Oil Spill Waste Management

OPERATIONAL GUIDE

Cedre

Cover photo: final waste storage site used during the Prestige *pollution.*
Zierbena, port of Bilbao, Spain, March 2003.
Source: Cedre

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OPERATIONAL GUIDE

INFORMATION

DECISION-MAKING

RESPONSE

This guide was written and produced by *Cedre*, the Centre of Documentation, Research and Experimentation on Accidental Water Pollution, as part of its technical program, with financial support and advice from the Ministry of Equipment and Transport (Direction du Transport Maritime des Ports et du Littoral) and the Ministry of Ecology and Sustainable Development (Direction de l'Eau).

Translated and adapted by Sally Ferguson from the French version published in February 2004.

Purpose of this Guide

In the event of accidental shoreline pollution, clean-up operations inevitably generate all kinds of waste materials, sometimes in great quantities. Their management, up to and including their final disposal and the complete restoration of all sites, can cause major problems for response co-ordinators. The options chosen must be in accordance with the regulations in force and ensure traceability throughout the entire chain. Communication should be rapid, accurate and transparent.

It is essential to make appropriate decisions at as early a stage as possible in order to control the situation and avoid hindering clean-up operations. This both facilitates the work in progress and helps to bring an end to the crisis, both in terms of image and cost.

The aim of this guide is to provide the information needed to help in initial decision-making in an emergency situation.

This information is mainly intended for response officials in charge of waste management in the event of an oil spill, in particular when a specialised land-based contingency plan is activated. This guide provides information in particular for officials that will man the 'operations' and 'logistics' units of response centres.

WASTE MANAGEMENT IS OFTEN THE LONGEST AND COSTLIEST OPERATION INVOLVED IN CLEAN-UP AFTER A MAJOR OIL SPILL.

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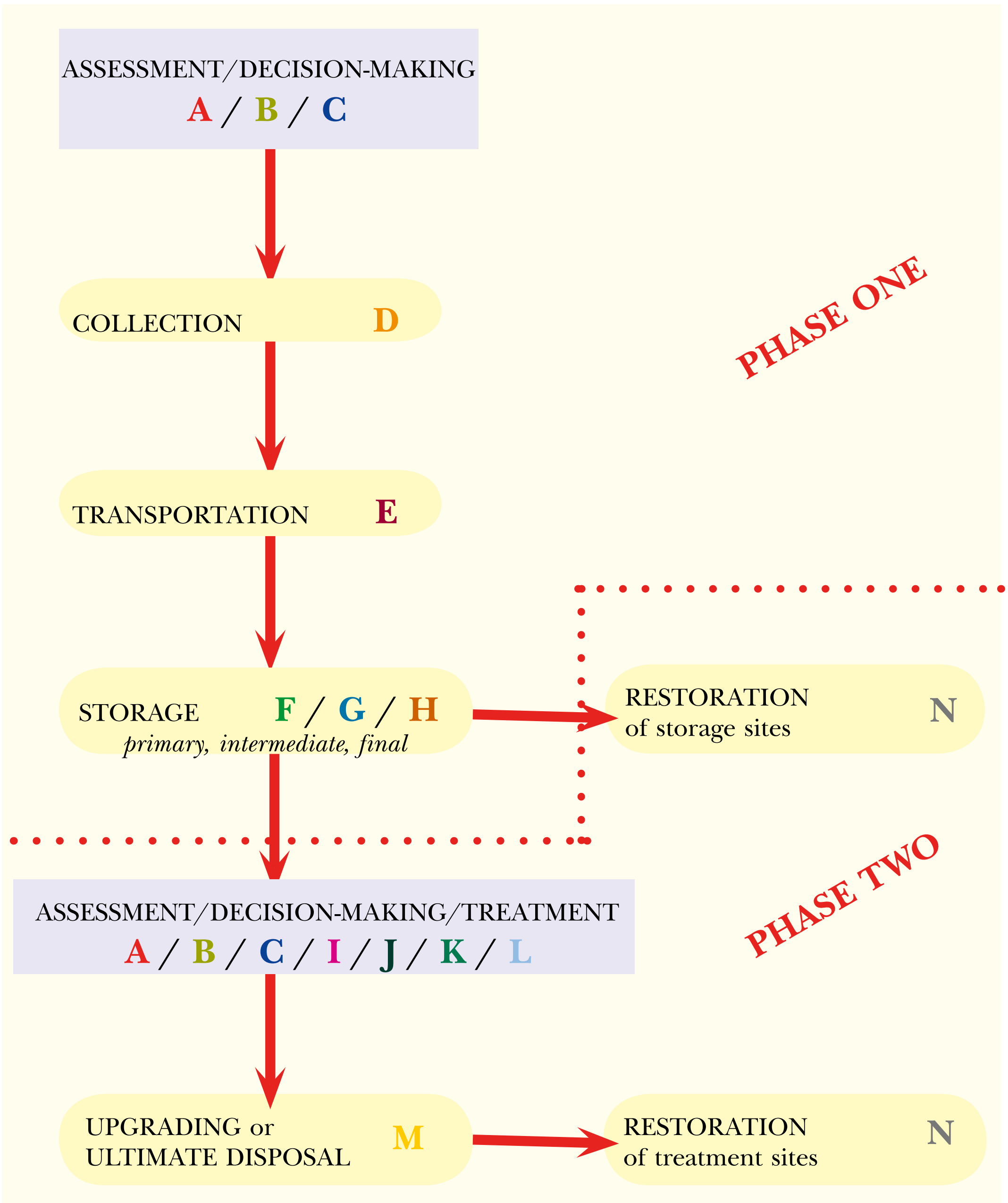
Structure

This guide was designed based on the chronological order of operations. It is made up of two main phases, with prior evaluation and decision-making processes. Phase one comprises storage and transportation, while phase two consists of pollutant treatment and disposal.



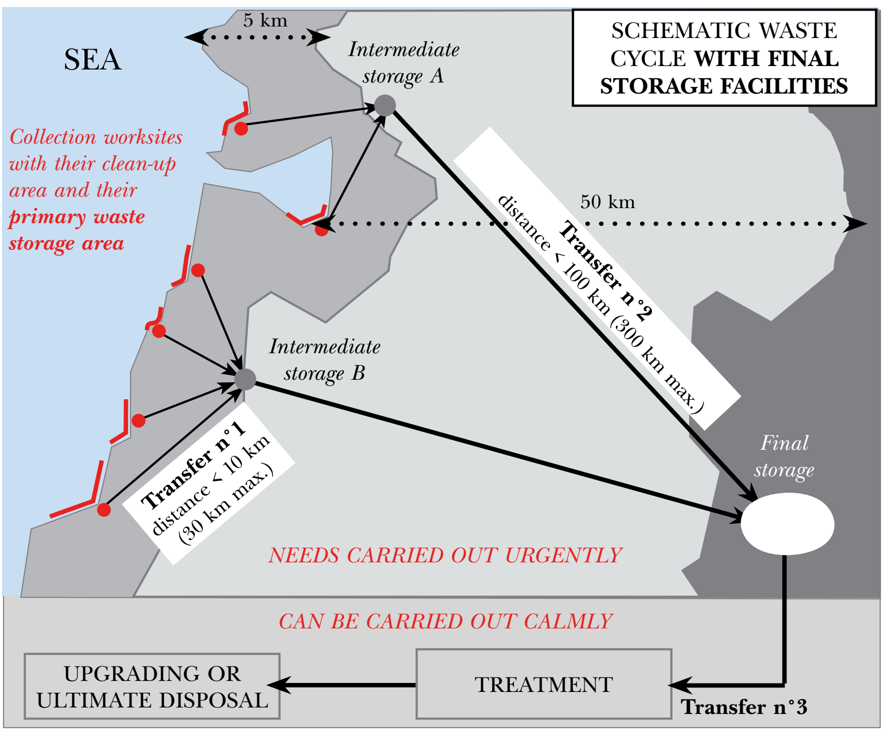
Phase one should take place at the same time as operations begin. It incorporates:

- primary storage facilities, in the immediate vicinity of the site and linked to the duration of the site
- intermediate storage facilities, serving several primary storage sites, cordoned off a few hundred metres or even several kilometres from the clean-up sites (these intermediate storage sites are closed once operations on the clean-up sites have been completed)
- final storage area(s), pooling all the separated polluted waste from one geographical area, which can last over a year depending on the performance of phase two
- transportation between storage sites.

A weak link in this chain will reduce the response capacity of the whole process.

The implementation of **phase two** can be deferred. This stage includes:

- treatment processes, with different procedures suitable for different waste types
- upgrading or disposal of treated waste
- restoration of all sites used at some point.



For the *Prestige* pollution, no final storage sites were set up in France. Waste was directly transferred from intermediate, or even primary, storage sites to treatment plants.

Overall Strategy

Basic rules:

- Have an up-to-date contingency plan
- Keep waste to a minimum (be selective)
- Avoid soiling the surrounding environment
- Prevent overflow, congestion and stand-stills
- Sort waste during phase one as far as possible
- Ensure transparency and traceability of processes
- Recycle or upgrade as much treated waste as possible
- Promptly restore all sites involved

In an emergency, you will need ready-to-use operational solutions.
This is the role of contingency planning, which means having tangible objectives such as agreements with specialised service providers and identification of potential intermediate and final storage sites.
Storage facilities are the most vital tool in waste management.
This requires secure storage areas in terms of the environment and human health and safety:
- local intermediate storage facilities near the shoreline, allowing rapid evacuation of collected waste on a daily basis generally in very sensitive coastal areas
- where necessary, final storage sites for the whole geographical area, which are temporary but longer term installations.

Requirements must be anticipated as much as possible to reduce the time needed to implement legislation (government authorisation, information campaigns...) and to outsource (laboratory analysis, calls for tenders, calls for bidders...).
Efficient waste management as part of contingency planning will require regular updating, particularly in relation to:
- developments in legislation and technology
- the inventory of treatment and disposal facilities.

Types of Waste

B

Fuel oil from the Prestige *spill on Barañan beach. Galicia, Spain.*

B1

Origins

The characteristics of polluted waste vary according to the type of pollutant and the response worksite, and in particular depending on the weather conditions, the type of foreshore and collection and storage methods. Polluted materials evolve over time, both in quality and quantity. They can be divided into two categories: liquid waste and solid and varied waste.

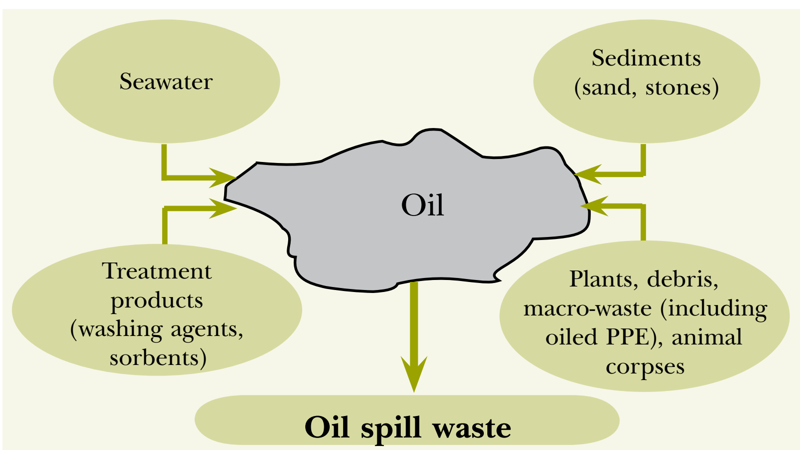
Liquid waste is produced during recovery operations at sea, inshore, in harbour areas, or in drainage ditches on land. They generally have a high pollutant or emulsion content, which varies with the extent of oil-water separation or water disposal techniques used during recovery and storage operations. The separation of pollutant for recycling does not normally cause any major difficulties.

Solid and varied waste is produced during land-based shoreline clean-up operations, which are generally carried out in two phases:

- initial clean-up to remove the bulk of the pollutant to prevent the pollution from being reclaimed by the sea and spreading to other areas.
  → *production of waste with a relatively high pollutant content (generally in the form of a paste), at a high rate (especially when using mechanical recovery)*
- final clean-up to allow normal shoreline activities to be resumed
  → *production of far more varied waste with fewer polluted solid materials, liquid washing effluents (pollutant, water, mud), used response products and materials.*

All worksites generate specific waste according to the means and protective clothing used: sorbents, various tarpaulins, Personal Protective Equipment (PPE)...

The fuel oils recovered at sea from the *Erika* and the *Prestige* were able to be recycled in thermal plants after simply screening out solid waste and emulsion-breaking by heating.



Diversity

Every oil spill produces specific waste according to:

- the quality of oil spilled
- the sea and weather conditions
- the substrate and the presence of seaweed and debris
- the quantities recovered.

The quality of oil spilled determines the initial properties of pollutant and its intrinsic weathering parameters:

- loss of light fractions (atmospheric evaporation or dispersion in the water)
- partial break down (effect of ultraviolet rays, biodegradation)
- formation of emulsions (incorporation of water with great increase in viscosity)

The prevailing weather and sea conditions and the length of time the pollutant remains in the environment influence the evolution of the pollutant, up until recovery and throughout the waste management process. A rough assessment of this evolution is possible in a few hours through modelling, based on comparable substances. More accurate assessment may be obtained some 2 to 3 weeks later through tests on the product itself.

Depending on the area polluted, the season and the response techniques employed, the waste recovered will contain varying amounts of sediments, seaweed and debris. The type and percentage of incorporation of sediment, seaweed and debris affect the physical appearance of the waste and its evolution over time.

