

Oil spill waste minimization and management

Good practice guidelines for incident management
and emergency response personnel





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Preface

This publication is part of the IPIECA-OGP Good Practice Guide Series which summarizes current views on good practice for a range of oil spill preparedness and response topics. The series aims to help align industry practices and activities, inform stakeholders, and serve as a communication tool to promote awareness and education.

The series updates and replaces the well-established IPIECA 'Oil Spill Report Series' published between 1990 and 2008. It covers topics that are broadly applicable both to exploration and production, as well as shipping and transportation activities.

The revisions are being undertaken by the OGP-IPIECA Oil Spill Response Joint Industry Project (JIP). The JIP was established in 2011 to implement learning opportunities in respect of oil spill preparedness and response following the April 2010 well control incident in the Gulf of Mexico.

The original IPIECA Report Series will be progressively withdrawn upon publication of the various titles in this new Good Practice Guide Series during 2014–2015.

Note on good practice

'Good practice' in the context of the JIP is a statement of internationally-recognized guidelines, practices and procedures that will enable the oil and gas industry to deliver acceptable health, safety and environmental performance.

Good practice for a particular subject will change over time in the light of advances in technology, practical experience and scientific understanding, as well as changes in the political and social environment.

Contents

Preface	2	References and further reading	44
Why do we need oil spill waste management good practice?	4	Appendix A: Example structure of an oil spill waste management plan	45
General waste management considerations	8	Appendix B: Example of a hazardous waste consignment note	48
Regulatory context	8	Terminology and abbreviations	49
Waste hierarchy	9	Acknowledgements	49
Minimization	10	Case studies	
Risk assessment and option selection	11	Case study 1: Legislation in the UK	8
Segregation	12	Case study 2: Waste segregation	13
Secondary contamination	13	Case study 3: Onshore management of extremely high volumes of waste	20
Health and safety	14	Case study 4: Waste management strategies	23
Waste management strategy	15	Case study 5: Waste management plan	26
Relationship between clean-up and waste management strategies	15	Case study 6: Waste treatment and disposal—exploring ‘green alternatives’	41
Waste types	18		
Waste quantities	19		
Waste management objectives and strategy/policy	22		
Oil spill waste management planning	24		
Oil spill waste management plan	24		
Waste management plan— the details	26		
Documentation, record keeping and data management	27		
Waste collection and storage	28		
Waste collection	28		
On-site/near-site temporary storage	28		
Intermediate storage	30		
Long-term storage	32		
Waste transportation	34		
Waste consignment	35		
Waste pretreatment, treatment and final disposal	36		
Waste management— initial response actions	42		
Conclusions	43		

Why do we need oil spill waste management good practice?

The response to an oil spill often results in the rapid generation and accumulation of large quantities of oily waste. Emulsified oil, oiled sand, gravel and entrained debris can increase the volume of waste to many times the volume of oil originally spilled. This waste often exceeds the capacity of the locally available waste management infrastructure. As a result, the management of the oily waste and other associated response-related wastes can become the most time-demanding and costly aspect of an oil spill.

Management of waste from a spill involves the setting up of a logistics chain to transfer waste in a safe and secure manner from the recovery point to a final recycling or disposal facility. In most cases this involves the establishment of temporary infrastructure along the chain. The chain needs to be rapidly established and tailored to the spill scenario/situation. Failure to do so can create a bottleneck that hinders the efficiency of the recovery operation, and may generate additional risks of environmental damage and increase the costs.

The waste management strategy and plan are vital components of any oil spill contingency plan and response action. The clean-up strategy and waste management strategy are interdependent and each must be developed with due regard for the impact on the other. A well-developed waste management plan addresses the following components: waste minimization measures; waste recovery and recycling opportunities; environmentally-sound waste disposal; and a logistics chain comprising secure and appropriately designed temporary storage sites and transportation that has the ability to interface with the existing available waste infrastructure. The available resources, in terms of hardware and personnel, as well as the level of training of the organization's staff and clean-up crews, will complement the plan.

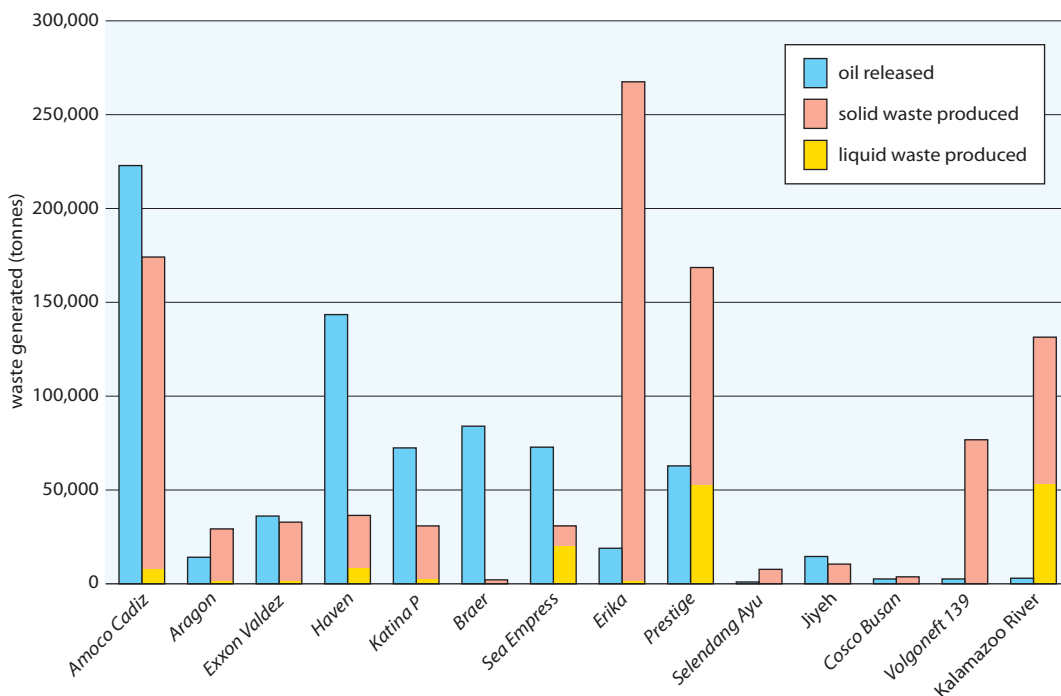
Where the location of impact of the oil spill is not known, it is not possible to define the precise location of the waste infrastructure to support the spill response. However, it is important to identify, before a spill occurs, the nature and location of infrastructure within the area at risk, and the outline of the waste management strategy and plan to supplement this existing infrastructure. This exercise will highlight any barriers or gaps that may exist in the availability of equipment or personnel, so that they can be addressed prior to a spill. The suitability of existing facilities to handle waste should be checked, confirming in the process the existence and validity of suitable licences. The philosophy for selection of storage sites can also be established and potential constraints identified. At the time of a spill, the waste management plan is refined to reflect the actual circumstances; sites for temporary storage and final disposal facilities can be chosen and measures to recover/recycle waste re-confirmed where practicable.

This document aims to introduce the reader to the principles involved in considering each of the aspects of oil spill waste management highlighted above. These principles are relevant to both offshore and onshore spills worldwide, and affect upstream and downstream operations from oil exploration and production, through processing, refining, transport and storage activities. Additional sources of more detailed information can be found in the References section on page 44.

When an oil spill occurs, the principle aim of the response organization is to minimize the potential damage to people and the environment from the spilt oil. The various response and clean-up techniques available to do this are discussed in detail in other publications in the IPIECA-OGP series of good practice guides. Many of these techniques necessarily result in the accumulation of oily waste material in large volumes and over a short time period.

Historical data show that oil spills that affect the shoreline can, in extreme cases, produce up to 30 or 40 times more waste than the volume of oil originally released (see Figure 1). It is notable that a significant number of smaller spills have created large amounts of waste.

Figure 1 Comparison of quantities of oil released and waste produced for selected historic spills



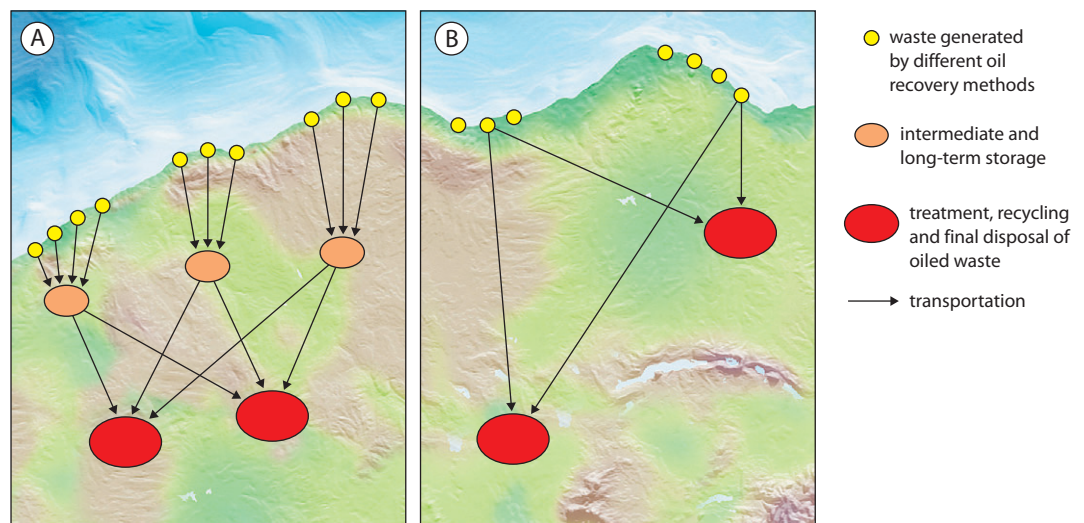
The volume of waste generated over a short time frame often is more than the existing infrastructure can handle. The safe and efficient handling and movement of this waste material to a location where it can be treated, reused, recycled or disposed of is an important element of the response. Poor waste management can hamper the clean-up effort, by prolonging the process and potentially introducing secondary contamination that may increase the impact of a spill. The handling and ultimate disposal of waste can take the longest time of any operation in the response—sometimes taking years from the date of the spill. Until final disposal, there remains a higher degree of environmental and health risk associated with handling and storing the waste materials. In addition, certain disposal options (e.g. landfill) may be associated with a potential environmental liability risk. The management of all waste in any spill should, therefore, be regarded as a high priority, and pre-planning should be established in order to minimize the potential effects.

Waste from an oil spill clean-up event typically follows the physical transfer chain illustrated in Figure 2. In this model, oily material is transferred from the clean-up site to a final treatment, recycling or disposal facility, either with or without the need for a series of temporary storage sites with transport between them.

Figure 2 Typical waste management logistics models showing the stages from waste generation to final disposal, as discussed in this document. The logistics models apply equally to an offshore spill or onshore spill where the oil enters a lake or river.

A: an area/event where the waste quantity exceeds the pre-existing capacity of the infrastructure

B: an area where the existing infrastructure capacity is sufficient to allow transfer directly from the spill site to treatment, recycling and disposal facilities. (For diagrammatic simplicity the transport routes from selected sites only are represented in this case.)



The models in Figure 2 apply equally to offshore and inland spills; in the case of the latter, in particular where oil enters a watercourse such as a lake or river. Such a scenario is illustrated in the case study on the Kalamazoo River pipeline spill (Case Study 3).

It is essential that oil spill contingency plans include adequate provision for the management of wastes. In addition, it is a fundamental requirement that, as soon as an incident occurs, the right decisions are made and the contingency plans are confirmed and set in motion. This will support a successful waste management and clean-up operation that will minimize environmental impact and, subsequently, response costs.

The aim of this document is to provide information on the waste management issues related to oil spill clean-up. It discusses the general principles of waste management, and the planning of waste management as part of the oil spill contingency planning process, and follows the progress of waste through each stage of this model. The document is divided into seven main sections:

1. **General waste management considerations:** describes certain basic principles that may guide the goals and the decision making process of the waste management task.
2. **Waste management strategy:** explains the close relationship between the clean-up and waste management strategies, discusses the types and quantities of waste that may be encountered and reviews the process of establishing the waste management strategy/policy.

3. **Oil spill waste management planning:** the plan details how the waste management goals are to be achieved and by who, and describes the processes and procedures for addressing uncertainty.
4. **Waste collection and storage**
5. **Waste transportation**
6. **Waste pretreatment, treatment and final disposal**
7. **Waste management: initial response actions:** addresses the early actions that should be taken in the event of a spill that help to refine the waste management plan and mobilize resources in a timely manner.

The principles described in this document can be applied to offshore, nearshore and onshore spills, to exploration and production operations and oil transport by tanker or pipeline, and to processing operations including, for example, refinery activities. Case studies of waste management that describe historic spill responses are used to illustrate certain points being raised in the document and to give practical illustrations of the waste management challenges inherent in oil spill response operations.

General waste management considerations

In designing and implementing a waste management strategy and plan, consideration should be given to a number of basic principles and the context within which the strategy and plan sit.

Regulatory context

The precise regulatory context within which oil spill management operations are carried out will differ depending on its geographic location. In general, however, oily material that is classified as waste is also categorized as being hazardous in nature.

In an international context, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989) applies. Under this Convention, oily waste is classified as hazardous and thus subject to the provisions of the Convention. These require that any plans to transfer oily waste internationally, to or from a country that has signed the Convention, need to comply with the provisions of the Convention, including gaining government permission for the transboundary dispatch and receipt.

