would be generated by different response techniques and different treatment endpoint standards. The tool was developed jointly by Polaris Applied Sciences, Inc. and The Oil Spill Training Company Ltd, for the Emergency Prevention, Preparedness and Response (EPPR) Working Group of the Arctic Council under the direction of the Joint Secretariat (Inuvialuit Settlement Region), with support from the Governments of Canada, Norway and the United States.



Input

1. Substrate (shoreline) type
2. Oil type
3. Degree of oiling (surface oiling category)
4. Shoreline length (optional)

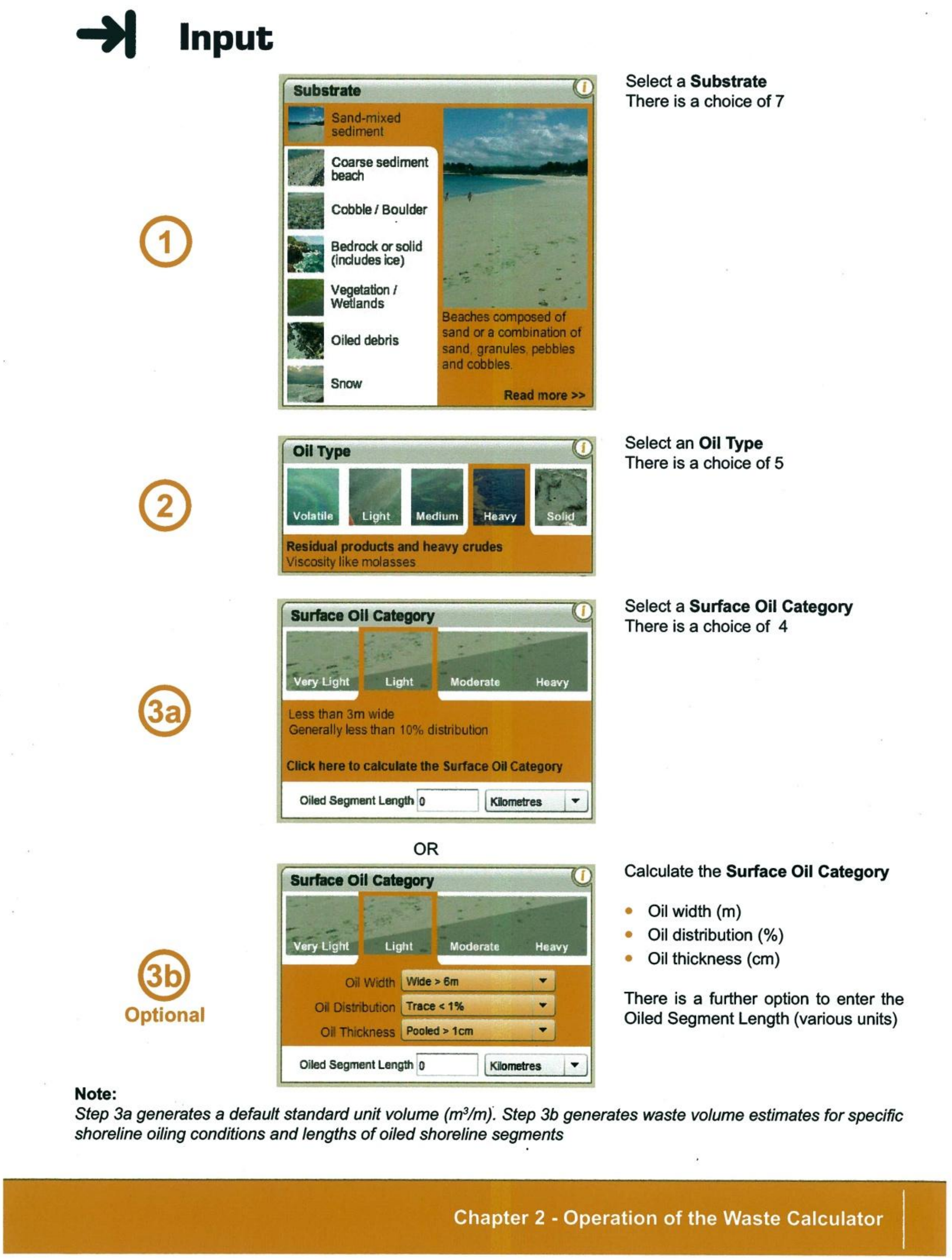
Output

A. Preferred treatment options
B. Oily waste volume
   - shoreline treatment endpoint
C. Waste types

Chapter 1 - Introduction

Input data is obtained from the SCAT report for each segment of shoreline:

Figure 5-3 - Input Data for Waste Management calculator

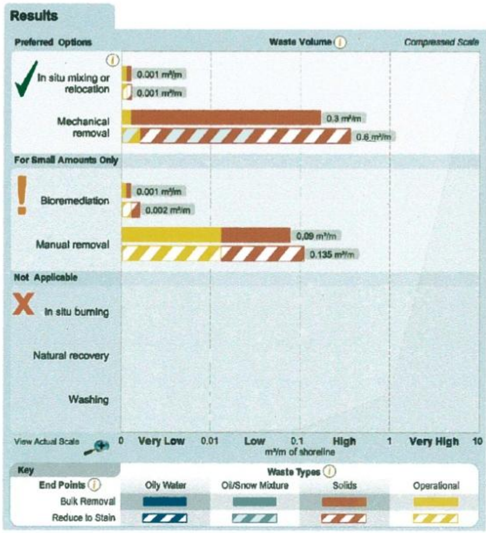


The output is then immediately presented in tabular and graphical form, as shown below, with different quantities of waste produced dependent on whether the objective is to clean the beach completely ("Reduce to Stain"), or just remove the bulk of the contamination and allow natural processes to complete the work:

Figure 5-4 - Output Options from Waste Management Calculator

Output

4a

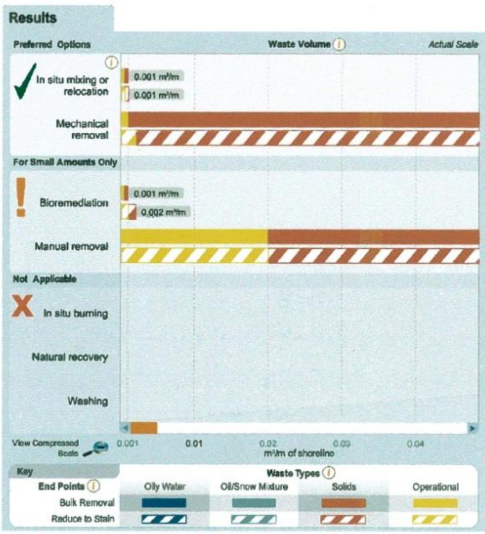


A bar graph that presents the consequences of the selected input parameters is displayed automatically in **Results**

The **Treatment Tactic Options** are listed. The waste volumes for both treatment **endpoints** are displayed

Two Scales are available. In **Compressed Scale** the sub-sections are not in proportion and are not to scale; the full chart can be seen

4b



In **Actual Scale** each sub-section on the X-axis is of equal size and the output is shown in proportion

Scrolling is required to view the full chart

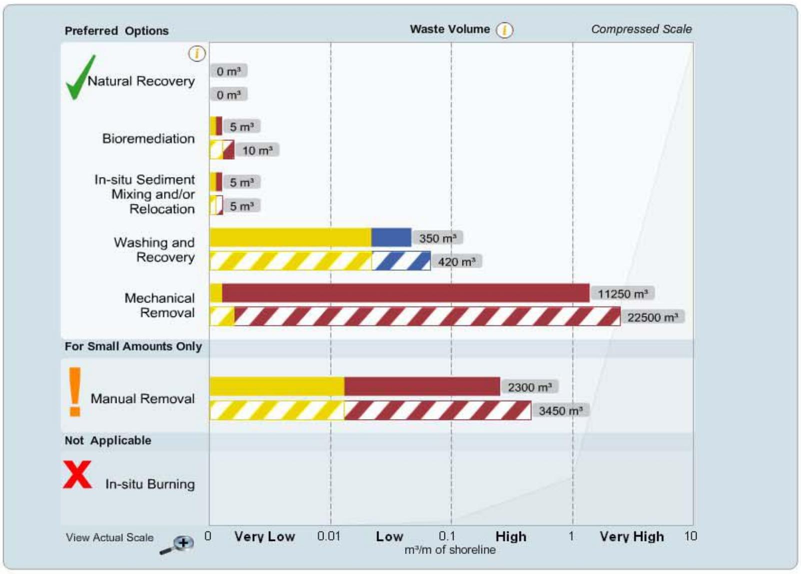
Figure 5-5 - Summary Output from Waste Management Calculator

Summary

Input

Substrate:	Coarse Sediment Beach	**Surface Oil Category:**	Heavy
Oil Type:	Medium	**Shoreline Length:**	5 km

Results	Bulk Removal			Reduce to Stain		
	m^3/m	Volume (m^3)	Operational Waste %	m^3/m	Volume (m^3)	Operational Waste %
✓ *Preferred Options*						
Natural Recovery	0	0	0	0	0	0
Bioremediation	0.001	5	50	0.002	10	50
In-situ Sediment Mixing and/or Relocation	0.001	5	50	0.001	5	50
Washing and Recovery	0.07	350	57.14	0.084	420	47.62
Mechanical Removal	2.25	11250	0.044	4.5	22500	0.044
! *For Small Amounts Only*						
Manual Removal	0.46	2300	4.35	0.69	3450	2.9
X *Not Applicable*						
In-situ Burning	--	--	--	--	--	--



Data output from Waste Generation Toolkit
Wed Sep 22 12:15:13 GMT+0100 2010

5.5.2 Selection of Technologies Suitable to Process Waste

If existing, permitted, mobile or fixed facilities are available which can be utilized to process the spill arisings, their use will in the vast majority of cases represent the most expedient solution, as selection of the most appropriate technologies is taken out of the hands of the spill response team and placed with specialists. Such operations will also have arrangements in place for the ultimate disposal of the treated waste to outlets which meet the requirements of the regulatory framework.

However, the opportunity to use such facilities may not always exist, and in these cases the spill response team may need to procure treatment technologies to undertake the processing. The experienced process engineer will use his knowledge of the available treatment technologies to select the most appropriate and will then engage in detailed discussions with suppliers and/or manufacturers to refine his selection, including commercial assessments.

This decision making tool is intended to guide a non-expert to quickly come to sensible conclusions about technologies which might be appropriate to the particular spill (or part of a spill) under consideration. It was therefore necessary to develop some means by which the skill and experience of the process engineer could be distilled into an easily understandable process. Of necessity, the approach is a technical one, and only those logistical or legal considerations directly impacting on the selection process are considered. Simplicity is hence gained at the expense of specificity, and the use of this document is therefore not intended to fully replace the use of expert advisors, but is intended to be entirely compatible with the use of such advisors.

The approach adopted has been to develop a series of matrices relating to key elements of the decision making process which are then combined and used to “rank” available technologies or strategies to produce short-lists of the most appropriate which can then be subjected to closer scrutiny or investigation to lead to a conclusion on which as/are the optimum for a given situation(s). Population of these matrices is with real data where this exists, best estimates if possible, and industry “best practice” or the authors’ experience and skill where no other alternative is currently available. In considering the various aspects which need to be accounted for, the process attempts to classify each aspect into the bare minimum number of categories necessary to inform a decision, based where possible upon already-proven categorisations.

The “tiered” approach applies the same methodology at each stage – i.e. to rank the alternatives and then examine the preferred options in more detail.

To achieve this, candidate “generic” technologies are first selected, and then “sub-technologies” within each generic technology group. The process is shown in more detail in Section 6 below.

Another significant element of the overall spill-management process is the selection of how any developed strategy should be implemented and managed. A key example in the area addressed in this document is the management of processing of the waste. Given the other pressures under which members of the response teams are working, a strong argument could be put forward for engaging the services of a waste management contractor familiar with the technologies involved, and passing all of the decision-making and operational management on to this organisation. The approach adopted in this guide has been to use the methodology to determine, in the first instance, which processes/technologies might be the most effective. This will enable easier selection of appropriate equipment, suppliers and contractors to be made as the number of options will be limited.

5.5.3 Selection of Waste Treatment Facilities

As indicated in section 5.4, the EA provided SLR with details of all the permitted facilities in England and Wales, and contact was made with each, but a very poor response was received. Data which has been provided is shown in Part 4 of this report. In many cases it was felt that the lack of response was due to the recipients not considering that their putting effort into providing the requested details was worth while because there was not at the time a clear commercial opportunity. It is therefore to be hoped that in the event that there was a real spill, particularly one of significant magnitude for it to be high profile in the media, the response would be much better.

To anticipate this situation, a brief enquiry document has been prepared and is included as Appendix E2 . This has been developed to enable it to be quickly completed but to contain all the information important in reaching a quick decision on the viability of use of a particular facility or mobile unit.

5.5.4 Information on Storage Locations

As described in section 5.4.6, information on the location and infrastructure of proposed temporary storage sites is poor. Assessment of the space, access, facilities, neighbours and local infrastructure are essential elements in the determination of whether a particular treatment process can be installed and operated at a specific site.

To enable this data to be gathered quickly, a proforma has been prepared which could be sent to local authorities in advance of a spill, but as with the data on the waste treatment facilities, is more likely to be completed when a spill has taken place. A copy of this pro-forma is included in Appendix E3. It is possible that the spill response team may be better placed to obtain the necessary information than the local authority.

5.6 Ranking of Processes

5.6.1 Primary Ranking Process

The ranking method has been developed using 12 criteria for comparing the performance of different processes. These can be split into two sections:

Suitability of Technologies versus waste properties and characteristics:

- Waste volume
- Physical/chemical properties of oil contamination
- Physical/chemical properties of material to which oil has become attached/mixed
- Water with which waste is mixed
- Relative levels of contamination

Suitability of Technologies versus other factors:

- Waste Hierarchy
- Relative Costs
- Process Tolerance

- Resources Required
- Facilities/infrastructure required
- Available UK permitted facilities
- Residual contamination levels
- Time Pressure

The candidate "generic" technologies are as listed in Table 4-1, repeated here for convenience;

Table 5-3 – Generic Technologies for Processing Oily Waste

Generic Technology	General Description
Reprocessing	Oils substantially free of solids and water may be sent to a refinery as a feedstock for reprocessing into fuel
Oil-water separation	Separation of the oil and water phases in a mixture reduces waste volumes. This is usually achieved by gravity settlement, or what might be viewed as enhanced gravity settlement (centrifuges etc.), though flotation may also be used.
Emulsion breaking (oil/water emulsion)	Oil and waste can form an intimate stable mixture known as an emulsion. Emulsions cannot be separated into their components without destabilisation. The use of chemicals, heating, or a number of other techniques can effect this destabilisation
Stabilization/Storage/ Stockpiling	It may be expedient to render oily wastes suitable for longer term storage, or to store those wastes which are already reasonably stable. Mixing with quicklime can render sandy wastes into relatively stable solid form. Extreme conditions can turn some wastes into a glass suited to long-term storage.
Bioremediation	The organic component of wastes (including the oil present) can be food for microorganisms under a range of conditions. Bioremediation processes harness this technique to clean up contaminated materials.
Sediment cleaning	Oils can be washed from the surface of solid materials, and oil soaked into materials can be recovered in this way through size reduction prior to washing. Hot water and solvents can be used to enhance washing processes.
Thermal treatment	Oils can be mobilised, or volatilised by heat. There are a number of processes available to us which can carry out these operations to varying degrees.
Incineration	Oils can be partially or fully oxidized (burnt) by heat. Incineration is taken to include gasification and pyrolysis
(Heavy) fuel use	Oily wastes can be used as fuel and less oily wastes as feedstock in a number of industrial processes such as cement making.
Landfill	Wastes can be deposited at permitted landfills

Matrices have been produced which rank suitability (from 0 = unsuitable to 3 = highly suitable) of the various technologies available by means of the criteria above, with the exception of the waste volume criterion. Since volume of waste is so critical, the suitability of a particular technology has been scored from 0 - 5 rather than 0 - 3.

This is summarised in Table 5-4 below. The selection process uses the score for a given condition from the relevant cell and multiplies these together to give an overall score. The column which has the highest total score is ranked first and the second highest second etc.

Data provided by the operators of permitted facilities have been classified using the same generic technologies to enable selection to be made more easily between potential processes by reducing the number of options. This is achieved by focusing attention on the technologies ranked 1 - 3 in the table.

Table 5-4 - Technology Ranking Matrix

		Classification	Max score	**Reprocessing**	**Oil/water separation**	**Emulsion-breaking**	**Stabilisation/ storage**	**Bioremediation**	**Sediment Cleaning**	**Thermal Treatment**	**Heavy Fuel Oil Use**	**Incineration**	**Landfill**
Technologies versus waste properties and characteristics	Table 1 - Waste Volume	Tier 1	5	2	5	5	5	3	5	2	2	5	5
		Tier 2		3	5	5	4	4	5	3	2	5	4
		Tier 3		4	5	3	3	3	5	4	3	3	3
		Tier 4		5	4	2	2	2	5	4	4	2	2
		Tier 5		5	3	1	1	1	4	2	5	1	2
	Table 2 - Physical/ Chemical Oil Properties	Volatile	3	3	2	3	0	1	2	3	3	3	1
		Light		3	3	3	1	3	3	3	3	3	1
		Medium		3	3	3	2	3	3	3	3	3	1
		Heavy		3	1	2	2	2	2	2	3	3	2
		Solid		2	0	0	3	1	1	1	1	2	3
	Table 3 - Physical/chemical properties of solid component	Oil alone	3	3	0	1	3	1	0	0	3	2	0
		Oil + Water mix		0.5	3	3	2	0.25	0	0	2	0.5	0
		Sand mix		0	0	0	2	1	3	1	1	1	2
		Coarse mix		0	0	0	0.5	1	3	1	1	1	2
		Stone mix		0	0	0	0.25	0	2	1	0	0	2
		Organic debris		0	0	0	0	1	0	1	2	3	3
		PPE/equipment		0	0	0	0	1	0	0	0	3	3
	Table 4 - Water type	Fresh	3	3	3	2	3	3	3	3	3	3	3
		Brackish		2	2	2	2	2	2	2	2	2	3
		Salt		1	1	2	1	1	2	1	1	1	3

		Classification	Max score	Reprocessing	Oil/water separation	Emulsion-breaking	Stabilisation/ storage	Bioremediation	Sediment Cleaning	Thermal Treatment	Heavy Fuel Oil Use	Incineration	Landfill
	Table 5 - Relative levels of contamination	Very light	3	0.5	3	2	3	3	3	3	0	1	3
		Light		1	3	2	3	3	3	3	0	2	2
		Moderate		2	3	1	3	2	3	3	1	2	2
		Heavy		3	2	0	3	1	3	3	2	3	2
Technologies versus other factors	Table 6 - Waste Hierarchy		3	3	2	2	2	2	2	2	2	2	1
	Table 7 - Relative Costs		3	3	2	2	3	2	2	1	3	2	2
	Table 8 - Process Tolerance		3	1	2	2	3	2	2	2	2	2	3
	Table 9 - Resources Required		3	3	2	1	1	2	2	2	3	3	1
	Table 10 - Facilities Required		3	3	2	1	1	2	2	2	2	2	1
	Table 11 - available UK Permitted Capacity	Tier 1	3	3	3	3	3	3	3	3	3	3	3
		Tier 2		3	3	3	3	3	3	3	3	3	3
		Tier 3		3	3	3	3	3	3	2	3	3	2
		Tier 4		3	2	2	3	2	2	2	2	2	2
		Tier 5		3	2	1	3	2	2	1	2	2	1
	Table 11 - Residual Contamination Levels	Single stage	3	3	2	1	1	1	1	2	3	3	3
		Further treatment		3	3	3	3	3	3	3	3	3	3
	Table 12 - Time Pressure	High	3	3	2	2	3	2	2	2	2	2	3
		Medium		3	3	3	2	3	3	3	3	3	3
		Low		3	3	3	2	3	3	3	3	3	3

As is demonstrated in Table 4-2, there are typically 3 or 4 sub-technologies for each generic technology, and selection of the appropriate sub-technology would further optimise the selection process. Differentiation between the sub-technologies is, however, more difficult than between generic technologies, requiring more detailed information on the actual performance of each process, some of which is not freely available..

It might be that this second decision will be able to involve more specialised staff than those who were involved in the initial evaluation, and this second round of decision making might consequently be more sophisticated than the “black- box” approach used for the first tier.

This would be profitable, as a lack of information about the parameters which have been identified as being important to choose between available technologies means that considerable professional judgement will be required in making this decision at present. We have however identified a similar methodology to that used for the tier 1 decision making which could be used if additional information were made available by suppliers.

A third tier of decision making has also been identified, that of making the final decision as to precisely which technology is to be used, at precisely which location. This final level of decision making has proved recalcitrant to codification, as will we feel always be better done by a process engineer, with an intense period of research being carried out into the technologies, equipment and sites available in a timely fashion.

5.6.2 Difficulty with ranking sub-technologies

Local considerations may impact upon suitability of technology under the following headings (possible basis for quantification is shown in brackets):

Table 5-5 Possible Secondary Ranking Criteria

Criteria	Units
Rate of processing (as a function of waste characteristics if appropriate)	(te/h)
Physical limitations (eg max particle size, max oil content, oil viscosity etc)	(State)
Pre-treatment requirements	(£/te/h)
Residual contamination post processing	(TPH%)
Waste streams generated:	(Hazardous/Non hazardous)
Area needed	(m2/te/h)
Transport and access requirements	(road class)
Enabling facilities needed	(State)
Power	(kW installed/te/h)
Water	(m3/h/te/h as feed and waste streams)

Criteria	Units
Chemicals/solvents	(£/te/h)
Waste management	(£/te/h)
Time to mobilise to full operation	(d/te/h)
Existence of Mobile Plant Permit	(y/n)
Cost	(£/te/h)
Impact - noise, odour if adjacent to properties	(Statutory nuisance if unabated y/n)

As can be seen, some of these parameters seem to defy quantification, or even ranking, but those which are quantifiable seem (based on the limited information available) to give strong differences between technologies. This gives us confidence that they are well chosen, even if their values at not known at present.

Despite considerable effort being expended, it has not been possible to obtain from equipment suppliers and contractors much of the information which would be needed to allow forward planning of this level of choice of technology, as shown in Table 6-6. It might be speculated that with central government pressure, suppliers and contractors might be persuaded to release information to allow the “B”s in the table to become “A”s, but it seems that quite a bit of the information needed to make this stage of decision a simple process is unknown by anyone at present.

Table 5-6 - Technology Information Availability

Criteria	Reprocessing	Oil-Water Separation	Emulsion Breaking	Stabilization	Bio-remediation	Sediment-Washing	Thermal Treatment	Heavy Fuel Use	Landfill
Process performance									
Rate of processing (as a function of waste characteristics if appropriate) **te/h**	A	B	C	C	A	B	A	B	A
Physical limitations (eg max particle size, max oil content, oil viscosity etc) **State**	A	A	A	A	A	B	B	B	A
Pre-treatment requirements **£/te/h**	A	A	A	A	A	B	B	B	A
Residual contamination post processing (**TPH%**)	A	C	A	A	A	C	B	B	A
Waste streams generated: **Hazardous/Non hazardous**	A	A	A	C	B	B	B	B	A
Area needed **m2/te/h**	B	B	B	B	B	B	B	B	A
Transport and access requirements **road class?**	B	B	B	C	C	C	B	B	B
Enabling facilities needed									
Power **kW installed/te/h**	B	C	C	C	B	A	B	B	A
Water **m3/h/te/h as feed and waste streams**	A	A	B	C	B	B	B	D	A
Chemicals/solvents **£/te/h**	B	C	C	B	B	B	B	B	A
Waste management **£/te/h**	C	C	C	C	B	C	C	C	A
Time to mobilise to full operation d/te/h	B	C	C	C	B	C	C	C	A
Existence of Mobile Plant Permit y/n	A	B	B	B	B	B	B	B	A
Cost £/te/h	B	C	C	C	B	C	C	B	A
Impact - noise, odour if adjacent to properties Statutory nuisance if unabated y/n	A	C	C	C	B	C	C	B	A

Key: A- good data available B- data believed known to specialist companies but presently unavailable to us C- unknown to all at present but could be determined D - might be indeterminable on a general basis

In the absence of this detailed information, as a temporary measure, the same ranking methodology applied to the generic technologies has also been applied to sub-technologies, as shown in Table 5-7 below.

It is recommended that expert advice be sought if possible in preference to using this table, but in the absence of this facility, the table should provide some useful guidance.