Waste production varies greatly from one pollution incident to another and is not necessarily directly proportional to the size of the spill. The techniques used and the organisation of recovery have an effect on the quantities recovered, waste characteristics (according to its weathering) and the content of seaweed and other debris.

__Manual collection in individual bags__ is a very selective method but poses serious handling problems (fragility of bags, overflowing...).
→Hence the importance of being organised, to avoid waste being deposited haphazardly and unaffected surfaces being soiled. Organisers should make sure that well located, isolated, primary storage facilities are set up and that they are emptied daily.

B3

Waste Categories

The recording and storage of polluted waste can be divided into 7 categories, each corresponding to distinct management and treatment processes.

Category	% oil	% water (free)	Mineral matter	Organic matter	Comments
Liquids	> 10%	0 to 90%	< 10%	< 10%	Remove as much water as possible by settling
Pastes and solids (sand...)	> 10 %	10% to 20%	> 10%	< 10%	Define threshold according to pollutant
Polluted pebbles and stones	> 10 %	1%	> 80%	< 10%	Choice criterion: degree of surface polluted
Polluted sorbents	> 5%	< 10%	< 10%	< 5%	Bulk, mops, pillows, sheets...
Polluted seaweed	> 5%	< 20%	< 20%	> 80%	Fermentable substance ➔ Oleofactory disturbance
Polluted solid waste	> 5%	< 10%	< 10%	variable	Including gloves, boots, overalls...
Polluted fauna	> 5%	< 15 %	< 10%	> 70%	Bird and mammal corpses

NB: the percentages, given in weight, simply provide an indication of the relative values.

Sand with high heavy fuel oil content
The emulsion can be broken (separation of oil and water) by raising the temperature, thus making the oil blacker, stickier, stronger-smelling and runnier, hence the importance of watertight storage facilities.

Legislation

(State on 27 February 2004)

C

Recovery of polluted effluents on sorbent pom-poms, frost protection cover and boom. Main beach at Lacanau, Gironde, France.
→ Sorbents to be treated in a specific way (incineration), needing therefore to be stored separately.
Source: Cedre

Classification of Oil Spill Waste

C1

The European Directive n°75-442/EEC of 15 July 1975, as amended by Directive 91-156 of 18 March 1991, refers in annex 1 to “materials spilled, lost or having undergone other mishap, including any materials, equipment, etc., contaminated as a result of the mishap” (category Q4). The only known case in France relating to the characterisation of waste containing hydrocarbons (Commune of Mesquer against SA Total Raffinage Distribution, at the High Court of Rennes – judgement on 13 February 2002) refers to 3 texts:

- the French law of 15 July 1975, relating to waste disposal and material recovery, of which the main part was incorporated into the French "Code de l’Environnement" in 2000 (article L 541-1 and succeeding articles)
- the French order n°97/517 of 15 May 1997, relating to the classification of dangerous waste, reiterating the European Community’s list of such waste and defining the waste categories which, according to article 2-1 of the 1975 law, cannot be deposited in storage facilities receiving other categories of waste. This order was repealed and amended by the order 2002-540 of 18 April 2002, which specified the EWC (European Waste Catalogue) code of materials polluted by hydrocarbons as the 050105: accidentally spilled hydrocarbons
- the French order n° 77/974 of 19 August 1977, relating to the information to be provided on harmful waste, for which it establishes a list, according to the 1975 law.

These texts establish that:

- polluted waste containing hydrocarbons is considered dangerous waste in the sense of the term as stated in the French "Code de l’Environnement"
- if such waste is abandoned, the competent authority can, after giving formal notice, ensure the elimination of this waste at the expense of the party responsible (article L. 541-3)
- the treatment conditions for this waste are defined in the Polmar (French pollution response) instruction.

Final storage site for waste from the Prestige *pollution. Port of Bilbao, Spain.*

Waste within the French Polmar System

Increasing environmental sensitivity and the evolution of legislation on waste led to this issue being addressed in the contingency planning stage of the French pollution response system. The instruction dated 4 March 2002 (currently under amendment as a result of feedback from the *Prestige* incident), relating to pollution response in the marine environment, states that departmental plans must include an inventory of storage sites and treatment plants for polluted materials recovered (art. 4.4.1). It specifies, in the annex, the role and service missions in terms of preparation of departmental response plans and the implication of response operations. The services of the Ministry of Equipment and the Ministry of the Environment are concerned.

Equipment

The specialised maritime services and the maritime services of the departmental equipment directorates must:

- during preparation for response:
  - define primary storage site preparation techniques and draw up a list of specialised equipment to be bought or service provision agreements with private companies, in accordance with the regional environment directorates (DIREN)
- during response operations:
  - provide worksites with the equipment needed for recovery and organise the transportation of the recovered materials
  - select primary storage sites, with advice from the regional environment directorates (DIREN)
  - assist the DRIRE (regional directorates for industry, research and the environment) in the organisation of intermediate waste storage sites, in accordance with the DIREN.

Environment

The DRIRE and the DIREN must:

- during preparation for response:
  - research, update and distribute to the coastal *Préfets de department* an inventory of the places which could be used as intermediate and final waste storage sites, as well as the installations liable to contribute to waste treatment. Depending on the industrial capacities of the department, areas in other departments may have to be called upon as final storage sites
  - establish, update and distribute to the *Préfets maritimes* an inventory of ports where the materials recovered at sea could be unloaded
  - determine intermediate storage sites, in accordance with the DIREN and the DDE, taking into account water channelling, sensitive flora and likelihood of flooding.
- during response operations:
  - advise worksite coordinators on the elaboration of techniques and procedures which may be applied to primary storage sites
  - ensure restoration of primary storage sites after the collected materials have been evacuated
  - prepare authorisations for opening final storage facilities.

Collection

D

Basic rules:

- Restrict waste production
- Avoid spreading and burying
- Sort waste as early as possible
- Comply with expert advice
- Raise staff awareness and ensure training

Choosing the most selective and efficient recovery techniques

Many parameters are involved in response:

- the nature of the pollutant and the extent to which it sinks into the substrate
- weather conditions and sea state (wind, rain, temperature, tidal range, etc...)
- type of shore (accessible to machinery or not)
- availability of equipment and response personnel.

Be methodical:

- set up specific areas for polluted machinery and personnel (before they are cleaned)
- avoid using heavy machinery on ground with a low load-bearing capacity or use groundsheets
- keep onlookers and anyone who is not indispensable to operations out of polluted areas
- use a watertight decontamination area to clean personnel and machinery before they leave the clean-up area.

Use different waste containers from the start for the different types of waste.

Clearly identify and label them to avoid confusion and mixing during the rest of the treatment process: sort them by physical state, pollutant content, sediment, seaweed or other substrates.

A technical expert should train teams in sorting waste into categories and supervise the sorting process. For the same type of sand, its colour will indicate how heavily polluted it is (i.e. oil content), based on a standard scale.

Clean-up teams should implement approved techniques in previously identified areas according to expert advice.

Response personnel will need to be informed and trained at every level of the recovery process, in appropriate operating modes and safety rules and regulations.

Bins with a 60 litre capacity are affordable and practical options and enable selective manual collection.
Anti-adhesive coatings can be used to make bins easier to empty.
Evacuation to the storage site is carried out using machinery.

DECONTAMINATION OF PERSONNEL

Before leaving the worksite, response personnel must be "decontaminated" to:

- avoid spreading the pollution to surrounding unpolluted areas
- ensure at least a minimum amount of comfort after each work session (transport, meals...)
- maintain the efficiency of responders and prolong the life of response materials.

The principle is to have the personnel follow a cleaning chain, going from dirtiest to cleanest, on a watertight platform where the washing effluents can be recovered.

EQUIPMENT

Basic equipment:

- 1 flat or little-sloping platform (> 30 m^2), plastic film (or strips of geotextile) to cover the platform, stakes, fluorescent tape to identify the decontamination area
- 1 tank (1 to 2 m^3) + harmless washing agent + cloths or sponges for rough wiping down
- 1 hot water pressure washer (+ washing agent if necessary) to wash/rinse
- masks (with filters) and safety goggles
- rolls of sorbent (industrial format) for final wiping down
- 2 open 200 litre barrels (or bins) for solid waste.

Extra equipment:

Pump and storage tank for recovered washing effluents, a hut to store tools and personal protective equipment onsite according to the worksite.

DECONTAMINATION AREA

- Cordon off the response worksite (using stakes to attach the tape and to fix the plastic film to the ground).
- Arrange the ground so as to have a slightly sloping surface with a small trench on the lowest side to recover the effluents.
- Lay out the watertight film (or if you are using strips of geotextile, position them so that they overlap either perpendicular to the slope or in the direction of the slope to prevent any infiltration into the ground).
- Provide a light shelter onsite where all the (clean) materials and tools can be kept for protection and to facilitate their management.

Decontamination area.
Prestige pollution.
Lège-Cap-Ferret, Gironde, France.

Practical datasheets available on *Cedre*'s website (www.cedre.fr) provide detailed information which is updated after every accident.

Transportation

Basic rules:

- Avoid spreading polluted waste into the surrounding environment
- Use appropriate machines for the materials to be transported
- Keep processes short
- Ensure traceability for collected waste
- Comply with safety instructions

E

Ensure that skips and containers are watertight, and that vehicles using public roads remain clean. If necessary clean tyres, sills and skips in a decontamination area before the vehicle exits the storage area.

Adapt transfer and storage capacities according to:
- transported materials: liquid, paste, solid, hazardous
- environmental requirements: sensitive area, load-bearing capacity, access
- packaging: bulk, big bags, skips
- transportation distances.

Promote the use of specialised road tankers for the removal of substances which can be pumped, wherever the distance and equipment availability allow it: this enables direct transfer to the intermediate or final storage facility or to the treatment plant. This practice will avoid having to set up watertight storage areas which may be hard to protect and will reduce pollution of the subsoil.

Supervise the movements of each truck via transport sheets, stating the origin, destination, nature and weight or volume of transported waste, based on the example of the transportation of dangerous goods.

Implement a traffic separation scheme in a bid to mitigate risks and inconvenience caused by trucks and the possible danger of the pollutant (smells, flammability, toxicity). Where necessary, apply appropriate regulations regarding the transport of hazardous materials, in particular by ensuring that the equipment used is suitable (no incompatibilities between materials and resistance to solvents, pressure relief valves, explosion-proof equipment...).

DECONTAMINATION OF EQUIPMENT

All equipment leaving a worksite must first visit a decontamination area in order to avoid soiling clean areas.

EQUIPMENT

Infrastructures

- Permanent installation: watertight washing platform (minimum surface area of 5 m x 20 m for a section of boom) with a gutter and an oil separation system.
- Worksite installation: platform made watertight by plastic film or geomembrane, with a trench to recover waste waters.
- On a water body: containment and recovery system.

Basic equipment

- 1 or 2 spray guns to soften weathered hydrocarbons.
- 1 or 2 hot water pressure washers (with washing agent if necessary).
- 1 or 2 water/fire hoses for rinsing (or for washing in the case of little-adhesive pollutants; be aware of the quantities of water needing stored and settled).

Extra equipment: pump and settling/storage tank for recovered washing effluents.

Required amounts of water (fresh water or filtered seawater): pressure washer 1 m^3/h, i.e. 6 m^3/day for a permanent worksite.

STEPS TO TAKE

Preparing the decontamination area

- Choose a relatively flat surface near the worksite.
- Arrange the ground so as to have a slightly sloping surface with a small trench on the lowest side to recover the effluents.
- Lay out the watertight film (or if you are using strips of geotextile, position them so that they overlap either perpendicular to the slope or in the direction of the slope to prevent any infiltration into the ground).
- Cordon off the decontamination area.

Washing technique

- Soften and remove the oil stuck to the equipment by spraying and leaving a washing agent to take effect.
- Clean the surface of the soiled equipment by washing with water.
- On a little-adhesive substance, use fire hoses or cold water high pressure washers.
- On an adhesive substance, use washers and adjust settings (80° C and 100 bars).
- On a highly adhesive substance, use washers with the same settings + addition of washing agents.
- Regularly collect washing effluents and send them to a storage site.

→ WARNING: Be careful of aerosol projections caused by pressure washing (wear waterproof overalls and goggles).

Practical datasheets available on *Cedre*'s website (www.cedre.fr) provide detailed information which is updated after every accident.

Decontamination of a response vehicle.
Baltic Carrier, *Denmark, March 2001.*

MODEL DATASHEET FOR TRANSPORTATION FROM A STORAGE SITE

Date				
Transportation company				
Vehicle registration				
Type of vehicle	*Dump truck* ☐ *Road tanker* ☐		*Articulated truck* ☐ *Other:*	
Type of waste transported (avoid having different categories in same vehicle)	*Specify the type and give an indication of the estimated pollutant content*			
Quantity (preferable to state in weight, otherwise estimate volume)	*Volume in* m^3 *(estimation) =*		*Weight in tonnes* *(after being weighed) =*	
Packaging of materials	*Bulk* ☐ *Covered* ☐ *Not covered* ☐	*Big-bag* ☐ *Bag* ☐	*Closed skip* ☐ *Open skip* ☐ *Tank* ☐	*Other, specify:*
Place of loading	*(name of storage site, commune + n° of department)*			
Place of unloading	*(name of storage or treatment site, commune + n° of department)*			

Observations

	YES	NO
1. Does the waste transported correspond to its definition? *(to be accepted at its destination and deposited in the correct place)*	☐	☐
2. Is the container or packaging suited to its nature? *(sufficiently watertight)*	☐	☐
3. Is the vehicle clean enough so as not to soil public roads? *(no leaks of pollutant, clean wheels)*	☐	☐
4. Has all the information on this sheet been correctly supplied?	☐	☐
5. Does the transporter have a copy of this sheet? *(and is it identical?)*	☐	☐

→ All the above questions should have a positive answer before the vehicle can leave.