At a national level the regulatory framework is likely to embrace some, if not all, of the actions and activities relating to the management and processing of oil spill-related waste. This can include the activities of segregation, storage, transportation, treatment and disposal of oily waste material. It is essential, therefore, that those in the response team involved in the decision making process are aware of the relevant legislation concerning any aspect of the waste management chain. They should consult and liaise regularly with the relevant regulator's representatives, some of whom may be embedded in the response teams.

CASE STUDY 1: Legislation in the UK

The UK is a member of the European Union, and all hazardous waste in the UK is therefore strictly controlled by the European Council Directive 91/689/EEC on Hazardous Waste, as amended by Directive 2008/98/EC, the Waste Framework Directive. The Special Waste Regulations 1996 and subsequent amendments implement the Hazardous Waste Directive in the UK. Oil spill waste is considered a hazardous waste under these regulations. A system of consignment notes and licensing, administered by the Environment Agency, ensures that wastes are tracked from the point of generation to the point of disposal. Both temporary storage and transport of all oil spill waste must, therefore, be carefully documented and licensed. Although this specific legislation does not apply directly to other legal jurisdictions it can be seen as a system of good practice in any spill situation.

When dealing with small spills these regulations should not present difficulties, as there are likely to be adequate licensed hazardous waste carriers and storage/disposal routes to manage the waste. Practical difficulties may arise, however,

when large spills occur. The normal disposal routes may become overrun and new carriers and temporary storage sites must be identified. Licences will have to be issued or verified as valid before they can be used, which will almost certainly hinder the clean-up operation. It is up to the relevant authorities (in the UK the Local Authority and the Environment Agency) to work together to resolve this issue. To aid this the Hazardous Waste Directive states that:

'In cases of emergency or grave danger, Member States shall take all necessary steps, including, where appropriate, temporary derogations ... to ensure that hazardous waste is so dealt with as not to constitute a threat to population or the environment.'

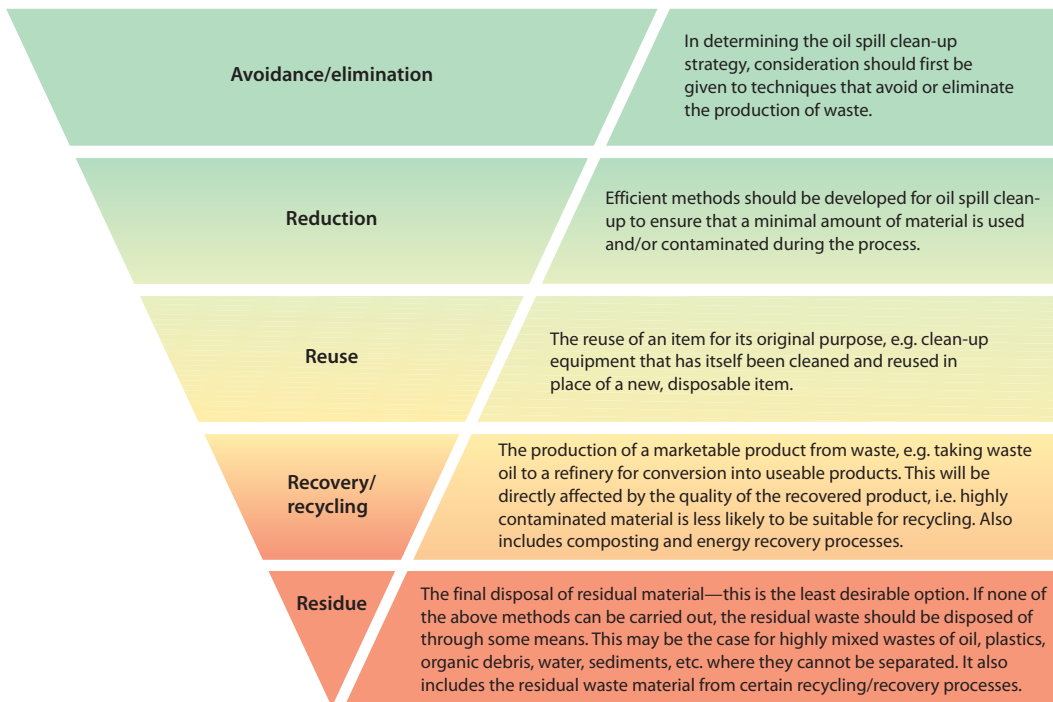
In addition, it is good practice during the contingency planning process to liaise with the regulatory authorities to anticipate events for which rapid regulatory decisions on licensing may be needed. This will give the opportunity to prepare in advance for such events in order to ease the licensing process.

The cost of waste treatment can represent a significant proportion of the overall cost of response operations. Some international conventions, related to oil spill compensation, are relevant and may apply to waste management. Compensation for damage caused by spills of persistent oil originating from tankers is now based on three international agreements—the 1992 Civil Liability Convention, the 1992 Fund Convention and the 2003 Protocol to the 1992 Fund Convention. This regime can cover reasonable expenses related to oil spill waste storage, transport, handling and treatment operations. To support claims under these Conventions, data on waste quantities, types and final destinations must be recorded and kept. For more details on claims and compensation aspects see IPIECA/ITOPF, 2007.

Waste hierarchy

A useful model when dealing with a waste stream originating from any source is the ‘waste hierarchy’ (Figure 3). This concept uses principles of waste avoidance/reduction to minimize the amount of waste produced and reuse/recycling to minimize the residual waste material. It thereby reduces the environmental and economic costs and ensures a consistent approach with legislative intent. It provides a tool for structuring a waste management strategy and can be used as a model for all waste management operations, including those associated with oil spill response activities.

Figure 3 The ‘waste hierarchy’ provides a tool for structuring an efficient waste management strategy



Minimization

Minimization refers to methods that reduce the amount or hazardous nature of waste entering the waste stream. It comprises the elements of 'avoidance/elimination', 'reduction' and 're-use' of the waste hierarchy. Waste minimization is essential for reducing the amount of waste for final disposal or for easing difficulties in finding suitable disposal routes, thus limiting the environmental and economic impacts of a spill.

A number of waste minimization methods are available; these include management arrangements, methods of avoiding waste production, ways to reduce the hazardous nature of the waste and efforts to reduce the quantity of waste produced. Examples of useful methods are provided in the boxes below according to their predominant aim.

In considering the various options to minimize waste volumes, consider the impact of additional waste streams that may be created and whether resources are available to implement the minimization technique. For example, washing PPE for reuse is labour intensive and generates an oily water waste stream that then also requires management.

Management arrangements to minimize waste

- Devise a clean-up strategy that accounts for the end point of any part of the response, consciously taking into account the waste at every stage of the clean-up process.
- Provide training to the clean-up crews to raise awareness of the requirements to minimize and segregate waste; provide training prior to and during an event, for example through toolbox talks.
- Provide a clear definition of management responsibilities with regard to waste, and provide the resources to support response staff in execution of these responsibilities.

Waste avoidance

- Prevent secondary contamination (see section below) of clean-up and storage sites and transport routes.
- Identify potential impact sites (IPIECA-OGP, 2014a) and, where possible, clear any pre-existing debris and rubbish to reduce the amount of oily debris that would need to be dealt with should the oil reach that area.
- Recovery equipment should be cleaned and reused rather than discarded.
- Reusable personal protective equipment (PPE) should be selected where appropriate and procured for use. For example, products such as rubber boots may be cleaned and reused.

Waste reduction

- Use sorbents sparingly and effectively.
- Minimize excavation of material: prioritize manual methods of recovery over mechanical means because it allows for removal of oil with less associated substrate (e.g. sand).
- As far as practicable in the scenario, choose clean-up techniques that separate the oil from the sediment, such as flushing oil buried in sand to the surface using air and water injected by hose.
- Use of in-situ treatment technologies reduces the amount of waste requiring transport, treatment and disposal. These methods can include washing (e.g. surf), burning (if permitted), sand sieving and bioremediation.
- As far as practicable, segregate at source the different types of contaminated wastes (liquid, solid, debris, PPE, etc.).
- Minimize rainwater infiltration and creation of additional types and volumes of waste. Containment sites and containers should, where possible, have a waterproof cover to prevent rainwater infiltration.
- Make use of separation treatment technologies, i.e. a settling system (e.g. gravity separator) for oily wastewater that allows for the draining of separated water.



Waste minimization:

1. Flushing allows selective recovery of oil without taking too much sediment.
2. Washing pebbles at the site.
3. Washing containment boom prior to reuse.

Risk assessment and option selection

During a response effort, it may be necessary to choose from a variety of available options for clean-up, waste treatment and disposal. For onshore spills, for example, options may exist to treat contaminated soil *in situ* as an alternative to excavating it for treatment elsewhere which may be logistically challenging and more costly. For offshore spills in high energy, rocky coastlines various options exist for removing oil, ranging from active washing of the rock to leaving the oil to weather naturally. The options will each have different environmental, health and safety, and social risks associated with them that need to be considered with regard to the specific scenario and location.

Where options exist it is useful to conduct a comparative risk assessment and include consideration of their relative positions in the waste hierarchy. The aim of this risk assessment is to identify the Best Practicable Environmental Option (BPEO), Best Available Technique (BAT) (for environmental protection) or the option that represents the least overall risk to environment or people.

The risk assessment may be qualitative, semi-quantitative or quantitative, depending on the circumstances in which it is being conducted. It may include analysis of the environmental, health and safety and social risks associated with each option, with a comparison of the risks leading to an overall ranking process to identify the preferred option. The assessment process may include an economic element to identify where expenditure on a given technique ranks compared to the reduction in risk that such a technique may generate. Note that, in certain jurisdictions, a BPEO or BAT analysis may be a formal regulatory requirement, and specific standards or guidance may be available to guide the analysis.

Segregation

In the event of a spill, the subsequent clean-up operation should include segregating collected oil and oiled debris, as well as other wastes produced during the clean-up activity. The segregation process should take the form of channeling the waste into separate, temporary storage facilities with consideration for the most suitable containment for each waste stream. It should consider available reuse, recycling or disposal routes as well as the nature and compatibility of the materials. In addition, consideration should be given to the storage and transport chains that lead to the ultimate treatment, recycling or disposal location. There may be circumstances where further segregation of waste is preferable to ease its storage, handling and transportation. The requirements for segregation that derive from these considerations should be understood and defined as early as possible, ideally in the contingency planning stage.

Waste collection methods in the field should be designed with minimization and segregation strategies in mind. It is important to interact with the teams collecting the waste and make sure that their proposed collection procedures and methodologies are aligned appropriately with the waste management strategy.

Below: a suitably lined, temporary storage pit, but with poor waste segregation; this will create difficulties for future handling and disposal.



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Tips to assist segregation

- Segregate at source the different types of waste (oily liquid, solid, debris, PPE, etc.).
- Where possible, use different types of containers for different waste streams.
- Know/understand the character of the waste, with particular regard to its hazards and components.
- Identify and label containers clearly to prevent them from being mixed up.
- Raise staff awareness, through training and spill drills and exercises, of the importance of sorting waste, and of the related consequences and costs of poor segregation.

Consideration should also be given to the capacity and management of the chain of transport, storage and treatment facilities to ensure that it is capable of handling the segregated waste. It is not uncommon for the capacity of storage facilities to be exceeded by the volume of waste recovered from the clean-up sites. Close management of the storage site may also be needed to ensure that it is used as designed. Systems designed to segregate waste can break down, either due to waste of different types being deposited together in the limited storage space available, or due to waste transporters failing to appreciate the segregation requirements at the storage site. The *Prestige* case study (below) illustrates some of the challenges of maintaining segregated waste during the response to large-scale oil spills.

CASE STUDY 2: Waste segregation

Prestige, Spain 2002

The oil tanker *Prestige* suffered engine failure off the north-west coast of Spain in November 2002. After several days at sea the ship broke up, spilling approximately 63,000 tonnes of heavy fuel oil to sea. This emulsified and resulted in 128,000 tonnes of emulsion that had to be addressed. A massive clean-up operation was mounted with large numbers of military, volunteer and specialist contractors on each affected site. Systems were put in place and workers briefed to segregate the collected waste. Oil-tight containment was provided for each waste type but, ultimately, through haste and operational pressures, workers still mixed the wastes. The failure to rigorously implement a comprehensive waste management plan meant collected wastes were deposited together in lined pits with no segregation for recycling or final disposal; the disposal process for this mixed waste was expensive and took years to complete.

Secondary contamination

Secondary contamination is the spread of oil to otherwise unpolluted areas via response activities associated with people, transport and equipment. This should be avoided to control the overall impact of the spill, and can be achieved in a number of ways. For example:

- designating 'clean' and 'contaminated' zones at the worksite;
- decontaminating personnel and equipment before leaving the work zone;
- conducting regular checks of all storage areas, pumps and hoses for leaks;
- ensuring all storage areas are impermeable to oil and water to prevent leakage, e.g. by carrying out maintenance type inspections during the response and, if waste is stored for long periods, through integrity assurance;
- ensuring that drainage from waste storage areas is adequately and properly contained;
- lining and decontaminating all vehicles intended for waste transportation before leaving the site or carrying wastes; and
- establishing a traffic management plan.

Decontamination sites should be established between the dirty and clean areas of the worksite. Ideally, decontamination should be carried out in stages to minimize the use of disposable materials. Sorbents, for example, should be reserved for the final cleaning stage. Personnel should follow the decontamination chain from dirtiest to cleanest on a watertight platform where the washing effluents can be drained and collected. A separate area should be used for the decontamination of vehicles and heavy machinery.

Secondary contamination due to degradation and inappropriate storage of plastic sacks filled with oily waste.