Table 5-7 - Ranking of Sub-technologies

	Classification	Reprocessing	Oil/water separation: Gravity	Oil/water separation: Hydrocyclone	Oil/water separation: Centrifuge	Emulsion-breaking: physical	Emulsion-breaking: chemical	Emulsion-breaking: electrochemical	Stabilisation/ storage: Lime	Stabilisation/ storage: Storage	Bioremediation: composting	Bioremediation: anaerobic digestion	Sediment Cleaning: minerals processing	Sediment Cleaning: centrifuge	Sediment Cleaning: hydrocyclone	Sediment Cleaning: cavitation scrubbing	Sediment Cleaning: jet pumps	Thermal Treatment: Desorption	Thermal Treatment:pyrolysis	Thermal Treatment: gasification	Heavy Fuel Oil Use	Incineration: municipal	Incineration: commercial	Incineration: specialist	Landfill: Hazardous	Landfill: nonhazardous	Landfill: inert
Table 1 - Waste Volume	Tier 1	2	5	5	5	5	5	5	5	5	3	3	5	5	5	5	5	2	2	2	2	5	5	5	5	5	5
	Tier 2	3	5	5	5	5	5	5	4	4	4	4	5	5	5	5	5	3	3	3	2	5	5	5	4	4	4
	Tier 3	4	5	5	5	3	3	3	3	3	3	3	5	5	5	5	5	4	4	4	3	3	3	3	3	3	3
	Tier 4	5	4	4	4	2	2	2	2	2	2	2	5	5	5	5	5	4	4	4	4	2	2	2	2	2	2
	Tier 5	5	3	3	3	1	1	1	1	1	1	1	4	4	4	4	4	2	2	2	5	1	1	1	2	2	2
Table 2 - Physical/ Chemical Oil Properties	Volatile	3	2	2	2	3	3	3	0	0	1	1	2	2	2	2	2	3	3	3	3	3	3	3	1	1	1
	Light	3	3	3	3	3	3	3	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1
	Medium	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1
	Heavy	3	2	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	2	2	2
	Solid	2	0	0	0	0	0	0	3	3	1	1	1	1	1	1	1	1	1	1	1	2	2	2	3	3	3
Table 3 - Physical/chemical properties of solid component	Oil alone	3	0	0	0	1	1	1	0	3	1	1	0	0	0	0	0	0	0	0	3	0	2	1	0	0	0
	Oil + Water Emulsion		1	1	1	3	3	3	0	2	0	1	0	0	0	0	0	0	0	0	2	0	1	1	0	0	0
	Oil + Water	1	3	3	3	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	2	0	1	1	0	0	0

	Classification	Reprocessing	Oil/water separation: Gravity	Oil/water separation: Hydrocyclone	Oil/water separation: Centrifuge	Emulsion-breaking: physical	Emulsion-breaking: chemical	Emulsion-breaking: electrochemical	Stabilisation/ storage: Lime	Stabilisation/ storage: Storage	Bioremediation: composting	Bioremediation: anaerobic digestion	Sediment Cleaning: minerals processing	Sediment Cleaning: centrifuge	Sediment Cleaning: hydrocyclone	Sediment Cleaning: cavitation scrubbing	Sediment Cleaning: jet pumps	Thermal Treatment: Desorption	Thermal Treatment:pyrolysis	Thermal Treatment: gasification	Heavy Fuel Oil Use	Incineration: municipal	Incineration: commercial	Incineration: specialist	Landfill: Hazardous	Landfill: nonhazardous	Landfill: inert
	Separate phases																										
	Sand mix	0	0	0	0	0	0	0	2	2	1	1	3	3	3	3	3	1	1	1	1	1	1	1	2	0	0
	Coarse mix	0	0	0	0	0	0	0	0.5	0.5	1	1	3	0	0	3	3	1	1	1	1	1	1	1	2	0	0
	Stone mix	0	0	0	0	0	0	0	0.5	0.5	0	0	2	0	0	2	2	1	1	1	0	0	0	0	2	0	0
	Organic debris	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	2	2	2	3	3	0	0
	PPE/equipment	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	2	2	3	3	0	0
Table 4 - Water type	Fresh	3	3	3	3	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Brackish	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3
	Salt	1	1	1	1	2	2	2	1	1	1	1	2	2	2	2	2	1	1	1	1	1	1	1	3	3	3
Table 5 - Relative levels of contamination	Very light	0.5	3	3	3	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	0	1	1	1	3	2	0
	Light	1	3	3	3	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	0	2	2	2	2	1	0
	Moderate	2	3	3	3	1	1	1	1	3	2	2	3	3	3	3	3	3	3	3	1	2	2	2	2	0	0
	Heavy	3	2	2	2	0	0	0	0	3	1	1	3	3	3	3	3	3	3	3	2	3	3	3	2	0	0
Table 6 - Waste Hierarchy		3	2	1	1	2	2	2	2	2	2	2	2	1	1	1	1	2	2	2	2	2	2	2	1	0	0

	Classification	Reprocessing	Oil/water separation: Gravity	Oil/water separation: Hydrocyclone	Oil/water separation: Centrifuge	Emulsion-breaking: physical	Emulsion-breaking: chemical	Emulsion-breaking: electrochemical	Stabilisation/ storage: Lime	Stabilisation/ storage: Storage	Bioremediation: composting	Bioremediation: anaerobic digestion	Sediment Cleaning: minerals processing	Sediment Cleaning: centrifuge	Sediment Cleaning: hydrocyclone	Sediment Cleaning: cavitation scrubbing	Sediment Cleaning: jet pumps	Thermal Treatment: Desorption	Thermal Treatment:pyrolysis	Thermal Treatment: gasification	Heavy Fuel Oil Use	Incineration: municipal	Incineration: commercial	Incineration: specialist	Landfill: Hazardous	Landfill: nonhazardous	Landfill: inert
Table 7 - Relative Costs		3	2	1	1	2	2	2	3	3	2	2	2	2	2	2	2	1	1	1	3	2	1	1	2	1	1
Table 8 - Process Tolerance		1	3	2	2	2	2	1	2	3	2	2	2	1	1	2	2	2	2	2	2	2	2	2	3	3	3
Table 9 - Resources Required		3	2	1	1	1	1	1	1	1	2	2	2	1	1	1	1	2	2	2	3	3	3	3	1	1	1
Table 10 - Facilities Required		3	2	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1
Table 11 - available UK Permitted Capacity	Tier 1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Tier 2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Tier 3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	3	3	3	3	2	2	2
	Tier 4	3	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Tier 5	3	2	2	2	1	1	1	3	3	2	2	2	2	2	2	2	1	1	1	2	2	2	2	1	1	1
Table 11 - Residual Contamination	Single stage	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	3	3	3	3	3	3	3
	Further treatment	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

	Classification	Reprocessing	Oil/water separation: Gravity	Oil/water separation: Hydrocyclone	Oil/water separation: Centrifuge	Emulsion-breaking: physical	Emulsion-breaking: chemical	Emulsion-breaking: electrochemical	Stabilisation/ storage: Lime	Stabilisation/ storage: Storage	Bioremediation: composting	Bioremediation: anaerobic digestion	Sediment Cleaning: minerals processing	Sediment Cleaning: centrifuge	Sediment Cleaning: hydrocyclone	Sediment Cleaning: cavitation scrubbing	Sediment Cleaning: jet pumps	Thermal Treatment: Desorption	Thermal Treatment:pyrolysis	Thermal Treatment: gasification	Heavy Fuel Oil Use	Incineration: municipal	Incineration: commercial	Incineration: specialist	Landfill: Hazardous	Landfill: nonhazardous	Landfill: inert
Levels																											
Table 12 - Time Pressure	High	3	2	2	2	2	2	2	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3
	Medium	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Low	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

5.7 Development of a Computer-based Model

5.7.1 Objective

One of the revised objectives of the project was the development of an automated system/computer-based model which replicated and enhanced the procedure and would enable the process to be repeated much more readily and with much greater consistency than might be possible if each of the steps was to be undertaken “by hand”. The concept was to create a series of linked steps, each of which could be used in isolation or integrated together, as follows:

1) Classification of waste
    a) Completion of spreadsheet version of SCAT form, modified to provide additional data and to output data in a form suitable for input to
    b) Waste Management Calculator, data from which would be consolidated by
        i) Location (shoreline segment, area and region)
        ii) Waste type (oil, oil/water, oil/solid)
        iii) Type of oil
        iv) Substrate
2) Input of above data into treatment processes ranking tool
3) Comparison of above data with permitted facilities to assess which could provide the necessary treatment - mobile units for application at TSS; refineries or oil processing
4) Comparison of operational requirements for mobile units selected at 3 with facilities available at TSS
5) Calculation of time taken to process waste at each site, check on acceptability
6) Ranking of acceptable processes
7) If no viable systems found, repeat 3, 5 and 6 for fixed systems
8) If no viable processes found, initiate purpose built system design process

Current Status

Considerable effort has been expended in attempting to develop this tool, but this has been substantially restricted by a lack of available information. Progress has been made sufficiently, however, to enable waste classification and waste volume assessments and the primary ranking process to be automated on a spreadsheet as follows:

1. A version of the SCAT form has been prepared on several tabs to allow for the input of several SCAT forms into the spreadsheet, with one SCAT form (tab) covering one shoreline segment.
2. Each SCAT form tab is linked to a Waste Volume Calculator tab which calculates the total volume of waste anticipated to be produced from adjacent sections of the shoreline segment.
3. The Waste Volume Consolidation tab is used for consolidating the data from each of the SCAT reports (tabs) to estimate the total volume of waste requiring treatment at each TSS.
4. The Ranking Assessment 1 tab which is used to produce the ranking matrix described in Section 6.6, using the main parameters data from the Waste Volume Consolidation tab main and automating the ranking.

Templates have been prepared and are being populated and refined to enable the primary selection and viability process to be automated once the appropriate data is available.

Use of these spreadsheets is demonstrated in Section 6.5.

6 THE DECISION-MAKING PROCESS - STEP-BY-STEP GUIDE

6.1 Introduction

This step-by-step guide to the making of decisions is presented in two sections. The first undertakes the process largely as a paper procedure, which makes the procedure much more transparent, and enables the development of the strategy to be more easily followed. Parts of the process have been automated via spreadsheets, which have been developed as part of a planned integrated overall model, and this is described in the second part of this section.

As referred to frequently in the preceding sections, the volume of oil spill waste and its characteristics are the critical elements which determine which treatment techniques will be effective in processing it. Since the basis of this guide is that waste to be treated is that which cannot be processed on the shoreline, it follows that the first opportunity to undertake treatment is when the waste has arrived at the temporary store.

It is likely that waste developed from more than one section of shoreline will be consolidated at one temporary storage site (TSS). This means that to enable an assessment to be made of possible processing options, the total volume of different wastes stored at a temporary site must be known. Data on this waste can obviously be obtained by measurement once it has been transferred, but selection and procurement of treatment processes can be put in hand earlier if alternatives are considered using estimates of the likely waste likely to be generated.

6.2 Assumptions

The following are the key assumptions which have been made in developing the tool and are used in the following explanations:

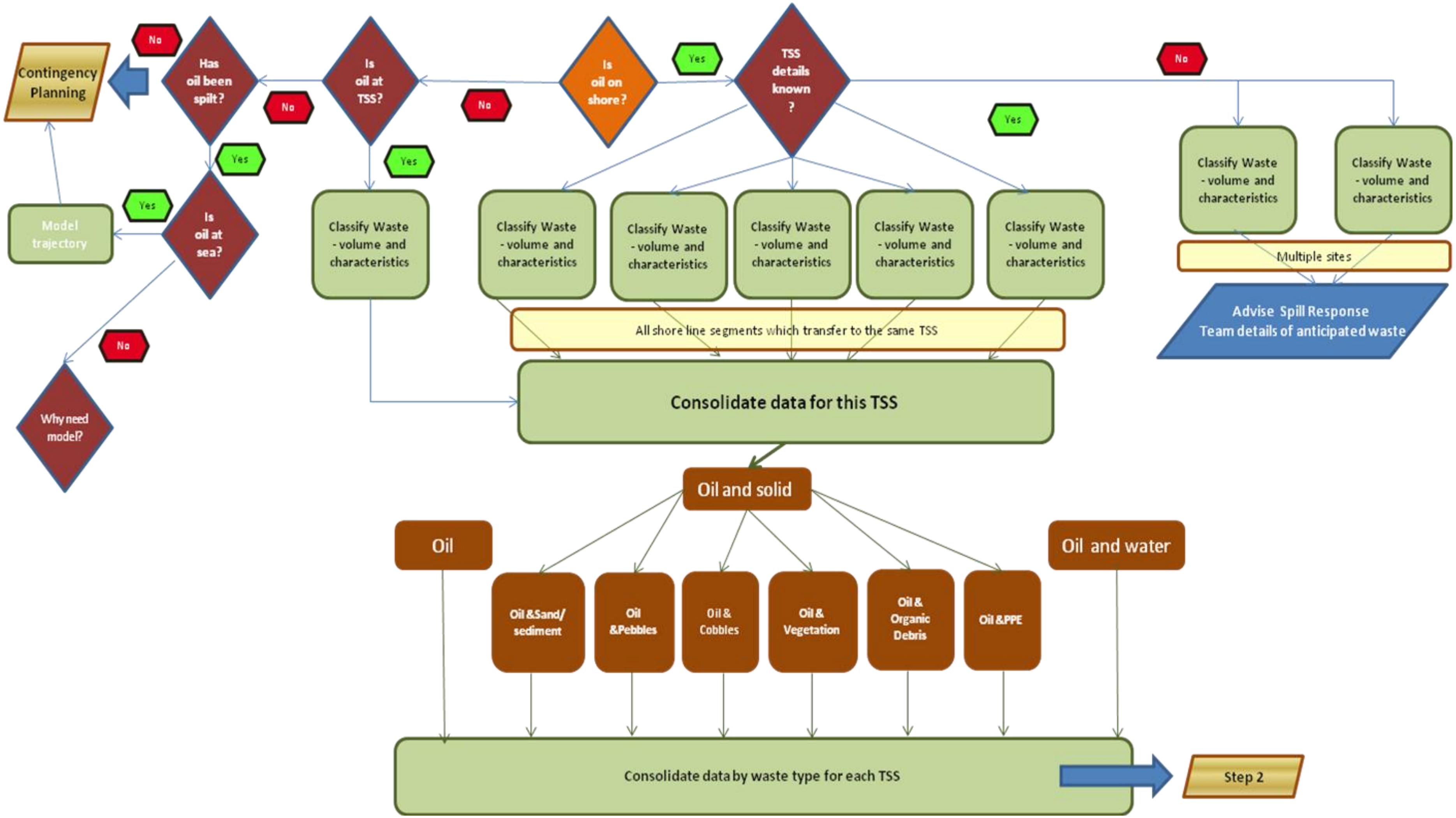
- It is assumed that any one shoreline section will only receive one type of oil
- Waste clean-up processes and transfer of waste to temporary storage sites is managed by others in accordance with MCA National Contingency Plan and Manual of Oil Spill Response
- The hierarchy of treatment preference is assumed to be:
    - Treatment at the shoreline
    - Treatment at the temporary storage site using permitted equipment (use of non-permitted equipment may be permitted if this can be shown to have environmental benefit)
    - Treatment at permitted, fixed facilities
    - Treatment at bespoke, purpose designed and built facilities

6.3 Following the Process without use of Spreadsheet

6.3.1 Step 1 - Waste Classification

This step is shown schematically in Flow Chart 6-1 below, and assumes the use of the Waste Management Calculator.

Flow Chart 6-1 - Step-by-Step Guide Step 1 - Waste Classification



6.3.1.1 Overall Waste - Waste still on Shoreline

SCAT surveyors are instructed to survey specific areas and prepare reports. SCAT survey forms relating to the same TSS are collated together. Data for each segment is input to the WMC to estimate the volume of waste which will be generated from that segment by the chosen waste clean up method.

The data from the SCAT form which is required to be used as input to the Waste Management Calculator is:

- Type of Substrate (eg, Sand-mixed sediment)
- Type of Oil (Light)
- Width of oil contamination (Wide > 6m)
- Length of contaminated segment (250 m)
- Oil distribution (trace <0.1%)
- Oil thickness (pooled > 1 cm)
  Clean up target (bulk removal, reduce to stain)

In addition to this data, this guide also considers the volume of oil which might be generated from removal from the shore and any pre-treatment at the TSS. The SCAT surveyors are therefore also asked to provide details, if appropriate and possible, of the “free oil” which is on the shoreline.

It is recognised that one of the most likely clean-up methods will involve the use of mechanical equipment such as diggers, JCBs etc. It will not be possible for such methods to access all areas of the shore line and so the surveyors are also asked to estimate the percentage of the area which they consider will not be accessible by mechanical equipment.

A SCAT report is therefore completed for each section of shoreline, as shown in Table 6-1 below:

Table 6-1 - Example Extract from SCAT Report (Surface Contamination)

Segment	Area		Cover/oil distribution		Oil Thickness		Estimated percentage of area necessitating manual removal of waste	Estimated percentage of free oil easily recovered	Oil Characteristics	Oil Type	Tidal Zone	Slope	Substrate/ shoreline
	Length (m)	Width (m)	Range	Est (%)	Range	Est (mm)							
A	200	5	Sporadic (1 - 10%)	5	Pooled (>1cm)	5	5%	5%	SR Surface Oil Residue (non cohesive, oiled surface sediments	Medium	L Lower Shore	F Flat (<5 °)	Sand / mixed sediment
B	100	20	Continuous (91 - 100%)	95	Pooled (>1cm)	3	10%	5%	SR Surface Oil Residue (non cohesive, oiled surface sediments	Medium	L Lower Shore	M Moderate (5 - 30°)	Sand / mixed sediment
C	50	2	Patchy (11 - 50%)	40	Cover (0.1 - 1cm)	0.5	10%	5%	SR Surface Oil Residue (non cohesive, oiled surface sediments	Medium	M Mid Shore	M Moderate (5 - 30°)	Pebbles
D	150	10	Broken (51 - 90%)	55	Coat (0.01 - 0.1cm)	0.01	5%	5%	SR Surface Oil Residue (non cohesive, oiled surface sediments	Medium	U Upper Shore	S Steep (31 - 60°)	Cobbles
E	50	3	Patchy (11 - 50%)	40	Cover (0.1 - 1cm)	0.8	5%	5%	SR Surface Oil Residue (non cohesive, oiled surface sediments	Medium	L Lower Shore	M Moderate (5 - 30°)	Oil debris

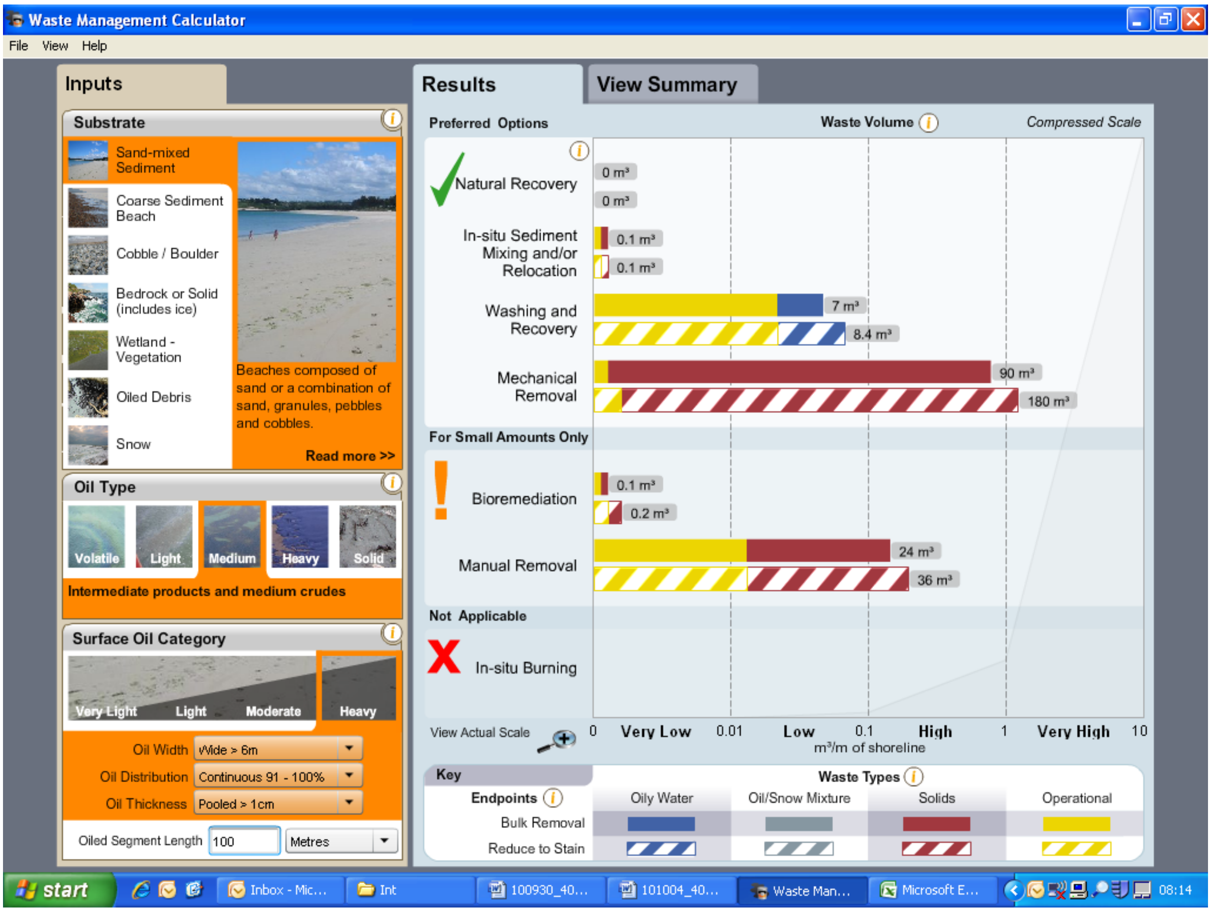
Table 6-2 - Example Extract from SCAT Report (Sub-Surface Contamination)

Pit	Tidal Zone	Oiled Zone Depth			Contaminated Material Characteristics	% Void Filled	Depth of Water Table (cm)	Sheen Colour	Substrate
		Pit Depth (cm)	Top	Bottom					
1	L Lower shore.	25	5	20	PP Partially filled pores (pore spaces filled with oil but no visible oil flow if disturbed)	80%	25	B Brown	Sand-mixed sediment
2	L Lower shore.	25	5	15	PP Partially filled pores (pore spaces filled with oil but no visible oil flow if disturbed)	80%	25	B Brown	Sand-mixed sediment
3	M Mid shore,	45	15	35	OR/C Cover (>0.1 - 1 cm) or Coat (0.01 - <0.1cm) of oil residue. (Easily removed with fingernail)	0%	40	R Rainbow	Coarse sediment beach
4	U Upper shore,	50	20	40	OR/C Cover (>0.1 - 1 cm) or Coat (0.01 - <0.1cm) of oil residue. (Easily removed with fingernail)	0%	>50	R Rainbow	Cobble/boulder
5	L Lower shore.	25	5	10	OR/C Cover (>0.1 - 1 cm) or Coat (0.01 - <0.1cm) of oil residue. (Easily removed with fingernail)	0%	25	R Rainbow	Oiled debris
6						0%			

Is the oil likely to remobilise:	No	**If Yes**	Sheen/Bulk (indicate on map)
Is there any floating oil:	No	**If Yes**	Sheen/Bulk (indicate on map)
Will next tide movement move oil?	Unknown		

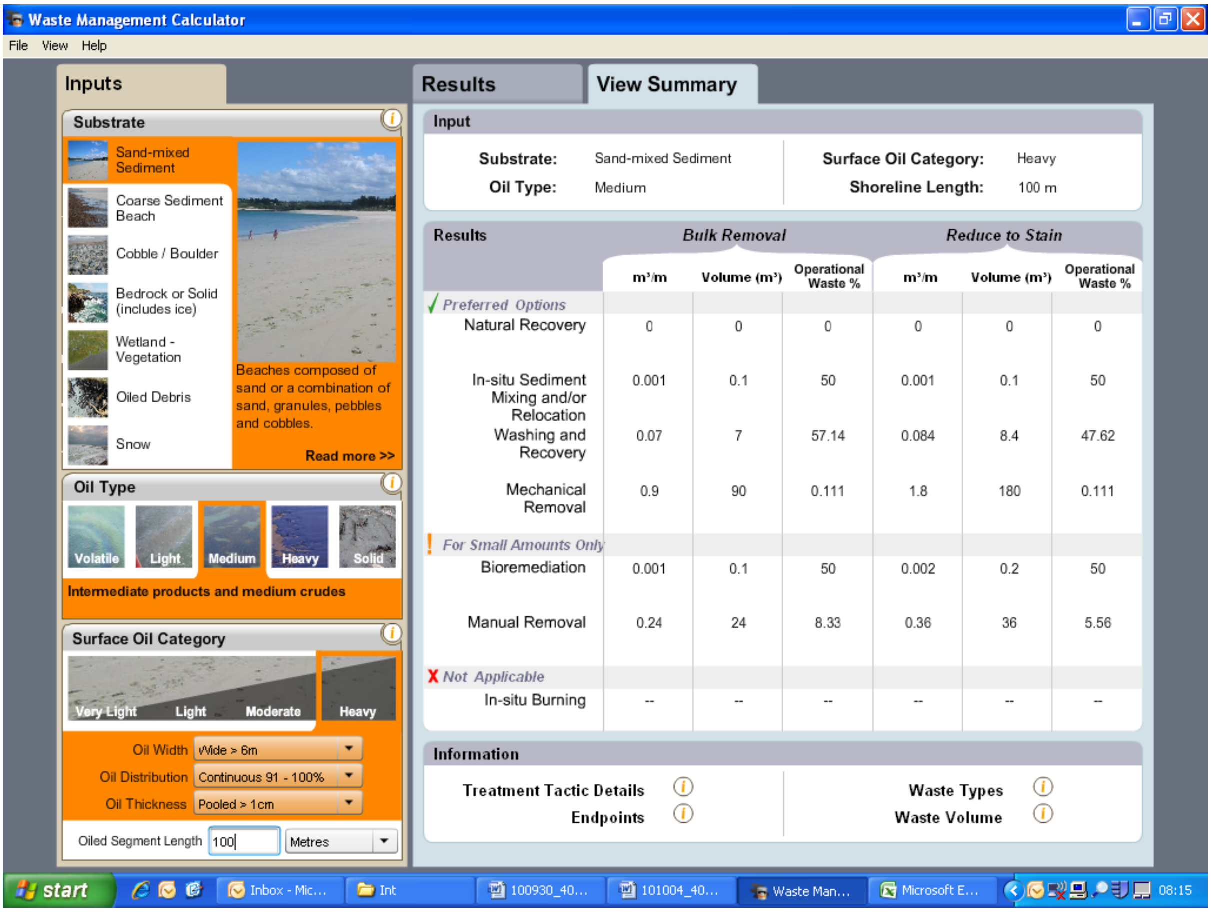
Data from each segment is entered into the Waste Management Calculator and the output summary reports inspected (Figures 6-1 and 6-2 below)

Figure 6-1 - Results Output from Waste Management Calculator - Segment B from above SCAT report



From inspection of this report, and discussions with the Oil Spill Response Team, a decision can be made with respect to which clean-up technique will be used. This will allow selection of the appropriate quantity of waste which will be generated.

Figure 6-2 - Results Summary from Waste Management Calculator - Segment B from above SCAT report



The above process is repeated for each segment, resulting in the following table, summarising the volume and types of waste which it is estimated will be created from the clean up operation in the shore line section covered by the SCAT report in Table 6-1.

The relevant data is input to the waste management calculator and the output from the summary table recorded in Table 6-3.