The roads and access paths must be able to bear the load of trucks.
Take the roads' width, load-bearing capacity and the space needed for waiting and manoeuvring into account.

Waste transfer requires suitable vehicles for the type of waste and the site in question.
The more sensitive and vulnerable an area is, the more attention will have to be paid to using light duty vehicles (e.g. quad bikes with low pressure tyres). On the other hand, transferring waste from intermediate storage facilities using heavy duty trucks reduces costs and causes less inconvenience.

Access control at final storage facilities slows traffic down.
Organise traffic based on reception capacities to avoid causing queues.

Primary Storage

Basic rules:

- Choose a flat, accessible piece of land, near the clean-up sites, where least harm will be caused to the site
- Avoid contaminating the subsoil and surrounding areas
- Sort and quantify waste by category
- Restrict washing by rain water
- Keep treatment and disposal processes short
- Organise rapid waste removal
- Clean and restore the site once the worksites have been closed.

F

ADVANTAGES OF PRIMARY STORAGE

- Optimises response team efficiency
- Allows greater flexibility in the management of flow from worksites and in the evacuation to intermediate storage sites.

SETTING UP PRIMARY STORAGE FACILITIES

Transfer facility

Primary storage facilities are simply temporary deposit platforms for transfer to an intermediate storage site. Their duration is directly dependent on the duration of the worksite(s) serviced. Waste should be transferred on a daily basis to prevent saturation, which would interrupt clean-up operations. These sites act as a breaking point for worksite machinery (loaders, quad bikes...) which is unsuitable for roads and transporting goods over a distance of several kilometres.

Site selection

The shoreline being very sensitive in essence, the chosen site will be justified in the minds of local residents and councillors by the fact that it is near the polluted area. The question of location will need to be studied on a case by case basis and will be a compromise between the following criteria:

- respect for the natural environment
- agreement of site owner or manager and of the local authorities in question

Tanks with linings on a weight-bearing framework can be used for storing, or increasing concentration by settling liquid effluents. The tanks are mounted on a level platform.

- sufficient surface area (at least 100 m^2)
- good load-bearing capacity of ground, not in a submersible area
- proximity and accessibility of shoreline worksite
- proximity and accessibility of road system
- sufficiently far from residential areas.

Protection

Soil and subsoils must be protected at all costs with watertight geotextiles and membranes (linings).

→ *see p.35 - Watertight protection of storage sites*

Access points and traffic should be supervised to avoid polluting clean areas: prevent public access, cover walkways with sorbent geotextiles, protect ground against damage from machinery using reinforced groundsheets.

Sorting

Provide a labelled container for each waste category. The container must be waste compatible:

- skips or cells with watertight walls for pastes
- watertight trenches or tanks for liquids
- watertight platform for bulk or bagged solids.

Water management

Protect bulk or bagged waste storage areas in addition to skips or containers from rain as far as possible using lids or tarpaulins .

Ensure there are run-off channels for rainwater as this will avoid trampling in mud onsite and causing further pollution.

Short processes

Promote solutions which directly dispose of waste so as to relieve the management of phase one of the waste treatment system by reducing waste transfer operations and separate storage solutions. Some waste types can be sent directly to treatment plants without going via an intermediate storage site. Liquid waste pumped into tanks can be directly routed to a deballasting station or a refinery. Waste likely to ferment will be sent directly to a biocentre or a composting facility. Plastics and sorbents can be sent to a household refuse incineration plant providing clearance has been given.

Evacuation

Waste should be evacuated every day to avoid bottlenecks, which could lead to deposits in unauthorised areas or clean-up operations having to grind to a halt.

Rehabilitation

The storage site will require cleaning and rehabilitation, immediately after closure of the worksites serviced (up to a week later), to avoid the risk of waste being carelessly forgotten.

→ *see datasheet p. 58 - Site restoration*

Restore the storage site rapidly after worksite closure (to stop the pollutant being permanently left onsite and penetrating the environment (public safety and credibility of response co-ordinators). Ensure that all membranes and geotextiles are entirely removed from the site.

CRITERIA FOR CHOOSING PRIMARY STORAGE SITE LOCATIONS

Primary storage sites are emergency facilities for depositing and transferring waste on a daily basis collected by clean-up teams on worksites in the immediate vicinity. This is where waste is initially sorted into categories and is the breaking point for the light duty vehicles on the worksite. The general criteria in terms of storage area size presented here should be adapted to local conditions (extent of the pollution, types of collected waste, site conditions...).

There are many different types of skips. They ensure efficient management of primary and even intermediate storage sites: sorting into different categories of waste, easy to ensure they are watertight, possibility of covering, removal by heavy duty vehicles.

Duration of temporary occupation	A few days to a few weeks, directly determined by the worksites serviced, with regular evacuation to the nearest intermediate storage site.
Surfaces and volumes needed for storage	100 to 500 m^2 with a few tanks for liquids and skips for solids, increasing their number according to the volumes and categories of waste collected.
Distance from supply sites	In the immediate vicinity of the shoreline clean-up sites (a few hundred metres, 1 km at the most).
Accessibility, particular modifications	Relatively direct access from the shore, feasibility of access via tracks (suitable for regular waste disposal by small vehicles), possibility of minor, easily reversible adjustments to landscape.
Land-related, legal and regulatory constraints	Choose wherever possible to use government land, otherwise ensure that the land owner or manager agrees to its being used (amicable agreement for minimum development and creating a working platform).
Topographical constraints	The land must be fairly flat to build an acceptable platform, with evacuation of run-off from rainwater.
Hydro-geological constraints	Lay protective films to reduce soil contamination. → *see datasheet p. 35 - Watertight protection of storage sites*
Environmental constraints	Away from residential areas (at least 50 m), outside of protected and sensitive land (dunes, vegetation...), restore the site as soon as the clean-up worksites have closed.
Management and maintenance	Sort waste (easy-to-read signs), supervise transfer, cover skips between filling operations and have them removed once they are full; assess quantities per waste category, count trucks.
Supervision	Promote site security, in particular to prevent them from turning into public dumps.

Intermediate Storage

Basic rules:

■ Choose a location near the clean-up sites that heavy duty vehicles can access, causing as little inconvenience to local residents as possible

■ Avoid spreading pollution into the surrounding environment

■ Sort, quantify, characterise and package waste

■ Manage the site and ensure waste traceability

■ Organise regular evacuation of waste and polluted materials

* Shut down the site as soon as possible so that it can be rehabilitated

ADVANTAGES OF INTERMEDIATE STORAGE

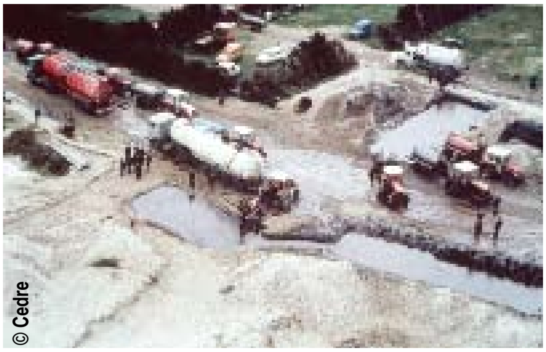
- Optimises long distance road transportation costs (final storage site being located several dozen kilometres away) through the use of heavy duty articulated lorries.
- Ensures better waste flow management in the event of a major oil spill because final storage sites cannot accommodate all the lorries from every intermediate and primary storage facility.
- Acts as a pooling and repackaging area, in some cases after the pretreatment phase, and as a platform for direct evacuation to treatment plants for some kinds of waste.
- Allows a period of a week or two to develop a potential final storage site.

SETTING UP INTERMEDIATE STORAGE SITES

Site selection

Storage sites should be arranged in advance so as to manage urgent storage requirements and not hinder recovery worksites. Make the best use of available local resources, such as large car parks, waste disposal facilities, burial centres that have available land reserves, industrial or harbour facilities, wild land... Bear in mind the distances between these facilities and primary storage sites so as to keep transportation times and costs down. Seek the assistance of government departments and institutions in order to locate such sites.

Intermediate storage ensures flexibility in the flow of incoming waste from primary storage sites and evacuation to treatment plants, disposal facilities or final storage sites in case of overloading.
Install access points and road surfaces which are suitable for heavy duty machinery, a checkpoint to keep track of arrivals and departures and ensure supervision of instructions.


© Cedre

If a new storage site has to be located in an area that is only thought to be slightly sensitive, the following issues should be addressed:
- the surface area available must be sufficient (1,500 to 3,000 m^2), it must be accessible for heavy duty lorries, have a good load-bearing capacity and must not be prone to short or medium term flooding
- environmental criteria: brief impact study with, in particular, analysis of the degree of inconvenience for local populations, which must remain acceptable
- land-based, health and regulatory issues: possible duration of use of site and compatibility with local planning regulations
- time needed to carry out study must comply with the urgency of the situation.

Protection

Keep damage and harmful effects to a minimum by taking the following measures:
- Protect the soil and subsoil

→ *see p 35 - Watertight protection of storage sites*
- Provide for drainage of seepage and divert run-off
- Set up a hydrocarbon recovery system by skimming or pumping
- Implement a one way traffic system for machinery to facilitate operations and keep collision risks to a minimum
- Signpost access roads and control entry to avoid polluting clean areas.

Reception capacities and waste characteristics

Use as many containers as there are waste categories. Ensure that signs can be read from far away and are water resistant (see table p. 12). Containers must be compatible with waste types and quantities:
- watertight trenches or tanks for liquids
- skips or cells with watertight walls for pastes
- watertight platform for bulk or bagged solids.

Regularly check the characteristics of the different waste types. Ask for expert assistance to define waste characteristics, give practical advice on differentiating them and validate their respective destinations. Use simple classification criteria such as colour, sand grain size, presence and proportion of debris mixed in with the waste (e.g. seaweed, plastics...). At this stage in the process, the waste may be repackaged or resorted into big-bags, skips or containers with a view to having them treated in specialised facilities.

Site management

Managing a storage site requires the following:
- permanent technical supervision of operations (quality control of incoming materials and their transfer, estimation of quantities and pollutant content, a waste record logbook to report all movements and incidents
- watertight skips, containers, platforms or trenches for waste storage
- maintenance and surveillance of the facility (compliance with safety regulations, security and hygiene)
- water management to avoid dispersion into the natural environment (run-off, seepage on site or off site if a storm-water tank is being managed)
- organisation of waste transfer to a treatment plant or final storage facility, if activated, to avoid saturation.

Final rehabilitation

Clearance for opening a site relies on its limited duration and proper restoration after use. Consequently, always clean the storage site within a few weeks once the coastal clean-up sites have finished and rehabilitate the area within two or three months at the most.

→ *see datasheet, p. 58 - Site restoration*

CRITERIA FOR CHOOSING INTERMEDIATE STORAGE SITE LOCATIONS

Intermediate storage sites are located near the coast, store waste from a number of primary storage sites and can be accessed by heavy duty lorries. They can also be used to sort and repackage waste and for pretreatment purposes, in order to reduce the volume of waste and facilitate waste handling. The general criteria in terms of storage area size presented here should be adapted to local conditions, to the extent of the pollution and to the specific worksite conditions.

Duration of temporary occupation	A few weeks to a few months with site rehabilitation as soon as shoreline clean-up is finished.
Surfaces and volumes needed for storage	1,500 to 3,000 m^2 with a few trenches (100 to 200 m^3), plus storage facility for large waste objects, bags, barrels, tanks (depending on recovered quantities).
Distance from recovery areas or supply sites	Near the coastal clean-up worksites, if possible less than 5 km from the coast (maximum 30 km).
Accessibility, particular modifications	Access, viability and traffic systems able to accommodate heavy duty lorries, creation of decontamination area for machinery.
Land-related, legal and regulatory constraints	Plan on occupying the site for several years (sufficient period of time for the site to be part of the response plan), compliance with local land occupancy regulations.
Topographical constraints	Land must be flat or slightly sloping to create a level platform (for settling tanks etc.), provide the appropriate rainwater run-off facilities.
Hydro-geological constraints	Subsoil should preferably be impermeable, surfaces must be made watertight and water management is vital.
Environmental constraints	Keep as far away as possible from residential areas (at least 50 m), avoid protected and sensitive areas (dunes, vegetation).
Management and maintenance	Supervise transfers (waste sorting, quantity estimation, lorry count, safety regulations and traffic system).
Supervision	Cordon off the area and if access cannot be completely prohibited provide supervision.

If liquid waste cannot be sent to a treatment plant immediately after collection, its intermediate storage requires particular attention in terms of the pollution of the subsoil (reinforced, artificial watertight protection). The subsoil should be regularly checked through wells and sampling trenches.
Temporary waste storage sites during the Erika *disaster.*
Caudan, Morbihan, France.