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Health and safety

All hydrocarbons potentially pose some degree of health risk, and it is therefore essential that a health and safety plan be drawn up before any activity commences. Risks from physical hazards, such as storage pits, should not be overlooked. Each stage of the management process should be assessed to establish any potential health and safety risks together with appropriate mitigating methods. Further information can be found in the IPIECA-OGP good practice guide, *Oil spill responder health and safety* (IPIECA-OGP, 2012).

Waste management strategy

The waste management strategy represents the product of the first part of the planning process, defining at a high level what needs to be done. It should be established before a spill, as part of contingency planning, and be re-confirmed or revised as appropriate at the start of a spill response. Developing the strategy involves:

- establishing the waste management objectives/policy;
- reviewing the objectives in the light of local circumstances, legislation, available resources etc.; and
- establishing the elements of the strategy that are required to achieve the objectives, e.g. characterization of waste types and quantities.

This section details some of the main considerations in establishing a waste management strategy for a spill response. It looks at the relationship between the clean-up and waste management strategies, the possible range of waste types and the quantities of waste that may be encountered, and discusses the steps involved in establishing the waste management objectives/policy and elements of the strategy.

Relationship between clean-up and waste management strategies

In the event of an oil spill, the type and quantity of solid and liquid waste produced is determined by the extent of the spill, the different environments that become oiled and the clean-up techniques employed. The close linkage between the clean-up strategy and the waste produced is illustrated in Table 1, which outlines possible response strategies and the types of waste that each of these can generate.

Thus, the types and volumes of waste generated are heavily influenced by the clean-up objectives set during contingency planning or by the spill management team. For example, if conditions permit, and the decision is taken to allow natural recovery of a shoreline, then little waste may be generated. Similarly, protection of shorelines through dispersant spraying offshore will reduce the amount of waste generated. Further, where oil is stranded on the shoreline of the sea, estuary or river, the main strategic clean-up considerations will be (a) the desired treatment end point (i.e. how clean) and (b) which treatment or clean-up methods should be used. Both decisions can have a fundamental influence on the type and quantity of waste produced. In the case of inland spills, decisions regarding the technique to be used for the clean-up of contaminated soil, e.g. in-situ clean-up or off-site clean-up following excavation, will similarly affect the quantity of waste produced.

Considerations of waste management are also important in the decision-making process while developing the clean-up strategy and techniques. Factors such as the capacity of the infrastructure to manage any waste produced and also the guiding principle of waste minimization must be balanced against other factors that influence the clean-up strategy. Ideally, waste minimization will be one of the principal guiding objectives of the clean-up operation.

Table 1 Categories of response strategy and types of waste typically generated

Clean-up technique	Effect on waste stream	Type of waste generated
<p>Dispersant application (IPIECA-OGP, 2014c)</p> 	<p>Waste concentrations are minimal as oil is suspended in the water column and allowed to degrade naturally.</p>	<ul style="list-style-type: none"> • PPE • Empty dispersant drums
<p>At-sea containment and recovery operations (IPIECA-OGP, 2014e)</p> 	<p>Recovery operations 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 spilt will have an effect on the resultant waste; viscous and waxy oils in particular will entrain debris and can create large volumes of waste. Such oils can also present severe handling difficulties.</p>	<ul style="list-style-type: none"> • Oiled equipment/vessels • Oiled PPE • Recovered oil • Oily water • Oiled vegetation • Oiled sorbent materials • Oiled flotsam and jetsam: organic and inorganic • Animal carcasses
<p>Shoreline clean-up (IPIECA-OGP, 2014a) Onshore clean-up (IPIECA-OGP, 2014f).</p> 	<p>Manual recovery is preferred over mechanical recovery because it has the effect of minimizing the amount of waste generated.</p> <p>The type of oil spilt will often have a profound effect on the amount of oily waste generated.</p> <p>Waste segregation and minimization techniques are key to ensuring an efficient operation. These should be established at the initial recovery site and maintained through to the final disposal site. If this is not done, waste volumes may spiral out of control. Waste sites should be managed in such a way as to prevent secondary pollution.</p>	<ul style="list-style-type: none"> • Oiled equipment/vessels • Oiled PPE • Recovered oil • Oiled vegetation • Oily water • Oiled sorbent materials • Oiled beach or land material: (sand, shingle, cobbles, soil) • Oiled flotsam and jetsam: organic and inorganic • Animal carcasses • Oiled transport
<p>Controlled in-situ burning (IPIECA-OGP, 2014b)</p> 	<p>Controlled, in-situ burning can reduce the amount of oil in the environment.</p> <p>Also, an atmospheric waste stream, smoke, is produced.</p>	<ul style="list-style-type: none"> • Burnt oil residues • Oil/fire damaged boom • Oiled vessel • Oiled PPE

Table 2 Oily and oil contaminated wastes (percentages are indicative)

Category	Characteristics	Examples	Comments
 <p>Oily liquids</p>	Generally oil and water, with the water content ranging from 0 to 90%+, usually towards the top end of that range. Minor amounts of mineral or organic matter may be present.	<ul style="list-style-type: none"> Liquid recovered from sediment or equipment washing activities Accumulated water from storage areas Liquids recovered from skimming operations 	Remove as much water as possible before managing the remaining liquid.
 <p>Pastes and solids</p>	<ol style="list-style-type: none"> Pastes/solids dominated by oil Pastes/solids dominated by fine mineral matter <p>Both may contain relatively low (<10%) amounts of water and/or organic matter.</p>	<ul style="list-style-type: none"> Tar balls Waxy deposits Oily sand/silt Oily soil/sediment from onshore spills 	Material recovered from onshore spills and river environments may contain significant quantities of organic matter and/or free water.
 <p>Pebbles and stones</p>	Generally low in free water (1%) and organic content (<10%). The oil content varies depending on the size of the stones and degree of oiling (often > 10%).	<ul style="list-style-type: none"> Pebbles on higher energy beaches Coarse gravel hard standing areas onshore 	
 <p>Sorbent material</p>	Natural and synthetic materials used to absorb oil, either from the water's surface or from the land. The bulk of the waste consists of the sorbent material itself. Oil content is often > 5% but variable. Water, mineral matter is low (< 10%) and organic matter very low (< 5%).	<ul style="list-style-type: none"> Bulk Mops Pillows Sheets Natural materials (e.g. straw) 	The oil content is highly variable. Sorbents with a high surface area to volume ratio, used in heavily oiled areas may contain significantly more than 5% oil.
 <p>Organic matter</p>	Typically consists of more than 80% vegetative material, 5+% oil with the remainder water and mineral matter.	<ul style="list-style-type: none"> Seaweed Waterside vegetation Terrestrial vegetation for onshore spillages 	Biodegradable substances. Smell and toxicity hazards associated with decomposition.
 <p>Solid waste</p>	Solid material of various sorts that has become oiled. Oil content variable (>5%), water and mineral matter low (<10%), organic matter variable and high if the waste is itself organic.	<ul style="list-style-type: none"> Debris lying on the oil affected area (e.g. plastics, wood, metals) PPE (e.g. gloves, boots, coveralls, etc.) Used clean-up equipment; booms, buckets, scrapers etc. 	For PPE and clean-up equipment, consider washing and re-use.
 <p>Oiled fauna</p>	Fauna that has become oiled. The animal is organic (>70%), with the oil content variable (>5%), free water (<15%) and mineral matter (<10%) being low.	<ul style="list-style-type: none"> Mainly birds Also fish, mammals, reptiles 	Live fauna should be sent to specialist cleaning facilities. All corpses should be counted before disposal. Some may be kept for necropsies and scientific studies.

Waste types

One of the most fundamental steps in developing a waste management strategy is to categorize the wastes produced. Tables 2 and 3 provide examples of classification systems for oily/oil-contaminated wastes and non-oily wastes, respectively. Similar classification systems may be used as a basis for planning, accounting also for local legislative requirements, with each category typically corresponding to distinct management and treatment processes. The classification system will need to be customized to account for local legislative and regulatory requirements or availability of treatment and disposal options.

Table 3 *Uncontaminated and ancillary wastes*

Category	Characteristics	Examples	Comments
Uncontaminated debris	Moveable solid debris lying on a site that may become contaminated as the spill develops. Generally non-hazardous/inert in nature.	<ul style="list-style-type: none"> • Wood • Plastics, packaging, toys etc. • Metals 	Removal of debris from the area at risk of oiling reduces the amount of hazardous waste that may be generated.
Uncontaminated organic matter	Vegetative or animal matter (excluding wood) that is likely to decompose rapidly.	<ul style="list-style-type: none"> • Seaweed • Loose vegetation • Animal carcasses 	Biodegradable substances. Smell and toxicity hazards associated with decomposition. Removal prior to oiling reduces risks of secondary contamination and may ease disposal.
'Industrial' solid materials	Solid waste generated at the response site.	<ul style="list-style-type: none"> • Packaging materials of spill response equipment • Empty dispersant drums • Batteries 	Establish the local hazard classification and segregate, treat and dispose of the waste accordingly.
Water/foam mix from fire fighting foam	Liquid waste with potentially high oxygen demand and toxicity, depending on the foam used	Various foam types depending on application, e.g. aqueous film forming foam (AFFF), film-forming fluoroprotein (FFFP)	Contain to prevent water and foam entering watercourses. Plan for disposal according to material data sheet recommendations.
Kitchen/galley waste	Solid waste—surplus food and products of food and drink preparation and provision.	<ul style="list-style-type: none"> • Food waste • Disposable plates/cutlery • Paper napkins • Food packaging • Cans, tins 	Some of the waste may be recyclable. Segregate and dispose of as required locally.
Medical wastes	Variable materials related to first aid provision.	<ul style="list-style-type: none"> • Syringes, needles • Bandages, plasters 	Keep segregated.
'Grey' water	Predominantly water, with minor detergents.	<ul style="list-style-type: none"> • Wash water from kitchen facilities • Wash water from toilet blocks 	
'Black' water	Sewerage	<ul style="list-style-type: none"> • Toilet blocks 	
Office wastes	Wastes produced during the operation of the response centre(s).	<ul style="list-style-type: none"> • Paper • Plastic packaging • Spent printer cartridges • Batteries 	The hazardous nature of the wastes may vary. Materials should be segregated and disposed of as per normal office operational activity.

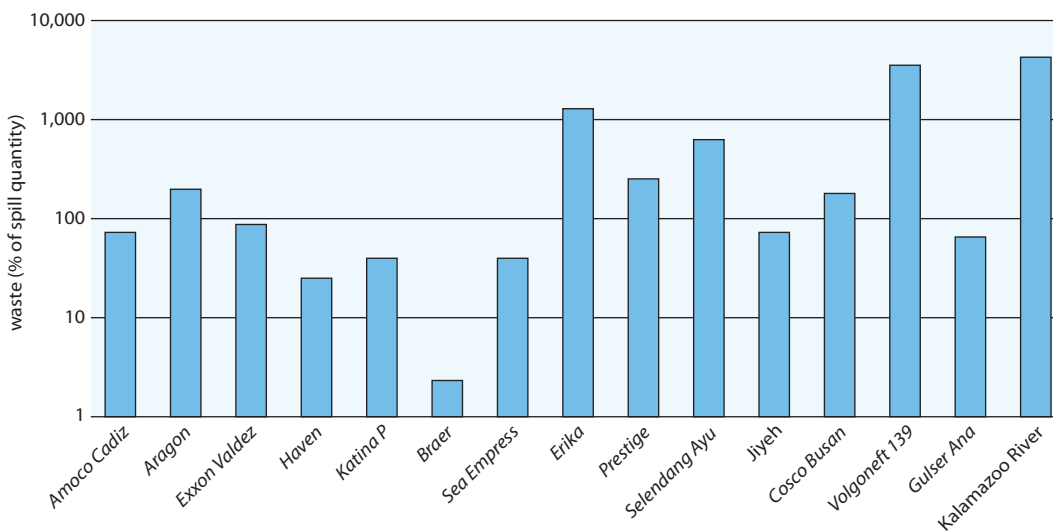
Waste quantities

The quantity of waste produced from a spill is influenced by many factors, principally the quantity of oil spilled, the environmental fate of that oil and the clean-up strategy and techniques adopted. Due to the variability in these factors, a precise estimation of the quantity of waste that may be produced is not possible, particularly in the planning phase prior to a spill event. Nonetheless, a high level estimate of the amount of waste that may be encountered is useful in identifying the waste management resources that may be needed.

Analysis of the waste produced by historical spills (see Figure 4) can give some indication of the potential order of magnitude of bulk waste that may be produced from a spill. The bulk quantity of waste produced by the offshore spills shown in Figure 4 was typically between 40% and 200% of the quantity of spilt oil. The outliers to this range occur for a variety of reasons; for example, in the *Braer* incident (2%), environmental conditions dispersed the majority of the oil before it hit the shoreline, significantly reducing the volume of waste produced. At the other extreme, circumstances can result in greater quantities of waste. Examples include the *Erika* spill (>1300%), *Selendang Ayu* (>600%) and *Volgoneft 139* (>3800%). In the *Erika* incident, emulsification, seaweed and large quantities of construction material used in the temporary storage sites bulked up the waste. The quantity of waste produced in the *Volgoneft 139* incident is considered to be exceptional for an offshore spill.

Data on waste generated from onshore spills are less readily available than from offshore incidents. Onshore incidents generally offer less opportunity for natural dispersion of the spilled oil, and typically result in contamination of vegetation and soil, if not water (both surface water and groundwater) depending on the situation. Where the response effort requires recovery and treatment of contaminated material, the quantity of waste is likely to exceed the quantity of

Figure 4 The total quantity of waste produced in various historical spill incidents, expressed as a percentage of the spill quantity (the y-axis is a logarithmic scale).



spilled oil. Although it may represent an extreme case, it is notable that for the onshore Kalamazoo River spill, the total volume of waste produced represented an estimated 4,000% of the reported spill volume (Case Study 3). The bulk of this waste was oil-contaminated soil/sediment and contaminated water.