Table 6-3 Estimation of Waste Volumes from one SCAT report

Segment		A	B	C	D	E
Input data	Substrate	Sand-mixed sediment	Sand-mixed sediment	Coarse sediment beach /Pebbles	Cobbles	Oil debris
	Oil Type	Medium	Medium	Medium	Medium	Medium
	Width	> 6 m	> 6 m	> 6 m	> 6 m	> 6 m
	Segment length	250	200	50	150	150
	Oil Distribution	Sporadic (1 - 10%)	Continuous (91 - 100%)	Patchy (11 - 50%)	Broken (51 - 90%)	Patchy (11 - 50%)
	Oil thickness	Pooled (>1cm)	Pooled (>1cm)	Cover (0.1 - 1 cm)	Coat (0.01 - 0.1 cm)	Cover (0.1 - 1 cm)
	Clean up target	Reduce to stain	Reduce to stain	Reduce to stain	Reduce to stain	Reduce to stain
	Clean up process	Mechanical Removal	Mechanical Removal	Mechanical Removal	Mechanical Removal	Mechanical Removal
Output from model	Total Waste generated (m^3/m)	1.5	1.0	2.5	5.0	0.2
	Total Waste generated (m^3)	375	200	125	750	30
	Oil (m^3)	0.125	0.285	0.001	0.008	0.002
	Oil water (m^3)	0	0	0	0	0
	Operational Waste (PPE) (%)	0.133%	0.2%	0.08%	0.04%	1%
	Operational Waste (PPE) (m3)	0.133/100*375 = 0.5	0.2/100* 200 = 0.4	0.08/100* 50 = 0.04	0.04/100* 150 = 0.06	1/100* 30 = 0.3

6.3.1.2 Estimation of Volume of Free Oil

The possible volume of free oil is estimated from the following calculation for each segment:

(Free oil width) x (estimated actual oil thickness) x (affected shore line length) x (estimated oil distribution) x (estimated % age free oil easily recovered)

For segment B of the above SCAT report, this will give:

$$\mathbf{20 \times (3/1000) \times 100 \times 95\% \times 5\% = 0.285\ m^3}$$

6.3.1.3 Estimation of Oil Concentration in Waste

A crude assessment can be made of the total volume of oil in the waste to be treated as follows:

(Free oil width) x (affected shore line length) x (estimated oil distribution) x (substrate voidage) x (oil penetration into substrate) x (percentage voids filled)

The oil penetration is a function of the oil type and the substrate type, and is shown in Table 4.2 of the Waste Management Calculator. The percentage voids is taken from the sub surface section of the SCAT report. The voidage is conservatively estimated to be 40% (gives a higher volume of oil)

For segment B of the above SCAT report this gives:

20 x 100 x 95% x 40% x 0.25 X 80% = 152 m^3

This can be used to make an equally crude assessment of the average oil concentration in the waste to be processed by dividing the total volume of oil by the total volume of waste produced:

Again for Segment B, this gives

152 / 200 = 76%

Note if the free oil estimated above is not collected separately, and is a significant volume, this volume will also be removed by the cleaning process and must therefore be added to the above calculation. In this case (ie for Segment B) this would not be significant, but if it was, this gives

(152 + 0.285) / 200 = 76%

If more than one segment has the same waste characteristics, and the waste is mixed on arrival at the TSS, the concentration should be averaged - ie

For Segments A and B above,

(152 + 189)/ (200 + 375) = 59%

Similarly if wastes from different sections/SCAT reports are mixed together, the concentration should be averaged across the whole volume.

The contamination level is then categorized into:

Light - <15%

Medium - 15 - 50%

Heavy - > 50%

For comparison with technology and/or processing equipment capability.

6.3.1.4 Classification into European Waste Catalogue Codes

The appropriate EWC codes will need to be selected (see Appendix A) and provided to potential suppliers/facilities.

6.3.1.5 Summary of Waste at TSS

If the shoreline segments from which waste will be sent to a particular TSS are known, the estimated total amount of waste of each type which will be delivered to each TSS can then be summarised in a table, as shown in Table 6-4 below.

Table 6-4 - Total waste at TSS (m^3)

Waste Type	Oil	Oil & Water	Oil & Sand-mixed sediment	Oil & Coarse sediment beach (pebble)	Oil & Cobble / boulder	Oiled debris	Operational Waste
SCAT 1	0.4	0	575	90	150	30	1.25
SCAT 2	1.25	30	250	125	75	15	1.6
SCAT 3	0.75	10	25	350	200	25	1.5
SCAT 4	2.5	25	150	75	50	50	3.5
Total	4.9	65	1000	640	475	120	7.85

The above data can then be used to assess treatment tactics for each stream.

6.3.1.6 Classification of Waste at TSS

Section 5.4.3 outlines the procedure for classification of waste once it has arrived at the temporary storage site. This should be self explanatory.

Table 6-5 below uses the template included in Appendix E4 to summarise the data:

Table 6-5 - Waste Classification for TSS

WASTE CLASSIFICATION AND VOLUME											
This table is used to classify the oily waste at the temporary storage site and provides an estimate of the volumes of each classification of oily waste present. This sheet should be completed in addition to the Temporary Waste Storage Location Information Sheet.		**OIL TYPE**									
		Volatile - Gasoline products - Viscosity like water		**Light** - Diesel & light crudes - Viscosity like water		**Medium** - Intermediate products & medium crudes		**Heavy** - Residual products & heavy crudes - Viscosity like molasses		**Solid** - Bitumen, tar, asphalt - Does not pour	
		Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil
TYPE OF OILY WASTE	Oil					4.9					
	Oil/Water					65					
	Oil/Water Emulsion										
	Sand - mixed sediment - sand or a combination of sand, granules, pebbles and cobbles.					1000	76%				
TYPE OF OILY WASTE	Coarse Sediment - the clearly dominant material is pebbles and/or cobbles. Pebbles grain size diameter 4 - 64mm & cobbles 64 - 256mm.					640	30%				

WASTE CLASSIFICATION AND VOLUME											
This table is used to classify the oily waste at the temporary storage site and provides an estimate of the volumes of each classification of oily waste present. This sheet should be completed in addition to the Temporary Waste Storage Location Information Sheet.		OIL TYPE									
		Volatile - Gasoline products - Viscosity like water		**Light** - Diesel & light crudes - Viscosity like water		**Medium** - Intermediate products & medium crudes		**Heavy** - Residual products & heavy crudes - Viscosity like molasses		**Solid** - Bitumen, tar, asphalt - Does not pour	
		Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil
TYPE OF OILY WASTE	Cobble/Boulder - the clearly dominant material is cobbles (64 - 265mm) and/or boulders (>256mm).					475	15%				
	Oiled Debris - Scattered organic or inorganic materials e.g. fish, birds, plants, cans, plastic bottles etc.					120	12%				
	PPE and construction material used in the manual clean up of the oil spill.					7.85	1%				

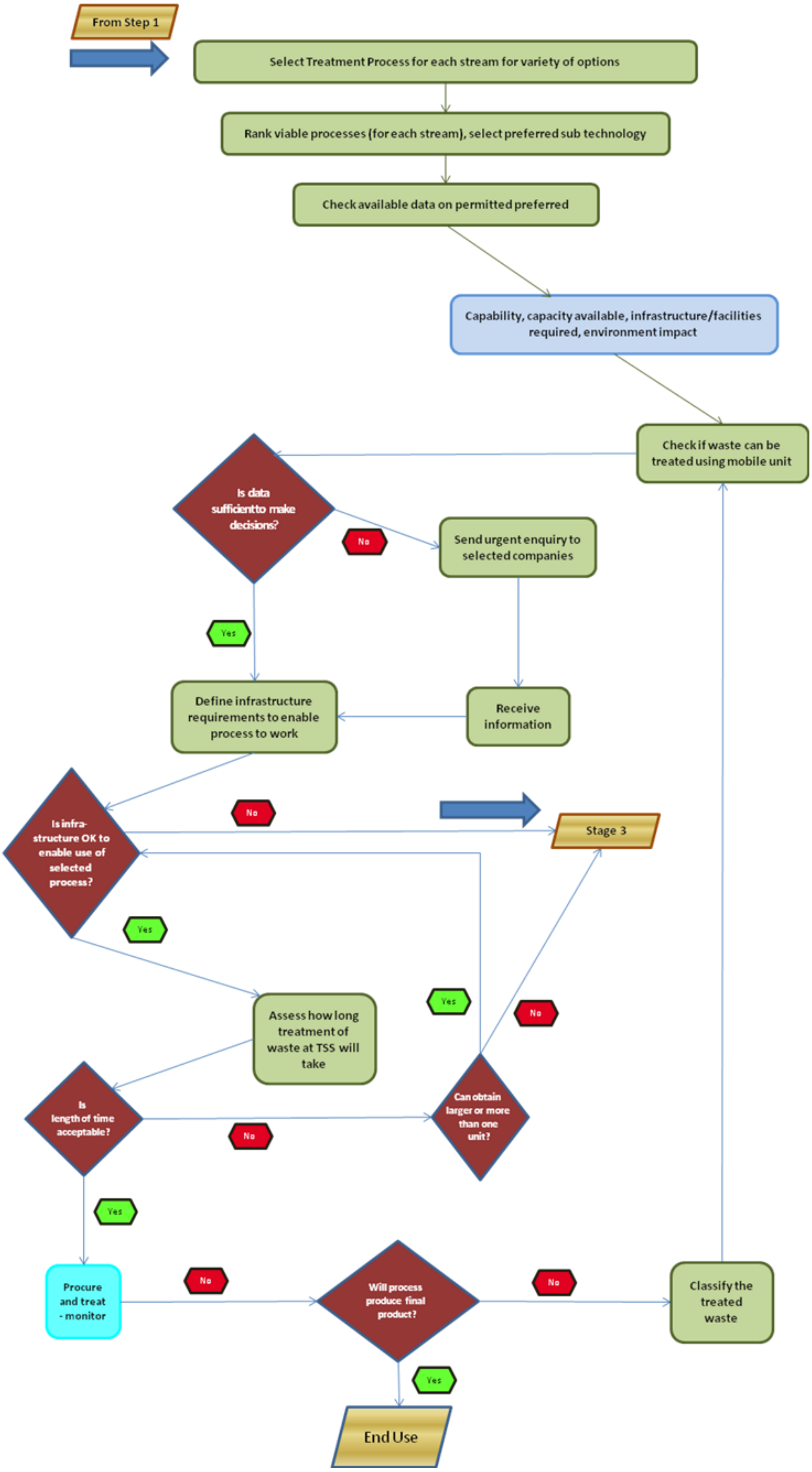
6.3.2 Step 2 - Feasibility of Using Mobile Treatment System

The step 2 procedure is shown schematically in Flow Chart 6-2 below:

The environmental regulators' preference is that waste should be treated at source if possible. In this instance, it is assumed that treatment at the shore has been effected as well as practicable and that the TSS can then be considered to be the source of the waste once it has been transferred.

This step considers how an assessment can be made of the feasibility of using a mobile treatment system for cleaning up or pre-treating the waste. The basis of the step is to compare the characteristics of the waste with the treatment capability of permitted mobile units.

Flow Chart 6-2 - Process Selection Step 2



As explained in Section 5.5.3, information was requested from all of the operators of permitted mobile units as provided by the EA (for England and Wales). Part 4 of this report includes the data which has been collated from the companies' responses. Where possible, data provided by the mobile plant licence holders has been rationalized so that critical information is included within the tables using the same terminology and classification as the data created by Step 1. This should ease the selection process and also assists in automating the tool.

The detail required to make the comparison, and the source of information is shown in Table 6-6 below:

Table 6-6 - Waste Classification Information Required to Assess Feasibility of using Mobile Plant

Information Required	Source
Volume of waste	Scat reports consolidated - Table 6-3
Oil type	Scat reports consolidated - Table 6-3
Substrate - including maximum particle size	Scat reports consolidated - Table 6-3
Concentration of oil (%)	By calculation - see section 6.4.2
Volume of free oil (m^3)	By calculation - see section 6.4.1
Water type	Scat report
European Waste Catalogue Classification	Appendix A

The above data is then compared with the data available from the suppliers - see Part 4 of this report - example below in Table 6 -7.

In this instance, it can be seen that insufficient or inappropriate data has been provided by the supplier. It is therefore necessary to obtain this information quickly in order to allow the decision-making process to continue. An urgent enquiry should be sent to the supplier, and a form has been prepared to expedite this process, as shown in Table 6-8 below, which has been completed for the same data which has been used above.

Table 0-1 - Details of Mobile Plant Licensed Equipment

Operator			
Project/ Facility			
Type of Oil?			
Solid Material			
Concentration of oil (contamination)?			
Acceptable water type based on salt content?			
Region			
Treatment rate (tons of waste per day)?			
Town/ City			
Postcode			
NGR			
Permit No.			
Contact Name			
Contact Number			
Contact Email			
Website			
Brief description of installation			

Table 0-2 - Enquiry Form

Enquiry for Oily Waste Processing Equipment		
We have a requirement for equipment to treat EWC Code	Oily Waste 13.08.99	with the following detailed characteristics:
Oil characteristics	Gasoline products – viscosity like water	
	Diesel/ light crudes – viscosity like water	
	Intermediate products and medium crudes-viscosity around twice that of water	X
	Residual products and heavy crudes – viscosity like molasses	
	Bitumen, tar, asphalt – does not pour	
Solids Characteristics	N/A: Oil with no substantial water or solids content	
	N/A:Oil + Water mix (including emulsions)no substantial solids content	
	Mineral: sand (< 4mm) or a combination of sand, pebbles and cobbles.	X
	Mineral: predominantly pebbles (4-64 mm) and/or cobbles (64-256 mm range)	
	Mineral: predominantly cobbles (64-256 mm) and boulders (greater than 256 mm)	
	Predominantly organic debris (Plant and animal origin)	
	Predominantly PPE/equipment	
Water characteristics	N/A: Water not present	
	Fresh	
	Brackish	
	Salt	X
Degree of Contamination	Very light (trace)	
	Light (<15%)	
	Moderate (15 - 50%)	
	Heavy (>50%)	X
	N/A: Oil with no substantial water or solids content	
Urgency of Enquiry	URGENT-please reply within 24h of receipt if you wish your tender to be considered	X
	Please reply within one week of receipt if you wish your tender to be considered	
	Please reply within two weeks of receipt if you wish your tender to be considered	
Waste Quantity	<250 m^3	
	250 - 1000 m^3	
	1000 - 5000 m^3	X
	5000 - 10000 m^3	
	>10000 m^3	
Please advise as a minimum your best availability and price for equipment, as well as technical characteristics as listed below		

Temporary/Mobile Plant

Rate of processing (as a function of waste characteristics if appropriate)
Physical limitations (eg max particle size, max oil content, oil viscosity etc)
Pre-treatment requirements
Residual contamination post processing
Waste streams generated
Area needed
Transport and access requirements
Enabling facilities needed
Power requirements
Water requirements as feed and waste streams
Chemicals/solvents required
Waste management considerations
Time to mobilise to full operation
Existence of Mobile Plant Permit?
Cost
Impact - noise, odour etc
Other Technical Considerations

Fixed Plant

Storage Capacity
Current Availability
Rate of processing (as a function of waste characteristics if appropriate)
Physical limitations (eg max particle size, max oil content, oil viscosity etc)
Pre-treatment requirements
Residual contamination post processing
Waste streams generated
Area needed
Transport and access requirements
Power requirements
Water requirements as feed and waste streams
Chemicals/solvents required
Waste management considerations
Cost
Impact - noise, odour etc
Other Technical Considerations

Please distinguish in your offer between fixed and mobile plant. Where both are offered, please list information separately above
Please attach technical brochures for offered equipment along with your reply.

The response from the supplier should contain the information required to enable the assessment to be made, typically as shown in Table 6-9 below:

Table 0-3 - Mobile Plant Information from Supplier

Parameter	Response
Rate of processing (as a function of waste characteristics if appropriate) - m^3/hr	25 m^3/hr
Physical limitations (eg max particle size, max oil content, oil viscosity etc)	<100 mm, <50%, <heavy
Pre-treatment requirements	None
Residual contamination post processing	Solids non hazardous
Waste streams generated	Oil, water
Area needed	30 m^2
Transport and access requirements	30 tonne articulated lorry, 6 m high
Enabling facilities needed	
Power requirements	60 kW
Water requirements as feed and waste streams	Water supply, waste water discharge > 20 m^3/hr
Chemicals/solvents required	None
Waste management considerations	Waste water
Time to mobilise to full operation	1 week
Existence of Mobile Plant Permit?	Yes
Cost	£750 per week
Impact - noise, odour etc	<70 dBA at 1 m
Other Technical Considerations	

This data is then used to assess the viability of using the process at the relevant TSS:

- To assess whether access is sufficient to enable the equipment to be delivered
- To assess whether the facilities which exist are capable of providing the necessary resources to enable the equipment to operate
- To assess how long treatment of the waste at the TSS would take, and whether this time period would be acceptable
- To assess the potential impact the operation of the equipment might have on neighbours and whether this would be acceptable.

To do this, it is necessary to have details of the TSS available. Table 6-10 below indicates the information required, with typical data inserted. A template for this form is included in Appendix E.

Table 0-4 - Temporary Storage Site Information Sheet

<table>
<tr><th colspan="6">TEMPORARY WASTE STORAGE LOCATION INFORMATION SHEET</th></tr>
<tr><td colspan="6">The storage location information sheet is used to compile information concerning the waste which can be stored at a temporary waste storage site. The sheet should be completed in its entirety in as much detail as possible as each question provides valuable information to ensure the best form of treatment is selected for the waste.</td></tr>
<tr><th colspan="6">SITE DETAILS</th></tr>
<tr><td>Site Name</td><td colspan="2">Bognor Regis 2</td><td>Site Reference</td><td colspan="2">ABC 1234</td></tr>
<tr><td rowspan="2">Address</td><td colspan="2" rowspan="2">The Promenade</td><td>Postcode</td><td colspan="2">BR 23 4DF</td></tr>
<tr><td>Grid Reference</td><td colspan="2"></td></tr>
<tr><td>Site Contact</td><td colspan="2">Norman Smith</td><td>Landline</td><td colspan="2">01283 757106</td></tr>
<tr><td>Mobile</td><td>07777 99700</td><td colspan="4">Email</td></tr>
<tr><td>Site Emergency Contact</td><td colspan="2"></td><td>Fax</td><td colspan="2"></td></tr>
<tr><td colspan="6">Details of the 'catchment area' which the storage site would cover (receive waste from):

Bognor East beach and Bognor West beach</td></tr>
<tr><th colspan="6">SITE ACCESS</th></tr>
<tr><td>Is there road access to the site e.g. for cars, lorries etc?</td><td>yes / ~~no~~</td><td colspan="4">If yes, what is the maximum size the road vehicle can be to gain access by road and how close is the road to the site?</td></tr>
<tr><td>Is there rail access to the site e.g. for trains, freights etc?</td><td>~~yes~~ / no</td><td colspan="4">If yes, what is the maximum tonnage of the rail vehicle and how close are the tracks to the site?</td></tr>
<tr><td>Is there port access to the site e.g. for boats, ships etc?</td><td>~~yes~~ / no</td><td colspan="4">If yes, what is the maximum size the floating vessel can be to gain access via the port and how close is the port to the site?</td></tr>
<tr><td>By inland waterway access to the site e.g. for boats, ships etc?</td><td>~~yes~~ / no</td><td colspan="4">If yes, what is the maximum size the floating vessel can be to gain access by inland waterway and how close is the waterway to the site?</td></tr>
</table>

TEMPORARY WASTE STORAGE LOCATION INFORMATION SHEET		
Are there multiple Entrances?	~~yes~~ / no	If yes, which should be used?
Is keyfob/keypad access used?	~~yes~~ / no	If yes, is there emergency access (e.g. via security guard, site contact)?
Is there a barrier and/or height restriction?	~~yes~~ / no	If yes, what are the maximum height and/or width for a vehicle to access the site?
Is 24 hour access to the site required and/or permitted?	yes / ~~no~~	If yes, by whom, on what basis, etc.
Can local access roads/routes be used by large vehicles, including roads between local access to the site and main trunk roads? Are there any other vehicle restrictions? YES		

WASTE HANDLING AT THE SITE		
What is the approximate size of the site? (m^2) 2500		What is the maximum height at which the waste can be stored? (m) 2.5 m
How much could be used for storage? (m^2) 2000		What is the maximum height at which the waste can be stored? (m) 2.5 m
Is there any type of waste which the site could not store?	yes / ~~no~~	If yes, please provide details
Could waste stored on the site migrate off site (e.g. via wind, leaching, rainwater run-off etc.)		If yes, please provide details YES
If yes, what measures could be used to prevent migration of waste (e.g. bunding, fencing etc.)		If yes, please provide details Bunding, barrier
Is there a water supply on site?		If yes, please provide details Yes, > 20 m3/hr
Is there a drainage connection on site?		If yes, please provide details

<table>
<tr><th colspan="3">TEMPORARY WASTE STORAGE LOCATION INFORMATION SHEET</th></tr>
<tr><td></td><td colspan="2">Yes. Connected to surface water run-off - can clean water at up to 30 m3/hr</td></tr>
<tr><td>Is there a power supply on site?</td><td colspan="2">If yes, please provide details

Yes, 40 kW</td></tr>
<tr><td>Is there space on site to allow for segregation of the waste?</td><td colspan="2">If yes, please provide details

YES</td></tr>
<tr><td>Are there any sensitive receptors (e.g. to noise, smell) nearby (e.g. housing, school)?</td><td colspan="2">If yes, please provide details

YES, School 20 m</td></tr>
<tr><td>Will the site be completely rehabilitated after the waste has been completely removed?</td><td colspan="2">If no, please provide details and reasons

YES</td></tr>
<tr><td colspan="3">Name & Reference of nearest intermediate storage facility if known

Not known</td></tr>
<tr><th colspan="3">GENERAL INFORMATION</th></tr>
<tr><td colspan="3">What is the site normally used as/for?</td></tr>
<tr><td rowspan="2">Can the normal site use/activity be stopped whilst the site is used for storage?</td><td colspan="2">If yes, how long for (approx)?</td></tr>
<tr><td colspan="2">If no, how much of the site (m^3) can be used for storage whilst normal operations continue?</td></tr>
<tr><td colspan="3">Describe the availability of the site to be used as a waste storage site on the following scale</td></tr>
<tr><td colspan="3">(1 - available 24-7) (2 - Available, causing no/little interference with normal site usage) (3 - Available, causing manageable disruption to site) (4 - Available, but would cause significant disruption) (5 - Available only in case of emergency) 4</td></tr>
<tr><td>Is there a weighbridge?</td><td>~~yes~~ / no</td><td></td></tr>
</table>

With the benefit of this information, comparison can be made as follows:

Table 0-5 - Comparison between Required and Available Features - Mobile Plant

Parameter	Mobile Plant	Available/ waste detail	OK?
Rate of processing (as a function of waste characteristics if appropriate) - m^3/hr	5 m^3/hr	N/A	OK
Physical limitations (eg max particle size, max oil content, oil viscosity etc)	<250 mm, <50%, <heavy	4 - 64 mm	OK
Pre-treatment requirements	None	N/A	OK
Residual contamination post processing	Solids non hazardous	Required	OK
Waste streams generated	Oil, water	YES	OK
Area needed	30 m^2	500 m^2	OK
Transport and access requirements	30 tonne articulated lorry, 6 m high	30 tonne, 7 m access	OK
Enabling facilities needed			
Power requirements	30 kW	40kW	OK
Water requirements as feed and waste streams	Water supply, waste water discharge > 20 m^3/hr	Water supply, >20 m^3/hr	OK
Chemicals/solvents required	None	N/A	OK
Waste management considerations	Waste water		OK
Time to mobilise to full operation	1 week	1 week	OK
Existence of Mobile Plant Permit?	Yes	Required	OK
Cost	£750 per week	<£1000 per week	OK
Impact - noise, odour etc	<70 dBA at 1 m	<80 dBA at 1 m	OK
Other Technical Considerations		None	OK

Inspection of the above table shows that the proposed equipment could be delivered to and operated at the chosen site, to process the sand/sediment fractions of the waste at TSS.

The total volume of this waste at this storage site is (from Table 6-4 and 6-5) 1,000 m3. At a processing rate of 5m^3/hr, assuming operation for 10 hr/day, (50 m^3/day) this would take 20 days to process. Allowing for the mobilisation and demobilisation times (say 1 week each), the waste could be processed and the site evacuated within 6 weeks. Assessment would then need to be made as to whether this was acceptable.

If more than one mobile treatment plant is available which can process the waste effectively, a selection needs to be made between these. Consideration should be given as to whether there may be other TSS which are holding waste which needs processing. If some of this is more difficult to treat and only one of the candidate processes can treat it, logically this should take preference. If this is not the case, it is suggested that selection of the preferred process could be done based on comparing the environmental impact of the alternatives, as shown in Table 6-12.

There are also other situations which need to be addressed before a final selection can be made. For example, if the only process viable to treat the waste at the temporary store can only act as a pre-treatment stage for a further process, consideration should be given as to whether transfer of the waste to a fixed facility treatment would be more effective as this will almost certainly have outlets for the treated waste streams already in place.

Table 0-6 - Example Ranking of Viable Alternatives

Scores out of 3 for each element

Parameter	Plant 1	Plant 2	Plant 3
Power consumption (kW)	1	3	2
Chemical Consumption	3	2	2
Waste generated	2	3	1
Noise	1	1	2
Odour	3	3	3
Cost	2	3	1
Overall Score (add up)	12	15	11
Overall Ranking	2	1	3

Once the selection is made, a contract could be entered in to with the mobile plant permit holder. They would need to apply for a deployment licence, which normally takes 30 days to be approved. However, based on the implementation of the EA emergency measures, the equipment could be delivered and start to operate whilst this is being processed.

Many of the elements in the above table would be sufficient to prevent this piece of equipment being used in this application. In this case, STEP 3 will need to be followed, as shown in the next Section.

6.4 Step 3 - Waste Transferred for Processing

6.4.1 Using Fixed Permitted Facilities

If treatment using mobile treatment plant is not viable, the second preference is to treat at a fixed, permitted waste processing facility. This process is shown schematically in Flow Chart 6-3 below, and is very similar to that shown in Step 2.

If the spill is large, treatment of waste at fixed facilities is likely to involve the processing of waste from more than one TSS. It is recommended that in the first instance, however, the waste arising from one TSS should be assessed.