FLOW OF PRODUCTS AT AN INTERMEDIATE WASTE STORAGE SITE

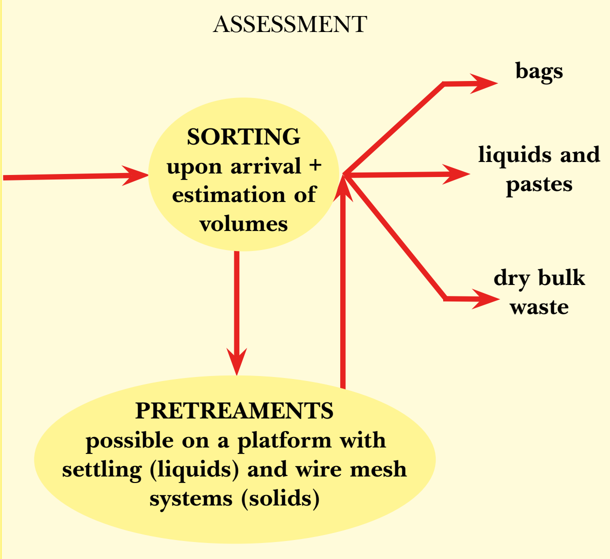
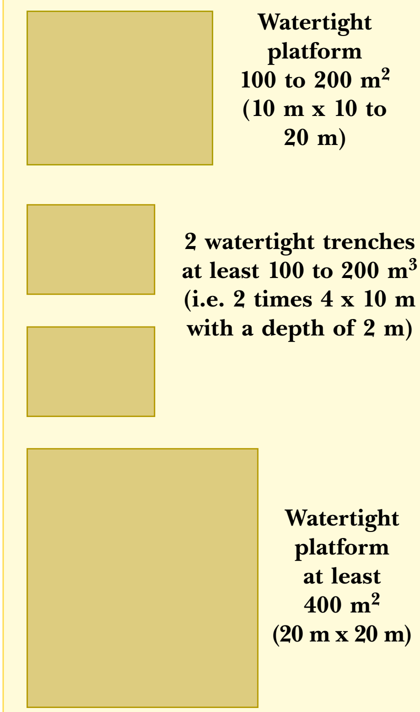


DIAGRAM ILLUSTRATING PRINCIPLE OF AN INTERMEDIATE WASTE STORAGE FACILITY



DAILY WASTE STORAGE SITE MANAGEMENT SHEET

This sheet summarises the most important information from the transportation sheets on p.20 and is to be used by the site leader.

Site:				
Date:		Site leader:		
Name of trans-portation society	*Type of vehicle (truck, GVW) and registra-tion*	*Packaging of waste (bulk, big-bags, bags), their origin and destination*	** Volume or weight of INCOMING waste*	** Volume or or weight of OUTGOING waste*

***Specify method: estimation or measurement (by weighing) and the units of references: m^3 or tonnes.**

If possible, these sheets should be computerised, in the form of a spreadsheet, in order to easily calculate totals, means and statistics on the waste stored and evacuated. This data is then transferred to the response centre.

WASTE TRACKING SLIP

Waste tracking slips should be filled in from the waste's production to its ultimate elimination. See below the waste tracking slip used by the Aquitaine region (France) for waste transfer during the *Prestige* pollution.

1- PRODUCER

Registered identification n°:

Company name:

Person in charge:

Address, Telephone, Fax:

Type of waste:
Give details (e.g. fuel oil, fuel oil + sand...)

Nomenclature code
If product is soiled: 16 07 08
|_|_C_|_|_|_A_|_|

Transportation of dangerous goods
Equivalent susbstance: *Group n°:*

Consistency of waste: ☐ *solid* ☐ *sludge* ☐ *liquid*

Transport: ☐ *skip* ☐ *tank* ☐ *barrels n°:* ☐ *other (specify):*
provide the skip identification n° (or other method of identification for unnumbered skips)

- *Mode of final disposal:*
- *Installation:* fill in for chosen procedure
- *Address - Telephone:*

N° of waste acceptance certificate:

I attest to the accuracy of the above information, that the materials delivered for transportation comply with the regulations for the transportation of dangerous goods and that in particular the packaging conditions have been fulfilled.
Name of person filling in slip (signing in place of the operations director):

Date of pick up:
most often: date of signature of tracking slip

Quantity picked up:
Estimate: density of sand 1.8: of fuel oil 1.
Otherwise indicate m^3

2- COLLECTOR - TRANSPORTER

Registered identification n°:

Company name:

Person in charge:

Address, Telephone, Fax:

Storage:
☐ *yes* storage site:
☐ *no*

I am aware of the above information,
Signature:

Date of transfer to recipient:

Quantity transported:
Tonnes

3- RECIPIENT

Registered identification n°:

Company name:

Person in charge:

Address:
Telephone:
Fax:

Procedure code: |_|_|

Operation on waste: ☐ *pretreatment* ☐ *pooling* ☐ *other (specify):*
☐ *valorisation* ☐ *incineration* ☐ *detoxication* ☐ *landfill*

In the case of pooling, give the tank n° and the final destination of waste:

In the case of pretreatment:
- *description of pretreatment :*
- *final destination of waste:*

Refusal of waste reception (date):

Reason(s):

Signature:

Date of waste reception:

Quantity received:
Tonnes

Final Storage

Basic rules:

- Choose the site during the planning stage and plan adjustments to the site based on large volumes and durability
- Quantify, characterise and distribute waste into categories
- Look into waste treatment processes and final disposal schemes
- Ensure onsite security and traceability
- Organise waste disposal and removal of oiled materials
- Clean and rehabilitate the site as soon as the job is done.

H

ADVANTAGES OF FINAL STORAGE

A final storage facility becomes necessary when the quantities of waste expected exceed the available tight flow treatment capacities.

- **Final storage sites provide enough time to prepare and implement the treatment and final disposal phases for the different categories of waste.** Carry out prior research on the different types of deposits of recovered waste, with quantitative and a qualitative characterisation through surveys and analyses. Develop or build the treatment plant(s).
- **Final storage sites supply treatment plants with waste according to their exact reception and processing capacities.** Here sorting and pretreatment operations which may have begun during phase one can be completed. These facilities allow total control over outbound flow.

SETTING UP A FINAL STORAGE FACILITY

Site selection

Choosing the appropriate sized storage facility (several hectares with simultaneous use of several pits enabling selective storage right from the outset) and the period of time it will be used for (several months) will involve regulatory procedures which are incompatible with an emergency situation. It is therefore necessary to pre-select sites outside of crisis periods, as part of contingency planning. The selection method will consist of listing potential candidate sites and matching them with feasibility criteria, in the same way as with intermediate storage sites but with stricter requirements and on a larger scale. Request assistance from government departments to locate suitable sites.

Final waste storage pit from the Erika *pollution: pollutant in the form of a paste, waiting to be transferred to a treatment plant.*
Donges, Loire Atlantique (44).

Using locally available resources is a good selection method providing the facility is large enough to deal with the quantities involved, such as land reserves, industrial or harbour facilities, wild land. In all cases, the general criteria are the following:

- not too far from the coast (no more than 50 km servicing 100 to 200 km of coastline)
- large enough surface area (2 to 10 hectares) and accessible to heavy duty trucks, with good load-bearing capacity in an area that is not prone to flooding
- acceptable in terms of environmental sensitivity, subject to a few compensatory measures (on the basis of a complete impact study)
- compliant with land occupancy, health and regulatory requirements (long term occupancy, compliancy with planning regulations and waste management requirements)
- approval given by local council and population; creation of a local supervisory committee.

Protection

Careful site development and management will reduce risks of damage and harm to the environment to a minimum:

- pits with guaranteed watertightness

→ *see p.35-Watertight protection of storage sites*

- drainage system to channel seepage waters to a water treatment plant (oil-water separator, lagoon for run-off water and site drainage, outfall pipe controlling total hydrocarbon content)
- cover (watertight tarpaulin, lid) for full storage facilities (pits, containers or skips) and channelling of run-off; vents to let any fermentation gases escape
- decontamination area for machinery
- regular checks using piezometers placed downstream of the site to ensure that the water management scheme is working correctly. A piezometer positioned upstream of the site will act as a control (standard sampling and testing procedures)
- separate pits for waste with high and low pollutant content. If materials used on the worksite have not already been incinerated, reception platform for this waste (personal protective equipment, sorbents, soiled nets...)
- basins or tanks for liquids
- unpacking area (e.g. waste delivered in big-bags).

Site management

Devise a traffic circulation plan to facilitate onsite movements and keep accident risks to a minimum, with signposting and regulation.

Set up permanent technical supervision of arrivals and departures:

- identify pits
- check trucks using tracking slips and identify waste
- direct and supervise unloading
- keep a daily record book of all arrivals, departures and incidents
- inspect and maintain the facility (safety rules, supervision, cleanliness)
- ensure as many containers as waste categories are continually in operation and anticipate their duration in order to prepare to open new reception capacities where necessary.

Transfer to treatment plants

Organise the transfer of waste to treatment plants as soon as the contracts have been signed and the plants are up and running. Use a plant as near as possible to the final storage site to reduce costs and inconvenience for this third transfer.

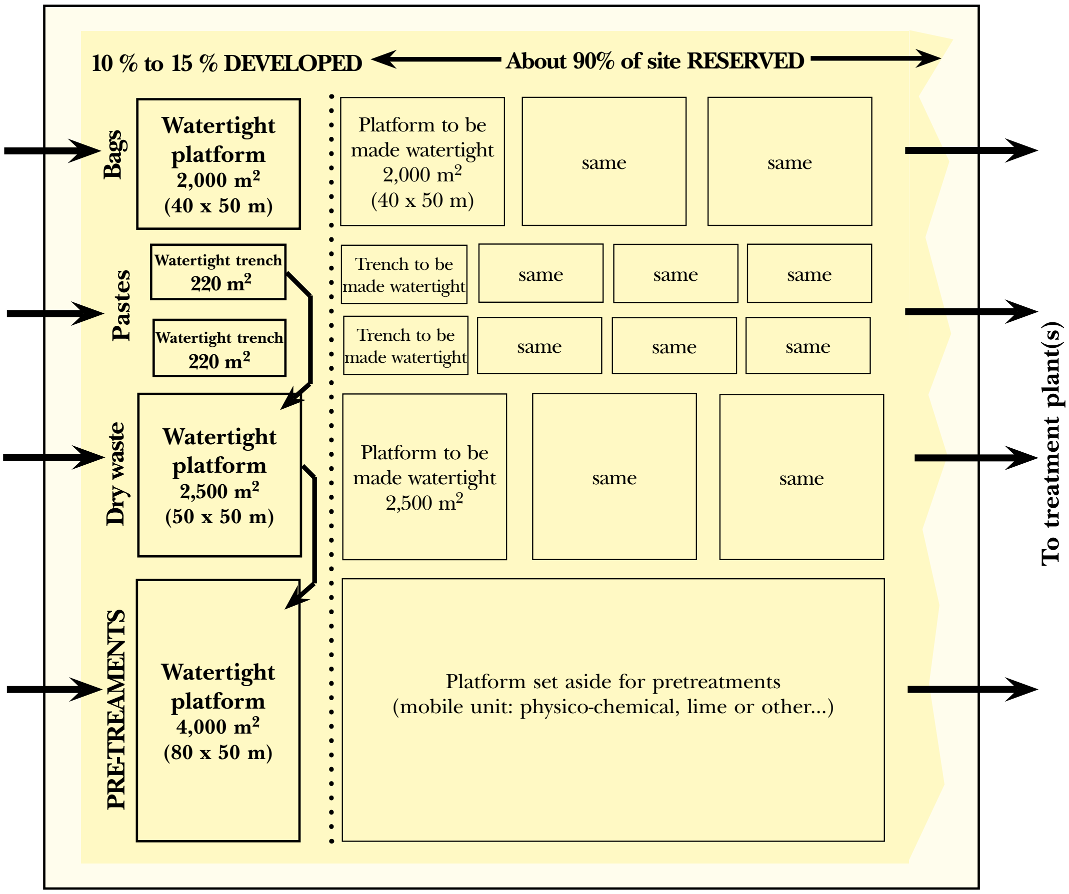
Final rehabilitation

Site approvals will be facilitated if there is a clear understanding and commitment on how long it will operate and the fact that it will be fully cleaned up once the job has been done. This may last up to two years or even more. The tarpaulins, geotextiles and groundsheets will also be added to the waste to be treated and may well amount to an extra 15 to 20% of the total quantities.

→ *see datasheet, p.58 - Site restoration*

DIAGRAM ILLUSTRATING THE PRINCIPLE OF
A FINAL WASTE STORAGE FACILITY

Surface area of around 5 hectares (200 x 250 m), partially developed, which could be used for recreational purposes but reclaimed at any moment in the event of the activation of a pollution response plan.



→ Rainwater drainage trenches, polluted water storage areas, access channels and incoming waste checks (weigh in) must also be provided.

CRITERIA FOR CHOOSING FINAL STORAGE SITE LOCATIONS

Final storage sites are places where concentrations of large quantities of waste are gathered in order to prepare and engage calmly in the treatment and ultimate disposal phases.

Definitive storage can only be envisaged for ultimate, stabilised waste after a treatment which fulfils the criteria in force.

Duration of temporary occupation	A few months to a few years.
Surfaces and volumes needed for storage	20,000 to 10,0000 m^2 (2 to 10 hectares), with a few pits of 1,000 to 10,000 m^3, plus a sorting, pretreatment, stabilisation and deposit area for some types of waste.
Distance from recovery areas or supply sites	Less than 300 km (ideally 100 km max.) from the collection sites or the intermediate storage facilities and 50 km from the shoreline at the most.
Accessibility, particular modifications	Organise access for 30 to 40 tonne heavy duty lorries (arrivals, departures, load-bearing capacity and width of roads), weighing scales, trench for tyre washing.
Land-related, legal and regulatory constraints	Guaranteed occupation of land for 10 years should be made part of the response plan.
Topographical constraints	Possibility of carrying out terrace earthworks and grading at various levels with access points and collection of rainwater.
Hydro-geological constraints	Land must be watertight (use a specialised company): natural or man-made clay or geomembrane (1 pit ready to use, others in reserve).
Environmental constraints	Compatibility with protected areas, buffer distance of at least 100 m from nearest houses downwind, monitor impact of lorries.
Management and maintenance	Supervise movements (waste sorting, quantity estimation, lorry count, safety regulations and traffic system).
Supervision	Cordon the area off (permanent fence) and ensure permanent surveillance.