CASE STUDY 3: Management of waste from an onshore spill

Kalamazoo River pipeline, USA 2010

The geographic area affected by many onshore spills is limited in extent as the product spilled becomes contained either by the on-site containment arrangements or by the soil or ground into which it seeps. The response to such spills is typically less complex than a response to an offshore spill that may have a potential impact on the shoreline.

The situation may become more complex, for example, if a spill reaches drainage networks and watercourses, when the response may become similar, in logistical terms, to a marine shoreline response. The case of the 2010 pipeline spillage into the Kalamazoo River illustrates this point.

In July 2010, approximately 3,100 m³ of crude oil with benzene diluent were reported to have been released from a ruptured pipeline near Marshall, Michigan, USA. The spill entered Talmadge Creek and the Kalamazoo River, 80 miles upstream of Lake Michigan and affected approximately 40 miles of waterway.

Wastes produced from the clean-up operation included:

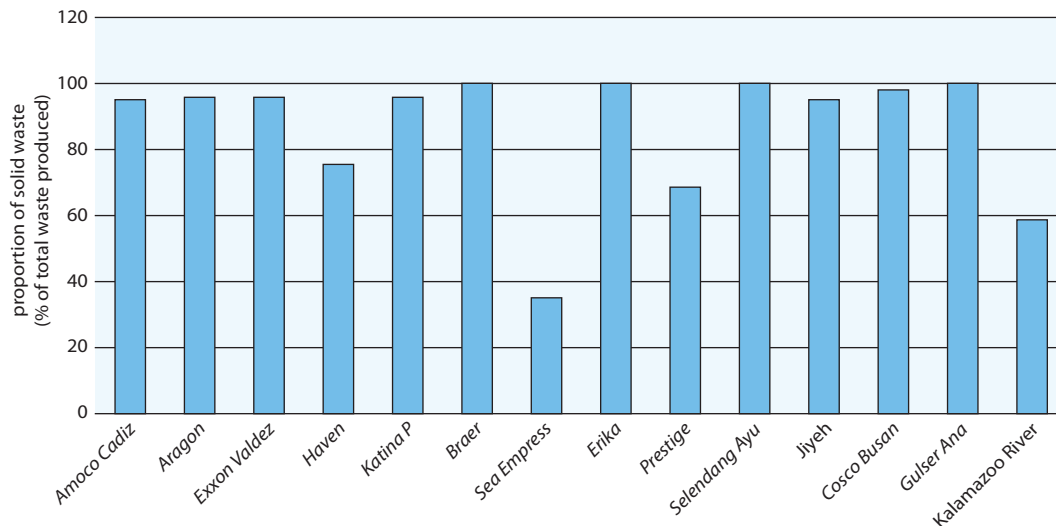
- oil and oil/water mixtures—collected from 40 different containment areas along the system, by vacuum truck, skimmers and absorbents;
- oiled vegetation—from both submerged and bankside locations;
- heavily oil saturated soils—particularly at the pipeline leak and along a two-mile stretch of Talmadge Creek;
- weathered oil, oil/water/sediment mixtures from the riverbed; and
- water, 53,000 m³ removed from the Kalamazoo river, treated and returned to the river under permit.

With the exception of the water returned to the river, these wastes were managed at several constructed transportation staging areas and removed for disposal off-site. Lined and bermed staging areas were constructed for the temporary storage while the wastes were sampled/characterized for off-site disposal or recycling. Solids were placed into lined/bermed areas while liquid wastes were placed in fractionation tanks within the bermed areas.

As of March 2011, the following quantities of waste had been handled:

- liquids, disposed of as hazardous waste: 13,600 m³
- liquids, disposed of as non-hazardous waste: 36,300 m³
- Oil recovered: 2,900 m³
- Soil: 73,200 m³
- Debris, non hazardous: 1,600 tonnes
- Debris, hazardous: 9,200 m³

Figure 5 *The proportion of solid waste as a percentage of the total waste produced in various historical spill incidents*



The proportion of waste that constitutes solid waste of some description typically exceeds 90%, and reflects the dominant waste produced from shoreline and physical clean-up techniques used in a response (see Figure 5). Where containment and recovery techniques have been used, the proportion of liquid waste produced increases.

Attempts are being made to more accurately predict waste quantities (e.g. Polaris, 2009) with simple computer-based models being developed to assist in the estimation. This is an evolving area and one that, as the models improve, should offer opportunities to better understand, during contingency planning and the early stages of a response, the potential waste management task that may be faced. In using such models, however, it should be recognized that the quality of the output depends directly on the quality of the data input. Caution should be exercised both in interpreting and relying on the results.

During a spill response itself, shoreline assessment techniques (IPIECA-OGP, 2014a) may be used to gain a better estimate of the likely types and quantities of waste that may be generated.

Waste management objectives and strategy/policy

Ideally, the spill response objectives will include consideration of the waste management component as they are developed. Consideration should be given to objectives based on:

- use of the waste hierarchy;
- minimization of waste, risk and impact;
- legal compliance;
- health and safety; and
- supporting the efficient implementation of the clean-up strategy.

The quantity, composition and characteristics of the waste, its location relative to the waste infrastructure, and local regulatory and stakeholder requirements, amongst other factors, may all influence the objectives and the strategy required to achieve those objectives. It is important, therefore, to gain information on these factors and build this into the decision making process before the objectives and, subsequently, the strategy/policy, are finalized.

Each objective should be supported by one or more strategy (also sometimes referred to as policy) statements. These define, at a high level, what shall be done to meet the objective. Table 4 gives an example of possible objectives and supporting strategy statements.

Table 4 *Examples of oil spill response/waste management objectives and how they may translate into strategy/policy statements*

Response/waste management objective	Strategy/policy
Comply with regulatory requirements	<ul style="list-style-type: none"> • Use only licenced, reputable waste management companies. • Implement a data and record management system. • Ensure, through training and support, that staff are aware of regulatory requirements. • Identify requirements for a waste management plan (WMP).
Minimize oily waste disposed to landfill	<ul style="list-style-type: none"> • Incorporate waste minimization measures in clean-up techniques. • Investigate and evaluate alternatives to landfill disposal. • Evaluate ways to apply the waste hierarchy.

As the waste management strategy is developed, options for waste pretreatment, treatment and disposal will become apparent which may have implications for the clean-up strategy and techniques. Within the context of the overall spill response objectives it is, therefore, important to maintain a feedback loop between the clean-up and waste management strategies to ensure that they complement each other to the fullest possible extent. The *Gulser Ana* spill (Case Study 4) illustrates an example of this in practice, and shows how the logistical difficulties in handling waste had a direct influence on the techniques used for beach clean-up.

CASE STUDY 4: Interaction between waste management and clean-up strategies***Gulser Ana, Madagascar 2009***

On 26 August 2009, the *Gulser Ana* became grounded off the southern coast of Madagascar, releasing 568 tonnes of intermediate fuel oil and 66 tonnes of diesel oil. Approximately 68 km of coastline was oiled in a remote setting, 175 km from the nearest town and 3 days' drive from the capital, Antananarivo. There was no road access to the coast and the beach material was not strong enough to carry heavy vehicle traffic.

The remote setting and access difficulties had a particular influence on the clean-up and waste management strategy. Multiple, temporary, intermediate storage sites had to be established along the beach and between the beachhead and the nearest road. These included sites at the beachhead, 700 m back from the beach and then 3 km from the beach at a point where lorries could gain access. Transport of waste along the beach and to the intermediate storage sites was by hand and/or by all-terrain vehicle.

This difficulty in transportation focused attention on the advantage of minimizing the waste collected at the source. Manual cleaning was conducted using small hand tools such as lightweight plywood scrapers, oily sand being scraped into dustpans, transferred to buckets and then into plastic bags. In many cases new sand had been washed over the oiled layer. In these cases, to minimize the waste collected, the clean sand was scraped off the top and then the oiled sand removed from below. To facilitate handling of the waste between storage sites prior to those with road access, a strict weight limit per bag of 10 kg was enforced.

At the main storage sites with road access, these bags were then transferred into larger sacks suitable for loading onto trailer trucks. The waste of 335 tonnes of oily sand and tar balls was transferred by road to a waste handling facility in Antananarivo. Here it was mixed with quicklime to stabilize the oil and produce a sandy product suitable for use as a foundation material for a new hard standing area in the waste handling facility.

Oil spill waste management planning

The collection, transportation, storage, treatment and disposal of oil and oily waste constitute a major exercise in terms of logistics. The waste management part of the oil spill contingency plan must define how this logistics chain is to be executed. It is difficult to devise and establish such a logistics chain in a hurry and, particularly, during a spill when pressure to act may encourage suboptimal decisions. This, together with the close interrelationship between clean-up strategy and waste management strategy, makes it essential to devote a part of the contingency planning process to an in-depth consideration of waste management. In addition, the inclusion of waste management considerations during the planning stage will enable any potential barriers to efficient and more 'sustainable' handling of waste to be identified, and will allow time for these to be removed before a spill occurs.

Oil spill waste management plan

While the waste management strategy identifies the waste to be handled, and the goals and broad approaches and programmes of the waste management task, the waste management plan (WMP) defines the detail of how the work is to be done and by whom. The relative roles of the strategy and plan are illustrated in Table 5.

Table 5 Illustration of the relative roles and levels of detail of waste management objectives, strategy/policy and plan

Response/waste management objective	Strategy/policy	Waste management plan
Comply with regulatory requirements	<ul style="list-style-type: none"> Use only licenced waste management companies Implement a data and record management system Ensure, through training and support, that staff are aware of regulatory requirements 	<ul style="list-style-type: none"> Lists licenced waste management companies and contact details Defines due diligence requirements to precede use (audit/inspection/discussion with regulator) Defines what data and records need to be produced and kept, by whom and for how long Identifies resources available/required to set up a data management system Defines what training is required for whom and when/how it should be given Allocates responsibilities for ensuring training is conducted Identifies resources to ensure ongoing support of operational staff (e.g. inspectors/advisers)
Minimize oily waste disposed to landfill	<ul style="list-style-type: none"> Incorporate waste minimization measures in clean-up techniques Investigate and evaluate alternatives to landfill disposal (BPEO/BAT application) 	<ul style="list-style-type: none"> Defines the clean-up techniques required for each substrate type Identifies resources available to support clean-up techniques Describes the programme required to investigate and evaluate alternatives, responsibilities and resources to implement the programme, and the process of decision making confirming the acceptability of alternatives

The WMP should cover all elements of the waste management activities, including: the legislative context in which it sits; the quantities and types of waste that may be generated under the spill scenarios in the contingency plan; the organizational and human resource arrangements; decision making processes; and all aspects of waste handling from collection and storage, through to final disposal.

The WMP should be documented, either within the oil spill contingency plan or as a separate document, appropriately cross-referenced within the oil spill contingency plan. An example of the contents list of a detailed oil spill waste management plan is contained in Appendix A, together with some useful questions to ask while establishing or reviewing plans.

It should be noted that the details of any part of the plan (legislation, waste treatment sites, contact lists, etc.) will become dated as circumstances change. A review process is required to ensure that the information in the plan is kept up to date. Where several organizations in the same geographic area are maintaining oil spill contingency plans, consideration can be given to making this review process more efficient through the sharing of information about external factors such as legislation, infrastructure and the results of audits and inspections.

At the stage of contingency planning, there exists a degree of uncertainty about the location, size and fate of a spill that may become the subject of a later response. This uncertainty about aspects of the actual spill translates into uncertainty about the precise requirements of the waste management activities required to support the spill response. The need for, and the precise locations of, some of the waste management infrastructure (e.g. storage sites) may be difficult to define and agree in advance of a spill.

Spill modelling and analysis of the potential wastes that may be generated will increase understanding of the scale, location and likelihood of the scenarios that may be faced. The WMP should be designed to deal with these scenarios and to accommodate any remaining uncertainty. In this respect, it should be:

- a) scalable—reflecting the range of scenarios that may occur, defining threshold points in logistical support needs;
- b) flexible—where uncertainty remains, establishing the processes and principles of decision making to be used when more information becomes available;
- c) risk-based—focusing planning effort on resolving barriers to effective waste management in proportion to risk factors; and
- d) timely—identifying matters that may involve long lead times (e.g. permitting, site selection and construction) and actions that may be taken in advance of a spill that seek to shorten this lead time.

The purpose of the contingency planning stage, therefore, is to establish the principles, overall framework and logistical needs of responses to the range of potential spills that may be encountered. The strategy and plan must be refined at the initial stage of an oil spill response effort to make it specific to the actual situation on the ground.

Waste management plan—the details

The plan should be examined in detail and exercised where possible in order to improve the chances of it being implemented successfully. Questions that should be addressed include: What human resources are needed to support the physical elements of the plan? What skills must they have and what process is required to find and employ these people? What management support information is required and who will deliver it? Providing answers to questions such as these can help to ensure the successful implementation of the plan and avoid difficulties arising later on. The response to the *Deepwater Horizon* incident (Case Study 5) illustrates some of the detailed arrangements that were necessary to support an effective response.