Table 6-3, which summarises the waste at one TSS is repeated below for convenience:

Flow Chart 0-1 - Step 3

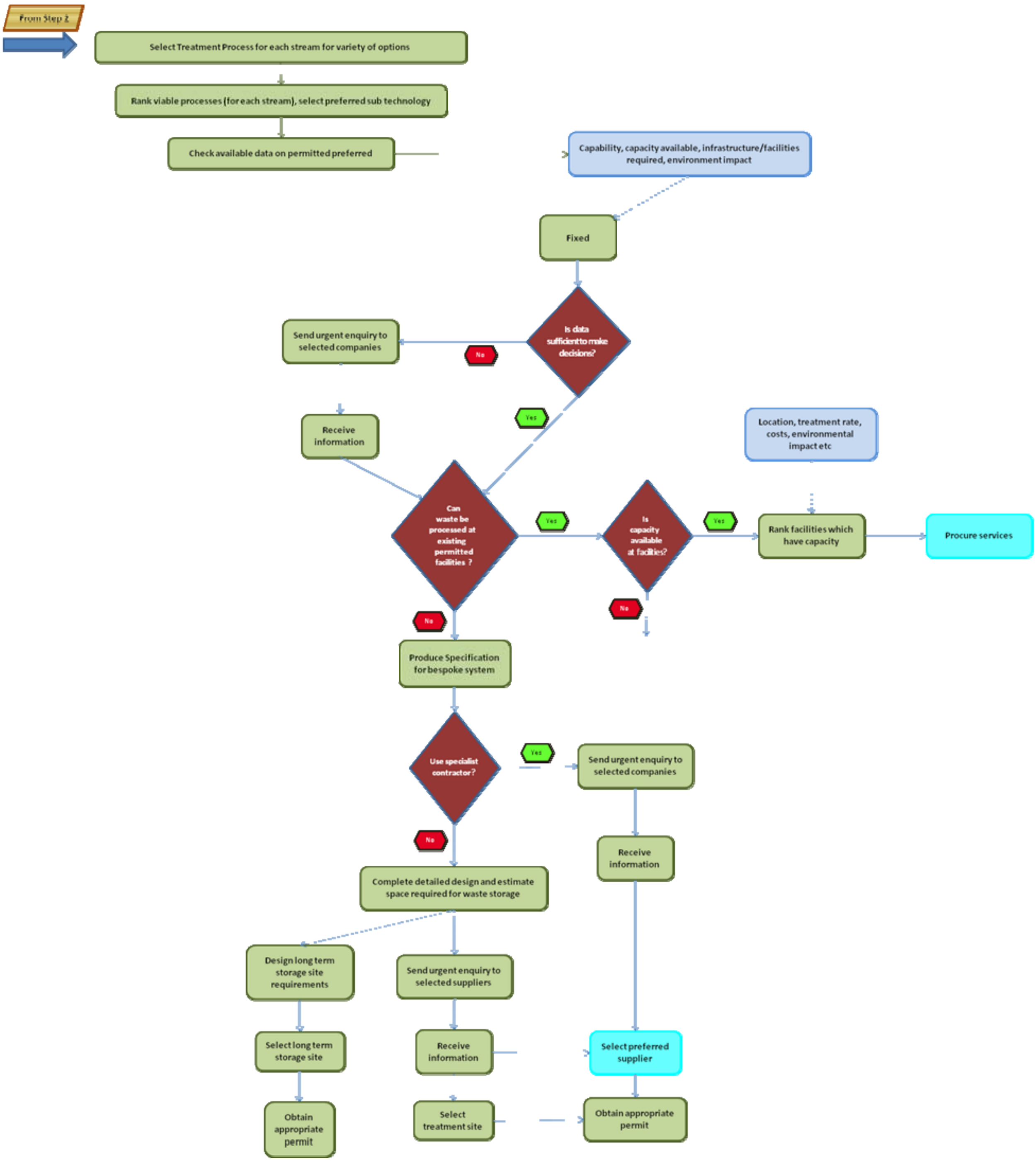


Table 0-7 - Total waste at TSS (m^3)

Waste Type	Oil	Oil & Water	Oil & Sand-mixed sediment	Oil & Coarse sediment beach (pebble)	Oil & Cobble / boulder	Oiled debris	Operational Waste
SCAT 1	0.4	0	575	90	150	30	1.25
SCAT 2	1.25	30	250	125	75	15	1.6
SCAT 3	0.75	10	25	350	200	25	1.5
SCAT 4	2.5	25	150	75	50	50	3.5
Total	4.9	65	1000	640	475	120	7.85

The same approach as used in Step 2 is used here - ie to compare the characteristics of the waste with the treatment capability of permitted facilities.

The same basic details of the waste are required to make the comparison, so Table 1-4 is also repeated below for convenience

Table 0-8 - Waste Classification Information Required to Assess Feasibility of using Fixed Permitted Facility

Information Required	Source
Volume of waste	Scat reports consolidated - Table 6-3
Oil type	Scat reports consolidated - Table 6-3
Substrate - including maximum particle size	Scat reports consolidated - Table 6-3
Concentration of oil (%)	By calculation - see section 6.4.2
Volume of free oil (m^3)	By calculation - see section 6.4.1
Water type	Scat report
European Waste Catalogue Classification	Appendix A

The above data is then compared with the data available from the suppliers - see Part 4 of this report - example below in Table 6-15

Table 0-9 - Example of Details of Fixed, Permitted Facilities
(Master list in Part 4 of Report)

Operator				
Project/ Facility				
Type of Oil?				
Solid Material				
Concentration of oil (contamination)?				
Acceptable water type based on salt content?				
Region				
Treatment rate (tons of waste per day)?				
Town/ City				
Postcode				
NGR				
Permit No.				
Contact Name				
Contact Number				
Contact Email				
Website				
Brief description of installation				

In this instance, it can be seen that insufficient or inappropriate data has been provided by the supplier. It is therefore necessary to obtain this information quickly in order to allow the decision-making process to continue. An urgent enquiry should be sent to the supplier, and a form has been prepared to expedite this process, as shown in Table 6-8, repeated below, which has been completed for the same data which has been used above.

Table 0-10 - Fixed Processing Facility Enquiry Form

Enquiry for Oily Waste Processing Equipment		
We have a requirement for equipment to treat EWC Code	Oily Waste 13.08.99	with the following detailed characteristics:
Oil characteristics	Gasoline products – viscosity like water	
	Diesel/ light crudes – viscosity like water	
	Intermediate products and medium crudes-viscosity around twice that of water	X
	Residual products and heavy crudes – viscosity like molasses	
	Bitumen, tar, asphalt – does not pour	
Solids Characteristics	N/A: Oil with no substantial water or solids content	
	N/A:Oil + Water mix (including emulsions)no substantial solids content	
	Mineral: sand (< 4mm) or a combination of sand, pebbles and cobbles.	X
	Mineral: predominantly pebbles (4-64 mm) and/or cobbles (64-256 mm range)	X
	Mineral: predominantly cobbles (64-256 mm) and boulders (greater than 256 mm)	X
	Predominantly organic debris (Plant and animal origin)	
	Predominantly PPE/equipment	
Water characteristics	N/A: Water not present	
	Fresh	
	Brackish	
	Salt	X
Degree of Contamination	Very light (trace)	
	Light (<15%)	
	Moderate (15 - 50%)	
	Heavy (>50%)	X
	N/A: Oil with no substantial water or solids content	
Urgency of Enquiry	URGENT-please reply within 24h of receipt if you wish your tender to be considered	X
	Please reply within one week of receipt if you wish your tender to be considered	
	Please reply within two weeks of receipt if you wish your tender to be considered	
Waste Quantity	<250 m^3	
	250 - 1000 m^3	
	1000 - 5000 m^3	X
	5000 - 10000 m^3	
	>10000 m^3	

Please advise as a minimum your best availability and price for equipment, as well as technical characteristics as listed below

Temporary/Mobile Plant

Rate of processing (as a function of waste characteristics if appropriate)
Physical limitations (eg max particle size, max oil content, oil viscosity etc)
Pre-treatment requirements
Residual contamination post processing
Waste streams generated
Area needed
Transport and access requirements
Enabling facilities needed
Power requirements
Water requirements as feed and waste streams
Chemicals/solvents required
Waste management considerations
Time to mobilise to full operation
Existence of Mobile Plant Permit?
Cost
Impact - noise, odour etc
Other Technical Considerations

Fixed Plant

Storage Capacity
Current Availability
Rate of processing (as a function of waste characteristics if appropriate)
Physical limitations (eg max particle size, max oil content, oil viscosity etc)
Pre-treatment requirements
Residual contamination post processing

Table 6-17 shows the minimum information which the facility operator would need to return to enable a decision to be made.

Table 0-11 - Fixed Facility Information from Supplier

Parameter	Response
Rate of processing (as a function of waste characteristics if appropriate) - m^3/hr	25 m^3/hr
Max particle size,	240 mm
Max oil content	<50%
Max oil type	heavy
Pre-treatment requirements	None
Transport and access requirements	30 tonne articulated lorry, 6 m high
Cost	£750 per week
Impact - noise, odour etc	<70 dBA at 1 m
Other Technical Considerations	

Table 0-12 - Comparison between Required and Available Features - Fixed Processing Facility

Parameter	Facility Performance	Available/ waste detail	OK?
Rate of processing (as a function of waste characteristics if appropriate) - m^3/hr	25 m^3/hr	N/A	OK
Physical limitations (eg max particle size, max oil content, oil viscosity etc)	<240 mm, <50%, <heavy	4 - 64 mm, 64 - 256 mm, >256 mm	Some OK
Pre-treatment requirements	None	N/A	OK
Residual contamination post processing	Solids non hazardous	Required	OK
Transport and access requirements	30 tonne articulated lorry, 6 m high	30 tonne, 7 m access	OK
Existence of Environmental Permit?	Yes	Required	OK
Cost	£1200 per tonne		OK
Other Technical Considerations		None	OK

Inspection of the above table shows that the facility could process the sand/sediment and pebbles fractions of the waste.

The total volume of the types of waste at this storage site which are treatable at this facility is (from Table 6-4, 1,640 m^3 (1,000 + 640). At a processing rate of 25m^3/hr, assuming operation for 10 hr/day, (250 m^3/day) this would take 7 days to process, which would not be expected to impose any significant additional load on the facility.

It is even more likely in this situation that more than one facility will have the capability and capacity to process the waste. Ranking of the viable alternatives would again then be recommended. Here, location is a critical factor as it will have an impact on costs and carbon footprint- ie

Table 0-13 - Example Ranking of Viable Fixed Facility Alternatives

Scores out of 3 for each element except distance

Parameter	Facility 1	Facility 2	Facility 3
Distance from TSS to facility (ranked out of 5)	3	5	2
Speed of Processing	2	2	3
Percentage of waste recycled/recovered	3	2	2
Power consumption (kW)	1	3	2
Chemical Consumption	3	2	2
Waste generated	2	3	1
Cost	2	3	1
Overall Score (add up)	16	20	15
Overall Ranking	2	1	3

Discussions should then be entered into with the highest ranked facilities to put the appropriate contracts in place. For extensive spills, it is probable that use of more than one facility will be required. Priority should be given to using the nearest facility, particularly if the spill is extensive, as waste from other sites may need to be processed elsewhere.

6.4.2 Using Bespoke, Purpose-built Treatment Systems

6.4.2.1 Introduction

If existing, permitted, mobile or fixed facilities exist which can be utilized to process the spill arisings, their use will in the vast majority of cases represent the most expedient solution, as selection of the most appropriate technologies is taken out of the hands of the spill response team and placed with specialists. Such operations will also have arrangements in place for the ultimate disposal of the treated waste to outlets which meet the requirements of the regulatory framework.

However, the opportunity to use such facilities may not always exist, and in these cases the spill response team may need to procure treatment technologies to undertake the processing. The experienced process engineer will use his knowledge of the available treatment technologies to select the most appropriate and will then engage in detailed discussions with suppliers and/or manufacturers to refine his selection, including commercial assessments.

Experience from the Erika spill leads to the conclusion that if waste containing heavy oils are to be treated, this approach is most likely to be necessary in many cases.

This decision making tool is intended to guide a non-expert to quickly come to sensible conclusions about technologies which might be appropriate to the particular spill (or part of a spill) under consideration. It was therefore necessary to develop some means by which the skill and experience of the process engineer could be distilled into an easily understandable process. Of necessity, the approach is a technical one, and only those logistical or legal considerations directly impacting on the selection process are considered. Simplicity is hence gained at the expense of specificity, and the use of this document is therefore not intended to fully replace the use of expert advisors, but is intended to be entirely compatible with the use of such advisors.

The approach assumes that technical specification of the waste to be treated will be at best sketchy, and hence simple and readily available proxies are used for the detailed technical information which would be the ideal basis for selection of the "best" technology and management.

The approach adopted has been to develop a series of matrices relating to key elements of the decision making process which are then combined and used to "rank" available technologies or strategies to produce short-lists of the most appropriate which can then be subjected to closer scrutiny or investigation to lead to a conclusion on which as/are the optimum for a given situation(s). Population of these matrices is with real data where this exists, best estimates if possible, and industry "best practice" or the authors' experience and skill where no other alternative is currently available. In considering the various aspects which need to be accounted for, the process attempts to classify each aspect into the bare minimum number of categories necessary to inform a decision, based where possible upon already-proven categorisations.

The "tiered" approach applies the same methodology at each stage – ie to rank the alternatives and then examine the preferred options in more detail.

To achieve this, candidate "generic" technologies are first selected, and then "sub-technologies" within each generic technology group. The process is shown below.

Another significant element of the overall spill-management process is the selection of how any developed strategy should be implemented and managed. A key example in the area addressed in this document is the management of processing of the waste. Given the other pressures under which members of the response teams are working, a strong argument could be put forward for engaging the services of a waste management contractor familiar with the technologies involved, and passing all of the decision-making and operational management on to this organisation. The approach adopted in this guide has been to use the methodology to determine, in the first instance, which processes/technologies might be the most effective. This will enable easier selection of appropriate equipment, suppliers and contractors to be made as the number of options will be limited.

If this situation should arise, it is recommended that two parallel approaches are used:

- To invite specialist contractors to provide and operate equipment on a design/build basis
- To undertake an initial appraisal of the best options and then engage the services of specialist contractors

The latter option has the benefit of reducing the number of options, making the management process simpler. Using the ranking process developed here, it should be possible to undertake the preliminary appraisal very quickly to reduce the number of options.

6.4.2.2 Overall Contractor Approach

The contractor should be provided with all the data available and asked to present an outline of his solution and budget costs for design, supply, construction and operation. A suitable form of contract would be used to ensure fair distribution of risk between the contractor and the body responsible for the clean-up process and costs.

The information supplied by the contractors will enable designs to be prepared for the long term storage necessary.

With the benefit of details from the chosen contractor, appropriate environmental permit applications need to be prepared and submitted for approval before processing can commence.

6.4.2.3 Ranking of Processes before Contractor Selection

This approach can also be adopted to reduce the number of options which need review in both Steps 2 and Step 3 (fixed facilities) - the process to be followed is described in the following section.

If it is found that building a bespoke facility is necessary, the high capital cost would suggest that as much waste as possible be processed through the system, indicating that waste from a number of temporary sites should be treated at the same treatment facility - this must be considered at the early conceptualization stage. The extended delay before implementation also means that it will be necessary to transfer the waste from temporary storage areas to loner term storage, which will require separate design and construction as soon as possible. Sections 6.3.2, 6.3.3 and 6.3.4 contain information on the principles of design of these sites.

The basis and development of the ranking process is described in Section 6.6. Since the ranking is considerably simplified using the spreadsheet version, a second version of the ranking spreadsheet can be found on the CD “Treatment Options Assessment”, which can be used in conjunction with the paper versions of the SCAT reports.

The example of this process shown in Table 6-20 uses the same data as in Table 6-4 above.

From Table 6-20 it will be seen that in this case, the preferred technologies are Sediment/cleaning; fuel use and incineration.

Having identified the most suitable technologies, sub technologies from the generic technologies, as listed in Table 4-2 are then ranked, as shown in Table 6-21, using the data presented in Table 6-7. This indicates that the preferred technology for this duty would be large scale sediment cleaning using quarrying-type equipment. Additional ranking methods are being developed for this element, which should enable the process to be more selective based on actual data for the relevant criteria.

Enquiries would then be issued to relevant suppliers, selected from the suppliers list included in Appendix D and Part 4 pf this report, or contractors if a system needs to be designed and constructed.

The information supplied by the contractors will enable designs to be prepared for the long term storage necessary.

The design of bespoke /purpose built systems can be a complex and time consuming process and must be undertaken by experienced process engineers / contractors in conjunction with other stakeholders.

With the benefit of details from the chosen contractor, appropriate environmental permit applications need to be prepared and submitted for approval before processing can commence.

6.4.3 Application of Model after Spill before Waste Reaches Shore

Some pre-planning can be done between the spill incident and the oil's arrival at the shoreline. MCA can forecast the trajectory of the oil, leadng to identification of where it may reach the coast. The method described in Part 2 of this report can then be used to estimate the volumes and types of waste which might be generated. This data can then be inout into the methodology above to enable preliminary selection of and discussion with candidate technologies, facilities and/or contractors.

Table 0-14 - Process Selection Stage 1 - Generic Technology Ranking

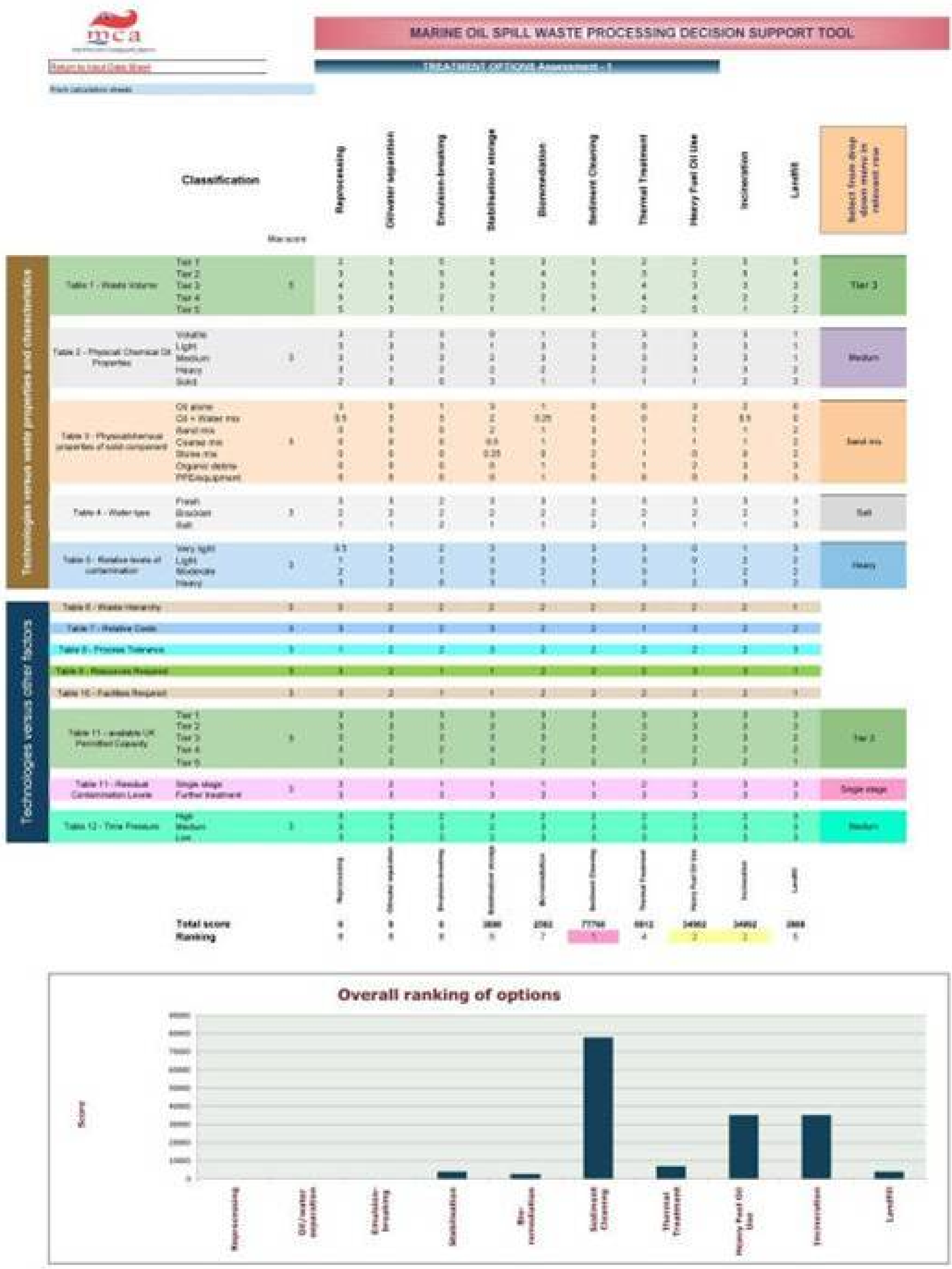
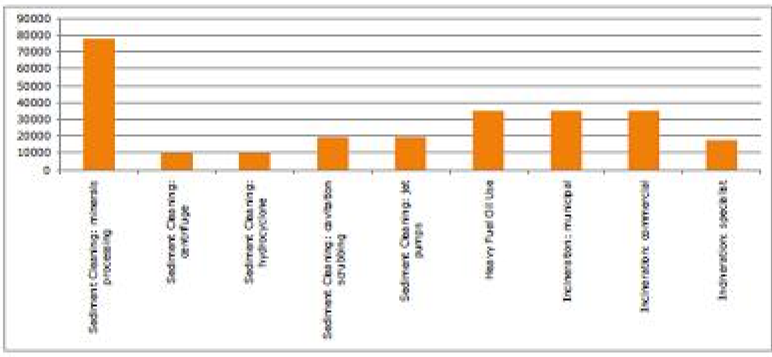


Table 0-15 - Secondary Ranking

MARINE OIL SPILL WASTE PROCESSING DECISION SUPPORT TOOL

Group	Classification	Option	Max score	Sediment Cleaning: minerals processing	Sediment Cleaning: centrifuge	Sediment Cleaning: hydrocyclone	Sediment Cleaning: cavitation scrubbing	Sediment Cleaning: jet pumps	Heavy Fuel Oil Use	Incineration: municipal	Incineration: commercial	Incineration: specialist	Select from drop down menu in relevant row
Technologies versus waste properties and characteristics	Table 1 - Waste Volume	Tier 1	6	5	5	5	5	5	2	5	5	5	Tier 3
		Tier 2		5	5	5	5	5	2	5	5	5	
		Tier 3		6	6	6	6	6	3	3	3	3	
		Tier 4		5	5	5	5	5	4	2	2	2	
		Tier 5		4	4	4	4	4	6	1	1	1	
	Table 2 - Physical/ Chemical Oil Properties	Volatile	6	2	2	2	2	2	3	3	3	3	Medium
		Light		3	3	3	3	3	3	3	3	3	
		Medium		3	3	3	3	3	3	3	3	3	
		Heavy		2	2	2	2	2	3	3	3	3	
		Solid		1	1	1	1	1	1	2	2	2	
	Table 3 - Physical/chemical properties of solid component	Oil alone	3	0	0	0	0	0	3	0	2	1	Sand mix
		Oil + Water Emulsion		0	0	0	0	0	2	0	1	1	
		Oil + Water Separate phases		0	0	0	0	0	2	0	1	1	
		Sand mix		3	3	3	3	3	1	1	1	1	
		Coarse mix		3	0	0	3	3	1	1	1	1	
		Stone mix		2	0	0	2	2	0	0	0	0	
		Organic debris		0	0	0	0	0	2	2	2	3	
		PPE/equipment		0	0	0	0	0	0	2	2	3	
	Table 4 - Water type	Fresh	3	3	3	3	3	3	3	3	3	3	Salt
		Brackish		2	2	2	2	2	2	2	2	2	
		Salt		2	2	2	2	2	1	1	1	1	
	Table 5 - Relative levels of contamination	Very light	3	3	3	3	3	3	0	1	1	1	Heavy
		Light		3	3	3	3	3	0	2	2	2	
		Moderate		3	3	3	3	3	1	2	2	2	
		Heavy		3	3	3	3	3	2	3	3	3	
Technologies versus other factors	Table 6 - Waste Hierarchy		3	2	1	1	1	1	2	2	2	2	
	Table 7 - Relative Costs		3	2	2	2	2	2	3	2	2	1	
	Table 8 - Process Tolerance		3	2	1	1	2	2	2	2	2	2	
	Table 9 - Resources Required		3	2	1	1	1	1	3	3	3	3	
	Table 10 - Facilities Required		3	2	2	2	2	2	2	2	2	2	
	Table 11 - available UK Permitted Capacity	Tier 1	3	3	3	3	3	3	3	3	3	3	Tier 3
		Tier 2		3	3	3	3	3	3	3	3	3	
		Tier 3		3	3	3	3	3	3	3	3	3	
		Tier 4		2	2	2	2	2	2	2	2	2	
		Tier 5		2	2	2	2	2	2	2	2	2	
	Table 11 - Residual Contamination Levels	Single stage	3	1	1	1	1	1	3	3	3	3	Single stage
		Further treatment		3	3	3	3	3	3	3	3	3	
	Table 12 - Time Pressure	High	3	2	2	2	2	2	2	2	2	2	Medium
		Medium		3	3	3	3	3	3	3	3	3	
		Low		3	3	3	3	3	3	3	3	3	
	Score			77760	8720	8720	19440	19440	34992	34992	34992	17496	
	Ranking			1	8	8	5	5	2	2	2	7	



6.5 Use of the Spreadsheet Model

As indicated in Section 6.7, the development of a fully integrated model has been severely limited by lack of information. Progress has been made, however, on the production of parts of the integrated model, and these are outlined below.

6.5.1 Waste Characterisation

A spreadsheet model has been developed to assist in the development of decisions on waste processing. At present, three elements are developed:

- The first is the waste characterisation model, which incorporates (several) tabs containing the SCAT form and a newly developed model to calculate the actual waste volumes
- The second is a tab which summarises the volumes and types of waste on a wider basis - temporary site, area and region to assist in the assessment of possible treatments for waste from more than one location and to assist in prioritisation of activities.

- The third tab is the generic ranking process spreadsheet

Reference should be made to the CD which accompanies this document; the spreadsheet included entitled “Decision Making Tool for Report”

The first three tabs of the spreadsheet are flow charts of the process, included in this document as Flow charts 6-1 to 6-3

6.5.1.1 SCAT Form and Waste Volume Calculator

These tabs are used to estimate flows and waste volumes for each shoreline segment, with each shoreline segment having its own corresponding SCAT report and Waste Volume Calculator tab. Data from the SCAT report tabs are transferred to the corresponding Waste Volume Calculator tabs, to summarise the data inputted into the SCAT reports. In addition the Waste Volume Calculator tabs are also populated with data from the Waste Management Calculator and calculate the following:

1. Volume of different classifications of waste from each shoreline segment
2. The average oil concentration in the different types of waste
3. The quantities of waste classified by substrate type and oil type
4. An estimate of the volume of free oil which will be produced from the clean up
5. An estimate of the volume of free oil storage which will be required at the temporary storage site.

6.5.1.2 Waste Volume Consolidation

The Waste Volume Consolidation tab is used to consolidate the data from each of the shoreline segments which are transferred to a TSS. The details of the TSS storing the waste from the shoreline segments are recorded along with the shoreline segments where the waste has be transferred from. The volumes of waste are calculated automatically from the data provided by the SCAT report and Waste Volume Calculator tabs are summarised along with additional characteristics of the waste.

6.5.1.3 Ranking Assessment

The ranking assessment tab is a spreadsheet version of the tables shown as Table 6-4 and 6-7.