Refineries often have facilities which can provide emergency solutions:
- *a liquid effluent reception capacity (storage tanks and lagoons at the deballasting station, waste water treatment network and station)*
- *platforms where waste solids and pastes can be stored depending on a few further developments (clearance is more easily obtained as they are already classified facilities).*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__Developing a final storage site__
by building pits on the surface surrounded by dikes, rather than filling holes with waste which would be more difficult to supervise.

__Developing a final storage site:__
- underlayer with drainage
- geotextiles and geomembranes (watertight seals).

__Unpacking, sorting__
Provide pits or simple platforms for unpacking certain types of waste (e.g. arrivals in big-bags) and sorting plastics, PPE, sorbents, seaweed.

__Water management__
The drainage network leads to a lagoon. Outflow waters pass through an oil separator and are continually analysed before being released into the natural environment.

WATERTIGHT PROTECTION OF STORAGE SITES

Waste storage facilities should be systematically accompanied by a system to ensure that they are watertight in order to reduce the impact on the environment and in particular to prevent infiltration and contamination by run-off.

Watertightness can be ensured using different types of materials, in general geomembranes or plastic films.

Geomembranes are flexible materials with standardised application techniques and conditions. Those that are recommended for hydrocarbons are the type HDPE (thickness of 1.5 to 2 mm, in rolls of 100 m with a width of 5 to 10 m). Geomembranes are made watertight by sealing, carried out by a specialist.

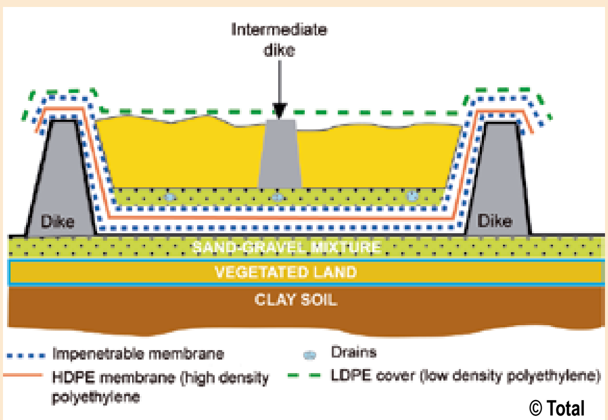
Plastic films are tarpaulins used in particular in agriculture or construction, with a thickness of generally less than 0.25 mm. They are much more flexible, easier to handle, less expensive and more widely available (agricultural cooperatives, construction and public works material wholesalers) than geomembranes. They are however less resistant to impact, ripping and tension. Several layers should therefore be used together, along with geotextiles*.

When the aim is simply to form an anti-contamination barrier under watertight tanks or skips, use an ordinary plastic film. Make sure to prepare the ground accordingly. Lay a geotextile between the ground and the plastic film to avoid perforation of the film.

In the case of bulk storage of pastes, geotextiles can be laid without sealing or sticking but a quadruple covering should be ensured by folding two sheets one over the other. Place a geotextile as an under layer to reduce piercing and cross over successive layers.

Intermediate and final storage pits should be made thoroughly watertight, taking into account specific technical aspects (choice of geomembranes, sealing of strips of textiles...). Pits should be lined from the bottom to the top with an impenetrable geotexile, a hydrocarbon-resistant geomembrane, a second impenetrable geotexile and a layer of sand for protection against the traffic of heavy duty machinery.

*** Geotextiles are synthetic fabrics, with a weight of 300 to 500 g/m^2 which come in rolls of 100 m and different widths (3, 4, 5 m or even 6 m), used as under layers to reduce impact on geomembranes and watertight films.**



Cross section of final waste storage facilities for the Erika *pollution. Donges, Loire-Atlantique, France.*

Treatment

Thorough sorting during collection and storage, based on standard written specifications and careful checks, facilitates treatment.

Pretreatment can be necessary before the actual treatment process begins. This additional optional element is incorporated in the diagrams given in this chapter.

Treatments and Pretreatments

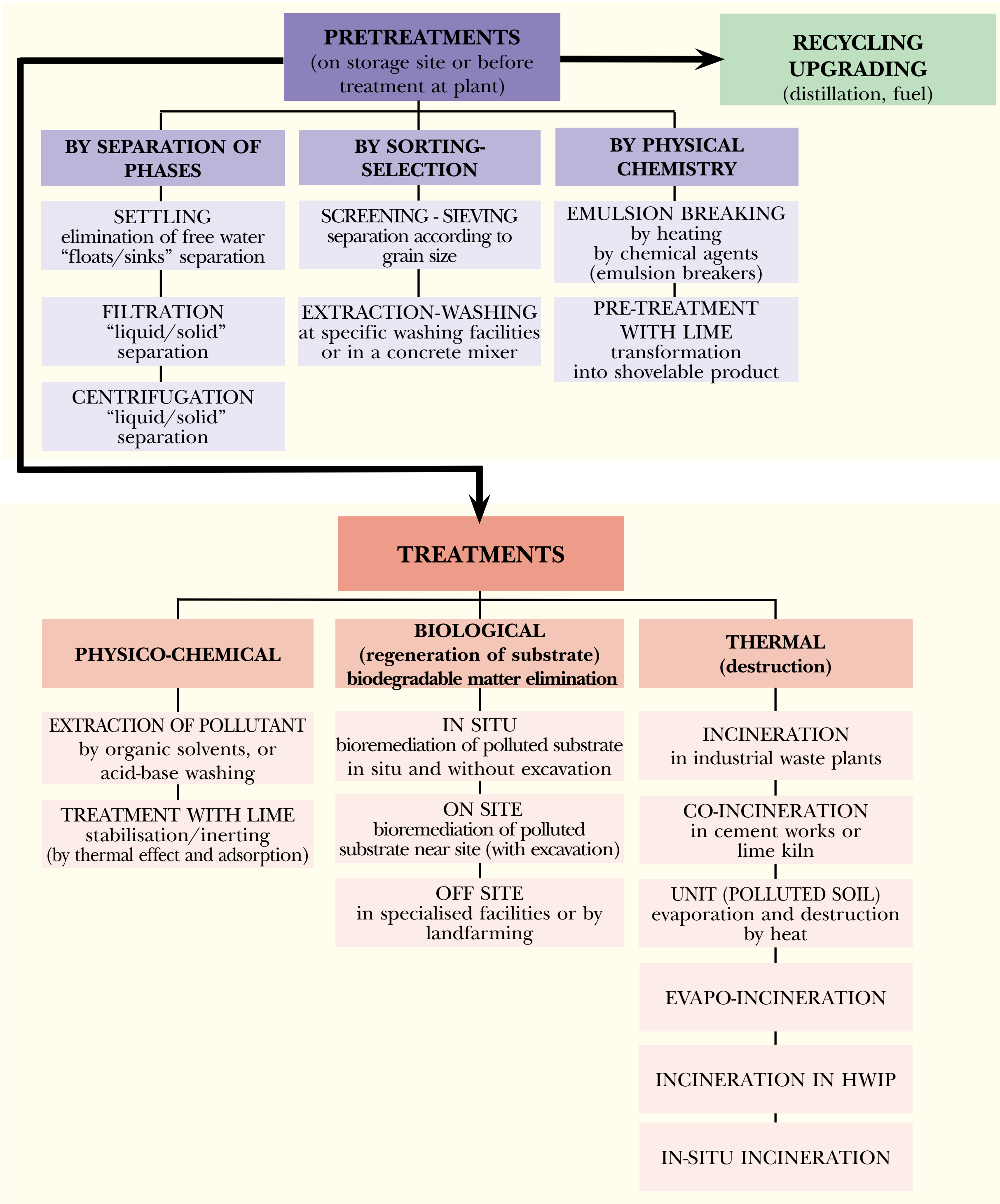
The choice of the method of treatment is closely linked to the type of waste and the possibilities of upgrading or ultimate disposal for the waste in question:

- conduct an accurate assessment of the different wastes: type, quantity, characteristics (nature, grain size, pollutant content, water content...)
- choose a suitable course of action for each type of waste, according to the level of cleaning required for upgrading or ultimate disposal.

Treatment selection criteria:

- nature, characteristics and quantities of waste
- local resources and facilities
- location of specialised plants (distance, easy access)
- reception capacities and treatment rate
- cost of treatment, up to and including final disposal.

INVENTORY OF TREATMENT PROCEDURES FOR DIFFERENT TYPES OF OIL SPILL WASTE



Diagrams of Various Procedures

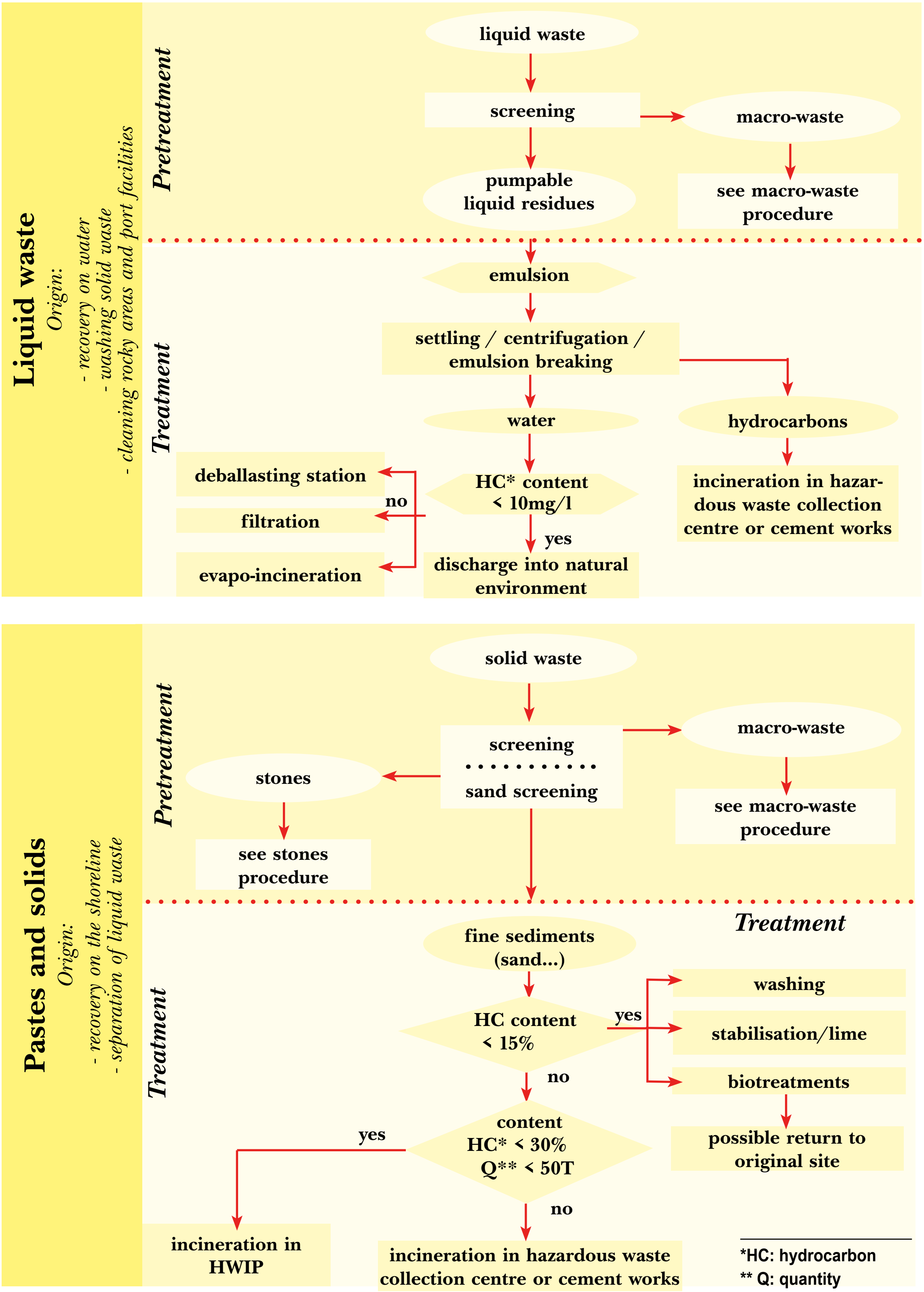
Treatment procedures are chosen according to the waste category. The different treatment procedures are presented below in the form of flowcharts. Thereafter, each of the three main treatment processes will be explored in detail.