CASE STUDY 5: Waste management plan—some detailed considerations

Deepwater Horizon, USA 2010

The *Deepwater Horizon* spill in the Gulf of Mexico occurred in a location where there is a mature and extensive industry that is used to dealing with oil products and wastes. Marine and road transport, mobile containers and a variety of recycling and disposal sites were readily available for use by the response team. These allowed for an approach where intermediate storage sites were not needed despite the large scale of the clean-up operation. The logistics operation was managed such that waste could be picked up from the beachhead and dock facilities and delivered directly to final treatment and disposal sites. The value of this approach was that it effectively eliminated the environmental risks associated with the establishment, management and reclamation of intermediate disposal sites.

However, to manage such an operation effectively required a high level of operational control, supported by excellent information management that allowed transport resources to be directed in a timely manner to where they were needed. Overall, this was a massive clean-up operation that involved waste produced by both onshore and offshore activities and the resources of the waste management team were stretched considerably. Of the many factors contributing to operational success, the following five were notable:

- 1) Team member skills: in addition to technical skills, good interpersonal and communication skills, initiative, the ability to adapt to changing situations and a strong work ethic were important individual attributes.
- 2) Linkages to operations: open, timely and transparent communications between the waste management team and the operations staff enabled both parties to communicate the relevant aspects of the waste management plan, and to receive feedback where changing conditions required a change to the plan.
- 3) Data management: the establishment and use of a web-based data management system allowed staff at the clean-up sites to input relevant data concerning waste, and support staff to read, analyse and act on such information; this was critical in allowing real-time dispatching of containers and transportation equipment to the clean-up sites.
- 4) Maintaining compliance: this is a challenge for a large operation spread over a wide area including multiple States. Particular focus therefore was placed on a high level of inspection of, and liaison with, operational sites and personnel as well as audit of waste treatment and disposal activities.
- 5) Green alternatives: see Case Study 6.

For more detail on each of these factors see Sweeten, 2012.

Documentation, record keeping and data management

The waste management activity must be accompanied by a rigorous system of documentation, record keeping and data management. This system is required to manage the waste operation and to provide assurance that waste is stored, transported and disposed of in accordance with regulatory requirements as well as the waste management plan. Accurate records will be required to support financial claims that may be made, or to allocate payments for waste management services procured. In addition, there is often an interest in knowing the fate of the oil spilled and, in particular, knowing the quantity of oil recovered compared to that spilled.

Data should be generated for waste produced, transported, stored, treated and, finally, disposed of. It should differentiate between the various classes of waste determined as relevant for the spill. For responses covering multiple clean-up sites, storage facilities and waste management/disposal sites, the data management task may be large and complex. As well as recording weights or volumes of all types of waste generated and transferred between sites, analysis of samples may be desirable in order to estimate the quantity of oil in the waste. For accounting purposes it can be useful to maintain two types of 'balance sheet', one for waste and another for oil. The first provides a record of all waste produced and tracks its progress to final reuse or disposal. The second records the quantity of oil recovered and its fate.

The potential nature and magnitude of the data management task should be considered in the contingency planning stages, and outline protocols produced or resources identified with expertise in this area that can be contracted to assist in the event of a spill.

Waste consignment notes should be used to record the transfer of waste from one location to another and, in particular, where responsibility for managing the waste changes e.g. generator to transporter. A typical example of a waste consignment note is provided in Appendix B.

Data and records of the waste operation should be retained for a specified period after the spill response effort has finished. The minimum retention period for this information should be determined taking into account legislative, financial and external interest requirements and this should be detailed in the contingency plan or waste management plan.

Waste collection and storage

Waste collection

Collection should be organized so that waste material can be removed efficiently from the water or land. Techniques for collection should seek to minimize the quantity of waste generated, and segregate waste appropriately.

On-site/near-site temporary storage

The establishment and management of temporary storage of waste, where required, must remain a high focus area of the response operation. Mismanagement of key controls such as the waste inventory, tracking of waste movement, waste sampling or rainwater run-off may cause difficulties in terms of additional contamination, unsegregated waste or suboptimal treatment and disposal. These may add to the time, cost and potential environmental impact of the spill response operation.

On-site, temporary storage areas are often established close to the clean-up sites in order to facilitate the clean-up activity and place the oily waste in a position where it is not remobilized by the environment. These are usually small, short-lived, emergency areas for the immediate deposit of waste arising from a clean-up before transfer to an intermediate or long-term storage site or to a treatment and disposal facility. They may also be important locations for segregating and quantifying the types and volumes of waste, and for undertaking on-site pretreatment to reduce the volumes of waste requiring transport. It should be noted that, in certain circumstances, appropriate equipment and transport may be available which allows the oily waste to be transported directly from the contaminated site to a treatment/disposal facility without the requirement for on-site storage.

Where storage areas are required, particular consideration should be given to sites in close proximity to the clean-up sites; care should be taken to ensure that these are located away from sensitive areas or habitats, out of reach of the sea, tide, waves or variable river levels and away from residential areas. There should be sufficient space for waste segregation and, ideally, the sites should be accessible by road. The permission of landowners, the local authority and environmental regulators should be obtained before setting up the site. Consideration should be given, during contingency planning, to the need for and role of on-site/near-site temporary storage. Ideally, where possible, sites should be identified, agreed with the relevant parties involved and included in contingency plans. Where this is not possible, the contingency plans should include guidance on the criteria for site selection, and sensitivity maps should include information related to these criteria.

The temporary storage site should be prepared in a way that allows for safe and efficient handling and storage of waste, to avoid contamination of the surrounding area. Soil and subsoil should be protected with watertight membranes or geotextile, ideally underlain with fine gravel or sand to prevent puncturing of the membrane. Waste in containers should be protected from rainfall through the use of covers (e.g. tarpaulins or lids on containers) and drainage of the area should be through a channel system. In regions subjected to extreme heat, certain storage containers, especially plastic bags, should be protected from prolonged exposure to direct sunlight as this can cause breakdown of the material.

Table 6 Examples of temporary and on-site storage and relevant considerations

Storage type	Considerations
<p>At sea/on water</p>  <p>In-built vessel tanks Inflatable barges/bladders</p>  <p>Heated tanks</p>	<ul style="list-style-type: none"> • Wastes should be segregated to optimize storage, handling and disposal. • Water recovery should be kept to the minimum in order to maximize the space available for recovered oil. • The use of vessel-tanks can incur high costs, and these can be difficult to empty and clean after the operation. • Deck storage must be secured tightly to prevent spillage. • Lids are required to prevent spillage with vessel movement. • Heated vessel tanks are strongly recommended to ease the transfer of oil from the vessel. • When selecting at-sea storage, consideration should be given to shoreline transfer facilities to ensure that the waste can be transferred effectively.
<p>At the shoreline/on land</p>  <p>Skips Portable tanks</p>  <p>Sacks</p>  <p>Barrels</p>  <p>Lined pits</p>	<ul style="list-style-type: none"> • Wastes should be segregated to optimize storage, handling and disposal. • Storage tanks must be located on firm, level ground and designed to prevent secondary contamination. • Facilities should be within close proximity to the recovery, equipment to limit the potential for secondary contamination. • Adequate access is required for heavy vehicles to remove water and wastes from the site. • Storage facilities should be located above variable water levels, e.g. tidal ranges, flood prone areas. • A water-tight covering is required to prevent rainwater infiltration. • Rainfall run-off from potentially contaminated areas should be routed to an oil trap. • Pits must be lined with impermeable materials to prevent ground contamination. • Storage areas should be marked clearly and cordoned off where there is a risk to personal safety. • Security may be required to prevent unauthorized dumping.

On-site, temporary storage of waste in sacks laid on impermeable sheeting at the beachhead.

Storage containers should be labelled with the contents, quantities and relevant hazard labels before transportation, and relevant documentation passed to the driver or waste manager. In some countries this is enforced by legislation.

Storage equipment should be chosen and set up according to the site and pollution characteristics. Consideration should be given also to the accessibility of the site to transport. Table 6 presents several different examples of possible storage methods.



ITOPF

Intermediate storage

After the waste has been segregated and stored in appropriate containers on site it will often be transported to storage sites where it remains pending final disposal. In certain circumstances, where local infrastructure allows, the waste may go directly to a final reuse, recycling or disposal site (see Case Study 5). Where possible, this is preferred as it reduces unnecessary handling and opportunities for mismanaging wastes. Sending the waste directly to its final destination will also reduce the overall clean-up costs because of reduced handling, transportation and storage costs.

Figure 2, on page 6, shows alternative schematic geographical structures of the stages of waste storage. Efficient transfer and storage of recovered waste is an essential part of waste management. If waste is not removed from the recovery site, further operations could be hampered, both upstream and downstream.

The purpose of setting up intermediate waste storage is to establish a buffer site between the temporary storage at the clean-up sites and treatment facilities or long-term storage sites. This buffer helps to manage fluctuating waste flows and alleviates situations where the capacity of temporary

storage or treatment sites, or transportation, may be exceeded. The intermediate storage site also allows for the sorting, repackaging and accounting for waste before transferring to long-term storage or treatment.

Typically, these facilities should be temporary, existing for a few weeks to a few months, with the site being rehabilitated once all materials are transferred to long-term storage or to a treatment/disposal facility. However, in designing the site, the potential that it may be occupied for longer, even years, should be considered.

Below: removal of waste from the recovery site will allow the clean-up operation to continue unhampered.



A range of criteria should be considered when selecting a site (or sites) for intermediate storage, i.e. the site should:

- be able to service multiple temporary storage sites that are typically about 5 to 30 km away;
- be sited at an appropriate distance from residential areas;
- be situated on level ground, on a close-to-level gradient, or at a site that can be graded as such;
- allow for good access for heavy-duty lorries and other equipment, with consideration of the impact of traffic movements on the local road network;
- contain sufficient area to allow for effective waste segregation, decontamination of vehicles and machinery, an enclosed drainage system with oil traps, security fencing, and the establishment of a one-way traffic system;
- provide a means for protecting the waste from the elements (e.g. wind and rain);
- ideally, be situated at a location where the underlying surface of the storage area is impermeable; and
- be located away from wetlands, water catchment areas, areas prone to flooding or areas which form natural drainage paths.

The design of the facility should provide protection of the soil through the use of a thick, impermeable membrane plus geotextile and fine gravel to prevent punctures. An internal drainage system should be designed, incorporating an oil trap with a facility to recover the oil. Clean and potentially contaminated areas should be segregated, and the run-off from clean areas diverted away from the site. A one-way traffic system should be organized to facilitate efficient operation and minimize collision risks. In addition, an area should be designated for washing down lorries and other equipment.

It is recommended that the advice of specialists (e.g. hydrogeologists) is sought with regard to the design and siting of intermediate storage sites to ensure that the risk of further environmental damage and the potential for longer-term liability is minimized. The authorities should also be consulted to ensure that the sites comply with local regulations. In most cases a licence will need to be obtained from the local authorities. Temporary storage areas should be inspected regularly to ensure compliance with applicable regulatory requirements and proper containment. Any deficiencies identified during the inspection should be corrected as soon as practicable.

Operational management considerations for waste storage sites

- Waste handlers should have proof of competence such as legal registration or, where no such registration exists, demonstrable experience of waste handling.
- Batches of waste should be marked according to the type of waste and source, date received and date sampled.
- Documents should be retained for a defined period of time.
- Sites should be well set up in areas with good access routes.
- Storage containers should be compatible with the types of waste.
- Where feasible, consideration should be given to consolidating waste using compactors to reduce the volume of waste prior to storage or transport.
- Containers should be leakproof to avoid secondary contamination.
- All contaminated water produced on site should be dealt with in a way that prevents environmental damage.

Long-term storage

Long-term waste storage, i.e. for periods exceeding one year, allows:

- time for final disposal options to be confirmed or identified;
- the segregation of mixed wastes to be carried out;
- the preparation for final disposal, negotiating contracts, permits and time-scales etc.; and
- the controlled release of waste for treatment at rates that the available infrastructure can handle.

The principles of site selection and design for a long-term storage site are similar to those for the intermediate sites (see Table 7). In this case however, it is possible that the site may exist for several years, and this longer period of occupation must therefore be taken into account in the evaluation of factors relating to site selection and the quality of design. For example, additional facilities such as a dedicated unpacking area, fully watertight and lined pits, a drainage and water recovery system with water treatment plant, covered storage facilities and a venting system to prevent gas accumulations should all be considered. In addition, groundwater monitoring systems should be considered to ensure that the system protecting the soil and groundwater is working. Again, it is likely that the site will need to be licenced by the local authorities; specific conditions of the licence may be set regarding monitoring systems and reporting data.

In situations where there is an existing facility that may be available for use as a long-term storage site, its suitability for such use should be confirmed. This may include a review of the capacity of the site to take the additional waste from the oil spill operation, the site's licence conditions, and an operational record of the site owners. A pre-use audit of the facility and its management may be useful, and additional management controls should be identified if required to ensure appropriate handling of the waste from the clean-up operation.

In all cases of long-term storage, it is worthwhile considering a programme of periodic inspection and/or audit of the facility and its management to ensure a continued high standard of performance in pollution prevention and waste management.