The primary ranking is automated using data from Waste Volume Consolidation tab producing data as shown in Table 7-20 and 7-21.

6.5.2 Instructions for Data Input into the Decision Making Tool Model

6.5.2.1 SCAT Report

The SCAT report tabs are to be populated using the SCAT reports produced at the spillage site. The SCAT report covers each segment of shoreline of the affected area, which is then broken down into several sections of the segment to aid with categorising the surface and sub-surface oil characteristics.

There may be more than one SCAT report, as the spill reached more than one segment of the shoreline. Each paper SCAT report should be transferred to a separate SCAT report in the computer model; with each SCAT report in the model being on a separate tab. (additional tabs can be created if more than 3 shoreline segments are consolidated to one TSS).

6.5.2.2 Colour Coding of Cells

The cells where data should be inputted from the SCAT reports are colour-coded with three different colours, to distinguish between data which should be entered by typing, data which should be entered using a drop-down menu and data which will be automatically generated from other cell inputs but which should be checked to ensure it correlates with the paper copy of the SCAT report, these are as follows: -

Colour of Cell	Description of how data should be entered in the cell
(orange)	Input information - Data should be entered into the cell directly from the paper copy of the SCAT report
(beige)	Drop-down menu selection - The drop-down menu in the cell should be used to select the entry which corresponds with data on the paper copy of the SCAT report.
(pink)	Automatically generated - The data in the cell will be automatically generated from data entered into other cells. The entry which is automatically generated should be checked to ensure it correlates with the data on the paper copy of the SCAT report.

6.5.2.3 Other Notes for Data Input

The table headed Waste Management Calculator Input is all automatically generated and is not part of the paper form of the SCAT report. The table should be left unedited.

The definitions to aid input into the SCAT report are found at the bottom of the SCAT report.

6.5.2.3.1 Basic Information section -

The cell for the SRC/LA Briefing answer, which has ‘Yes/No’, should be entered by deleting the wrong option.

If the ‘shoreline’ sensitivity differs between the different sections of the shoreline segment, then the most sensitive option should be entered.

If there are not enough free cells for the photograph references then another line should be entered, or a cell should be used to enter all the extra detail.

6.5.2.3.2 Samples section -

If there are not enough free cells for the samples taken then another line should be entered, or a cell should be used to enter all the extra detail.

6.5.2.3.3 Resources/receptors impacted section -

If the answer to any of the questions are ‘yes’, the ‘If Yes give details here’ text should be deleted and the appropriate details entered in the corresponding cell. The same action should be taken for the cell adjacent to the ‘Is clean up required’ cell which has the text ‘If "Yes", indicate rationale, technique and resources required.’

6.5.2.3.4 Other Information - map/sketch -

Leave as paper version only

6.5.3 Waste Volume Calculator

The majority of the waste volume calculator tab is automatically generated from the data inputted into the corresponding SCAT report. A Waste Volume Calculator tab exists for each SCAT report tab which is produced.

6.5.3.1 Section 1 - Possible Shoreline Clean-up Methods

This table has already been populated and should be left unedited; it is used to aid with the decision of which method of clean of the spillage would be most suitable to each section of the shoreline segment.

6.5.3.2 Section 2 - Shoreline Segment/Location Information

The drop-down menu in the cells adjacent to the ‘clean up target’ cell under the ‘information to input to Waste Management Calculator’ section of the table should be used. The input here will generally be ‘remove to stain’ unless specified otherwise by the SCAT team

6.5.3.3 Section 3 - Waste Volume estimation using Waste Volume Calculator (separate software)

The first section of the table, Waste {m^3/m oiled length}, is populated by using the output from the Waste Management Calculator (Refer to section 7.3). The second section, Waste volume total {m^3}, is automatically calculated from the first section.

The principal clean up method being used for each section of the shoreline segment should be chosen from the drop-down menu in the cells adjacent to ‘Select chosen principal clean up method from drop down list' The principal method will normally be selected by the SCAT/ Oil Spill Response Team, but if this has not been done, the user should select the method which appears to be most effective having looked at the options and reviewed the guidance in the WMC.

6.5.3.4 Section 4 - Primary Treatment (at shoreline, temporary/intermediate storage location or waste facility)

This section is completely automated and is used to provide input information for the Waste volume consolidation tab.

6.5.4 Waste Volume Consolidation

The details of the storage location should be entered in the first table under the cell containing 'Storage Location Details - to be entered by user', please provide as much detail as is available.

The table adjacent to the cell containing 'Shoreline Segment Details - to be entered by user' (under the previously mentioned table) should be populated using the information found in the 'Basic Information' section on the SCAT report.

The remainder of the tab should remain unedited as it is completely automated and will generate data to allow the treatment options for processing the waste at the storage location to be ranked.

6.5.5 Ranking Assessment

The Ranking Assessment tab is completely automated.

6.5.6 Continuation of the Decision Making Process

To continue the decision making process and make decisions as to whether the processing options ranked as the most favourable are viable options and if so which treatment facilities should the waste be transferred to, then the user should refer back to section 7.3.2 and continue the process from there.

APPENDICES

Appendix A - European Waste Catalogue Codes

The possible EWC categories for waste streams arising from oil spill clean-up operations are as follows:

05 Wastes from Petroleum Refining
05 01 wastes from petroleum refining 05 01 02* desalter sludges 05 01 03* tank bottom sludges 05 01 04* acid alkyl sludges 05 01 05* oil spills 05 01 06* oily sludges from maintenance operations of the plant or equipment 05 01 07* acid tars 05 01 08* other tars 05 01 09* sludges from on-site effluent treatment containing dangerous substances 05 01 10 sludges from on-site effluent treatment other than those mentioned in 05 01 09 05 01 11* wastes from cleaning of fuels with bases 05 01 12* oil containing acids 05 01 13 boiler feedwater sludges 05 01 14 wastes from cooling columns 05 01 15* spent filter clays 05 01 16 sulphur-containing wastes from petroleum desulphurisation 05 01 17 bitumen 05 01 99 wastes not otherwise specified
13 Oil wastes and wastes of liquid fuels
13 05 oil/water separator contents 13 05 01* solids from grit chambers and oil/water separators 13 05 02* sludges from oil/water separators

13 05 03* interceptor sludges 13 05 06* oil from oil/water separators 13 05 07* oily water from oil/water separators 13 05 08* mixtures of wastes from grit chambers and oil/water separators
13 08 oil wastes not otherwise specified 13 08 01* desalter sludges or emulsions 13 08 02* other emulsions 13 08 99* wastes not otherwise specified
14 Waste organic solvents, refrigerants and propellants
14 06 waste organic solvents, refrigerants and foam/aerosol propellants 14 06 05* sludges or solid wastes containing other solvents
15 Waste packaging; absorbents, wiping cloths, filter materials and protective clothing not otherwise specified
15 02 absorbents, filter materials, wiping cloths and protective clothing 15 02 02* absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances 15 02 03 absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02
16 Wastes not otherwise specified in the list
16 07 wastes from transport tank, storage tank and barrel cleaning 16 07 08* wastes containing oil 16 07 09* wastes containing other dangerous substances 16 07 99 wastes not otherwise specified
17 Construction and demolition wastes (including excavated soil from contaminated sites)
17 05 soil (including excavated soil from contaminated sites), stones and dredging spoil

19 Wastes from waste management facilities, off-site waste water treatment plants and the preparation of water intended for human consumption and water for industrial use
19 02 wastes from physico/chemical treatments of waste (including dechromatation, decyanidation, neutralisation
19 02 03 pre-mixed wastes composed only of non-hazardous wastes 19 02 04* pre-mixed wastes composed of at least one hazardous waste 19 02 05* sludges from physico/chemical treatment containing dangerous substances 19 02 06 sludges from physico/chemical treatment other than those mentioned in 19 02 05 19 02 07* oil and concentrates from separation 19 02 08* liquid combustible wastes containing dangerous substances 19 02 09* solid combustible wastes containing dangerous substances 19 02 10 combustible wastes other than those mentioned in 19 02 08 and 19 02 09 19 02 11* other wastes containing dangerous substances 19 02 99 wastes not otherwise specified
19 03 stabilised/solidified wastes
19 03 04* wastes marked as hazardous, partly stabilised 19 03 05 stabilised wastes other than those mentioned in 19 03 04 19 03 06* wastes marked as hazardous, solidified 19 03 07 solidified wastes other than those mentioned in 19 03 06
19 12 wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising) not otherwise specified
19 13 wastes from soil and groundwater remediation 19 13 01* solid wastes from soil remediation containing dangerous substances 19 13 02 solid wastes from soil remediation other than those mentioned in 19 13 01 19 13 03* sludges from soil remediation containing dangerous substances 19 13 04 sludges from soil remediation other than those mentioned in 19 13 03

Appendix B - Waste Management Calculator User Guide

Appendix C - Treatment Process Details

(Modified from REMPEC 2010)

PRE-TREATMENT	Screening
Description	Separation of the polluted solid waste and sand and pebbles from the liquid phase (oil and/ or water). Note. Some equipment is specifically designed to sort metallic from non-metallic elements (and plastic from non-plastic), using magnetic sorting equipment.
Waste	Liquid Polluted sand and pebbles/ stones Polluted solid waste
Situation / Potential in the country	Use of public work/ construction work equipment easy to import and implement in any country.
Interest	Allows segregation of solids and sediments from the liquid phase for more specific waste treatment.
Entry criteria	Any type of liquid with pastes and solid, polluted sand/ pebbles/ solid waste.
Operational constraints	Requires personnel, specific screening equipment, energy, and storage for segregated material. May not be carried out on sediment trapped in heavy / weathered / emulsified oil without fluidification. Possible installation ranges from simple screen to heavy industrial screening equipment.
Impacts	Minimal if equipment is suited, correctly operated and there are no oil leaks.
Legal constraints	Refer to those applying to the transport, handling and storage of oil products.
Efficiency	Depending on equipment.
Cost	CAPEX and OPEX vary widely depending on the installation purchased/ rented.
PRE-TREATMENT	**Size sorting**
Description	Sorting of sediments (and other waste) based on size (fine sediment, sand, gravel, pebble, cobble, boulder).
Waste	Polluted sand and pebbles/ stones
Situation / Potential in the country	Use of public work/ construction work equipment easy to import and implement in any country.
Interest	Some machinery is suited to use with sand, some with gravel, others with pebbles and cobbles. Most organic and inorganic contaminants tend to bind to the fine fraction of a soil (i.e. clay and silt). Thus, separating the fine clay and silt particles from the coarser sand and gravel soil particles concentrates the contaminants into a smaller volume of soil that can then be treated or disposed of.
Entry criteria	Any type of pastes and solid, polluted sand/ pebbles/ solid waste.
Operational constraints	Requires personnel, specific sorting equipment, energy, and storage for the sorted sediment. May not be carried out on sediment trapped in heavy / weathered / emulsified oil without fluidification (because oil fills in the pores of the sorting equipment).
Impacts	Minimal if equipment is suited, correctly operated and there are no oil leaks.
Legal constraints	Refer to those applying to the transport, handling and storage of oil products.
Efficiency	Depending on equipment, can allow sorting waste / various sizes of sand and pebbles (depending on the screen used in the machine). The size of the installation ranges from simple sorting equipment (few 10's of cubic metres per hour) to heavy of industrial equipment, e.g. Trommel screening type (screened cylinder used to separate materials by size, 200 to 300 cubic metres per hour).
Cost	CAPEX and OPEX vary depending on the installation purchased/ rented.

PRE-TREATMENT	**Mills/ Shredders/ Shearing machines/ Crushers**
Description	Equipment used to reduce size of solid waste. Equipment used depends on the type of waste. • Mills: breakable solid waste • Shredders: cardboard, polystyrene • Shearing machines: plastic, paper, cardboard, wood • Crushers: wood/ log, rubble, plastic, large pieces of waste
Waste	Solid waste Mineral waste (gravel, pebble, boulder)
Situation / Potential in the country	Equipment can be imported and implemented easily.
Interest	Allows preparation smaller size material for treatment (e.g. incineration, co-incineration etc.).
Entry criteria	Depends on the type of equipment.
Operational constraints	The equipment is subject to rapid wear, and wearing parts must be changed frequently.
Impacts	Environmental impacts are limited to the noise.
Legal constraints	Limited.
Efficiency	Very good when implemented adequately.
Cost	CAPEX: price of the equipment ranges from few thousand Euros to few million Euros depending on the capabilities and complexity of the equipment. OPEX will vary accordingly.
PRE-TREATMENT	**Drying of seaweed**
Description	Drying of oiled seaweed and sea grass before incineration. Seaweed and sea grass are disposed in piles (e.g. 2m x 2m), height must not exceed 20 cm.
Waste	Seaweed and sea grass lightly (to medium) oiled
Situation / Potential in the country	Pre-treatment can be implemented very easily with limited equipment (earth moving equipment).
Interest	Allows decreasing the overall weight of a minimum of 50% of the sea weed and grass (and removing water) before incineration, thus reducing the cost and facilitating the incineration.
Entry criteria	Drying is used for light to medium oiled marine plant derived waste.
Operational constraints	The drying requires non sensitive land areas. Ground must be protected to avoid infiltration.
Impacts	Environmental impacts are limited to the odours (if infiltration is managed).
Legal constraints	Limited
Efficiency	In a temperate country, seaweed dries off in 15 days, less on hotter conditions.
Cost	Limited to the rental cost of earth moving machines, personnel and land.
PRE-TREATMENT	**Decantation (settling)**
Description	Separation of a liquid phase (oil or oily water) from another phase (liquid and/ or solid) either on the field during response operations or after the response operations in specialized installations (refinery, deballasting stations, etc.).
Waste	Liquid (may contain limited volumes of pastes and solid)
Situation / Potential in the country	Equipment easy to implement in any country (requires tanks for settling and storage, and pumps able to pump water and oil).

Interest	Allow separation of oil and water from an oil and water mix (may also allow recovery of sediment depending on equipment). During response operations, it might be acceptable for the separated water to be discharged into the environment thus reducing the need for storage capabilities (on the working sites and on the spill response vessels recovering oil offshore).
Entry criteria	Any oil, water and solid particle mix may be decanted to a certain degree. Oil and water cannot be recovered directly from emulsified oil. Emulsion breaking is necessary prior to decantation.
Operational constraints	Requires personnel, a suitable site and storage capabilities for the recovered oil, water and solids (and/ or the possibility to discharge the recovered water in the environment).
Impacts	➔ Decantation in the field during response operations: the decantation has limited impact. It is often accepted that the recovered water is discharged in the environment (during the spill response operations). ➔ During waste treatment in specialized plants (once emergency response operations is completed): minimal if equipment is suited, correctly operated and there are no oil leaks.
Legal constraints	Refer to those applying to the discharge of water in the environment. Higher concentrations of oil in water (in the discharged water) are acceptable during spill response operations.
Efficiency	Typical maximum flow rate depends on the pumps and decantation equipment. ➔ Decantation in the field during response operations: decantation time depends on the oily water recovered (typical time is one hour). Pumps with typical flow rates of 10 to 50m3/ hr are used. ➔ During waste treatment in specialized plants: few cubic metres to 10's of cubic metres per hour.
Cost	CAPEX, mobilisation cost: • Decantation in the field during response operations: costs of rental/ purchase for storage tanks (10 m3 or more) and volumetric pumps (10 to 50 m3/ hr flow rate) • None if existing installation OPEX : varies depending on the type of installation; however costs are limited (around 50 Euros/ per m3 of waste to decant).
PRE-TREATMENT	**Centrifugation**
Description	Separation of phases : oil - water – sediment using specific centrifugation machine.
Waste	Liquid (with limited fraction of sediments, threshold depends on equipment). Simple centrifugation may also be used to recover oil from heavily polluted sands.
Situation / Potential in the country	Equipment easy to import and implement in any country.
Interest	Allows separation of oil, water and sediment. Recovered oil may be re-used.
Entry criteria	Typical feed limit characteristics for centrifugation equipment: • Oily sludge pumpable by standard volumetric pumps • Dry solid content : maximum 15 % • Grain size : no particles bigger than 5 mm (plastic, sand, stones, wood, rust and other materials) • Oil content : 0 - 100 % • Water content : 0 - 100 % Note. Other equipment allows the centrifugation of heavily oiled sands.
Operational constraints	Requires personnel, site (surface of 200 m2 minimum), and input: • Electrical supply • Polymer (flocculent) powder can be used to facilitate the recovery of fine sediment (use 10 to 12 kg per ton of dry solid) • Demulsifying chemicals can be used for emulsion. • Water may be required in case of heavy sludge with low water content, to liquefy the product before inputting into the centrifugation machine.
Impacts	Minimal if equipment is suited, correctly operated and there are no oil leaks.

Legal constraints	Refer to those applying to the transport, handling and storage of oil products.
Efficiency	Typical maximum flow rate : • 750 kg dry solids per hour • 12 m^3/h maximum. Based on experience, 40 to 60 m3 of sludge can be treated daily (based on an 8 hours working day). Quality of oil recovered: • Contains 5% < BSW < 10%. Depending on the type of mud and machine tuning. Quality of water output by centrifuge machine: • Contains 2%<oil<10% and 0,1%<SPM<3%. Depending on the mud & machine tuning. • Water can be retreated in a lamellar decanter to reach a content of oil inferior to 0,1% and SPM inferior to 0,1%. Quality of sediment: • Contains 5 < Oil leachate < 10% and 30% < DS < 45%. • Depends on the type of mud, machine tuning and additives (flocculants).
Cost	CAPEX, example of mobilisation cost for centrifugation equipment with above mentioned efficiency: • Trans Mediterranean transport of equipment (2 x open-top containers: 1 x 20 ft container, and 1 x 40 ft container) : approx. 10,000 Euros • Installation and start-up: approx. 25,000 Euros OPEX : Using centrifuge decanter and lamella decanter for the water and including flocculants and de-emulsifier: approx. 60 Euros/ m^3 of sludge treated.
PRE-TREATMENT	**Emulsion breaking**
Description	Breaking up of emulsion of water in oil to discrete phases, either on site or in a suitable facility. Water in oil emulsions are very viscous and may contain up to 50 to 80% of water. ➔ Unstable emulsions can be broken by simple decantation or by heat treatment followed by decantation. The oil/water mixture should preferably be heated by circulation through an external heat-exchanger. ➔ Stable emulsions can be broken up by using demulsifying chemicals, which should be used as early as possible. The recommended dose rate varies with the type of oil and the age of the emulsion, but are usually very low (ranges from 250 to 5,000 ppm). Process lasts a minimum of 10 to 20 minutes.
Waste	Emulsified oil
Situation / Potential in the country	Heating equipment can be easily implemented. Demulsifying chemicals are easy to import and implement in any country.
Interest	Any decrease of the content of water in the emulsion implies less waste to treat afterwards. Water and oil can then be recovered separately using decantation or centrifugation.
Entry criteria	Any emulsified oil.
Operational constraints	➔ Heating. The safe working temperature limits is usually considered to be the flash point of the oil less 8°C. Generally, a working temperature of 60-66°C is used with a maximum temperature of 80°C to maintain operational safety. ➔ Use of demulsifying chemicals. There is no universally effective product. Screening and testing will be required.
Impacts	Emulsion breaking: minimal if equipment is suited, correctly operated and there are no oil leaks. ➔ Demulsifying chemicals may remain in the water after separation so care will be needed when disposing of the water. ➔ The water phase may be discharged to the environment after emulsion breaking at the recovery site (since the residual oil content is unlikely to increase damage to any species in an area already affected by a significant oil spill). If emulsion breaking is carried out after the cleanup operations, the water recovered should undergo further treatment via a separator unit to further reduce the oil content

Legal constraints	Refer to those applying to the transport, handling and storage of oil products, and discharge of water in the environment.
Efficiency	Generally, after separation into two layers, the water phase contains less than 1,000ppm of oil.
Cost	CAPEX will depend on the type of installation used but will be limited (especially for demulsifying agent). OPEX is also limited as installations are simple, and limited personnel are required (less than 50 Euros / m3).
PRE-TREATMENT	**Draining of sorbent**
Description	Draining of oil from sorbent prior to treatment (e.g. incineration) to recover the oil.
Waste	Oiled sorbent (may also be used for heavily oiled solid waste)
Situation / Potential in the country	Easy to implement in any country.
Interest	Allows recovery of the major part of the oil from the sorbent before further treatment.
Entry criteria	Any type of sorbent.
Operational constraints	Mainly related to the handling of the oily waste. No other specific technical requirements.
Impacts	Minimal if the oil and sorbent are recovered and managed correctly.
Legal constraints	Refer to those applying to the transport, handling and storage of oil products.
Efficiency	Limited, only to be used to recover bulk oil coating the waste or from sorbent.
Cost	Limited (depends mainly on personnel cost, equipment required is limited).

NATURAL TREATMENT	**Monitored Natural Attenuation**
Description	Comprises a range of physical and biological processes, which, unaided by deliberate human intervention, reduce the concentration, toxicity, or mobility of contaminants. Natural attenuation can be classified as destructive and non-destructive. • Destructive processes include biodegradation, photo-oxidation and hydrolysis. Biodegradation or bioremediation is by far the most prevalent destructive mechanism. • Non-destructive attenuation mechanisms include sorption, dispersion, dilution (most important non-destructive mechanisms) and volatilization.
Waste	Residual pollution (soil and groundwater on site)
Situation / Potential in the country	Does not require any equipment (apart from monitoring capabilities).
Interest	No investment (apart from monitoring capabilities).
Entry criteria	Controversial technique from a public and environmental point of view. May only be considered on residual and biodegradable pollution (or pollution that may be attenuated by the non-destructive mechanism).
Operational constraints	Long-term monitoring is necessary to demonstrate that contaminant concentrations continue to decrease at a rate sufficient to ensure that they will not become a health threat or violate regulatory criteria.
Impacts	Natural Attenuation is not appropriate where imminent risks are present.
Legal constraints	Refer to those applying to polluted soil and groundwater.
Efficiency	To be ascertained by the monitoring program. Research is on-going.
Cost	Related to the monitoring program (expertise, sampling and analysis).

PHYSICAL TREATMENT	**Washing of oiled sediment and soil** (Also known as "Solvent extraction" if solvent is used).
Description	Soil washing uses water to remove contaminants from soils. The process works by either dissolving or suspending contaminants in the wash solution (using hot water, 30° to 50°C and solvent/ dispersant chemical agent when required). It is often used in conjunction with other physical separation techniques (see decantation, centrifugation etc.).
Waste	Contaminated sediment and soil.
Situation / Potential in the country	Equipment may exist in public works, construction industry, or mining sectors or mobile units may be imported.
Interest	Soil washing starts by the separation of soil by particle size. Most organic and inorganic contaminants tend to bind and sorb to clay, silt, and organic soil particles. This fine sediment is separated from the remaining soil during the washing by scrubbing, water and possibly solvation. Washing does not treat the pollution but helps by removing the pollutants bonded to the finer sediments from the coarser sediments and concentrates them in a small volume of oily water, easier to treat and dispose of afterwards.
Entry criteria	The pollutants must be soluble in the given solvent (adsorbed to the fine sediment). Soil washing is a technique of concentrating contaminants through separation. It does not destroy or immobilize the contaminants. Consequently, the resulting concentrated contaminated soil and/ or effluents must be disposed of carefully.
Operational constraints	The "clean" portion of the separated soil must be analysed for residual contamination before it can be disposed of as clean material. Sand and gravel are relatively easy to wash. However, mud and clay retain, by adsorption, some oil and will require an additional treatment (Source: Bocard). Wash water requires treatment before it can be discharged, as it usually contains smaller particles or organic particles.
Impacts	Limited if wash waters are managed adequately and treated material is analysed before further treatment or disposal.
Legal constraints	Refer to those applying to polluted soil and groundwater and to the management of oily water.
Efficiency	Depending on the installation, may treat from few 10's of tons of waste per day to few 100's of tons.
Cost	OPEX: around 150 Euros / m3 (Source: KOLLER)
PHYSICAL TREATMENT	**Washing of heavily oiled solid waste**
Description	Washing oil from solid waste before storage or other final disposal using various techniques: ➔ Cold Water Flushing, simple technique, moderately successful, to wash large quantities of oiled debris with a high pressure hose to loosen and float away oil. The resulting oil/water mixture can then be treated via a separator ➔ Warm/Hot Water Flushing to clean pebbles, gravel and sand contaminated with oil or emulsion, using standard mineral processing equipment coupled to a conventional oil/water separator. ➔ High velocity steam jets directed onto an inclined, vibrating, perforated tray placed above a collector to trap oil and condensate, may be used to clean oil-contaminated sand. Possible use of demulsifier. ➔ Solvent Extraction may be considered as a possible mean of removing oil from collected sand, pebbles and debris. Limited research has been carried out in relation to the use of this technique.
Waste	Polluted solid waste and sediment
Situation / Potential in the country	Small installations are easy to implement (however, depends on the size of the equipment).
Interest	Recovery of recyclable material (e.g. plastic and other type of waste).

	Possibility of incinerating the cleaned waste or storing the cleaned waste in landfills. Possible recovery of oil (if decantation / centrifugation is used after the washing).
Entry criteria	Any type of heavily oiled solid waste or sediment.
Operational constraints	Requires personnel, specific site, washing equipment, energy, effluent management facility, cleaning products and large volumes of water.
Impacts	Minimal if the washing effluents are managed correctly. However, requires large volume of water.
Legal constraints	Refer to those applying to the management of oily water.
Efficiency	Depending on the equipment used.
Cost	OPEX: around 150 Euros / m3 (Source: KOLLER) CAPEX and OPEX varies depending on the size and flow rate of the installation.
PHYSICAL TREATMENT	**Flotation (using heated water)**
Description	Flotation of oil from oiled sand in a tank filled with heated water tank (to fluidise the oil) by introducing air bubbles at the bottom of the tank. The air bubbles mobilize the oil from the sediment and re-float it at the surface of the water.
Waste	Polluted sand
Situation / Potential in the country	Mobile installation may be easily implemented in the country.
Interest	Allows cleaning of the sand, which may be returned on the beach (with possible final cleanup using surfwashing).
Entry criteria	Lightly to medium polluted sand (oil from heavily polluted sand should be recovered prior to flotation using e.g. centrifugation).
Operational constraints	Requires the setup of a complete installation, power supply and water supply. Requires effluent management (for the recovered oil and the used water).
Impacts	Minimal if the washing effluents are managed correctly.
Legal constraints	Refer to those applying to the management of oily water.
Efficiency	Flotation is reportedly capable of cleaning about 1 ton of oil contaminated sand per hour. When operating with sand containing up to 2% of oil, approximately 95% of the oil may be removed.
Cost	Varies depending on the size and capabilities of the installation.
PHYSICAL TREATMENT	**Filtration**
Description	Filtration is the physical process whereby particles suspended in water are separated by forcing the fluid through a porous medium (i.e. a filter). The suspended particles are trapped in the filter. Filtration relies on the pore size of the membrane, which can be varied to remove particles and molecules of various sizes. Micro-filtration processes generally work best for separating very fine particles (0.1-0.001 microns) from the liquid.
Waste	Liquid (oil, oily water, water) with sediment (usually fine sediment)
Situation / Potential in the country	Easy to import and implement in any country.
Interest	Allows removal of fine sediments from a liquid waste before treatment.
Entry criteria	The liquid phase must not be too viscous to flow through the filtering device.
Operational constraints	Limited. The filtering device must be cleaned and/ or changed frequently.
Impacts	Minimal if equipment is suited, correctly operated and there are no oil leaks.
Legal constraints	Refer to those applying to the transport, handling and storage of oil products.
Efficiency	Depends on the type of installation, few cubic metres to few hundred's of cubic metres per day. Sampling the filtered water monitors the effectiveness of these processes.
Cost	CAPEX depends on the type of installation used (and its capabilities). OPEX are limited to the personnel, power supply and maintenance of the filtering device.