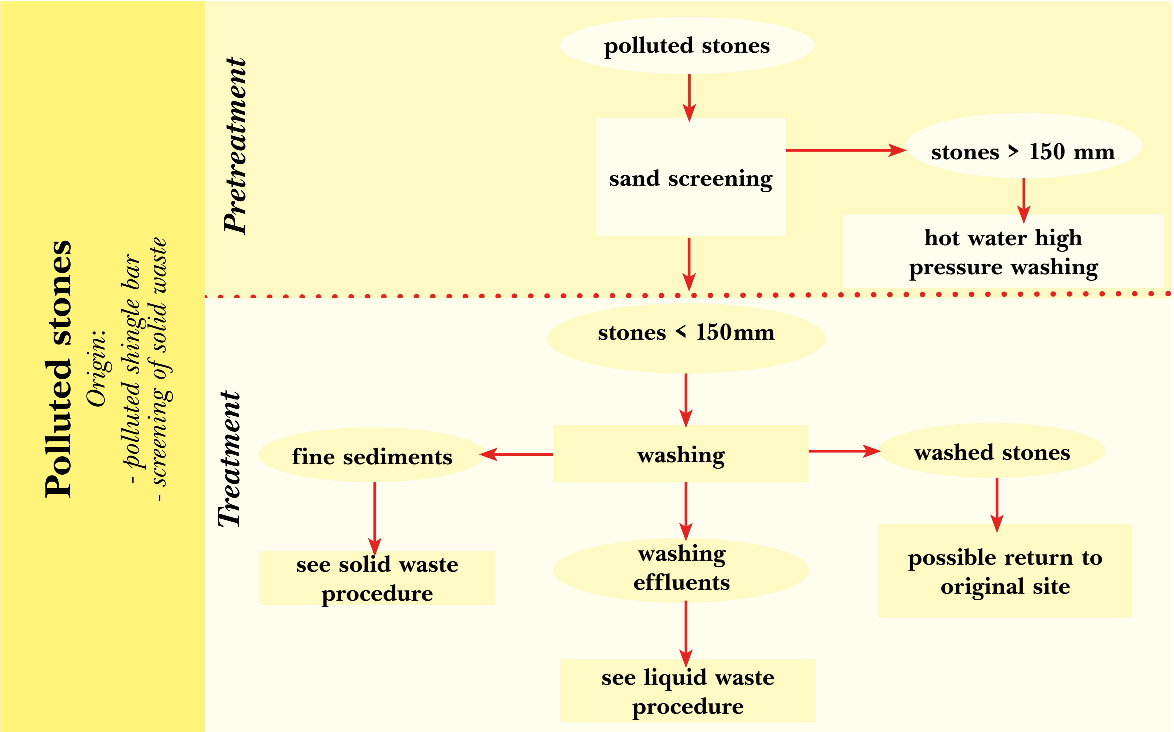
Animals (dead or alive) are sent to specialised centres. When animal corpses leave these centres, they re-enter the contingency planning organisation for disposal. The method of disposal is chosen by the rescue centre and the competent authorities. Destruction is normally carried out by approved knackers or renderers. Incineration may also be a possibility.

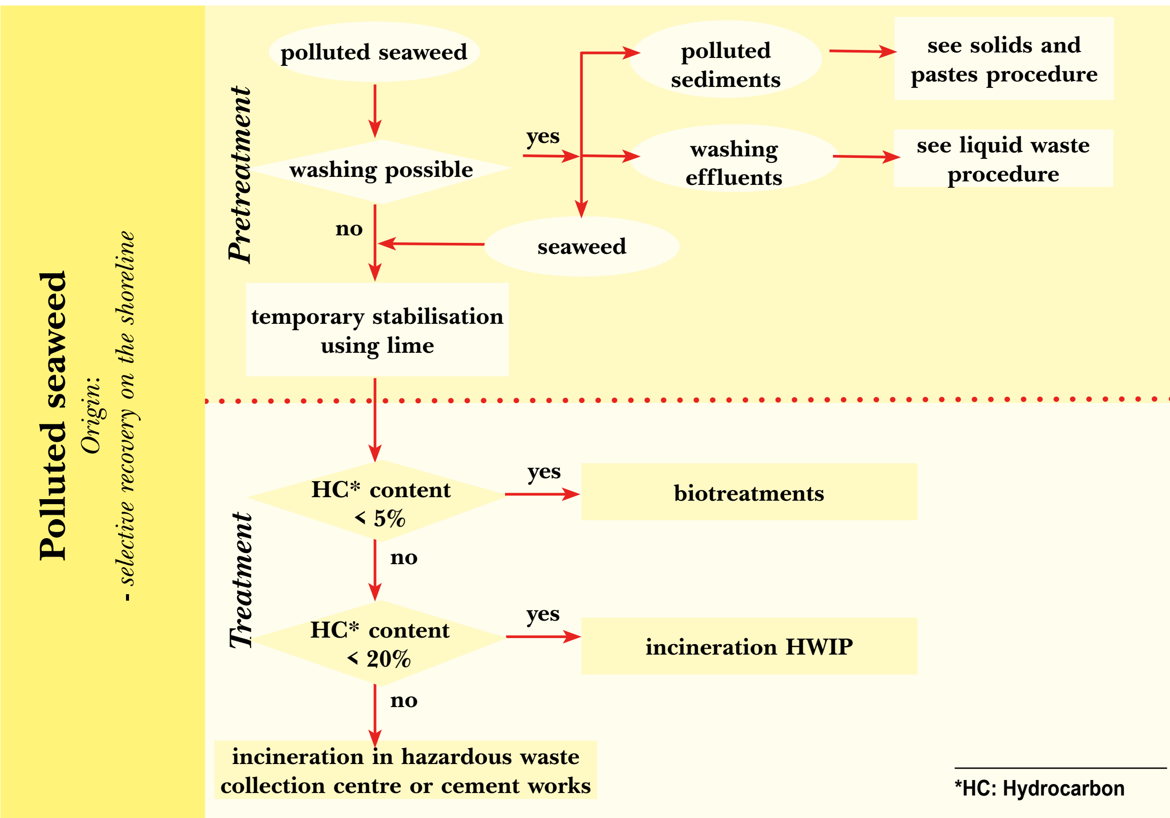
WASTE FROM THE PRESTIGE – TREATMENT PROCEDURES
Example of procedure sheet applied in January 2003 on the coast of Aquitaine, France, for use by departmental response centres.

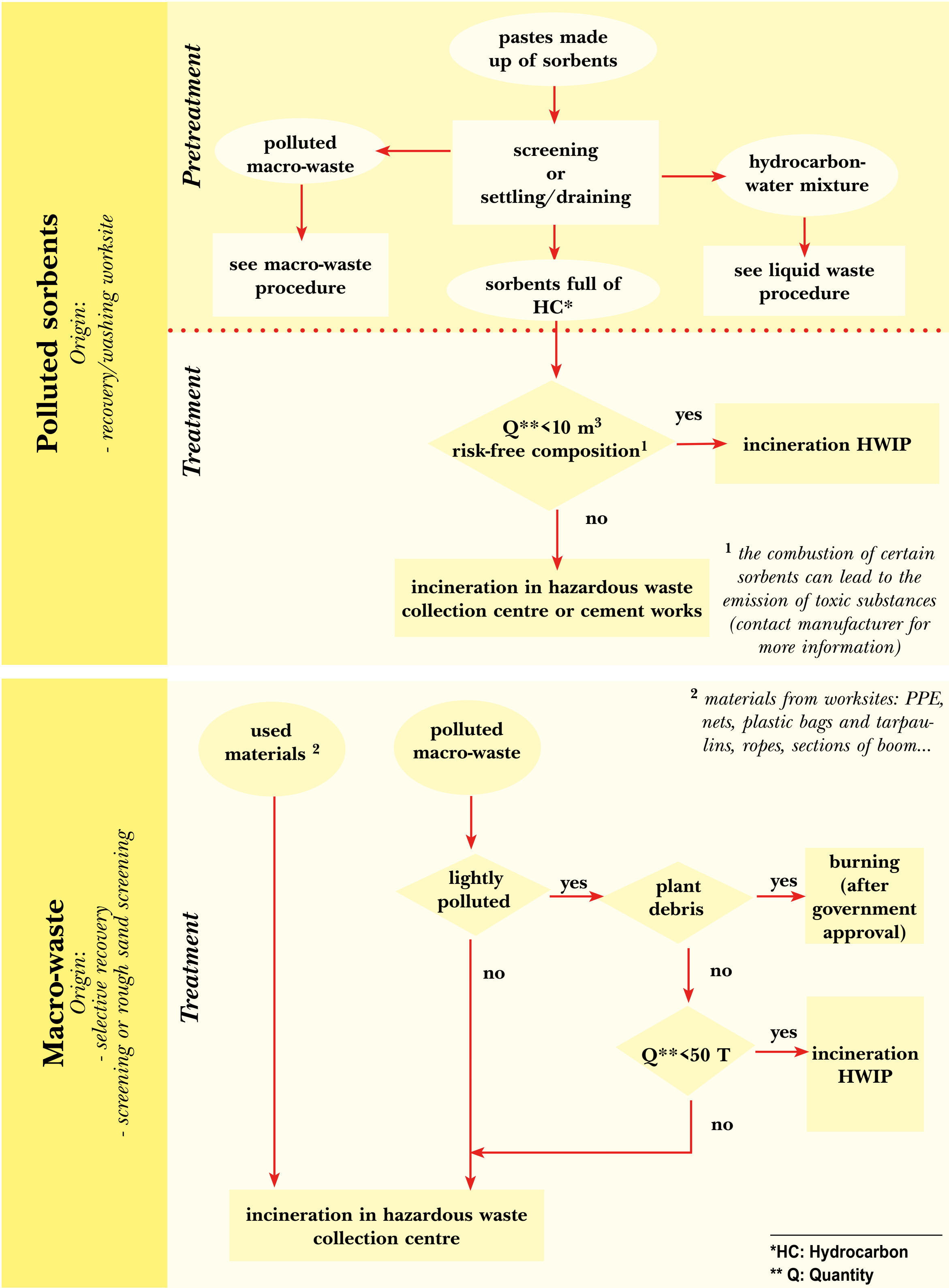
Type of skips	A	B May be divided into 3 sub-categories according to HWIP B1	B2	B3	C
Nature of waste	Patties or tar balls (with sand)	Soiled miscellaneous (kelp, wood, plastics...)	Used or soiled personal protective equipment (PPE)	Small nets (trammel)	Bird corpses
Most suitable method of disposal	SIAP (Bassens 33) 25 t/day max. ***	Nearest HWIP			"Pre-care centre" for counting and identification then nearest HWIP
Cost in euros (excluding tax) per tonne excluding transport	400	60	60	60	40-60
Back-up method of disposal	Intermediate storage, other procedures*	ASTRIA (Bègles 33). 60 t/day max.**			ASTRIA** (Bègles 33). 60 t/day max.
Cost (excluding tax & transport)		60	60	60	60

* Check with the zonal response centre or regional government division
** Elimination at ASTRIA plant as a back-up plan
*** Must contact the zonal response centre or regional government division before any transfer


Liquid waste
Origin:
- recovery on water
- washing solid waste
- cleaning rocky areas and port facilities
Pretreatment
liquid waste
screening
macro-waste
pumpable liquid residues
see macro-waste procedure
Treatment
emulsion
settling / centrifugation / emulsion breaking
water
hydrocarbons
HC* content < 10mg/l
no
yes
deballasting station
filtration
evapo-incineration
discharge into natural environment
incineration in hazardous waste collection centre or cement works
Pastes and solids
Origin:
- recovery on the shoreline
- separation of liquid waste
Pretreatment
solid waste
screening
sand screening
macro-waste
see macro-waste procedure
stones
see stones procedure
Treatment
fine sediments (sand...)
HC content < 15%
yes
no
washing
stabilisation/lime
biotreatments
possible return to original site
content HC* < 30% Q** < 50T
yes
no
incineration in HWIP
incineration in hazardous waste collection centre or cement works
*HC: hydrocarbon
** Q: quantity


Polluted stones
Origin:
- polluted shingle bar
- screening of solid waste
Pretreatment
polluted stones
sand screening
stones > 150 mm
hot water high pressure washing
Treatment
stones < 150mm
washing
fine sediments
washed stones
see solid waste procedure
washing effluents
possible return to original site
see liquid waste procedure


Polluted seaweed
Origin:
- selective recovery on the shoreline
Pretreatment
polluted seaweed
washing possible
yes
polluted sediments
see solids and pastes procedure
washing effluents
see liquid waste procedure
no
seaweed
temporary stabilisation using lime
Treatment
HC* content < 5%
yes
biotreatments
no
HC* content < 20%
yes
incineration HWIP
no
incineration in hazardous waste collection centre or cement works
*HC: Hydrocarbon


Polluted sorbents
Origin:
- recovery/washing worksite
Pretreatment
pastes made up of sorbents
screening or settling/draining
polluted macro-waste
see macro-waste procedure
hydrocarbon-water mixture
see liquid waste procedure
sorbents full of HC*
Treatment
Q**<10 m3 risk-free composition1
yes
incineration HWIP
no
incineration in hazardous waste collection centre or cement works
1 the combustion of certain sorbents can lead to the emission of toxic substances (contact manufacturer for more information)
Macro-waste
Origin:
- selective recovery
- screening or rough sand screening
Treatment
2 materials from worksites: PPE, nets, plastic bags and tarpaulins, ropes, sections of boom...
used materials 2
polluted macro-waste
lightly polluted
yes
plant debris
yes
burning (after government approval)
no
no
Q**<50 T
yes
incineration HWIP
no
incineration in hazardous waste collection centre
*HC: Hydrocarbon
** Q: Quantity

Physico-chemical Treatment

Lime treatment in successive strips.
This type of treatment can be carried out for smaller quantities, at a lower rate, in a treatment plant or in piles.

Washing

Washing plant

This technique is widely used to treat soil polluted by hydrocarbons. Solid waste is ground or stirred in a washing plant with a fluid (water alone or with a flow agent) before separating the phases by settling and flotation. Its efficiency depends on the homogeneity of the sediment needing treated. Washing was the main process chosen to treat nearly 272,000 tonnes of waste during the *Erika* disaster. However, due to the heterogeneity of the waste collected and in order to the upgrade the products resulting from the treatment process, a multitude of additional physico-chemical treatments was required.

Washing platform

This includes all facilities where washing (chemical extraction by grinding with a fluid) and physical separation take place: screening, sand screening, sieving, settling and flotation.