Table 7 Summary of site selection, design and baseline considerations for intermediate and long-term waste storage sites

Criteria	Intermediate storage	Long-term storage
Occupancy	<ul style="list-style-type: none"> Plan on occupying the site for 0–1 years 	<ul style="list-style-type: none"> Plan on occupying the site for up to 10 years
Typical storage capacities	<ul style="list-style-type: none"> 1,500 to 3,000 m² surface area Storage pits (100–200 m³) Storage for debris, bags etc. 	<ul style="list-style-type: none"> 20,000 to 100,000 m² surface area Storage pits (1,000–10,000 m³) Sorting, pretreatment, stabilization
Distance from recovery or previous storage site	<ul style="list-style-type: none"> Usually not more than 5 km Occasionally up to 30 km 	<ul style="list-style-type: none"> Not more than 50–100 km or One hour by road from previous storage
Access and earthworks	<ul style="list-style-type: none"> Access by heavy lorries is preferable 	<ul style="list-style-type: none"> Access by heavy lorries necessary
Land conditions	<ul style="list-style-type: none"> Flat and graded, capable of accommodating settling tanks Rain run-off collection facilities may be required 	<ul style="list-style-type: none"> Flat and graded to accommodate settling tanks Build appropriate rain run-off collection facilities
Hydrogeological considerations	<ul style="list-style-type: none"> Load-bearing capacity must be adequate Impermeable subsoil, either natural or artificial Avoid groundwater systems 	<ul style="list-style-type: none"> Load-bearing capacity must be adequate Impermeable subsoil, either natural or artificial Avoid groundwater systems
Environmental conditions	<ul style="list-style-type: none"> At a safe distance from populated areas (typically > 100 m) Avoid cultural or archaeologically sensitive sites 	<ul style="list-style-type: none"> At a safe distance from populated areas (typically > 100 m) Plan for the impact of lorries Avoid cultural or archaeologically sensitive sites Buffer for sensitive areas
Baseline information	Information relevant to potential impacts and restoration requirements, e.g.: <ul style="list-style-type: none"> Soil quality Water quality 	Information relevant to potential impacts and restoration requirements, e.g.: <ul style="list-style-type: none"> Soil quality Water quality
Management and maintenance considerations	<ul style="list-style-type: none"> Sort waste Assess quantities Organize final disposal contracts Water management Security to prevent unauthorized dumping Site restoration 	<ul style="list-style-type: none"> Sort waste Assess quantities Organize final disposal contracts Water management Security to prevent unauthorized dumping

This information is usefully gathered during contingency planning to predetermine areas that are potentially suitable for waste storage.

Waste transportation

During clean-up operations both onshore and at sea, waste will have to be transported, both within the response area and further afield to storage and disposal sites. In some circumstances the waste may need to be taken to another country.

The transportation of waste within any operational site will require the use of small vehicles such as dump trucks, front-end loaders and all-terrain vehicles; in inaccessible areas landing craft or, in extreme cases, helicopters may be required. In some circumstances there may be no alternative to manual transfer. In such cases, particular attention should be paid during clean-up to maintaining a maximum size and weight of containers of waste material.

The transfer of waste from recovery sites to storage sites should also be carried out by suitable vehicles, e.g. tankers for liquid waste and sealed trucks for solid waste. In an emergency, a variety of vehicles not normally used for oil transport may be used. This may include vacuum trucks, tipper trucks, skips or refuse trucks. Sources of transport should, ideally, be identified in the contingency plan, and agreements made in advance.

The appropriate protection of different types of transport from oil contamination through, for example, lining with impermeable material, should be considered and defined. It is important to ensure that these transport vehicles do not leak and are carefully decontaminated before leaving the site in order to reduce secondary contamination of roads and access routes. Local legislative requirements should be given due consideration, and it should be noted that transport licences will often be required for the movement of hazardous wastes.

Particularly where heavy vehicles are used, transport routes should be planned to ensure that the operation is carried out efficiently, safely and with minimal risk to the environment and community. Where narrow roads are used, the options for establishing a one-way transport system



ITOPF



ITOPF

Right: on-site removal of waste from a beach which is inaccessible to vehicles; far right: airlifting bags of waste



ITOPF



ITOPF

Far left: transfer of waste to a barge which is lined to prevent contamination by oil; near left: on-site transfer of waste

should be evaluated and, where possible, implemented. Training and awareness raising for transport companies and drivers with regard to safety and the environmental risks of the operation is useful. Emphasis should be placed on safe driving at speeds suited to the road and usage by others.

Waste consignment

All transport of waste away from the clean-up site should be documented. This enables the organization generating the waste to exert a duty of care for its handling and disposal, to reduce the potential for fly tipping or other inappropriate storage or disposal, and to satisfy regulatory and public reporting requirements. Such documentation, which may take the form of consignment notes or similar, should record the quantity and type of waste picked up and the receipt of the same waste at the subsequent storage site, treatment or disposal facility. An example of a consignment note is provided in Appendix B. The documentation should record a chain of custody for the waste as the responsibility for handling and managing it is transferred between organizations.

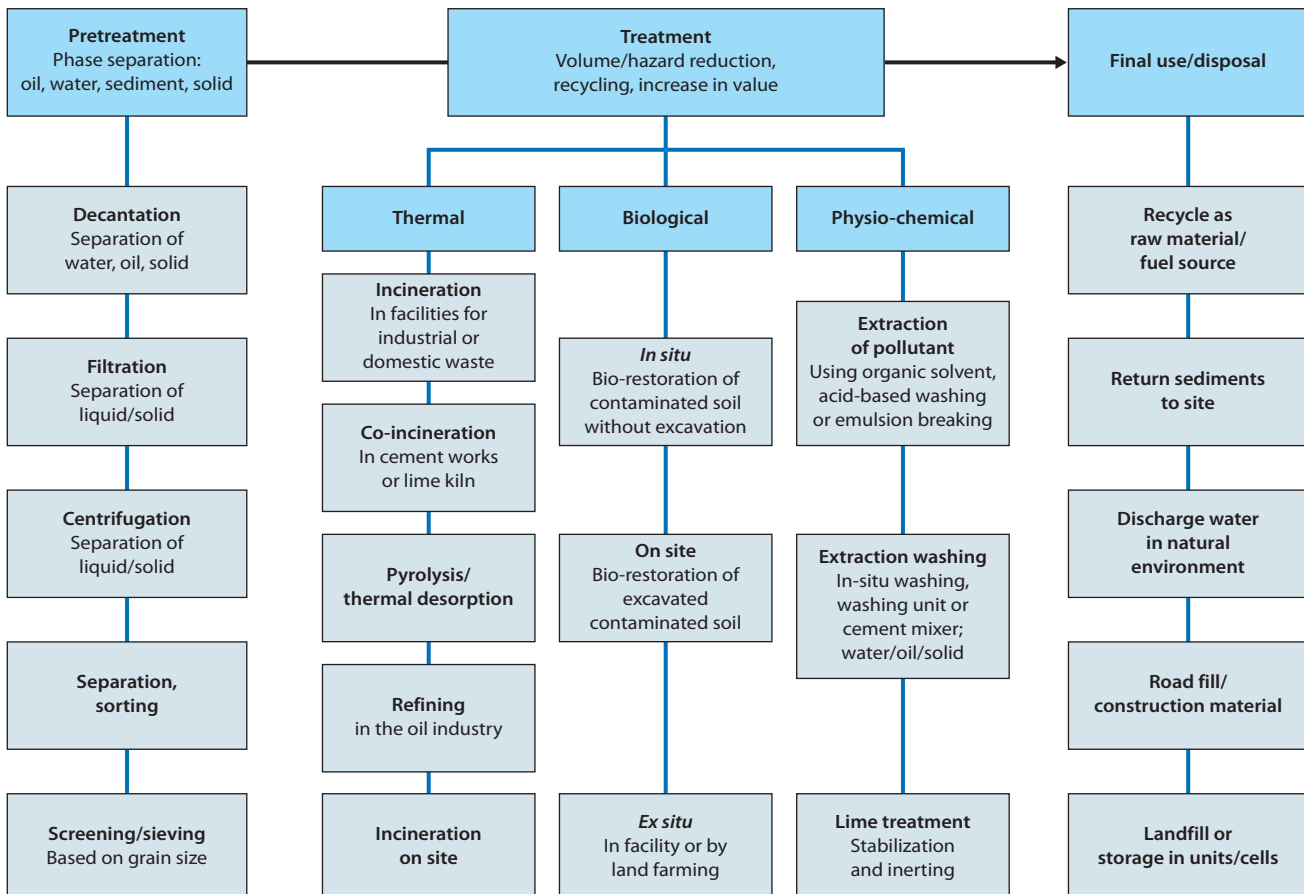
Waste pretreatment, treatment and final disposal

One of the objectives of any oil spill clean-up operation is ultimately to treat, recycle or dispose of the oily waste in an efficient and environmentally sound manner. The treatment and disposal options chosen will depend upon the amount and types of oil and contaminated debris, the location of the spill, environmental and legal considerations, the available infrastructure and the likely costs involved.

Three main categories of waste handling may be defined, i.e. pretreatment, treatment and final use/disposal. The objective of pretreatment is generally the separation of the different phases of the waste recovered (oil, water and solids). This may serve to reduce the quantity of waste material requiring treatment or disposal, or it may be used to separate the waste into components that are more easily handled, treated or disposed of. Treatment of the waste is a set of activities that reduce the waste quantity or its hazard status, or which recycle the waste or increase its value through recovery of energy or conversion to a material that may be used productively. Final management of the waste is through disposal, usually to land or water, or productive use of residual material that may be derived from the pretreatment and treatment activities.

The broad range of options available for each of these categories is summarized in Figure 6.

Figure 6 Summary of the options for pretreatment, treatment and disposal of oily waste (source: modified after CEDRE 2011)



Further information on a number of common classes of treatment and disposal options for waste generated during a spill response is provided in Table 8. Techniques are summarized along with some considerations for assessment of the suitability of the treatment/disposal method.

Table 8 Summary of treatment and disposal options available for oily waste

Treatment/disposal method	Techniques	Considerations
<p>Reprocessing</p> 	<ul style="list-style-type: none"> Oil is recovered with a low water and debris content and is then reprocessed through an oil refinery or recycling plant. Oil can then be reused—the preferred option as identified in the waste hierarchy (see Figure 3). 	<ul style="list-style-type: none"> Refineries cannot accept oil with a high salt content because it can cause irreversible corrosion damage to the pipework. Oil that is heavily contaminated with water, sediment and debris is also unacceptable.
<p>Oil/water separation</p> 	<ul style="list-style-type: none"> Separation generally occurs by gravity i.e. oily water is put into a lined pit and allowed to separate out. A skimmer is then used to remove the oil from the surface. Special separation equipment, portable or found at oil processing installations, is also often used. Specialist centrifuges or filtration technology may also be available for finer separation of oil from water. 	<ul style="list-style-type: none"> Oily water residue from separation techniques may then have to undergo further treatment, e.g. through a system of weir separators, as the hydrocarbon content will still be too high for release into the environment.
<p>Emulsion breaking</p> 	<ul style="list-style-type: none"> Heating can be used to break emulsions down to oil and water phases. In some cases specialized emulsion breaking chemicals may be required. Once separated the recovered oil can be blended into refinery feedstock or reprocessed. 	<ul style="list-style-type: none"> Any chemicals used may remain in the water after separation so additional water treatment may be required before release into the environment.
<p>Stabilization</p> 	<ul style="list-style-type: none"> The oil can be stabilized using inorganic substances such as quicklime (calcium oxide), fly ash or cement. Stabilization forms an inert mixture that reduces the risk of the oil leaching out and thus can be sent to landfill with fewer restrictions than free oil. 	<ul style="list-style-type: none"> Contact with quicklime can cause irritation to eyes, skin, respiratory system, and gastrointestinal tract. Quicklime reacts with water, releasing sufficient heat to ignite combustible materials. The waste product is often increased in volume. Although less hazardous, there is a greater quantity to manage. <p style="text-align: right;"><i>continued ...</i></p>

Table 8 Summary of treatment and disposal options available for oily waste (continued)


Treatment/disposal method	Techniques	Considerations
<p>Bioremediation</p> 	<ul style="list-style-type: none"> • Bioremediation is used to accelerate the natural, microbial breakdown of oil. • One example of bioremediation is land farming. Oily debris, with relatively low oil content, is spread evenly over the land and thoroughly mixed into the soil promoting natural breakdown of oil by microorganisms • For onshore spills, it may be possible to remediate contaminated soil or rock <i>in situ</i>, thereby eliminating handling and treatment of an oily solid waste. 	<ul style="list-style-type: none"> • Bioremediated material may need mixing at intervals to encourage aeration; fertilizer may be added if necessary and consideration should be given to the suitability of location e.g. adequate distance from potable aquifers. • Landfarms suitable for bioremediation are becoming difficult to find. • Space, climate and water availability considerations may limit the usefulness of this option. • Use a risk based approach to evaluate if in-situ bioremediation is the best practicable environmental option. • The suitability of an off-site bioremediation facility should be assessed before use to prevent secondary contamination and groundwater impacts.
<p>Beach washing</p> 	<ul style="list-style-type: none"> • Involves the cleaning of pebbles and cobbles, either <i>in situ</i> or at a separate treatment site. • For boulders and rocks coated in oil, cleaning may be carried out through washing on a grill allowing the oily water to drain off for treatment. • For light oiling, boulders and pebbles can be moved into the surf zone for natural cleaning. The wave energy will move them back into their original position over time. • During surf washing, pollutant is collected on the sea surface by net. 	<ul style="list-style-type: none"> • Removal of material for washing should only be considered when the sediments hold a large quantity of oil because it is time consuming, costly, produces a lot of oily water waste requiring treatment, and there is often difficulty in defining when material is oil free and can be returned to the beach.
<p>Sand washing</p> 	<ul style="list-style-type: none"> • The preferred method is through surf washing of the sand <i>in situ</i>. • During surf washing, pollutant is collected on the sea surface by sorbent nets, booms or snares. • For sandy sediments, specialist sand cleaning equipment can be used. • A suitable solvent may also be added, where permitted, to aid the process. 	<ul style="list-style-type: none"> • In general, excavation and washing of sand is not recommended. It is time consuming, costly, and produces a lot of oily water waste requiring treatment. It is often difficult to determine when sediment is oil- or solvent-free and can be returned to the beach. <p style="text-align: right;"><i>continued ...</i></p>