PHYSICAL TREATMENT	**Washing of pebbles (concrete mixer or hot water/ high pressure)**
Description	Cleaning of pebbles and stones using high pressure / hot water cleaners.
Waste	Polluted pebbles/ stones
Situation / Potential in the country	Required equipment could be sourced in any country
Interest	Allows return of clean pebbles to the beach.
Entry criteria	Any polluted pebbles and stones.
Operational constraints	Requires personnel, specific site, high pressure cleaner / steam cleaners, energy, washing effluent management facility. Steam cleaners that can work with sea water should preferably be used to limit the use of fresh water.
Impacts	Minimal if the washing effluent is managed correctly and if sea water is used.
Legal constraints	Refer to those applying to the management of oily water.
Efficiency	Depends on the number of cleaner used.
Cost	CAPEX : one high pressure / hot water cleaner working with sea water: 7,000 Euros. One portable concrete mixer (petrol engine): 1,000 Euros. OPEX is mainly related to the cost of manpower (3 to 4 workers per high pressure machine/ concrete mixer).
	 **Pebble washing on site (Source: Le Floch Depollution)**

PHYSICAL TREATMENT	**Surf-washing**
Description	Cleaning of polluted sand and pebbles by moving the sediments into the surf zone.
Waste	Medium to lightly polluted sands Medium to lightly polluted pebbles & stones
Situation /	May be considered in every country, require marine geologist advice and testing in situ.

Potential in the country	
Interest	Use of the "natural" energy of the waves and return of the sediments on the beach. Low cost and no specific, costly equipment required.
Entry criteria	Usable only for sediments that will remain on the beach and that are lightly to medium polluted.
Operational constraints	Requires personnel and earth moving equipment to push the polluted sediment in the surf zone and sorbent material to recover the oil.
Impacts	Minimal if the oil is correctly recovered using sorbent.
Legal constraints	Refer to those applying to the management of oily water and quality of coastal water (however, special authorisation will be required for such work).
Efficiency	Depending on viscosity and weathering of oil, temperature, exposure to waves.
Cost	CAPEX : none (if local equipment is rented) OPEX for one working site and team: daily cost of one or two mechanical shovel, team of one supervisor, 10 personnel, PPE and sorbent.

STABILISATION TREATMENT	**Stabilisation, using binding agent, e.g. quicklime (Pastes and solid and oily sands)**
Description	This process comprises two steps: • Solidification: transforms the waste into a granular solid with limited porosity and improved mechanical characteristics, • Stabilisation: transforms soluble compounds into stable less soluble compounds. The redox reaction of quicklime with the oil on the sediments stabilises the thickest oil compounds and (partially) degrades the lightest compounds of the oil. Stabilisation may be carried out on the working site or in specialized units.
Waste	Pastes and solid Polluted sands Note. Liquid waste should not be treated if oil content is too high.
Situation / Potential in the country	Quicklime is easily available and cheap. Other proprietary hydraulic binding materials are also available.
Interest	• Stabilizing the leachate of oil and toxic compounds. • Produces a granular hydrophobic material, physically and chemically suitable for use as a filling material, as raw material in civil works (quality of the material must be tested prior to any use), or to be left in-situ in a stabilised condition.
Entry criteria	Avoid polluted (organic?) waste, polluted sorbent and pebbles.
Operational constraints	Requires easily available equipment (e.g. earth moving equipment to mix the quicklime with the polluted material), little personnel, and binding agent (e.g. quicklime). If oil content is too high or high environmental temperature, there is a risk of fire. The grain size of the bulk quicklime has to be adapted to the grain size of the oiled sediment to treat (the smaller the sediment, the coarser the quicklime, e.g. quicklime grain of 20 to 40mm to treat silt and sand mix).
Impacts	The redox reaction is followed by atmospheric releases of dust, gases and fumes. Leachate of stabilised material has less than 1% of oil (in the worst case). The gradual degradation of the stabilisation process and the consequent release of the remaining contaminants into the environment must be anticipated, when considering the final disposal environment.
Legal constraints	Refer to atmospheric releases legislation (however, special authorisation may be required for such work). May require THC and leachate testing, and EIA or legal authorisation.
Efficiency	80 m^3/ day of waste treated with one mechanical shovel and one experienced driver.
Cost	CAPEX/ OPEX: the price for the stabilisation of 1 m3 of waste is approx. 150 to 200 Euros (depending on the local availability of binding agent).
STABILISATION TREATMENT	**Stabilisation - Vitrification**
Description	Vitrification uses heat to melt at very high temperature, (1,500° to 2,300°C) the waste, then decrease the temperature abruptly to solidify harmful chemicals in a solid mass of glasslike material. It can be applied on soil in-situ (in-situ vitrification or ISV) or in an external treatment unit (ex-situ).
Waste	Final wastes from incident (e.g. polluted soils, solid waste)
Situation / Potential in the country	Equipment can be imported and installed. Transportable vitrification systems exist.
Interest	Contaminants is stabilized and solidified in a glasslike material, with better long term performance than other solidification means (hydraulic binding agent).
Entry criteria	Complete characterization of the candidate waste stream is essential, before initiating either in-situ or ex-situ vitrification, to determine what glass forms are already present in the waste and what additional glass stabilizers and fluxes need to be added.

	Debris greater than 60 mm in diameter typically must be removed prior to processing.
Operational constraints	Use, storage, or disposal of the vitrified slag is required. High level of heat/ energy are required.
Impacts	Concerns include the durability of the vitrified waste, although vitrified waste (as compared to a grouted or cemented waste form) is expected to be more stable over longer periods due to the corrosion resistance of glass. The heat used to melt the soil can also destroy some of the harmful chemicals and cause others to evaporate. The evaporated chemicals must be captured and treated.
Legal constraints	Related to waste management and disposal (for the glass like material) and to gas emission and treatment during vitrification.
Efficiency	Vitrification is a proven technology that has been employed during various oil spills. However, very high levels of energy are required, which leads to high costs.
Cost	OPEX: from 150 to 230 Euros/ ton (Source: KOLLER), depending on the size and capabilities of the installation, to more than 300 Euros/ ton for specific waste.
BIOREMEDIATION TREATMENT	**Bioremediation: enhanced bioremediation <u>In Situ</u>**
Description	Stimulating bioremediation by addition of microorganisms (e.g., fungi, bacteria, and other microbes) and/ or nutrients (e.g. oxygen, nitrates) to the subsurface environment to accelerate the natural biodegradation process by the naturally occurring microorganisms of the soil. Bioremediation can take place under aerobic or anaerobic conditions. There are four major processes, briefly described below. **Bio-Stimulation:** • **Gaseous Nutrient Injection** In this case, nutrients are fed to contaminated groundwater and soil via wells to encourage and feed naturally occurring microorganisms. • **Oxygen Enhancement** with hydrogen peroxide as an alternative to pumping oxygen gas into groundwater. • **Nitrate Enhancement** A solution of nitrate is sometimes added to the groundwater to enhance anaerobic biodegradation. **Bio-augmentation** Sometimes acclimated microorganisms are added to the soil to increase biological activity. However, the efficiency of this technique is not as well proven as the bio-stimulation. The first three methods are preferred because they stimulate the naturally occurring indigenous micro-organisms, already adapted to the environment.
Waste	Lightly oiled sediment (sand, gravel, soil, mud). Oiled seaweed and vegetation (even fauna) may be treated
Situation/potential in the country	May be easily implemented on any polluted site (usually considered for coastal sheltered sites with slow natural clean-up by waves or inland sites).
Interest	it is relatively inexpensive with low energy requirements it can be carried out without elaborate equipment
Entry criteria	Oil with a high asphaltene and resin content degrades slowly due to the recalcitrance of the hydrocarbons. Oil with a high aliphatic and aromatic content is a much more nutrient-dependent process and will degrade more rapidly within an adequate environment. It is recommended to carry out a GC/ MS analysis to define the composition of the oil and evaluate its biodegradability. To achieve maximum biodegradation, sediment pore water should exhibit concentrations of 1.5 mg nitrate/litre, Phosphorous concentrations of approximately one-tenth of the nitrate levels, with oxygen levels above 2 mg/litre (Source: AMSA). High permeability soils are required to allow the nutrients to reach the indigenous microorganisms (avoid fine clays).
Operational constraints	Easy access to the treatment site. Biodegradation is less efficient at low temperature. Soil must be humid. Pollutants must not be adsorbed to clay and/ or mud. In this case, they are unavailable for the microorganisms.

Impacts	Under anaerobic conditions, contaminants may be degraded to a product that is more hazardous than the original contaminant. Nitrate injection to groundwater is of concern because nitrate is a regulated compound. Bio-augmentation using non-native micro-organisms is also controversial. The circulation of water-based solutions through the soil may increase contaminant mobility and necessitate treatment of underlying groundwater.
Legal constraints	Refer to those applying to the management of polluted soils in situ. Special authorisation should be delivered for such work.
Efficiency	Bioremediation is a long term process (months to year(s)). Bioremediation degrades aromatics, N-alkanes and iso-alkanes. Resins and Asphaltenes are usually resistant to bioremediation. Cyclic hydrocarbons (Saturated and Aromatics) are partially biodegraded. The efficiency of biodegradation can be 99% when correctly implemented on biodegradable material.
Cost	Limited, less than 30 Euros / m3 (Source: KOLLER), 15 to 75 Euros/ ton (Source: Bocard) Related to the manpower, equipment for the spreading and purchase of stimulating agent.
BIOREMEDIATION TREATMENT	**Bioremediation: land farming**
Description	Contaminated soils are mixed with soil bulking agents and nutrients, and then they are tilled into the earth. The oily debris should be evenly spread over the scarified land surface in a layer 2-10cm thick. Contaminants are degraded, transformed, and immobilized by microbiological processes and by oxidation.
Waste	Pastes and solids lightly oiled.
Situation / Potential in the country	May be very easily implemented.
Interest	Allows biodegradation of oily waste with little equipment (requires large area of land away from ground water and human settlements).
Entry criteria	Oil with a high asphaltene and resin content degrades slowly due to the recalcitrance of the hydrocarbons. Oil with a high aliphatic and aromatic content is a much more nutrient-dependent process and will degrade more rapidly within an adequate environment. It is recommended to carry out a GC/ MS analysis to define the composition of the oil and evaluate its biodegradability. Lightly oiled sediment (sand, gravel, soil, mud), less than 1 to 2% of oil. Land farming is best suited for debris comprised of small particles such as oiled soils, and should not be attempted for waste comprised of particles larger then 15cm to avoid handling difficulties and problems with mixing of the waste.
Operational constraints	Requires large area of land in a suitable environment: land farming is best suited to warm climates with moderate precipitation and evaporation. The degradation process may stop when temperatures fall below freezing. Regular tilling is necessary for aeration. Sufficient moisture is required in the oil/soil mixture to support microbial activity, which is usually naturally available except in very dry areas. Areas should be located where water bodies and other supplies of potable water are not at risk from the possible release of contaminants. Slope of area should be less than 4% (or else plan for run-off water management). Soil permeability should be low to avoid percolation of leachates into the ground water. Slope should also be low to avoid running. Additions of nitrogen (as ammonium nitrate) and soluble phosphorous (eg superphosphate) are necessary for the degradation of oily wastes at optimum rates. Environmental monitoring is necessary (soil and ground water analysis).
Impacts	Main risk is the contamination of the ground water by percolation of contaminants and running surface water carrying the contaminant away from the land farming area.
Legal constraints	Refer to limits of contaminants that can be spread on land (e.g. regulations related to land farming of mud from sewage water treatment plants).

	May require EIA or legal authorisation.
Efficiency	Land farming degrades oil into carbon dioxide gas, water and residue within 2 years or less. Bioremediation is a long term process (months to years). Bioremediation degrades aromatics, N-alkanes and iso-alkanes. Resins and Asphaltenes are usually resistant to bioremediation. Cyclic hydrocarbon (Saturated and Aromatics) are partially biodegraded.
Cost	Cost of the equipment is limited (earth moving equipment). However, land farming requires large areas of land (to rent or purchase for years). OPEX: • 5 to 50 Euros / m^3 for “natural” treatment (without nutriments and/ or enzymes) and without any treatment of leachate. • 20 to 150 Euros / m^3 for treatment with nutriments or enzymes and without any treatment of leachate (Source: UNDP).
BIOREMEDIATION TREATMENT	**Bio-treatment: composting**
Description	Composting is the biological conversion of organic waste solids into stable, humic material (which contributes to the soil structure as well as its nutritional status). Composting is achieved by mixing with bulking agents and organic amendments, spreading the oily waste in windrow (or other shapes), regular tilling for oxygenation and addition of nutrients. There are three major designs used in composting. • aerobic static pile/ compost is formed into piles and aerated with blowers or vacuum pumps, • use of a vessel similar to a bio-reactor, where the compost is mechanically agitated and aerated, • windrow composting, usually considered the most cost-effective composting alternative.
Waste	Lightly oiled seaweed and vegetation (i.e. biodegradable material), sand may be present
Situation / Potential in the country	May be very easily implemented.
Interest	• Recovery of natural resource (sand) • Low cost • Larger quantity will result in economy of scale
Entry criteria	Oil with a high asphaltene and resin content degrades slowly due to the recalcitrance of the hydrocarbons. Oil with a high aliphatic and aromatic content is a much more nutrient-dependent process and will degrade more rapidly within an adequate environment. It is recommended to carry out a GC/ MS analysis to define the composition of the oil and evaluate its biodegradability. Usable only for oiled vegetal that are lightly to medium polluted, and should not contain cobble or boulder.
Operational constraints	Requires personnel, expertise, earth moving equipment, nutrients and large area of ground, particularly for in-situ treatment options. The site must meet hydro-geological and physical requirements. Selection criteria include the following items: • no oil is recovered; • requires a lot of testing, monitoring, foundation and mechanical work; • requires large surface area; • dispersed quantity of contaminated soil increases the cost.
Impacts	Minimal if suited monitoring and containment program is implemented. But possible increase of VOC (Volatile Organic Compound) emissions. Windrow composting has a high dust emission.
Legal constraints	Refer to waste and oily water / soil legislation.

Efficiency	Composting is faster than enhanced bioremediation on site: process lasts less than one year (may be 3 to 6 months depending on the degree of pollution of the waste). Bioremediation degrades aromatics, N-alkanes and iso-alkanes. Resins and Asphaltenes are usually resistant to bioremediation. Cyclic hydrocarbon (Saturated and Aromatics) are partially biodegraded.
Cost	Costs comparable to land farming (usually less than 50 Euros per ton). However, composting does not require large areas of land and compost can be sold at 15 to 23 Euros per ton (Source: Damien).
BIOREMEDIATION TREATMENT	**Bioremediation: Biopile**
Description	A bio-pile is a bioremediation technology in which excavated soils are mixed with soil amendments, formed into compost piles, and enclosed for treatment. The basic bio-pile system includes a treatment bed, an aeration system, an irrigation/nutrient system and a leachate collection system. Note. Systems known as Bio-Reactors are usually used to treat sewage water. They can also treat oily water, and testing is on-going to treat polluted soils with this technique. Contaminated groundwater is circulated in an aeration basin where microbes degrade organic matter, forming a sludge that is disposed of or recycled.
Waste	Oily water. Light to Medium polluted sediment (up to 5% of oil, more depending on installation)
Situation/potential in the country	Technically easy to implement if land is available on long term basis (few years).
Interest	Biopile is a more controlled and efficient treatment than composting, allowing treatment of more oiled sediment and waste. The material may be returned on site once the treatment is completed.
Entry criteria	Oil with a high asphaltene and resin content degrades slowly due to the recalcitrance of the hydrocarbons. Oil with a high aliphatic and aromatic content is a much more nutrient-dependent process and will degrade more rapidly within an adequate environment. It is recommended to carry out a GC/ MS analysis to define the composition of the oil and evaluate its biodegradability. Treatability testing should be conducted to determine the biodegradability of contaminants and appropriate oxygenation and nutrient loading rates. Laboratory or field treatability studies are needed to identify the best amendments.
Operational constraints	The site of implementation of the biopile depends on the land availability in the area and on the volume of waste to treat (cost of transport). Testing (in laboratory and on limited quantities) is necessary. Continuous contaminant and environmental monitoring program is necessary (moisture, heat, nutrients, oxygen, and pH).
Impacts	Biogas and leachate must be managed adequately. The treatment area is generally covered or contained with an impermeable liner to minimize the risk of contaminants leaching into an uncontaminated soil.
Legal constraints	Refer to waste and oily water / soil legislation.
Efficiency	Bioremediation is a long term process, although speed is increased in biopile, degradation of resistant oil compound may still take more than 2 years. Bioremediation degrades aromatics, N-alkanes and iso-alkanes. Resins and Asphaltenes are usually resistant to bioremediation. Cyclic hydrocarbon (Saturated and Aromatics) are partially biodegraded.
Cost	Varies depending on the volumes to be treated. Ranges from 60 to 200 Euros per tons of waste to treat (if there is less than 100 tons) to 50 to 100 Euros per ton (for 1,000 tons or more of waste) including the analysis.

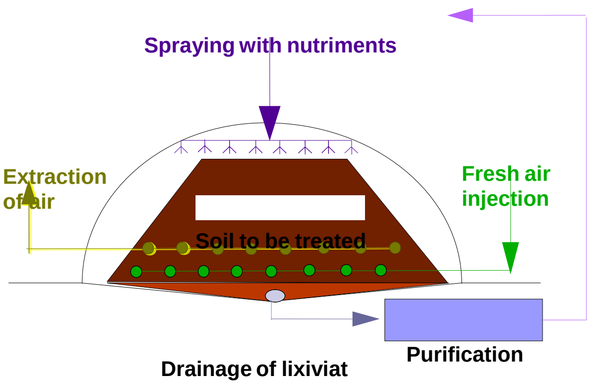
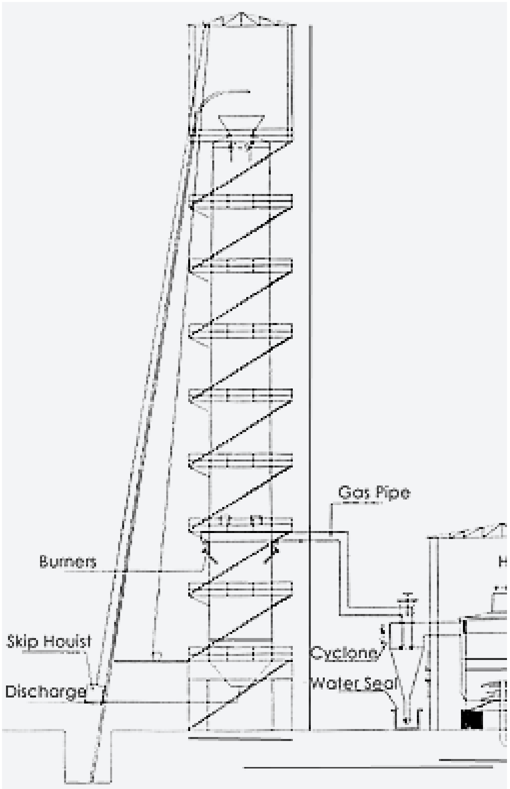


Figure 0-1 : Conceptual model of a Biopile (lixiviat is French for leachate)

THERMAL TREATMENT	**Incineration in domestic waste incinerators**
Description	Incineration of the waste in incinerators used for domestic waste.
Waste	Liquid Pastes and solid Lightly Polluted sorbent Lightly Polluted solid waste
Situation / Potential in the country	Some domestic waste incinerators may be technically suited to receive oily waste.
Interest	• Permanent waste elimination. • Could achieve up to 99% volume reduction. • Operated at very high temperature (at 1,200°C), the process is suitable for the destruction of many hazardous air pollutants.
Entry criteria	The list of types of domestic waste that can be treated in the plant is often defined by national regulations. This list may be temporarily and exceptionally enlarged to accept oil spill waste. Domestic incinerators can manage lightly to medium oiled waste, but may not be able to handle heavily oiled waste (which may cause thermal imbalance of the incinerator unless diluted sufficiently with the "normal waste".
Operational constraints	Domestic waste incinerator are generally not the best suited incinerators since chlorides from sea water leads to corrosion. The oily waste may have to be diluted with the "normal" waste, thus decreasing the treatment rate. Requires personnel, site, incinerator and waste handling equipment. • Treatment rate is limited (oily waste must be diluted with other type of waste). • No energy is recovered. • Air pollution control devices might not be suitable. • Salt in recovered oil could increase corrosion in system.
Impacts	Incinerators may release carcinogenic and toxic chemicals, including heavy metals, partially-burned organic material such as polyvinyl chloride (PVC), and other organic chemicals, including polycyclic aromatic hydrocarbons (PAHs), dioxins and furans. The concentration of the release depends on the type of waste, of incinerator and of filter installed on the chimney.
Legal constraints	Refer to incineration and atmospheric releases legislation. Special authorisation may be required for such work.
Efficiency	Relies on the type of incinerator and gas treatment.
Cost	For the construction of a domestic incinerator:

	CAPEX: high investment cost, OPEX : 100 to 400 Euros / m3 (Source: KOLLER), depends on the size and personnel of the installation, and on pre-treatment required.
THERMAL TREATMENT	**Incineration in industrial incinerator or other type of furnace / kiln or power plant**
Description	Incineration of the waste in specialized incinerators used for hazardous waste / industrial waste.
Waste	Any type of waste but mainly used for: Liquid Pastes and solid Polluted solid waste
Situation / Potential in the country	Installation that may incinerate oil spill waste: • Industrial incinerator (850° to 1,100°C) • Power plant • Lime kiln (operates at 950° to 1050° C) • Glass industry • Smelting industry
Interest	• Permanent waste elimination. • Could achieve up to 99% volume reduction. • Operated at very high temperature (at 1,200°C), the process is suitable for the destruction of many hazardous air pollutants. • Able to handle waste with hazardous substances (Cl, S, heavy metals, PAH, PCB…).
Entry criteria	Industrial incinerator can accept a wide variety of waste, even over 30% oil content. Entry criteria depends on the gas and fume treatment capability of the plant. Power plant can accept solid waste (when operating with grill incinerator or fluidized beds). Power plants with fuel burner/ gas burner can accept liquid waste and solid waste (if it is finely shredded). Other kilns have more restrictive entry criteria, e.g. for lime kilns in France: • Size of particle < 10 mm, • Calorific value > 2500 kcal/Kg, • Water content < 30%, • Sulphur < 1%, • Total halogens (Cl, Br, F, I) < 1%, • PCB < 100 mg/Kg, and PCT < 100 mg/Kg. The oily waste will be added to the incinerator feed in a proportion depending on the composition of the oily waste.
Operational constraints	Requires personnel, site, incinerator and waste handling equipment. • No energy is recovered. • Air pollution control devices must be suited to monitor the incineration of large quantities of petroleum product. • Salt in recovered oil could increase corrosion in system. • If the facility does not exist, this type of project needs a long period to be implemented.
Impacts	Incineration (e.g. in power plants) result in the production of ashes and co-products that must be disposed of correctly. Incinerators may release carcinogenic and toxic chemicals, including heavy metals, partially-burned organic material such as polyvinyl chloride (PVC), and other organic chemicals, including polycyclic aromatic hydrocarbons (PAHs), dioxins and furans. The concentration of the release depends on the type of waste, of incinerator and of filter installed on the chimney.
Legal constraints	Refer to incineration and atmospheric releases legislation. Special authorisation may be required for such work.
Efficiency	Relies on the type of incinerator and gas treatment.

Cost	CAPEX : Very high investment cost. OPEX : 100 to 400 Euros / m3 (Source: KOLLER).
	 **Figure 0-2 : Lime kiln**
THERMAL TREATMENT	**<u>Co</u>-Incineration as fuel source (in cement works, lime kiln, power plant or other kiln)**
Description	Incineration of the liquid oil recovered as fuel source in cement works (and/ or industrial furnaces) Note. Co-incineration is the incineration of waste in industrial incinerators, kilns, furnaces as an alternative or complementary fuel source and/ or as material source.
Waste	Liquid Pasty waste Depending on installation: solid waste
Situation / Potential in the country	Some cement facilities have special adaptations to receive OSW as fuel.
Interest	Liquid : • Recovery and re-use of oil as valuable energy source • Cost recovery option
Entry criteria	Waste has to meet stringent technical specifications: • heavy metals, mercury, MgO and zinc (e.g. less than 1%), • chlorine (e.g. less than 2%), • sulphur (e.g. less than 4%), etc. • (Possible reference to the Stockholm convention). The kiln operator will evaluate the calorific value of the waste, minimum of 2,500 to 3,000 kcal/ kg is required. Additional monitoring requirements will be required by the kiln operators regarding sulphate, alkalinity, and solid residue content.