- Fluid used: water and possibly after trials a flow agent (in the interests of safety, ambient temperatures and solvents with low volatility such as diesel should be used). Optimisation of solvent quantities will involve counter-flow recycling. Clean water and flow agent supply can be used during final rinsing; spent fluids will be extracted. Waste waters will be treated once the oil has been separated and can then be used for power generation.
- Separation of plastics and macro-waste for specific thermal treatment (mobile pyrolytic reactor, for instance).
- Subject to authorisation, possibility of upgrading the clean substrate (sand, gravel) for use in public works or construction work. May possibly be returned to natural environment.
- Effect of large-scale operations due to the complexity of setting up the facility (if quantities are greater than 100,000 tonnes, treatment costs will drop below 150 Euros per tonne).
- As the process generates virtually no final waste, it can be considered as environmentally friendly.

Additional treatment processes may also be used at different stages in the physico-chemical treatment procedure.

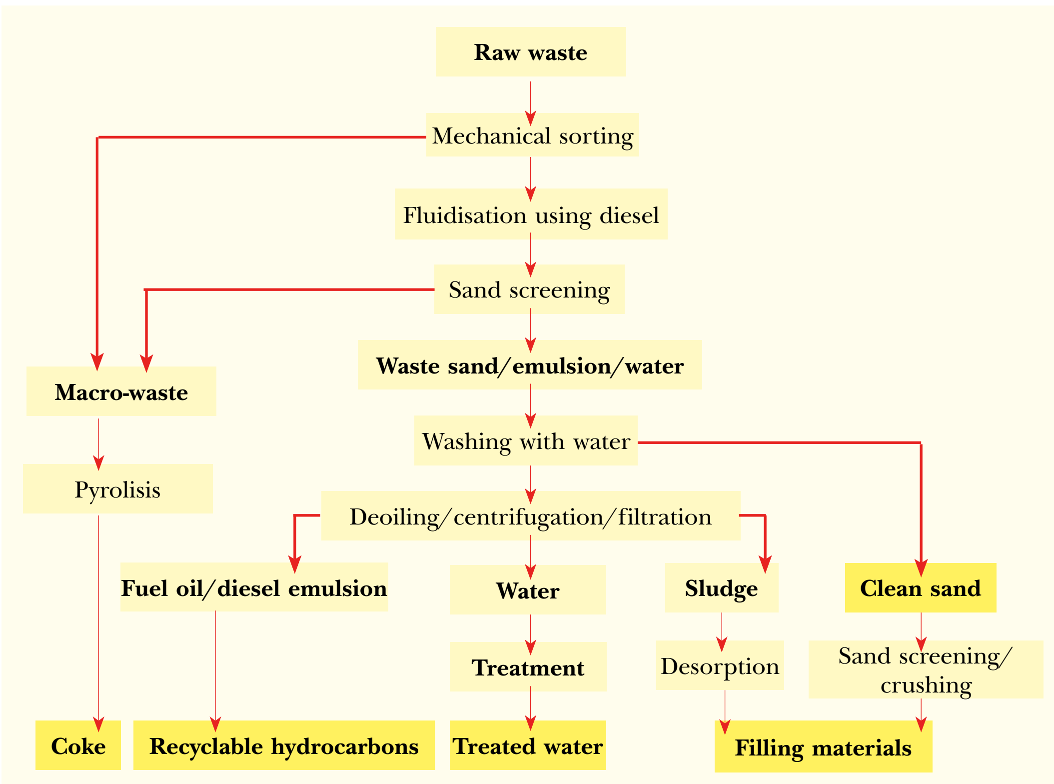
- Phase separation and mechanical sorting:
  - **Settling**: separation of solids (sink to the bottom) and of liquids into layers according to density (oil, water) in a stilling basin (slow currents)
  - **Flotation**: injection of very small air bubbles to facilitate separation of products that are slightly less dense than water by skimming supernatants
  - **Sand screening**: separation of dry solids on a grid or a coarse-mesh screen (a few decimetres)
  - **Screening**: separation of dry or damp solids on a relatively coarse-mesh screen (a few centimetres)
  - **Sieving**: separation of dry or damp solids on a relatively fine-mesh screen (a few millimetres)
  - **Filtration**: separation of dry solids and liquids on a woven or non-woven surface, such as a very fine-mesh sieve or porous material in bulk (sand, peat, diatomaceous earth...). To prevent clogging, the filter should be regularly renewed.

J1

- Preparatory work required for phase separation:
- **emulsion breaking**: oil-in-water emulsions or water-in-oil reverse emulsions slow down or stop phase separation. Adding an emulsion breaker (or using heat) breaks down this stability and leads to rapid settling.

- Other operations that may take place at intermediate or final stages:
- **Crushing**: grinding of materials to obtain smaller grain size. At intermediate stages, size reduction and homogenisation can facilitate the final process (output, efficiency). At the final stage, an increase in grain surface area can improve adsorption of the residual pollutant.
- **Granulometric sorting**: use of grids and perforated sheets. Revolving screens operating continuously will ensure a rate of several tens of tonnes per hour. This process combines grinding, mixing, phase separation and granulometric sorting.
- **Draining**: on mats or grids at the revolving screen system output point.

PHYSICO-CHEMICAL TREATMENT PROCEDURE USED ON WASTE FROM THE *ERIKA* POLLUTION



DEBALLASTING STATION

Many ports, in particular those with a refinery, have reception capacities for storing and treating ballast waters and slops (diverse oily waste from engine rooms and tank bottoms onboard tankers).

Treatment consists of removing sludge and oil, before lagooning, ensuring an output of no more than 10 mg of hydrocarbons per litre. Treatment costs vary a great deal from one port to another (300 to 1,800 Euros (excluding tax) to treat 200 m^3 of ballast water).

- **Sludge removal**: removal of sediments from the bottom of an installation. The oily water is allowed to pass freely through the basin. This operation is conducted in a small stilling basin (with moderate currents).
- **Oil removal**: elimination of floating oil in a small stilling basin (with moderate currents). Mechanical skimming is carried out to remove the oil.
- **Combined model**: the oil industry generally uses rectangular API (American Petroleum Institute) separators. Sludge is removed from the bottom and oil skimmed from the surface by low speed alternate sweeping.

Physico-chemical treatment by washing
The waste is mixed with water and possibly washing agents (flux such as diesel). The pollutant is extracted between the liquid and the solid phase. Each type of pollutant is upgraded in a specific way.
Erika *waste washing facilities.*

Application: *Erika*

The equipment needed to treat the 272,000 tonnes of waste from the *Erika* spill (December 1999) was installed on land belonging to the Donges refinery (Total). The diesel and water used for fluidisation and washing were supplied directly from the refinery. At the end of the treatment process, the sand and gravel, separated by sand screening, were washed then upgraded on public works worksites. Macro-waste recovered after mechanical and manual sorting was washed and ground, then incinerated as ordinary industrial waste.
After filtering in a filter press, sludge could be upgraded to be used as filling material after thermal treatment or treatment in a cement works. Hydrocarbons (fuel oil and diesel) were recycled in the refinery's facilities. Water from treatment operations was also sent to the refinery, to the waste waters treatment station.

Lime Treatment

The term quicklime encompasses a variety of soft and hard calcium carbonates. When in contact with water, these minerals, dehydrated by lime-burning (also known as calcination), provoke a more or less spontaneous exothermic reaction. The absence of regulations and standards on this material's ultimate disposal and upgrading affect the use of this treatment method.

Powdered quicklime

The physico-chemical effect dries out materials and partially breaks them down. The fine deactivated mineral particles soak up liquid or become coated in fats. This exothermic reaction breaks hydrocarbons down (into CO2 + H2O) and neutralises the heaviest fractions. There are three modes that are generally used to implement the process:

- in strips on a flat surface for a rate of about 100 tonnes per hour
- in a treatment plant for continuous outputs of about 30 tonnes per hour
- in pits or in piles with sequential outputs of about 30 to 60 tonnes a day.

These methods can be applied to polluted materials in the form of pastes or waste that can be shovelled. In situ techniques generate dust and organic compounds and therefore require precautionary measures. After being left to mature for several days, a hydrophobic, sandy substance is obtained. The volume of the initial product increases by 4 to 10%. The cost is competitive (60 to 100 Euros per tonne excluding tax).

Quicklime pellets

This procedure is a more sophisticated treatment method, based on controlling the exothermic reaction of quicklime at over 500°C in a closed environment. It relies on three main elements:

- inorganic calcium oxide and various inorganic hydroxides are extracted in the form of pellets from a rock selected for its physical and chemical characteristics (especially the association of its components), which correspond to the required exothermic effects
- a pretreatment additive, or co-additive, which absorbs unstable compounds or isolates them in order to control the reaction (gas, heat), or supplies the water needed to activate the pellets
- a lid (either material or structure) which finally covers the whole system in order to optimise and control the effects of the reactions (odours, vapours) and protect from adverse weather conditions (rain).

This method can be applied to both solid and liquid products. The treatment capacity is around 30 to 80 m^3 per day. Although its cost is slightly higher than that of the previous treatment method (90 to 130 Euros per tonne excluding tax), it allows the co-product to be upgraded.

Application: *Amoco Cadiz*

Part of the waste generated by the *Amoco Cadiz* pollution (March 1978) was treated with lime. Two types of lime were used: quicklime and hydrophobic quicklime (quicklime to which certain additives have been added to give it a hydrophobic character, which delays the reaction). Thus 10,000 m^3 of pastes were treated with hydrophobic lime, 35,000 m^3 of "dry" waste were treated with ordinary quicklime and 20,000 m^3 of "dry" waste were treated with ordinary quicklime in a specialised treatment plant. This method was also used to treat the bottom of some storage trenches, into which quicklime was directly injected and the substances were then mixed with a mechanical shovel. The products made inert through this process were then used as filling materials.

Biological Treatments

Biological treatments, or biotreatments, can be divided in three categories, according to where the treatment takes place.

Each category requires similar if not identical technologies, requiring alterations to the equipment so as to treat most of the polluted material on site:

- in situ biotreatment (on original ground), used for final treatment of dispersed pollution and amenable sites
- onsite biotreatment (on site after excavation): composting and biopile
- offsite biotreatment (on a specialised facility): landfarming, composting, biopile.

Biological treatment processes that are currently applied to oil spill waste can only be used on dry waste.

Liquid effluents generally have a high oil content and their treatment in bioreactors with bacteria is still under research. No realistic short term options for the massive quantities of waste that major oil spills generate have yet been found.

Choosing a biological treatment process requires prior feasibility testing.

These laboratory-based tests should last for at least two months and are conducted on liquid samples (of around 1 litre). Note:

- degradable compounds in the long run: n-alkanes, iso-alkanes, and aromatics
- partially degradable compounds: saturated and aromatic cyclic hydrocarbons
- resistant compounds: resins and asphaltenes.

Some techniques can be used to break down resistant molecules. However, widespread full scale use of such techniques in open areas requires much caution so as to avoid uncontrolled dispersion of the micro-organisms used into the environment.

Landfarming

Landfarming, also known as land treatment or land application, was the only bioremediation process used (on a small scale) for slightly oiled waste (less than 1 to 2 %) for a long time. It requires large surface areas, and the application process is difficult to implement (many people to convince and checks to be conducted). The efficiency and rapidity (one to two years) of the biodegradation process varies in particular with the soil's aeration, humidity, the bioavailability of nutrients, the presence of microbes and the temperature. Cultivation promotes the metabolism of micro-organisms.

The main risk which must be controlled is that the pollution in the soil can seep into the ground water (surface run-off, infiltration into ground water).

Other, more elaborate techniques require preparation of the material to be treated:

- before treatment: sand screening, homogenisation, expansion (increase in porosity)
- during treatment: aeration, addition of nutrients and water, with regular monitoring of these parameters and of the reduction of hydrocarbon content.

Applications: *Heinrich Heine* and *Mataram* - *Sea Empress*

On 2nd April 1988, two cargo ships (the *Heinrich Heine* and the *Mataram*) collided with each other near the mouth of the Kiel canal in Germany. Despite the intervention of 5 oil recovery vessels, the banks of the Elbe were affected. Three thousand tonnes of polluted clay soil were extracted during clean-up operations and transferred to an intermediate storage site. Tests were conducted on the composition of the soil and the oil, which indicated the possibility of treatment by landfarming.

Landfarming is the most old-fashioned method of biological treatment.

The treatment area was set up in May 1989 in a field where wheat had previously been cultivated, not far from the intermediate storage site. The land treatment was carried out in the summer. After 15 weeks of loosening, fertilising and watering the soil, tests showed a decrease in the total hydrocarbon concentration: 500 mg of hydrocarbon per kilogram (the set rehabilitation level), compared to the initial concentration of 5,400 mg of hydrocarbon per kilogram.