Table 8 Summary of treatment and disposal options available for oily waste (continued)

Treatment/disposal method	Techniques	Considerations
<p>Incineration</p> 	<ul style="list-style-type: none"> • A treatment technology involving the destruction of waste by controlled burning at high temperatures. In the instance of oiled waste, the high temperatures break down the hydrocarbons. The remaining solids are reduced to a less voluminous, generally inert ash. • High temperature industrial incinerators are able to deal with oily wastes. • Small quantities may be admitted to domestic waste incinerators. • Cement factories and kilns are often a permitted, viable method and will keep costs down, as treated waste can sometimes be used as a raw material or as an alternative fuel. • Incinerator options exist that are mobile and can be established at the spill clean-up site. 	<ul style="list-style-type: none"> • Up to 99% reduction in the volume of waste may be achieved. • The use of portable incinerators is often prohibited by legislation that stipulates that the location must be licenced and an environmental impact assessment carried out because of atmospheric pollution. • Oil recovered from the marine environment may contain salt; its highly corrosive nature may render the waste unsuitable for incineration. • High temperature industrial incinerators are limited in supply, making them unable to deal with large quantities of waste, and they are often costly. • Ash residue must be disposed of correctly.
<p>Pyrolysis and thermal desorption</p> 	<ul style="list-style-type: none"> • Pyrolysis is an example of high temperature thermal treatment. The method converts organic oily waste into gas and solid residues through indirect heating without oxygen. The process historically was used for distilling coal but is now used for dealing with industrial oil-polluted waste materials. • Thermal desorption aims to separate contaminants from sediments. This is achieved by heating the waste to vaporize the contaminants, without oxidizing them. • Thermal desorption can be carried out either as high temperature thermal desorption (320–560°C) or low temperature thermal desorption (90–320°C). The latter is most often used for remediating soils containing hydrocarbons as it enables treated soil to retain the ability to support biological activity and for reclamation of the oil without it 'cracking'. 	<ul style="list-style-type: none"> • Due to the specialized nature and sophistication of the plant, high costs may be incurred. • High organic or moisture content may increase costs and increases the difficulty of treating the gas emissions. • High sediment content can potentially damage the processor unit. Anything greater than 60 mm in diameter typically must be removed prior to processing.

continued ...

Table 8 Summary of treatment and disposal options available for oily waste (continued)

Treatment/disposal method	Techniques	Considerations
<p>Landfill</p> 	<ul style="list-style-type: none"> Oily waste containing a low percentage of oil (% variable depending on local circumstances) may be suitable for co-disposal with non-hazardous, domestic waste and taken to designated landfill sites. Established landfill sites are usually lined, which is a requirement for oily waste as it prevents the oil leaching out into surface water and aquifers. They are also usually covered daily, which prevents infiltration of rainwater thus reducing the potential for an increase in generation of leachate. 	<ul style="list-style-type: none"> The landfill sites may need special permission from the local regulatory authority to receive this type of waste and volumes are often limited. Chemical testing should be conducted to determine the hazardous content of the oil at this stage. Space and liability concerns are reducing the availability of landfill sites suited to taking oily waste. Subject to stringent long-term monitoring. Increases the long-term liability risk.

The most appropriate choice of treatment and disposal options will depend on the type of waste. Table 9 identifies some of the different treatment and disposal options available relative to different categories of waste that may be encountered. It is worthwhile, as part of the contingency planning process, to create a similar table to match the likely wastes that may be encountered with the practical options for treatment and disposal available locally.

Table 9 Compatibility of different treatment and disposal methods with various waste types

Waste type	Treatment/disposal method								
	Reprocessing	Oil-water separation	Emulsion breaking	Stabilization	Bioremediation	Sediment washing	Thermal treatment	Heavy fuel use	Landfill
Pure oil	✓	✗	✗	✗	✗	✗	✓	✓	✗
Oil and water	✓	✓	✓	✗	✗	✗	✗	✓	
Oil and sediment (fine or coarse)	✓	✗	✗	✓	✓	✓	✓	✗	✓
Oil and organic debris	✗	✗	✗	✓	✓	✗	✓	✗	✓
Oil and PPE/equipment	✗	✗	✗	✗	✗	✗	✓	✗	✓

CASE STUDY 6: Waste treatment and disposal—exploring ‘green alternatives’

Deepwater Horizon, USA 2010 (see also Sweeten, 2012b)

A gas release and subsequent explosion occurred on the *Deepwater Horizon* oil rig while drilling an exploration well at the *Macondo* prospect in the Gulf of Mexico. This resulted in a release of crude oil to the sea before the well was sealed. The offshore and onshore response involved, at its peak, some 47,000 people. To deal with the large quantity of liquid and solid oily waste that was being generated a waste management team of some 125 people was established, split between the command centres and the field sites. Part of this team was dedicated to finding and evaluating options to reuse or recycle the various waste types being generated, as a ‘Green Alternatives’ programme.

This programme tested the logistical feasibility of the promising options for recycling/reuse before implementing those that proved feasible in the circumstances of this spill. The options that progressed to full-scale implementation included:

- recycling polypropylene from sorbent boom for use in plastics for vehicle parts;
- recovery of energy from 3.8 million feet of damaged hard containment boom; and
- recycling and processing of liquid oil and emulsions to mineral oil products.

Although the use of oiled sand and tar balls as input materials for asphalt was eventually proven in concept, the time taken to satisfy the regulatory process for the pilot phase delayed full-scale implementation to the point where it was impractical to include it in the waste management programme.

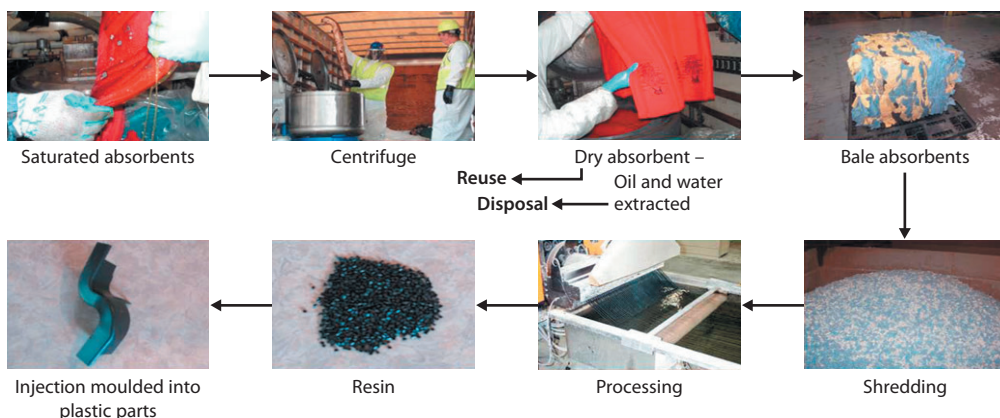
The key benefits of recycling/reuse and green alternatives included:

- preserving critical landfill space and/or treatment throughput capacity;
- creating useable products; and
- creating energy value.

Evaluation of the options available for pretreatment and treatment of waste should take account of the waste hierarchy in the decision making process, with the aim of establishing the Best Practicable Environmental Option (BPEO) or Best Available Technique (BAT) given the circumstances of the spill. Technologies that result in reduction or beneficial use of waste should be given priority where practicable.

For spills that produce large quantities of waste of different types it can be valuable to allocate accountability to a part of the response team to explore and evaluate recycling/reuse options. In some cases, as in the response to the *Deepwater Horizon* spill in 2010 (Case Study 6 and Figure 7), opportunities may become available that were not envisaged during contingency planning.

Figure 7 Illustration of a recycling process from boom material to plastic products



Courtesy of BP

Waste management—initial response actions

At the beginning of a response to an oil spill, the waste management strategy and plan must be refined to match the circumstances of the spill in question. In addition, certain early actions are useful to ensure the waste management element of the response starts in a timely manner. Some of the practical actions that can be taken are summarized in Table 10.

Table 10 Practical early actions to take in response to an oil spill to confirm and implement the waste management strategy

Aspect	Practical actions
Establish the nature of the task	<ul style="list-style-type: none"> • Gather information through <i>A guide to oiled shoreline assessment (SCAT) surveys</i> (IPIECA-OGP, 2014a), predicting likely locations, quantities and types of oily waste that will be produced. • Confirm the types of waste that may be expected. • Make an initial qualitative/semi-quantitative estimate of the likely volume of waste.
Take early action	<ul style="list-style-type: none"> • Notify applicable regulatory agencies. • Mobilize initial oil spill response teams. • Notify/mobilize waste management support companies. • Take early steps to minimize the oily waste produced. • Predict which coastline may be oiled and act to remove debris from that area prior to oil landing. • Deploy resources to minimize impacts on human health and the environment.
Waste management strategy and plan	<ul style="list-style-type: none"> • Confirm availability of permitted facilities and waste users. • Confirm storage capacity of existing infrastructure. • Consider the environment and the health of public and responders. • Refine the waste management strategy and plan, reflecting the practical situation. • Confirm classification of the wastes. • Define waste minimization and segregation needs. • Estimate infrastructure required to support the waste management strategy. • Identify issues to be resolved and allocate accountabilities for their resolution, including liaison with regulators.
Communication/training	<ul style="list-style-type: none"> • Ensure the spill management and clean-up teams are familiar with the defined waste management strategy. • Ensure good, ongoing communication links between the clean-up operations teams and those responsible for waste management.
Recruitment	<ul style="list-style-type: none"> • Set up a defined recruitment process to ensure human resource needs are met with suitably qualified individuals. • Ensure adequate staffing levels are available for a continuous response effort.
Compliance	<ul style="list-style-type: none"> • For complex logistical arrangements consider implementing a compliance assurance system including inspections, audits, waste management advisers at clean-up sites, consignment notes.
Green alternatives	<ul style="list-style-type: none"> • Test the options generated during contingency planning. It is possible that location, logistics, economics or regulatory hurdles may make an option unsuitable for this particular spill. • Identify and evaluate new options for reuse and recycling.

Conclusions

Waste management is an important component of most, if not all, oil spill response efforts. Furthermore, it may be one of the most significant aspects, in terms of both the operational impact and the environmental and financial burdens, in both the long and short term. Effective waste management facilitates an efficient clean-up operation, may reduce environmental risk/liabilities and enables environmentally beneficial actions through recycling, reuse or energy recovery. Conversely, poor management of waste may hamper the clean-up effort, increase environmental risk and financial cost, and potentially generate longer-term liabilities from secondary contamination.

The waste management activities may be complex and require significant resources. They may involve multiple types of waste, both oily and non-oily, be controlled by national and, potentially, international legislation, and require a logistics chain of waste collection and transportation, temporary storage site(s) and multiple recycling and/or disposal sites.

For the effective management of waste it is essential that this potential for complexity and the issues it may raise are well understood in advance of a spill event so that they can be planned for and mitigated. Waste management planning for oil spill response, therefore, is a fundamental part of the contingency planning process and principally involves:

- anticipating the types, associated hazards and potential quantities of wastes that may be generated in oil spill scenarios;
- identifying the legal requirements relating to all potential waste types and, specifically, how they are managed, in terms of their storage, transportation, treatment and disposal;
- identifying the existing baseline infrastructure of waste storage sites, transport, treatment and disposal facilities and their capability;
- establishing the waste management objectives of a clean-up, ideally building into the design of the clean-up strategy the concept of the waste management hierarchy, and especially prioritizing waste avoidance and reduction; further, for wastes generated, identifying and giving priority to options that recover, reuse or recycle material or energy;
- establishing a waste management strategy and plan as a component of the contingency plans that identify the waste management requirements and resources available to implement the plan.

This planning process should highlight potential risks to the efficient execution of a waste management plan. Identifying and understanding these risks in advance can enable appropriate mitigating actions to be taken in a timely manner.

In the event of a spill, the waste management strategy and plan should be re-examined and refreshed to ensure that they reflect the practical situation encountered and complement the clean-up strategy for this particular response. Key decisions on the solutions for the management of waste are best confirmed during the initial response effort when it is possible to make realistic expectations of waste quantity and type.

The use of good practice techniques described in this document, together with the development and implementation of an effective waste management plan, complementing the oil spill contingency plan, should contribute to an effective response to an oil spill.

References and further reading

CEDRE (2011). *Guidance on Waste Management During a Shoreline Pollution Incident. Operational Guidelines*. Detailed and practical manual guiding all aspects of waste management during a shoreline pollution incident. Useful tips and checklists on what to do and what not to do for each aspect. Points are well illustrated with diagrams and photographs. (80 pages.)

IPIECA/ITOPF (2007): *Oil Spill Compensation: A Guide to the International Conventions on Liability and Compensation for Oil Pollution Damage*. A guide providing a summary of the fundamental features of the Conventions. Comprises an explanatory text and a series of answers to commonly asked questions. (21 pp.)

ITOPF (2011). *Disposal of Oil and Debris. Technical Information Paper no. 9*. This paper summarises the nature of waste generated from oil spills and how to minimize, handle, store, transport and treat such waste. Based on extensive experience of ITOPF in spill response. Usefully illustrated with photographs. (11 pp.)