	➔ Some cement kilns have restrictive criteria: • no sand, • dry residue: 2% maximum, at 90 microns maximum, • no (or very little) chlorine), • plastic is possible but no PVC or chlorine. Pre-treatment is often needed.
Operational constraints	Waste must be homogeneous and of a controlled and quantified calorific value. Requires personnel, site, incinerator and waste handling equipment. • salt in recovered oil could increase corrosion in system; • depends on the installations (i.e. burners and injectors); • content in chlorine and sulphate must be limited; • requires **pre-treatment** (processing and screening) which is labour intensive; • quality of oil recovered could be a limiting factor.
Impacts	Incinerators may release carcinogenic and toxic chemicals, including heavy metals, partially-burned organic material such as polyvinyl chloride (PVC), and other organic chemicals, including polycyclic aromatic hydrocarbons (PAHs), dioxins and furans. The concentration of the release depends on the type of waste, of incinerator and of filter installed on the chimney.
Legal constraints	Refer to incineration and atmospheric releases legislation. Special authorisation may be required for such work.
Efficiency	Depends on the substitution rate : from 1 to 1.5 tons/ day
Cost	CAPEX: use of already existing installation, may require adaptation to handle oil spill waste. OPEX : Estimated to 30 to 50 Euros/ ton but may be free, depending on the quality of the recovered oil and on the additional cost for waste pre-processing in the plant (demulsifying, screening for absence of heterogeneous elements etc.)
THERMAL TREATMENT	**Co-Incineration as Raw alternative material (in cement works or other)**
Description	Incineration of polluted sand and solid waste in cement works as Alternative Raw material (Sand is a natural raw material consumed in cement production). Note. Co-incineration is the incineration of waste in industrial incinerators, kilns, furnaces as an alternative or complementary fuel source and/ or as material source.
Waste	Polluted sand Polluted solid waste
Situation / Potential in the country	Some cement facilities have special adaptations to use OSW (sands, muds solid waste) as raw material.
Interest	• Contaminated solid waste (woods, plastic, and other macro-waste) could be processed in kiln as Alternative Fuel and Raw material. • Final elimination of contaminated sand and of most solid waste material. Previous successful experience in Holcim France for treatment of waste generated from Erika spill (Source: Holcim Europe direct communication).
Entry criteria	➔ Depending on each facility: • Sand may be processed; • No pebbles are allowed in the system; • Plastic is possible but no/ very little PVC or chlorine. The kiln operator must maintain an overall waste composition comprising: • SiO_2 : 21 to 24%, • Al_2O_3 : 4.5 to 6%, • Fe_2O_3 : 3 to 4%, • CaO : 64 to 66%.

Operational constraints	The content of oil in the waste must be limited to avoid energetic imbalance of the kiln (e.g. waste must have less than 0.5% THC in France) Requires personnel, site, incinerator and waste handling equipment. • salt in recovered oil could increase corrosion in system; • should be free of mercury, zinc, MgO and ferrous metals as it effects kiln operation; • potential change in emission characteristics due to waste characteristics; • requires **pre-processing** which is labour intensive.
Impacts	Loss of natural sand resources. Incinerators may release carcinogenic and toxic chemicals, including heavy metals, partially-burned organic material such as polyvinyl chloride (PVC), and other organic chemicals, including polycyclic aromatic hydrocarbons (PAHs), dioxins and furans. The concentration of the release depends on the type of waste, of incinerator and of filter installed on the chimney.
Legal constraints	Refer to incineration and atmospheric releases legislation. Special authorisation may be required for such work.
Efficiency	Depends on the substitution rate : from 1 to 5 tons/ day
Cost	OPEX: from 30 to 150 Euros / ton according to waste condition. Mostly no additional cost if lightly contaminated soil with oil and solid waste (Source: Holcim Europe direct communication)
THERMAL TREATMENT	**Thermal Desorption** (Low Temperature Thermal Desorption LTTD)
Description	Thermal desorption separates contaminants from soil. Soil is heated in a chamber in which water, organic contaminants and certain metals are vaporized. A gas or vacuum system transports vaporized water and contaminants to an off-gas treatment system (the design of a system aims to volatize contaminants, while attempting not to oxidize them; otherwise, thermal desorption would be another way of saying incineration). It is important to note that thermal desorption does not destroy organic compounds. Based on the operating temperature, this process is categorized into two groups. In **Low Temperature Thermal Desorption (LTTD),** wastes are heated to between 90° and 320°C. LTTD is most often used for remediating fuels in soil. Unless heated to the higher end of the LTTD temperature range, organic components in the soil are not damaged, which enables treated soil to retain the ability to support future biological activity. In **High Temperature Thermal Desorption (HTTD),** wastes are heated to 320° to 560 °C. HTTD is not used for oil/ fuel contaminated soil treatment.
Waste	Polluted soil, sand and often small pebble (e.g. no larger than 5cm)
Situation / Potential in the country	Equipment can be imported and installed.
Interest	• Very effective in reducing concentrations of petroleum products including gasoline, jet fuels, kerosene, diesel fuel, heating oils, and lubricating oils.
Entry criteria	• Applicable to constituents that are volatile at operating temperatures.
Operational constraints	Requires personnel and expertise to operate, site, waste transport and handling equipment. • Treatment of the off-gas must remove particulates and contaminants. • Dewatering may be necessary to achieve acceptable soil moisture content levels. • Technique developed for soil remediation (not accidental pollution treatment), applicability for OSW depends on the characteristics and on the hydrocarbon content of the waste. • THC concentration should be maximum 3% (except for systems operating in an inert atmosphere e.g. thermal screw). System is not suited for high concentrations of oil in waste (e.g. 20 to 30%). • Due to the low temperature used, it is probable that weathered oil generally recovered on beach will not be treatable as it would require higher temperatures to evaporate.

Impacts	Minimal, if the vaporized hydrocarbons are correctly treated in a secondary treatment unit: afterburner, catalytic oxidation chamber (which destroys the organic constituents), condenser, or carbon adsorption unit (which trap organic compounds for subsequent treatment or disposal) prior to discharge to the atmosphere.
Legal constraints	Refer to incineration and atmospheric releases legislation. Special authorisation may be required for such work.
Efficiency	• Rapid treatment time; most commercial systems capable of over 25 tons/ hr throughput. Thermal screw: up to 15 tons/ hr. • Can consistently reduce THC to below 10 ppm and BTEX below 100 ppb (and sometimes lower).
Cost	Total cost of treatment for one m3 ranges from 40 to 200 Euros / ton (Source: Bocard) Typical cost for oily waste treatment is approx. 150 Euros (Source: Cedre)
THERMAL TREATMENT	**Incineration in mobile incinerators**
Description	Incineration of the waste in mobile incinerators.
Waste	Liquid Pastes Oiled seaweed and vegetation Solid waste
Situation / Potential in the country	May be easily implemented in any country.
Interest	Complete incineration of the waste.
Entry criteria	Some plastic and metal wastes may cause problems (e.g. sorbent, gloves, complex plastics etc.). Sand, gravel and stones will not be incinerated.
Operational constraints	
Impacts	Incinerators may release carcinogenic and toxic chemicals, including heavy metals, partially-burned organic material such as polyvinyl chloride (PVC), and other organic chemicals, including polycyclic aromatic hydrocarbons (PAHs), dioxins and furans. The concentration of the release depends on the type of waste, of incinerator and the filter installed on the chimney.
Legal constraints	Refer to incineration and atmospheric releases legislation. Special authorisation may be required for such work.
Efficiency	Modern incinerators are efficient and allow treating on site the gas.
Cost	Highly variable depending on the size, capabilities and emission treatment capabilities of the incinerator.
THERMAL TREATMENT	**Burning of lightly oiled vegetation (open air)**
Description	Burning on site of vegetation (i.e. wood) lightly oiled.
Waste	Lightly oiled plant derived waste
Situation / Potential in the country	
Interest	Permanent elimination of oiled plant derived waste.
Entry criteria	Vegetation must be lightly oiled to avoid atmospheric releases of burnt HC.
Operational constraints	Requires adequate site, and personnel. Burn vegetation away from any sensitive areas, houses, etc. Ensure that fire is controlled.
Impacts	Limited if only vegetation such as wood is burnt.
Legal constraints	Refer to legislation related to burning of vegetation and atmospheric releases (open air burning of waste is often prohibited, but may be tolerated in emergency cases, for remote

	locations or islands for example). Specific authorisation may be delivered.
Efficiency	Allow reducing the volume of vegetation and wood by 80 to 90%. Ashes may be dispersed in fields.
Cost	CAPEX: none required. OPEX: limited to the operators.
THERMAL TREATMENT	**Evapo-incineration**
Description	This technique combines incineration and physicochemical treatment. It involves thermal cracking, during which the aqueous phase of the oil-water mixture vaporises: • Water evaporates (water in the vapour phase is treated by high temperatures in order to remove the residual organic phase). • An oily condensate forms that can easily be incinerated.
Waste	Liquid waste (Oily water, oil with water)
Situation / Potential in the country	May be implemented in any country.
Interest	Complete elimination of the waste.
Entry criteria	Can manage solid waste and sediment.
Operational constraints	Depends on the type of machine used.
Impacts	Minimal when processes are well managed and monitored regularly.
Legal constraints	Refer to incineration and atmospheric releases legislation. Special authorisation may be required for such work.
Efficiency	High with latest installation.
Cost	CAPEX: very high if no existing installation. OPEX: to define depending on installation.
THERMAL TREATMENT	**Pyrolysis**
Description	Pyrolysis is a form of incineration that chemically decomposes organic materials in the absence of oxygen. Pyrolysis typically occurs under pressure and at operating temperatures above 430 °C (as opposed to incineration and co-incineration which occur under aerobic conditions). Several types of pyrolysis units are available, including rotary kiln, rotary hearth furnace, and fluidized bed types.
Waste	Pastes and solid Polluted sand
Situation / Potential in the country	There are few installations available (recent technology).
Interest	Organic materials are transformed into gases, small quantities of liquid, and a solid residue containing carbon and ash. These co-products can be re-used (as energy or material).
Entry criteria	The technology requires drying of the soil prior to treatment. Particulate removal equipment is also required.
Operational constraints	Depends on the type of equipment used.
Impacts	Pyrolysis results in the production of solid residues (char), liquid residue (oil/ water) and gases that must be disposed of adequately. Incinerators may release carcinogenic and toxic chemicals, including heavy metals, partially-burned organic material such as polyvinyl chloride (PVC), and other organic chemicals, including polycyclic aromatic hydrocarbons (PAHs), dioxins and furans. The concentration of the release depends on the type of waste, of incinerator and the filter installed on the chimney.
Legal constraints	Refer to incineration and atmospheric releases legislation. Special authorisation may be required for such work.

Efficiency	Pyrolysis is still a recent technology.
Cost	CAPEX: very high if no existing installation. OPEX: to define depending on installation. 75 to 300 Euros / m3 (Source: Koller)

FINAL DISPOSAL	**Re-use of oil in refinery**
Description	Re-use of oil in refinery.
Waste	Oil (recovered and treated)
Situation / Potential in the country	Depends on the capabilities of the refineries in country.
Interest	Re-use of the oil as fuel.
Entry criteria	Oil must be compliant with the specific criteria of the refinery.
Operational constraints	Requires personnel, transport equipment and oil handling/ transfer equipment.
Impacts	None additional to those of the refinery.
Legal constraints	Depends on local regulations for refining oil.
Efficiency	Complete.
Cost	CAPEX: use of existing refineries. OPEX: limited to the handling of the oil and integration into oil production circuit of the refinery.
FINAL DISPOSAL	**Return of clean sediment on site**
Description	Return on the beaches of sediments (sand and pebbles) to limit erosion.
Waste	Clean to lightly polluted sand and pebbles
Situation / Potential in the country	
Interest	• Limits coastal erosion. • Diminishes the volume of waste to dispose of.
Entry criteria	Sediment must be clean to be returned on the beaches (however, sediments will continue to be cleaned in exposed areas by the action of the waves, see “surfwashing”). There are no general rules for the return of the sediments on site. Each situation will be considered on a case by case basis by the National Authorities. Example of ERIKA oil spill in France: the threshold was set at 2,500ppm for the cleaned sediments.
Operational constraints	Requires personnel, transport equipment and earth moving equipment.
Impacts	None for clean to very lightly oiled sediments.
Legal constraints	None.
Efficiency	Complete.
Cost	CAPEX: no specific equipment required. OPEX: hire existing equipments and personnel.
FINAL DISPOSAL	**Discharge in natural environment**
Description	Discharge of water following decantation of washing effluents from operations (washing of solid waste, high pressure cleanup of pebbles, etc.)
Waste	Recovered oil (from decantation) Treated washing effluents (from washing operations)

Situation / Potential in the country	During clean-up operations, it is usually allowable for recovered water from oil and water mixtures is discharged directly in the sea, after decantation in decantation tanks. This discharged water will have very little to insignificant impact compared to the on-going oil spill. During waste treatment, more restrictive threshold values must be in force (as time and equipment should be available to adequately treat effluent): • concentration for sea discharge • daily volume limit for sea discharge.
Interest	Avoids the treatment of lightly to very lightly polluted sea water resulting from clean-up operations.
Entry criteria	HC content of the discharged water must not exceed certain amount – to be validated by the National Authorities.
Operational constraints	Water must not be discharged close to sensitive areas. Check the HC content of the discharged water.
Impacts	None if HC content is low.
Legal constraints	Refer to legislation related to coastal water quality. Specific authorisation may be delivered.
Efficiency	Complete.
Cost	CAPEX: none. OPEX: none (related to the cleaning operations).
FINAL DISPOSAL	**Landfilling (controlled containment in specialized cells and/ or landfills)**
Description	Storage in landfills or specialized industrial waste storage or specialized cells. Oil spill debris can also be incorporated into an active landfill along with municipal refuse or industrial wastes. Co-disposal with domestic waste may also be considered. Oil can biodegrade slowly with the domestic waste and also remains absorbed by all type of domestic waste, with little tendency to leach out. "*As a general guide, oily waste should be deposited on a top of at least 4m of domestic refuse either in surface strips 0.1m thick or in silt trenches 0.5m deep to allow free drainage of water. The oily material should be covered by a layer of soil followed by a minimum of 2m of domestic waste to facilitate degradation* (...)". Source: IMO. Burial is another landfilling option. Oil spill debris is deposited into pits, trenches or other depressions prepared for debris disposal onsite. The excavated soil is used as intermediate and final cover of the debris.
Waste	Liquid Pastes and solid Polluted sand and pebbles Polluted sorbent Polluted solid waste
Situation / Potential in the country	Landfills are present in all countries. However, only controlled landfills must be considered.
Interest	**In landfills:** • May be suitable for disposal of lightly oiled waste, which is usually mixed with domestic at a 1 to 5 % ratio, to allow biodegradation of the oil. • Most cost effective solution. **In specialized OSW cells** (industrial landfill) • Depends on the type of storage that could be implemented.
Entry criteria	**In landfills:** • Landfills usually have strict and precise entry criteria. They can be adapted by the authorities: e.g. waste with less than 5% oil contamination. • Restriction on acceptance of oil solid waste types.

	In specialized OSW cells. • Depends on the type of storage and national regulation.
Operational constraints	Requires personnel, specific site, transport equipment, weather-proof containers and cover layer, etc.: • subject to stringent long term monitoring; • will not permanently eliminate the waste; • medium-long period for implementation; • potential higher cost for land filling of oil waste compared to normal domestic waste disposal cost.
Impacts	Leachate and biogas must be managed adequately. Limited if safe storage is implemented with a monitoring program (to avoid potential release of toxic compounds). However, landfills <u>do not lessen the toxicity, mobility or volume of waste</u>: they only control migration.
Legal constraints	Requires agreement of the National Authorities.
Efficiency	Complete if safe storage is used.
Cost	In controlled landfills: 75 to 270 Euros / m3 (for French installation, Source: Koller), 100 to 300 Euros/ ton (Source: Bocard)
FINAL DISPOSAL	**Re-use as road work material**
Description	Re-use of treated material as road fill or construction material.
Waste	Stabilized material
Situation / Potential in the country	No specific requirements.
Interest	Reduces the demand on raw material needed for construction projects if non-hazardous waste can be reused.
Entry criteria	Characteristics of material output to be ascertained.
Operational constraints	Personnel, energy, consumables, place, installation, etc.
	If test reveals hazardous material, then the material cannot be re-used: • Requires pre-processing; • Cost of raw material might be cheaper than cleaning of contaminated sand.
Impacts	Mishandling could result in offsite contamination.
Legal constraints	Refer to legislation regarding the characteristics of construction/ filling material (physical, chemical, geotechnical).
Efficiency	Complete
Cost	None if waste is usable on a “as is” basis.
FINAL DISPOSAL	**De-ballasting station**
Description	Facilities where oil tankers can berth and unload their washing waters from their tanks. These waters are then treated in the deballasting station by decantation often using API separators allowing skimming of the oil in surface and recovery of the settled sediment before discharging the water.
Waste	Liquid oily water (if not too weathered or emulsified and with no waste or no sediment) Washing effluent (from washing operations)
Situation / Potential in the country	Depends on installations present in the country.
Interest	Allows treating oily wash effluent and/ or oily water in a controlled environment before discharging in the environment.
Entry criteria	Must be liquid waste.

Operational constraints	Limited capacities Recovered oil is routed to oil refineries. Water is discharged after treatment in the environment.
Impacts	Minimal when processes are well managed and monitored regularly.
Legal constraints	Refer to legislation regarding waste management.
Efficiency	High with latest installation.
Cost	CAPEX: high if no existing installation. OPEX: to define depending on installation.

Appendix D - Technology Providers

Appendix D1 - Suppliers of Technologies

Technology	Supplier/Manufacturer
Reprocessing	
Oil/water separation: Gravity	
Oil/water separation: Hydrocyclone	
Oil/water separation: Centrifuge	
Emulsion-breaking: physical	
Emulsion-breaking: chemical	
Emulsion-breaking: electrochemical	
Stabilisation/ storage: Lime	
Stabilisation/ storage: Storage	
Bioremediation:	

Technology	Supplier/Manufacturer
composting	
Bioremediation: anaerobic digestion	
Sediment Cleaning: minerals processing	
Sediment Cleaning: centrifuge	
Sediment Cleaning: hydrocyclone	
Sediment Cleaning: cavitation scrubbing	
Sediment Cleaning: jet pumps	
Thermal Treatment: Desorption	
Thermal Treatment:pyrolysis	

Technology	Supplier/Manufacturer
Thermal Treatment: gasification	
Heavy Fuel Oil Use	
Incineration: municipal	
Incineration: commercial	
Incineration: specialist	
Landfill: Hazardous	
Landfill: nonhazardous	
Landfill: inert	

Note: The website http://wastedirectory.netregs.gov.uk can be used to search for local facilities for all of the generic technology catagories.

Appendix D2 - Specialist Equipment Suppliers

Note: It is recognised that many of the cells in this table are blank. This is intended to provide guidance as to the data which may be required in future and to ensuer this is requested.

Supplier				
Generic Technology Classification				
Sub Technology Classification				
Manufacturer's product designation				
Heaviest/highe				

st viscocity oil acceptable?				
Largest Size Solid Material acceptable?				
Maximum Concentration of oil (contamination) acceptable?				
Acceptable water type based on salt content?				
Supplier Location				
Treatment rate (tons of waste per day)?				
Town/City				
Postcode				
NGR				
Permit No.				
Contact Name				
Contact Number				
Contact Email				
Website				

Brief description of Technology				

WASTE PROCESSING AND ACCEPTANCE CRITERIA				
Supplier				
Type of waste managed / treated				
Analytical facilities available?				
Percent solids?				
Percent liquids?				
Maximum solid particle size?				
Maximum oil contamination level that can be treated?				
Upper viscosity limit of oil spill waste that can be accepted?				
Facility to handle volatile materials?				

Maximum degree of water contamination (for two-phase oil/water mixtures and also water-in-oil emulsions) of recovered oil that can be accepted				
Any other restrictions on the composition of recovered oil that can be accepted (e.g. contamination by dispersants, surfactants or demulsifiers, salt, sulphur etc).				
Specify pre-treatment required (if any).				
Pre-treatment capability				
Treatment rate (tons of waste per hour/day/ month/ year)?				
Batch or continuous operation?				
Average utilisation (%)?				

LOGISTICS/OPERATIONAL REQUIREMENTS AND CONSTRAINTS				
Supplier				
By sea? Max size of vessel? Daily reception capacity?				
By road? Max size of vehicle? Daily reception capacity?				
By train? Daily reception capacity?				
By inland waterway? Daily reception capacity?				
Storage capacity (total, typically available)?				
Energy, water and other input required (nature and typical quantity required per ton treated)				
Other constraint?				

POTENTIAL ENVIRONMENTAL IMPACTS				
Supplier				
Noise				
Atmospheric releases (after on site treatment)?				
Solid waste (hazardous)?				
Leachate or liquid effluents produced (after on site treatment)? Discharge consent in place?				
Highways/ transport?	n/a			
Others				

MATERIALS PRODUCED AFTER TREATMENT				
Supplier				
OIL				
Nature of material produced from the waste?				
Is it acceptable for general/ commercial use?				
Is there an existing outlet for product? Is this fixed in volume/ capacity terms?				
Please specify possible uses not currently being employed as outlets				
Could it be further treated to render it acceptable?				
SOLIDS				
Is it acceptable for general/ commercial use?				
Is there an existing outlet for product(s)? Please specify. Are these fixed in volume/ capacity terms?				
Please specify possible uses not currently being employed as outlets				
Could it be further treated to render it acceptable?				
Could it be landfilled with no further treatment?				

LEGAL CONSTRAINTS				
Supplier				
Is facility currently permitted? If yes, please provide details.				
If no, what is the basis of operational regulation?				

COST				
Supplier				
Cost per tonne treated				
Cost per tonne stored (if required)				

Supplier				
Generic Technology Classification				
Sub Technology Classification				
Manufacturer's product designation				
Heaviest/highest viscocity oil acceptable?				
Largest Size Solid Material acceptable?				
Maximum Concentration of oil (contamination) acceptable?				
Acceptable water type based on salt content?				
Supplier Location				
Treatment rate (tons of waste per day)?				
Town/City				
Postcode				
NGR				
Permit No.				
Contact Name				

Contact Number				
Contact Email				
Website				
Brief description of Technology				

WASTE PROCESSING AND ACCEPTANCE CRITERIA				
Supplier				
Type of waste managed / treated				
Analytical facilities available?				
Percent solids?				
Percent liquids?				
Maximum solid particle size?				
Maximum oil contamination level that can be treated?				
Upper viscosity limit of oil spill waste that can be accepted?				
Facility to handle volatile materials?				
Maximum degree of water contamination (for two-phase oil/water mixtures and also water-in-oil emulsions) of recovered oil that can be accepted				

Any other restrictions on the composition of recovered oil that can be accepted (e.g. contamination by dispersants, surfactants or demulsifiers, salt, sulphur etc).				
Specify pre-treatment required (if any).				
Pre-treatment capability				
Treatment rate (tons of waste per hour/day/ month/ year)?				
Batch or continuous operation?				
Average utilisation (%)?				

LOGISTICS/OPERATIONAL REQUIREMENTS AND CONSTRAINTS				
Supplier				
By sea? Max size of vessel? Daily reception capacity?				
By road? Max size of vehicle? Daily reception capacity?				
By train? Daily reception capacity?				
By inland waterway? Daily reception capacity?				
Storage capacity (total, typically available)?				
Energy, water and other input required (nature and typical quantity required per ton treated)				
Other constraint?				

POTENTIAL ENVIRONMENTAL IMPACTS				
Supplier				
Noise				
Atmospheric releases (after on site treatment)?				
Solid waste (hazardous)?				
Leachate or liquid effluents produced (after on site treatment)? Discharge consent in place?				
Highways/ transport?				
Others				

MATERIALS PRODUCED AFTER TREATMENT				
Supplier				
OIL				
Nature of material produced from the waste?				
Is it acceptable for general/ commercial use?				
Is there an existing outlet for product? Is this fixed in volume/ capacity terms?				
Please specify possible uses not currently being employed as outlets				
Could it be further treated to render it acceptable?				
SOLIDS				
Is it acceptable for general/ commercial use?				
Is there an existing outlet for product(s)? Please specify. Are these fixed in volume/ capacity terms?				
Please specify possible uses not currently being employed as outlets				
Could it be further treated to render it acceptable?				
Could it be landfilled with no further treatment?				

LEGAL CONSTRAINTS				
Supplier				
Is facility currently permitted? If yes, please provide details.				
If no, what is the basis of operational regulation?				

COST				
Supplier				
Cost per tonne treated				
Cost per tonne stored (if required)				

Supplier				
Generic Technology Classification				
Sub Technology Classification				
Manufacturer's product designation				
Heaviest/highest viscocity oil acceptable?				
Largest Size Solid Material acceptable?				
Maximum Concentration of oil (contamination) acceptable?				
Acceptable water type based on salt content?				
Supplier Location				
Treatment rate (tons of waste per day)?				
Town/City				
Postcode				
NGR				
Permit No.				
Contact Name				

Contact Number				
Contact Email				
Website				
Brief description of Technology				

WASTE PROCESSING AND ACCEPTANCE CRITERIA				
Supplier				
Type of waste managed / treated				
Analytical facilities available?				
Percent solids?				
Percent liquids?				
Maximum solid particle size?				
Maximum oil contamination level that can be treated?				
Upper viscosity limit of oil spill waste that can be accepted?				
Facility to handle volatile materials?				

Maximum degree of water contamination (for two-phase oil/water mixtures and also water-in-oil emulsions) of recovered oil that can be accepted				
Any other restrictions on the composition of recovered oil that can be accepted (e.g. contamination by dispersants, surfactants or demulsifiers, salt, sulphur etc).				
Specify pre-treatment required (if any).				
Pre-treatment capability				
Treatment rate (tons of waste per hour/day/ month/ year)?				
Batch or continuous operation?				
Average utilisation (%)?				

LOGISTICS/OPERATIONAL REQUIREMENTS AND CONSTRAINTS				
Supplier				
By sea? Max size of vessel? Daily reception capacity?				
By road? Max size of vehicle? Daily reception capacity?				
By train? Daily reception capacity?				
By inland waterway? Daily reception capacity?				
Storage capacity (total, typically available)?				
Energy, water and other input required (nature and typical quantity required per ton treated)				
Other constraint?				

POTENTIAL ENVIRONMENTAL IMPACTS				
Supplier				
Noise				
Atmospheric releases (after on site treatment)?				
Solid waste (hazardous)?				
Leachate or liquid effluents produced (after on site treatment)? Discharge consent in place?				
Highways/ transport?				
Others				

MATERIALS PRODUCED AFTER TREATMENT				
Supplier				
OIL				
Nature of material produced from the waste?				
Is it acceptable for general/ commercial use?				
Is there an existing outlet for product? Is this fixed in volume/ capacity terms?				
Please specify possible uses not currently being employed as outlets				
Could it be further treated to render it acceptable?				
SOLIDS				
Is it acceptable for general/ commercial use?				
Is there an existing outlet for product(s)? Please specify. Are these fixed in volume/ capacity terms?				
Please specify possible uses not currently being employed as outlets				
Could it be further treated to render it acceptable?				
Could it be landfilled with no further treatment?				

LEGAL CONSTRAINTS				
Supplier				
Is facility currently permitted? If yes, please provide details.				
If no, what is the basis of operational regulation?				

COST				
Supplier				
Cost per tonne treated				
Cost per tonne stored (if required)				

Supplier				
Generic Technology Classification				
Sub Technology Classification				
Manufacturer's product designation				
Heaviest/highest viscocity oil acceptable?				
Largest Size Solid Material acceptable?				
Maximum Concentration of oil (contamination) acceptable?				
Acceptable water type based on salt content?				
Supplier Location				
Treatment rate (tons of waste per day)?				
Town/City				
Postcode				
NGR				
Permit No.				
Contact Name				

Contact Number				
Contact Email				
Website				
Brief description of Technology				

WASTE PROCESSING AND ACCEPTANCE CRITERIA				
Supplier				
Type of waste managed / treated				
Analytical facilities available?				
Percent solids?				
Percent liquids?				
Maximum solid particle size?				
Maximum oil contamination level that can be treated?				
Upper viscosity limit of oil spill waste that can be accepted?				
Facility to handle volatile materials?				
Maximum degree of water contamination (for two-phase oil/water mixtures and also water-in-oil emulsions) of recovered oil that can be accepted				

Any other restrictions on the composition of recovered oil that can be accepted (e.g. contamination by dispersants, surfactants or demulsifiers, salt, sulphur etc).				
Specify pre-treatment required (if any).				
Pre-treatment capability				
Treatment rate (tons of waste per hour/day/ month/ year)?				
Batch or continuous operation?				
Average utilisation (%)?				

LOGISTICS/OPERATIONAL REQUIREMENTS AND CONSTRAINTS				
Supplier				
By sea? Max size of vessel? Daily reception capacity?				
By road? Max size of vehicle? Daily reception capacity?				
By train? Daily reception capacity?				
By inland waterway? Daily reception capacity?				
Storage capacity (total, typically available)?				
Energy, water and other input required (nature and typical quantity required per ton treated)				
Other constraint?				

POTENTIAL ENVIRONMENTAL IMPACTS				
Supplier				
Noise				
Atmospheric releases (after on site treatment)?				
Solid waste (hazardous)?				
Leachate or liquid effluents produced (after on site treatment)? Discharge consent in place?				
Highways/ transport?				
Others				

MATERIALS PRODUCED AFTER TREATMENT				
Supplier				
OIL				
Nature of material produced from the waste?				
Is it acceptable for general/ commercial use?				
Is there an existing outlet for product? Is this fixed in volume/ capacity terms?				
Please specify possible uses not currently being employed as outlets				
Could it be further treated to render it acceptable?				
SOLIDS				
Is it acceptable for general/ commercial use?				
Is there an existing outlet for product(s)? Please specify. Are these fixed in volume/ capacity terms?				
Please specify possible uses not currently being employed as outlets				
Could it be further treated to render it acceptable?				
Could it be landfilled with no further treatment?				

LEGAL CONSTRAINTS				
Supplier				
Is facility currently permitted? If yes, please provide details.				
If no, what is the basis of operational regulation?				

COST				
Supplier				
Cost per tonne treated				
Cost per tonne stored (if required)				

Appendix E - Examples of Useful Forms

Appendix E1 - Scat Form

SHORELINE POLLUTION SURVEY AND CLEAN-UP ASSESSMENT RECORD FORM

The role of the SCAT is to be the "eyes and ears" for the shoreline response / coordination centre and Environment Group. Record, on the form below form or in a field notebook and transfer to the form below, any and all information required to recreate later the character and location of the oil. Define practical segments, based on the physical shoreline character, oiling conditions, or operational units. Be more, rather than less, detailed and do not categorise (i.e., enter the actual value of 15% for Distribution, not >3%). Patchy; enter the value 15 m for Width of Oiled Band, not >3m. Always make a sketch (or draw a map or on a map) to indicate important features and the location of the oil. − If there is no standard term or definition that fits an observed feature, then define and describe the feature. Look around and identify advantages or constraints that might help or hinder the field cleanup crew. Be as clear as you can with respect to information to be used to determine the best processing options (highlighted in green below) for the waste once it has been removed from the shore.

BASIC INFORMATION								**Document Reference**
Shoreline Segment		**Date**		**Time**		**To**		
Surveyor Name		**Organisation**		**Tel No**				
Surveyor Signature				**SRC/LA Briefing:**		**Yes/No**		
Location Grid Reference		**Latitude/Longitude:**						
		State of tide:						
Weather:		**Shoreline Sensitivity**						
State of Sea:		**Shoreline access e.g. on foot only, by car etc.**						
Photographs taken:	If film used:	Roll #		Frames		To		
		Roll #		Frames		To		
If digital camera used		File name references			1			
2		3		4		5		
(indicate location & direction of the photos on a map)								

Surface Oil: (indicate areas on map and allocate identifier – definition of abbreviations below)														
	Area		**Cover/oil distribution**		**Oil Thickness**		**Oil Characteristics**	**Estimated percentage of area necessitating manual removal of waste**	**Estimated percentage of free oil easily recovered**	**Oil Type**	**Tidal Zone**	**Slope**	**Substrate/ shoreline**
	Length (m)	Width (m)	Range	Est (%)	Range	Est (cm)							
A													
B													
C													
D													
E													

Sub-surface Oil: (indicate areas on map and allocate identifier – definition of abbreviations below)

Pit	**Tidal Zone**	**Oiled Zone Depth**			**Contaminated Material Characteristics**	**% Void Filled**	**Depth of Water Table (cm)**	**Sheen Colour**	**Substrate**
		Pit Depth (cm)	**Top**	**Bottom**					
1									
2									
3									
4									
5									
6									

Is the oil likely to remobilise:		If Yes	Sheen/Bulk (indicate on map)
Is there any floating oil:		If Yes	Sheen/Bulk (indicate on map)
Will next tide movement move oil?	out to sea/on to the shore/unknown		

Samples					
Samples taken:		(indicate sampling position on map)			
Type of sample e.g. water, emulsion, sand, shellfish etc					
Sample Code Reference 1		Time		Type	
Sample Code Reference 2		Time		Type	
Sample Code Reference 3		Time		Type	
Sample code should include site name/date/unique number					

Summary of Oil Present:

Resources/receptors impacted			
Live oiled birds (contact response centre)	If Yes give details here	Dead oiled birds	If Yes give details here
Live oiled marine mammals (contact response centre)	If Yes give details here	Dead oiled marine mammals	If Yes give details here
Mass strandings of marine species e.g. Shellfish	If Yes give details here	Boilts/Marinas	If Yes give details here
Public amenity	If Yes give details here	Water intakes	If Yes give details here
Other: (specify)			

<table>
<tr><td colspan="2">Is the Contingency Plan still appropriate?</td><td colspan="4"></td></tr>
<tr><td colspan="6">If No, outline the operational and environmental constraints for clean-up.</td></tr>
<tr><td>Operational:</td><td colspan="5"></td></tr>
<tr><td>Environmental:</td><td colspan="5"></td></tr>
<tr><td>Is clean up required?</td><td colspan="5">If Yes, indicate rationale, technique and resources required.</td></tr>
<tr><td colspan="6">Other Information - map/sketch:</td></tr>
<tr><td>Indicate position of:</td><td colspan="5"></td></tr>
<tr><td>Stranded oil</td><td>Strandline</td><td>Photo no. and Direction</td><td>Floating oil</td><td colspan="2">Sea/shore interface</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Include:</td><td colspan="5">Scale and the direction of North
Substrate types (sand, shingle, boulder, mud, seawall, pebble, hard cliff, soft cliff, rock)
Prominent features (Boulders, streams, trees, fences, paths, caves, jetties etc.)
High water and low water marks</td></tr>
</table>

Definitions - Surface Oil

Oil Thickness	PO Pooled (Oil Generally consists of fresh oil or mousse accumulations >1cm thick CV Cover (0.1cm - 1cm) CT Coat (0.01cm - 0.1cm) - Can be scratched off with fingernail on coarse sediments/bedrock ST Stain (<0.01cm thick) - cannot be scratched off easily on coarse sediments/bedrock FL Film (transparent/translucent film or sheen)				
Oil Characteristics	FR Fresh SR Surface Oil Residue (non cohesive, oiled surface sediments MS Mousse (emulsified oil and water) AP Asphalt Pavement (cohesive mixture of oil and sediments) TB Tar Balls (dia. = <0.1m) or Mousse Patties (dia. 0.1 - 1.0 m) TC Tar (weathered coat/cover of tar) DB debris. NO No Oil				
Tidal Zone	S Splash zone;	U Upper shore,	M Mid shore,	L Lower shore.	
Slope	V Vertical (>90o);	VS Very Steep (61 - 90o);	Steep (31 - 60o);	M Moderate (5-30o);	F Flat (<5º)
Substrate	Sand-mixed sediment - Beaches composed of sand or a combination of sand, granules, pebbles and cobbles. Coarse Sediment beach - A beach where the clearly dominant material is pebbles and/or cobbles. Pebbles grain size diameter 4 - 64mm & cobbles 64 - 256mm. Cobble/Boulder - A beach where the clearly dominant material is cobbles (64 - 265mm) and/or boulders (>256mm). Bedrock or Solid (includes ice) - Bedrock shorelines are impermeable outcrops of consolidated native rock. Wetland - Vegetation - A coastal zone that is covered at least once a month at high tide and which supports >15% cover of salt-tolerant plants e.g. grasses, reeds, rushes & sedges.				

Oil Type

Oiled Debris - Scattered organic or inorganic materials that have washed up onto the shore.

Snow - A shoreline composed of seasonal snow that covers the underlying substrate.

Volatile - Gasoline products - viscosity like water

Light - Diesel & light crudes - viscosity like water

Moderate - Intermediate products and medium crudes

Heavy - Residual products and heavy crudes - viscosity like molasses

Solid - Bitumen, tar, asphalt - does not pour

% Cover - visual aid

Definitions - Sub-surface Oil

Tidal Zone See definitions for surface oil

Characteristics

AP Asphalt Pavement (cohesive mixture of weathered oil & sediment below the surface)

OP Oil-filled pores (pore spaces between the sediments are completely filled)

PP Partially filled pores (pore spaces filled with oil but no visible oil flow if disturbed)

OR/C Cover (>0.1 - 1 cm) or Coat (0.01 - <0.1cm) of oil residue. (Easily removed with fingernail)

OR/S Stain (<0.01 cm). (Can not be easily removed by fingernail)

TR Trace. (Discontinuous film of oil on sediments or an odour/tackiness without visible oil)

NO No Oil.

Sheen S Silver sheen, R Rainbow sheen, B Brown sheen

Substrate See definitions for surface

Appendix E2 - Oily Waste Processing Equipment Enquiry Form

Enquiry for Oily Waste Processing Equipment		
We have a requirement for equipment to treat EWC Code	INSERT DESCRIPTION OF WASTE INSERT IF KNOWN	with the following detailed characteristics:
Oil characteristics	Gasoline products – viscosity like water	
	Diesel/ light crudes – viscosity like water	
	Intermediate products and medium crudes-viscosity around twice that of water	
	Residual products and heavy crudes – viscosity like molasses	
	Bitumen, tar, asphalt – does not pour	
Solids Characteristics	N/A: Oil with no substantial water or solids content	
	N/A:Oil + Water mix (including emulsions)no substantial solids content	
	Mineral : sand (< 4mm) or a combination of sand, pebbles and cobbles.	
	Mineral: predominantly pebbles (4-64 mm) and/or cobbles (64-256 mm range)	
	Mineral: predominantly cobbles (64-256 mm) and boulders (greater than 256 mm)	
	Predominantly organic debris (Plant and animal origin)	
	Predominantly PPE/equipment	
Water characteristics	N/A: Water not present	
	Fresh	
	Brackish	
	Salt	
Degree of Contamination	Very light	
	Light	
	Moderate	
	Heavy	
	N/A: Oil with no substantial water or solids content	
Urgency of Enquiry	URGENT-please reply within 24h of receipt if you wish your tender to be considered	
	Please reply within one week of receipt if you wish your tender to be considered	
	Please reply within two weeks of receipt if you wish your tender to be considered	
Waste Quantity	<250 t	
	250 - 1000 t	
	1000 - 5000 t	
	5000 - 10000 t	
	>10000 t	

Please advise as a minimum your best availability and price for equipment, as well as technical characteristics as listed below

Temporary Plant

Rate of processing (as a function of waste characteristics if appropriate)
Physical limitations (eg max particle size, max oil content, oil viscosity etc)
Pre-treatment requirements
Residual contamination post processing
Waste streams generated
Area needed
Transport and access requirements
Enabling facilities needed
Power requirements
Water requirements as feed and waste streams
Chemicals/solvents required
Waste management considerations
Time to mobilise to full operation
Existence of Mobile Plant Permit?
Cost
Impact - noise, odour etc
Other Technical Considerations

Fixed Plant

Storage Capacity
Current Availability
Rate of processing (as a function of waste characteristics if appropriate)
Physical limitations (eg max particle size, max oil content, oil viscosity etc)
Pre-treatment requirements
Residual contamination post processing
Waste streams generated
Area needed
Transport and access requirements
Power requirements
Water requirements as feed and waste streams
Chemicals/solvents required
Waste management considerations
Cost
Impact - noise, odour etc
Other Technical Considerations

Please distinguish in your offer between fixed and mobile plant. Where both are offered, please list information separately above
Please attach technical brochures for offered equipment along with your reply.

Appendix E3 - Temporary Waste Storage Location Information Sheet 1

TEMPORARY WASTE STORAGE LOCATION INFORMATION SHEET				
The storage location information sheet is used to compile information concerning the waste which can be stored at a temporary waste storage site. The sheet should be completed in its entirety in as much detail as possible as each question provides valuable information to ensure the best form of treatment is selected for the waste.				
SITE DETAILS				
Site Name		Site Reference		
Address		Postcode		
		Grid Reference		
Site Contact		Landline		
Mobile		Email		
Site Emergency Contact		Fax		
Details of the 'catchment area' which the storage site would cover (receive waste from):				

SITE ACCESS		
Is there road access to the site e.g. for cars, lorries etc?	yes / no	If yes, what is the maximum size the road vehicle can be to gain access by road and how close is the road to the site?
Is there rail access to the site e.g. for trains, freights etc?	yes / no	If yes, what is the maximum tonnage of the rail vehicle and how close are the tracks to the site?
Is there port access to the site e.g. for boats, ships etc?	yes / no	If yes, what is the maximum size the floating vessel can be to gain access via the port and how close is the port to the site?
By inland waterway access to the site e.g. for boats, ships etc?	yes / no	If yes, what is the maximum size the floating vessel can be to gain access by inland waterway and how close is the waterway to the site?

Are there multiple Entrances?	yes / no	If yes, which should be used?

Is key fob/keypad access used?	yes / no	If yes, is there emergency access (e.g. via security guard, site contact)?
Is there a barrier and/or height restriction?	yes / no	If yes, what is the maximum height and/or width for a vehicle to access the site?
Is 24 hour access to the site required and/or permitted?	yes / no	If yes, by whom, on what basis, etc.
Can local access roads/routes be used by large vehicles, including roads between local access to the site and main trunk roads? Are there any other vehicle restrictions?		
WASTE HANDLING AT THE SITE		
What is the approximate size of the site? (m^2)		What is the maximum height at which the waste can be stored? (m)
How much could be used for storage? (m^2)		What is the maximum height at which the waste can be stored? (m)
Is there any type of waste which the site could not store?	yes / no	If yes, please provide details
Could waste stored on the site migrate off site (e.g. via wind, leaching, rainwater run-off etc.)		If yes, please provide details
If yes, what measures could be used to prevent migration of waste (e.g. bunding, fencing etc.)		If yes, please provide details
Is there a water supply on site?		If yes, please provide details

Is there a power supply on site?	If yes, please provide details

Is there space on site to allow for segregation of the waste?	If yes, please provide details
Are there any sensitive receptors (e.g. to noise, smell) nearby (e.g. housing, school)?	If yes, please provide details
Will the site be completely rehabilitated after the waste has been completely removed?	If no, please provide details and reasons
Name & Reference of nearest intermediate storage facility if known	
GENERAL INFORMATION	
What is the site normally used as/for?	
Can the normal site use/activity be stopped whilst the site is used for storage?	If yes, how long for (approx)?
	If no, how much of the site (m^3) can be used for storage whilst normal operations continue?
Describe the availability of the site to be used as a waste storage site on the following scale	
(1 - available 24-7) (2 - Available, causing no/little interference with normal site usage) (3 - Available, causing manageable disruption to site) (4 - Available, but would cause significant disruption) (5 - Available only in case of emergency)	
Is there a weighbridge?	yes / no

Appendix E4 Temporary Waste Storage Location Information Sheet 2 - Part 1

<table>
<tr><th colspan="6">TEMPORARY WASTE STORAGE LOCATION INFORMATION SHEET</th></tr>
<tr><td colspan="6">The storage location information sheet and accompanying waste classification sheet are used to compile information concerning the waste stored at a temporary waste storage site. The 2 sheets should be completed in their entirety in as much detail as possible as each question provides valuable information to ensure the best form of treatment is selected for the waste.</td></tr>
<tr><td colspan="6">SITE DETAILS</td></tr>
<tr><td>Site Name</td><td colspan="2"></td><td>Site Reference</td><td colspan="2"></td></tr>
<tr><td rowspan="2">Address</td><td colspan="2" rowspan="2"></td><td>Postcode</td><td colspan="2"></td></tr>
<tr><td>Grid Reference</td><td colspan="2"></td></tr>
<tr><td>Site Contact</td><td colspan="2"></td><td>Landline</td><td colspan="2"></td></tr>
<tr><td>Mobile</td><td colspan="2"></td><td colspan="3">Email</td></tr>
<tr><td>Site Emergency Contact</td><td></td><td>Fax</td><td colspan="3"></td></tr>
<tr><td colspan="6">Details of the 'catchment area' which the storage site has received waste from:</td></tr>
<tr><td colspan="6">SITE ACCESS</td></tr>
<tr><td>Is there road access to the site e.g. for cars, lorries etc?</td><td>yes / no</td><td colspan="4">If yes, what is the maximum size the road vehicle can be to gain access by road and how close is the road to the site?</td></tr>
<tr><td>Is there rail access to the site e.g. for trains, freights etc?</td><td>yes / no</td><td colspan="4">If yes, what is the maximum tonnage of the rail vehicle and how close are the tracks to the site?</td></tr>
<tr><td>Is there port access to the site e.g. for boats, ships etc?</td><td>yes / no</td><td colspan="4">If yes, what is the maximum size the floating vessel can be to gain access via the port and how close is the port to the site?</td></tr>
<tr><td>By inland waterway access to the site e.g. for boats, ships etc?</td><td>yes / no</td><td colspan="4">If yes, what is the maximum size the floating vessel can be to gain access by inland waterway and how close is the waterway to the site?</td></tr>
</table>

Are there multiple Entrances?	yes / no	If yes, which should be used?
Is key fob/keypad access used?	yes / no	If yes, is there emergency access (e.g. via security guard, site contact)?
Is there a barrier and/or height restriction?	yes / no	If yes, what is the maximum height and/or width for a vehicle to access the site?
Is 24 hour access to the site permitted?	yes / no	If yes, by whom, on what basis, etc.
Can local access roads/routes be used by large vehicles, including roads between local access to the site and main trunk roads? Are there any other vehicle restrictions?		
WASTE HANDLING AT THE SITE		
How much liquid waste is currently being stored on the site? (m^3)		How much more liquid waste could be stored on site? (m^3)
How much solid waste is currently being stored on the site? (m^3)		How much more solid waste could be stored on site? (m^3)
Is there any type of waste which the site could not store?	yes / no	If yes, please provide details
Is/could waste stored on the site migrate off site (e.g. via wind, leaching, rainwater run-off etc.)	If yes, please provide details	
If yes, what measures are/could be used to prevent migration of waste (e.g. bunding, fencing etc.)		
How long can the waste be stored on site for?		

Is there a water supply on site?	If yes, please provide details
Is there a power supply on site?	If yes, please provide details
Is there space on site to allow for further segregation of the waste?	If yes, please provide details
Is there any form of treatment currently being carried out on the on site waste?	If yes, please provide details
Are there any sensitive receptors (e.g. to noise, smell) nearby (e.g. housing, school)?	If yes, please provide details
Will the site be completely rehabilitated after the waste has been completely removed?	If no, please provide details
Name & Reference of nearest intermediate storage facility, if known	

Appendix E5 - Temporary Waste Storage Location Information Sheet 2 - Part 2

<table>
<tr><th colspan="12">WASTE CLASSIFICATION AND VOLUME</th></tr>
<tr><td colspan="2" rowspan="3">This table is used to classify the oily waste at the temporary storage site and provides an estimate of the volumes of each classification of oily waste present. This sheet should be completed in addition to the Temporary Waste Storage Location Information Sheet.</td><th colspan="10">OIL TYPE</th></tr>
<tr><td colspan="2">Volatile - Gasoline products - Viscosity like water</td><td colspan="2">Light - Diesel & light crudes - Viscosity like water</td><td colspan="2">Moderate - Intermediate products & medium crudes</td><td colspan="2">Heavy - Residual products & heavy crudes - Viscosity like molasses</td><td colspan="2">Solid - Bitumen, tar, asphalt - Does not pour</td></tr>
<tr><td>Volume of oil or oiled waste (m^3)</td><td>% of waste contaminated with oil</td><td>Volume of oil or oiled waste (m^3)</td><td>% of waste contaminated with oil</td><td>Volume of oil or oiled waste (m^3)</td><td>% of waste contaminated with oil</td><td>Volume of oil or oiled waste (m^3)</td><td>% of waste contaminated with oil</td><td>Volume of oil or oiled waste (m^3)</td><td>% of waste contaminated with oil</td></tr>
<tr><td rowspan="4">TYPE OF OILY WASTE</td><td>Oil</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Oil/Water</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Oil/Water Emulsion</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Sand - mixed sediment - sand or a combination of sand, granules, pebbles and cobbles.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

WASTE CLASSIFICATION AND VOLUME

This table is used to classify the oily waste at the temporary storage site and provides an estimate of the volumes of each classification of oily waste present. This sheet should be completed in addition to the Temporary Waste Storage Location Information Sheet.		OIL TYPE									
		Volatile - Gasoline products - Viscosity like water		**Light** - Diesel & light crudes - Viscosity like water		**Moderate** - Intermediate products & medium crudes		**Heavy** - Residual products & heavy crudes - Viscosity like molasses		**Solid** - Bitumen, tar, asphalt - Does not pour	
		Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil
TYPE OF OILY WASTE	Coarse Sediment - the clearly dominant material is pebbles and/or cobbles. Pebbles grain size diameter 4 - 64mm & cobbles 64 - 256mm.										
	Cobble/Boulder - the clearly dominant material is cobbles (64 - 265mm) and/or boulders (>256mm).										

WASTE CLASSIFICATION AND VOLUME

This table is used to classify the oily waste at the temporary storage site and provides an estimate of the volumes of each classification of oily waste present. This sheet should be completed in addition to the Temporary Waste Storage Location Information Sheet.		OIL TYPE									
		Volatile - Gasoline products - Viscosity like water		**Light** - Diesel & light crudes - Viscosity like water		**Moderate** - Intermediate products & medium crudes		**Heavy** - Residual products & heavy crudes - Viscosity like molasses		**Solid** - Bitumen, tar, asphalt - Does not pour	
		Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil	Volume of oil or oiled waste (m^3)	% of waste contaminated with oil
TYPE OF OILY WASTE	Oiled Debris - Scattered organic or inorganic materials e.g. fish, birds, plants, cans, plastic bottles etc.										
	PPE and construction material used in the manual clean up of the oil spill.										

Appendix E6 - Template for Fixed Facility Data

UK Fixed Treatment Facility Datasheet

Facility Name: xxxxxxxxxxxxx

This data sheet is used to identify and categorise assess each waste treatment facility. If more than one process is installed at one location, please provide details for each process on separate sheets.

Facility Name:	
Company:	
Process:	
	Information on the facility/ entity
Specify:	• Name and location(s) of the facility(ies) (if possible please provide Nat Grid reference or postcode) • Contact information o Name(s), telephone numbers, addresses and email addresses • Brief description of installation o Please describe broad nature of process(es) employed o Please list main items of equipment installed (where appropriate)
	Waste processing and acceptance criteria
Specify:	• Type of waste managed / treated • Analytical facilities available? • Acceptance criteria o Percent solids? o Percent liquids? o Maximum solid particle size? o Maximum oil contamination level that can be treated? o Upper viscosity limit of oil spill waste that can be accepted? o Facility to handle volatile materials? o Maximum degree of water contamination (for two-phase oil/water mixtures and also water-in-oil emulsions) of recovered oil that can be accepted o Any other restrictions on the composition of recovered oil that can be accepted (e.g. contamination by dispersants, surfactants or demulsifiers, salt, sulphur etc). o Specify pre-treatment required (if any). • Pre-treatment capability (please specify if facility has the option of being able to undertake any pre-treatment which may be required to render unacceptable materials acceptable)? • Treatment rate (tons of waste per hour/day/ month/ year)? • Batch or continuous operation? • Average utilisation (%)?
Rank:	+ Little variety of waste manageable to + + + Wide variety of waste manageable
	Logistics/ Operational requirements & constraints
Specify:	• Reception facilities: o By sea? Max size of vessel? Daily reception capacity? o By road? Max size of vehicle? Daily reception capacity? o By train? Daily reception capacity? o By inland waterway? Daily reception capacity?

	• Storage capacity (total, typically available)? • Energy, water and other input required (nature and typical quantity required per ton treated) • Other constraint?
	Potential environmental impacts
Specify:	• Noise • Atmospheric releases (after on site treatment)? • Solid waste (hazardous?) • Leachate or liquid effluents produced (after on site treatment)? Discharge consent in place? • Highways/transport? • Others
Rank:	x Little impact to x x x Potentially severe impact
	Material Produced after Treatment
	• Nature of material produced from the waste? • Oil o Is it acceptable for general/commercial use? o Is there an existing outlet for product? Is this fixed in volume/capacity terms? o Please specify possible uses not currently being employed as outlets o Could it be further treated to render it acceptable? • Solids o Is it acceptable for general/commercial use? o Is there an existing outlet for product(s)? Please specify. Are these fixed in volume/capacity terms? o Please specify possible uses not currently being employed as outlets o Could it be further treated to render it acceptable? o Could it be landfilled with no further treatment?
	Legal constraints
Specify:	• Is facility currently permitted? If yes, please provide details. • If no, what is the basis of operational regulation?
Rank:	x No regulatory constraints x x x Significant regulatory barriers
	Cost
Specify:	• Cost per tonne treated • Cost per tonne stored (if required)
Rank:	x Low cost to x x x Highly expensive