MCA (2010a). *Planning the Processing of Waste arising from a Marine Oil Spill: Part 3: Post Incident Planning*. Maritime and Coastguard Agency. Establishes a process for reviewing and confirming the waste management strategy at the time of an oil spill incident. Created for the purpose of dealing with an oil spill incident in the UK, the principles within the document have wider applicability. (202 pp.)

MCA (2010b). *Planning the Processing of Waste arising from a Marine Oil Spill; Part 4: Information and Data*. Maritime and Coastguard Agency. Contains useful data sheets for a wide range of treatment and disposal options for oil spill waste. (85 pp.)

IPIECA-OGP (2012). *Oil spill responder health and safety*. Details the health and safety considerations necessary during oil spill response. Applies to all aspects of the response. (38 pp.)

IPIECA-OGP (2014a). *A guide to oiled shoreline assessment (SCAT) surveys*.

IPIECA-OGP (2014b). *In-situ burning of oil* (in progress).

IPIECA-OGP (2014c). *Dispersant use on oil spills at sea* (in progress).

IPIECA-OGP (2014d). *Contingency planning for oil spills on water* (in progress).

IPIECA-OGP (2014e). *Mechanical recovery* (in progress).

IPIECA-OGP (2014f). *Inland response* (in progress).

IPIECA-OGP (2014g). *Economic assessment and compensation for marine oil spills* (in progress).

Polaris (2009). *Guidelines and Strategies for Oil Spill Waste Management in Arctic Regions*. Focuses on the considerations that are integral to the selection of practical and feasible strategies and tactics for arctic regions and, in particular, for areas that are remote from existing waste management infrastructure. (115 pp.)

Sweeten D. W. (2012). *Keys to Successful Response Waste Management Programs: Experience from the Deepwater Horizon*. SPE Paper 157513.

Sweeten D. W. (2012b). *Integrating Green Waste Management Strategies into Emergency Response Waste Management Programmes: Examples from the Deepwater Horizon Response*. SPE Paper 157514.

Dollhopf, R. and Durno, M. (2011), Kalamazoo River/Enbridge Pipeline Spill 2010. *Proceedings of the 2011 International Oil Spill Conference*, American Petroleum Institute, Washington DC.

Appendix A: Example structure of an oil spill waste management plan

Subject	Content	Useful questions to ask in planning
Introduction	Statement of scope, applicability, and references to supporting documents.	<ul style="list-style-type: none"> Is this plan consistent with, and integrated or cross-referenced within, the oil spill contingency plan?
Scope and responsibility	Statement of personnel, parties involved, and spill management roles assigned to responsibilities in the waste management process.	<ul style="list-style-type: none"> What specialist resources with regard to waste management will be needed for the various sizes and locations of spill? Where will these resources come from? Are there local waste management companies that are competent to provide the waste management part of the spill response team? Is the available local workforce sufficient for the initial response to oil spill clean-up efforts? Are emergency response contracts in place to work with local waste contractors and facilities in the event of a spill? Have waste management training and drills been defined and scheduled?
Legal requirements	List and describe applicable regulations and laws and how waste management will comply with requirements.	<ul style="list-style-type: none"> What is the applicable legislation that controls the treatment and disposal of oily waste? Who are the regulators that need to be consulted about waste storage, treatment and disposal? Are there aspects of legislation that could prevent the efficient and environmentally conscious storage, treatment and disposal of oily waste in the event of a spill?
Policy/strategy	Statement of policy/strategic objectives for waste management, including, for example, waste minimization, early planning, recycling, and disposal.	<ul style="list-style-type: none"> Are waste management matters clearly addressed in the clean-up objectives? What strategy/policy statements are required for waste management?
Decontamination	Procedures and responsibilities for equipment and personnel decontamination (or cross-reference where this is developed elsewhere).	<ul style="list-style-type: none"> Are arrangements in place to decontaminate equipment and personnel to prevent secondary contamination?
Wastes and classification	Describe expected or typical wastes generated from spill response, how these are classified, tests or procedures to be used to classify and segregate wastes, and packaging and labelling (where and if appropriate).	<ul style="list-style-type: none"> What types of waste are likely to be produced? What quantities of waste may be produced given the spill scenarios evaluated in the plan? What laboratory testing will be required?
Recovered oil, oily water and liquid mixes	Describe procedures for handling recovered oily liquids, including those from pumping (from tanks, pipelines, etc.) and skimming. 1. Initial process 2. Decanting (oil/water separation) 3. Storage 4. Recycling	<ul style="list-style-type: none"> How is liquid waste to be handled and stored?

continued ...

Appendix A: Example structure of an oil spill waste management plan (continued)


Subject	Content	Useful questions to ask in planning
Oily debris	<p>Describe procedures for handling recovered oily solids, including sorbents, oiled sediments or substrates, PPE, hoses, etc.</p> <ol style="list-style-type: none"> 1. Segregation 2. Testing 3. Containers 4. Interim storage 5. Burning 6. Transportation 	<ul style="list-style-type: none"> • What method(s) of oily waste collection is (are) required to minimize the quantity of waste produced? • Is specialist equipment required? • What PPE will be needed for the personnel conducting clean-up efforts?
Non-oiled material	<p>Describe procedures for handling solids that are not oiled. These are typically wastes generated at facilities, such as containers and refuse from food, water and services.</p> <p>Most often these follow standard (not oil spill) waste stream procedures.</p>	<ul style="list-style-type: none"> • What other, non-oily wastes will result from the clean-up operation—from support activities such as catering and sanitary facilities, for example?
Animal carcasses	<p>Describe procedures for handling carcasses (oiled and non-oiled). Generally entails coordination with government agency/agencies and, in cases, detailed logs and chain of custody.</p> <p>Typically coordinated with Wildlife Response Plan and teams.</p>	<ul style="list-style-type: none"> • Is there a risk of oiled wildlife? • How are animal carcasses to be dealt with?
Transportation	<p>Identify licensed transportation companies, contacts, agreements, capabilities and limitations.</p>	<ul style="list-style-type: none"> • What vehicles are available locally that can be used? • What additional materials would be needed to protect the vehicles from oil pollution and prevent leakage? • From where will these be obtained? • What transportation routes are available for use during oil spill response efforts? • What natural resources or sensitive areas along the transportation route need protecting?
Disposal and recycling facilities	<p>Identify licensed disposal and recycling companies, contacts, agreements, capabilities and limitations.</p>	<ul style="list-style-type: none"> • What facilities exist for treatment and disposal of oily waste? • Is this listed with contact details, and available to a response team? • What is the capacity of their storage and rate of treatment of waste in the event of a spill? • What options are available for the recycling/reuse of waste? • What factors would prevent the use of these options and what implications does this have for waste collection/segregation?

continued ...

Subject	Content	Useful questions to ask in planning
Resources and logistics	<p>Define the generic structure of the logistics chain(s); identify threshold points in size of spill response where they influence this generic structure.</p> <p>List or cross-reference equipment available (facility, company, local), capacities, points of contact, and limitations for temporary waste storage, oil-water separators, labs and test facilities, transportation (water, land and air, as appropriate), and disposal.</p> <p>Define requirements for temporary waste storage, including site selection criteria, baseline information required, generic design requirements.</p>	<ul style="list-style-type: none"> • Are appropriate quantities of suitable storage receptacles identified and available? • What network of waste storage sites will be required? • Have suitable sites (or unsuitable locations) for on-site storage been added to coastal sensitivity maps and GIS databases? • Is there sufficient existing infrastructure to make the setting up of intermediate storage sites unnecessary? • What options exist for intermediate storage sites? • Have generic design requirements of storage sites been defined and agreed to enable rapid implementation? • What environmental baseline information is required before using storage sites?
Record keeping and reporting	<p>Define what records need to be generated, reported and kept (e.g. for legal, compensation or cost recovery reasons), including arrangements for recording waste generated, transported (consignment notes) and disposed of.</p>	<ul style="list-style-type: none"> • What records will need to be generated? (e.g. waste quantities, consignment notes, laboratory analyses). • How should these records be stored and for how long?
Operational control and assurance	<p>Describe what activities are required to ensure work is being conducted in accordance with the plan (e.g. inspections, audit, organizational measures).</p>	<ul style="list-style-type: none"> • What organizational, inspection and audit arrangements are needed to ensure compliance with the plan?
Action plan	<p>Define actions that are to be taken to address identified issues with regard to any of the above plan elements.</p>	<ul style="list-style-type: none"> • Has anything changed since the plan was developed or last reviewed (e.g. legislation, treatment or disposal sites, oil spill risk assessment, etc.)? • What is the significance of these changes? Does the plan need to be updated? • What actions need to be taken prior to a spill in order to allow an effective waste management response? What barriers need to be overcome? Do call-off contracts need to be established?

Appendix B: Example of a hazardous waste consignment note

The note is completed by the waste producer, transporter and receiving waste management facility, each retaining a copy of the completed note.

Form HWCN01v111							
The Hazardous Waste Regulations 2005: Consignment Note					 Environment Agency PRODUCER'S/HOLDER'S/CONSIGNOR'S COPY (Delete as appropriate)		
PART A Notification details							
1 Consignment note code: <input type="text"/>			4 The waste will be taken to (name, address and postcode):				
2 The waste described below is to be removed from (name, address, postcode, telephone, e-mail, facsimile):			5 The waste producer was (if different from 2) (name, address, postcode, telephone, e-mail, facsimile):				
3 Premises code (where applicable): <input type="text"/>							
PART B Description of the waste If continuation sheet used, tick here <input type="checkbox"/>							
1 The process giving rise to the waste(s) was:			2 SIC for the process giving rise to the waste: <input type="text"/>				
3 WASTE DETAILS (where more than one waste type is collected all of the information given below must be completed for each EWC identified)							
Description of waste	List of wastes (EWC code)(6 digits)	Quantity (kg)	The chemical/biological components in the waste and their concentrations are:		Physical form (gas, liquid, solid, powder, sludge or mixed)	Hazard code(s)	Container type, number and size
			Component	Concentration (% or mg/kg)			
The information given below is to be completed for each EWC identified							
EWC code	UN identification number(s)	Proper shipping name(s)	UN class(es)	Packing group(s)	Special handling requirements		
PART C Carrier's certificate			PART D Consignor's certificate				
(If more than one carrier is used, please attach schedule for subsequent carriers. If schedule of carriers is attached tick here: <input type="checkbox"/>) I certify that I today collected the consignment and that the details in A2, A4 and B3 are correct and I have been advised of any specific handling requirements. Where this note comprises part of a multiple collection the round number and collection number are: <input type="text"/> / <input type="text"/>			I certify that the information in A, B and C has been completed and is correct, that the carrier is registered or exempt and was advised of the appropriate precautionary measures. All of the waste is packaged and labelled correctly and the carrier has been advised of any special handling requirements. I confirm that I have fulfilled my duty to apply the waste hierarchy as required by Regulation 12 of the Waste (England and Wales) Regulations 2011.				
1 Carrier name: On behalf of (name, address, postcode, telephone, e-mail, facsimile):			1 Consignor name: On behalf of (name, address, postcode, telephone, e-mail, facsimile):				
2 Carrier registration no./reason for exemption:							
3 Vehicle registration no. (or mode of transport, if not road):							
Signature Date <input type="text"/> Time <input type="text"/>			Signature Date <input type="text"/> Time <input type="text"/>				
PART E Consignee's certificate (where more than one waste type is collected all of the information given below must be completed for each EWC)							
Individual EWC code(s) received	Quantity of each EWC code received (kg)	EWC code accepted/rejected	Waste management operation (R or D code)				
1 I received this waste at the address given in A4 on: Date <input type="text"/> Time <input type="text"/>							
2 Vehicle registration no. (or mode of transport if not road):							
3 Where waste is rejected please provide details:							
I certify that waste permit/exempt waste operation number: <input type="text"/> authorises the management of the waste described in B at the address given in A4.							
Where the consignment forms part of a multiple collection, as identified in Part C, I certify that the total number of consignments forming the collection are: <input type="text"/>							
Signature Date <input type="text"/> Time <input type="text"/>							

HWCN01v111

Terminology and abbreviations

AFFF	Aqueous film forming foams
Best Available Technique (BAT)	The technology and/or operating practice that is most effective in achieving a high level of protection of the environment as a whole, subject to availability and a cost/benefit test.
Best Practicable Environmental Option (BPEO)	For a given set of objectives, the option that provides the most benefits or the least damage to the environment, as a whole, at acceptable cost, in the long term as well as in the short term.
CEDRE	Centre de documentation, de recherche, et d'expérimentations sur les pollutions accidentelles des eaux (Centre of Documentation, Research and Experimentation on Accidental Water Pollution)
FFFP	Film forming fluoroprotein
ITOPF	International Tanker Owners Pollution Federation
PPE	Personnel protective equipment
WMP	Waste management plan

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UK Maritime Coastguard Agency (MCA)

Oil Spill Response Limited (OSRL)

Owens Coastal Consultants Ltd



IPIECA is the global oil and gas industry association for environmental and social issues. It develops, shares and promotes good practices and knowledge to help the industry improve its environmental and social performance; and is the industry's principal channel of communication with the United Nations. Through its member led working groups and executive leadership, IPIECA brings together the collective expertise of oil and gas companies and associations. Its unique position within the industry enables its members to respond effectively to key environmental and social issues.

www.ipieca.org



OGP represents the upstream oil and gas industry before international organizations including the International Maritime Organization, the United Nations Environment Programme (UNEP) Regional Seas Conventions and other groups under the UN umbrella. At the regional level, OGP is the industry representative to the European Commission and Parliament and the OSPAR Commission for the North East Atlantic. Equally important is OGP's role in promulgating best practices, particularly in the areas of health, safety, the environment and social responsibility.

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