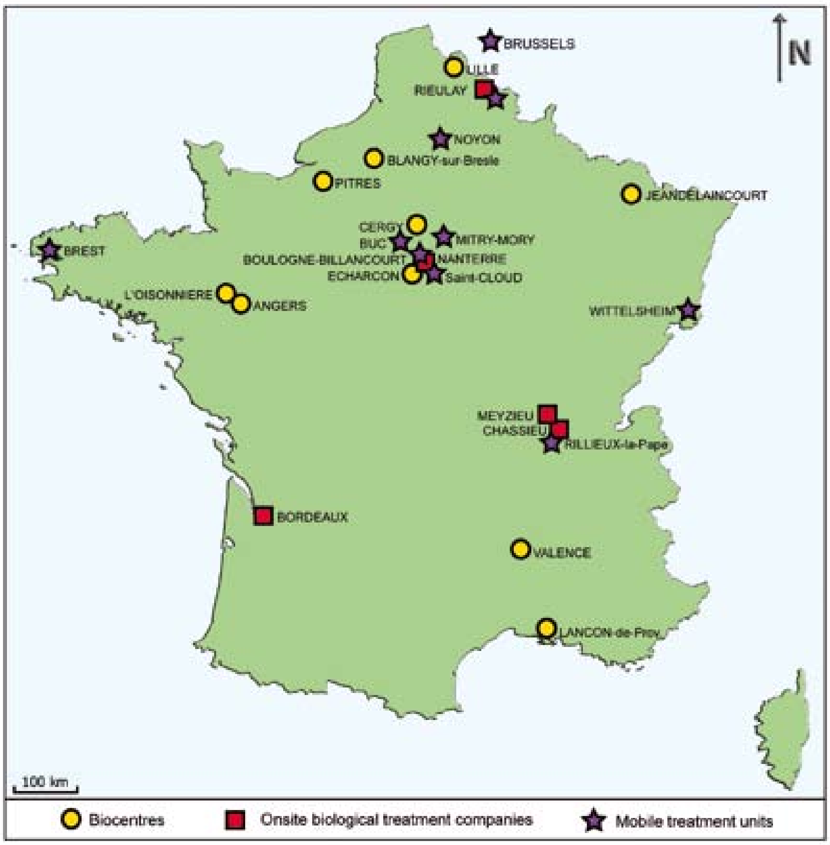
The shipwrecking of the *Sea Empress* (15 February 1996) generated 32,600 tonnes of waste, of which 12,600 tonnes were solid waste. Of these 12,600 tonnes of solid waste, 7,800 tonnes (including in particular polluted sand) were treated by landfarming at the Texaco refinery (destination of the oil from the *Sea Empress*), on a site conducive to bacterial activity.

Composting

Waste is laid out in windrows, in the open air or in a shed, with mechanical turning and additional aeration. Nutrients are added to speed up natural biodegradation and reduce treatment times to 3 to 9 months, depending on the pollutant. Experimentation has been carried out on unpolluted seaweed, and the technique could be extended to slightly oiled seaweed. However the resulting compost may be difficult to market (downgrading of the compost, consumer distrust).

Treatment in biocentres using the biopile technique may be a good solution in some instances (biodegradable pollutant). Biocentres can be built near the clean-up sites to reduce transportation times and promote in-situ recycling.

Biocentres, onsite biological waste treatment companies & mobile treatment units



K2

Biopile

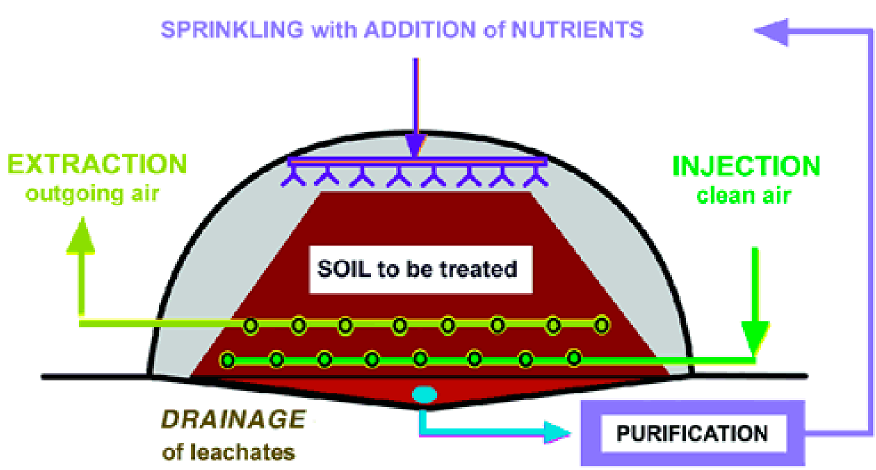
Biopile treatment is carried out under cover, with treatment of the gases and liquids (leachate) produced, aeration, humidification and addition of nutrients (nitrogen and phosphorous) to the substrate needing treated. Large quantities of solid waste (several hundred cubic metres) containing relatively high hydrocarbon concentrations (as much as 5% or 50,000 ppm) can be treated this way to rehabilitate polluted soil.

The polluted soil layer is excavated and on or off site treatment is conducted depending on quantities involved and distances to the nearest treatment centre.

- Treatment duration: 5 to 12 months depending on the kind of pollutant, or up to 3 years for particularly resistant polycyclic aromatic hydrocarbons (PAH).
- Costs of treatment: very attractive if quantities are high. From 150 Euros per tonne excluding tax for less than 100 tonnes of waste. Prices fall to 50-60 Euros per tonne for around 1,000 tonnes. Costs vary very little for prior analysis, preparation and analytical monitoring phases, whereas physico-chemical and thermal process costs vary more with the quantities to be treated.
- Advantage of biological techniques over thermal or physico-chemical techniques: treated materials do not undergo structural modification.

This technique, used to treat polluted soil, could be applied to oil spill waste containing, in particular, fermentable seaweed, providing the oil is sufficiently biodegradable, taking into account weathering at sea before the oil beaches and the time taken for recovery and storage.

Diagram illustrating biopile treatment



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Thermal Treatment

Incineration in a treatment plant for special industrial waste. Although the rotary kiln is at the centre of the process, it is the treatment of fumes which is the most complex and problematic issue.

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Pyrolysis and Thermolysis

Pyrolysis

This thermal treatment technique involves dry distillation in a closed chamber without oxygen. It generates gases, tar and coke for use in steel mills and requires a high temperature furnace (800 - 1100°C). The process used to be implemented for distilling coal and is now developing a new use in upgrading industrial oiled waste materials.

During the *Erika* spill, the waste containing plastic generated by sand screening machines used during the *Erika* pollution was treated by pyrolysis.

Thermolysis

Thermolysis is vacuum pyrolysis (where the internal pressure is about 100 millibars) with temperatures of about 500°C. It is applied to organic materials contained in waste. This technique can in theory be applied to solid oil spill waste, however no particular example of this is known to us.

Incineration of Industrial Waste

The following methods are used to dispose of waste with a very high oil content (more than 30%).

Incineration in hazardous waste collection centres

These facilities can treat virtually any kind of waste (cost: 300 to 900 Euros per tonne excluding tax). The major variations in cost are related to the net calorific value (NCV) and harmful substance content in the waste to be treated (Cl, S, heavy metals, PAH, PCB...).
In practice, these facilities are used to treat liquids and pastes that other processes cannot handle, if they contain one harmful substance or more.

Incineration in cement works (or co-incineration)

This technique is much less costly than the previous one (150 to 300 Euros per tonne excluding tax), but has more severe constraints (heavy metal content <1%, chlorine content < 2%, sulphur content < 4%).
Technical constraints: the waste adds an extra load to the incoming "raw" materials. So as not to alter the energy balance in the kiln, the total hydrocarbon content of the waste must remain below 5 000 mg/kg or 0.5% of the total hydrocarbon content, according to the French norm N FT 90.203.

Incineration in lime kilns

To safeguard the quality of the marketed end product, admissible halogen and sulphur contents are very restricted and can easily be reached when sea salt is present in the waste.
Prior analysis will be required to check that the waste can be treated using this method. Selection criteria are as follows:
- grain size less than 10 mm
- NCV greater than 2,500 kcal/kg (minimum NCV is higher than in cement works)
- less than 30% water
- less than 1% sulphur
- total halogen content (Cl, Br, F, I) less than 1%
- PCB and PCT less than 100 mg/kg each

Evapo-incineration

This technique combines incineration and physico-chemical treatment. It involves thermal cracking, during which the aqueous phase of the oil-water mixture vaporises. Water evaporates and an oil condensate forms that can easily be incinerated. Water in the vapour phase is treated by high temperatures in order to remove the residual organic phase.

Prestige

The main procedure used to treat the waste labelled "solid", collected in Aquitaine, France, from the *Prestige* pollution (19 November 2002) was incineration. The nature of the waste (in this case, containing sand or not) determined the type of centre to which it was sent for treatment. By the end of June 2003, a little more than 8,000 tonnes of waste (mainly made up of sand, fuel oil, nets and wood) had been treated in an incineration plant for special industrial waste, and around 1,000 tonnes of non sandy waste (bird corpses, PPE, plastics) had been taken on by a Household Waste Incineration Plant (HWIP).

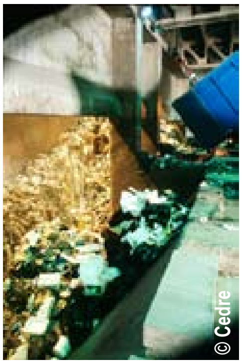
Special industrial waste treatment plant: arrival of waste on site and results of treatment.

Co-incineration in cement works reduces the cost of incineration by upgrading materials or generating power.
However access and implantation constraints mean that plants are often far from the shoreline, thus reducing their usefulness in the event of a major oil spill.

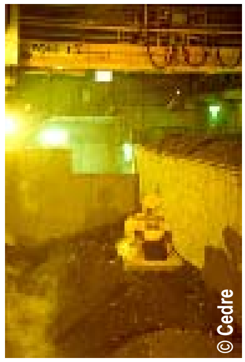
Incineration in Household Waste Incineration Plants (HWIP)

These incineration plants can only take waste included on their official authorised list (household waste, some small-scale commercial waste, but definitely no industrial waste). Some categories of oil spill waste can be added to the list subject to permission from the relevant regional government department, in particular PPE, polluted macro-waste that can be burned, sorbents, nets used for trapping oil, tarpaulins, watertight linings and flexible storage capacities.

The proximity of these plants, as they are relatively densely distributed, is an advantage. However, their treatment rates are low (oil spill waste has to be mixed with household waste) and they are inadequate for treating waste which has too high an oil content or is not sufficiently broken down (thermal balance may be affected and the furnace may overheat and be destroyed).



Houshold waste incineration plant: unloading waste and treatment prior to incineration.



Prestige

At the beginning of summer 2002, on land response to the *Prestige* pollution was concerned, amongst other issues, with treating polluted beached seaweed. The major concerns were where to store these piles (spread out to dry in layers to reduce volumes) and then how to dispose of them. The piles were very heterogeneous, depending on arrivals in the different communes, varying from a few cubic metres to a several hundred cubic metres. The task of disposing of the largest pile (750 m^3) containing a large quantity of sand was given to a private contractor who offered an efficient but expensive treatment technique. A large part of this process was carried out on the storage site at the beginning of the summer. It involved the separation of sand and seaweed by screening using a revolving screen, spreading then liming, before sending the waste to an incineration plant (HWIP). After analysis, the treated sand was returned to the beach to reinforce riprap.

Two solutions were chosen for the majority of the remaining piles (20 to 250 m3). The piles of lightly soiled seaweed were stored on land over the summer, and then returned to the water at falling tide, to be sorted by the sea, which spread the seaweed and tar balls over the foreshore. The tar balls could then be recovered manually. The piles of heavily polluted seaweed without sand were sent for incineration in specialised waste treatment plants, after liming to reduce volumes.

Upgrading and Ultimate Disposal

When appropriate pollution response strategies and waste management practices are chosen properly from the start (appropriate transfers, selective collection and storage), there will be smaller quantities of waste to treat and more options available for upgrading and recycling waste co-products.

Upgrading products of treatment processes

A few options for waste upgrading, to be considered on a case by case basis:

- return of treated materials to their original environment (although it is not often possible to achieve the quality required)
- fill for grading operations in construction
- underlayment in road construction (mixed with a sand-cement mixture or bitumen)
- top layer in waste burial facilities (e.g. used on a daily basis to cover household refuse and assimilated waste in waste burial facilities)
- sorbents used to protect ground surfaces for the co-product of lime treatment.

Waste burial facilities

In France, waste burial facilities, known as technical burial centres, have a classification system ranging from class 3 (inert mineral materials, construction debris) to class 1 (special industrial waste).

Approval criteria can be very stringent and costs increase from class 3 to class 1. These costs (90 to 150 Euros per tonne excluding tax) can double overall treatment costs, which is why it is advisable to keep waste quantities to a minimum and to optimise upgrading.

The only advantage of waste burial facilities is that they can rapidly deal with large quantities of waste.

Site Restoration

Basic rules:

- Plan on restoring the site from the moment it is opened
- Start restoration as soon as the site is no longer in use
- Be methodical and transparent

Justification

The opening of a waste storage or treatment facility will be considerably facilitated if there is a commitment in terms of the operational lifetime of the facility and its restoration after use. Restoration is therefore an essential part of the service contract and administrative approval procedures.

To prevent the facility from turning into an unauthorised dump (due to a lack of supervision), the facility must be evacuated and rehabilitated as soon as it is no longer required.

Tasks

Restoration involves the rehabilitation of different elements:

- top soil (and, where necessary, subsoil)
- access paths leading to the site
- surrounding vegetation that has been affected (to a varying extent)
- structures that existed prior to pollution response operations.

Limitations

The main objective will always be to reinstate the area to its original condition before it was used as a transfer, storage or treatment facility. Ensure that the contingency plan is lifted when this level is reached. Another budgetary allocation will be need if the area is to be altered or developed in relation to its original state (local authority, county or regional budget).

Implementation

- Stage 1: remove the bulk of the oil from the site, including removing clean sediment to extract polluted sediment.
- Stage 2: obtain an assessment by a specialised company, supervised by government experts, including:
  - mapping of the polluted area (extent, depth, concentrations)
  - a proposal of clean-up operations and levels to obtain.
- Stage 3: restoration work should be carried out by a different company from the one which conducted the assessment (this company should also be able to ensure the necessary measures and analysis for final disposal).

Acronyms and abbreviations

API: American Petroleum Institute
BRGM: Bureau de Recherches Géologiques et Minières
DDE: Direction Départementale de l'Equipement
DIREN: Direction Régionale de l'Environnement
DRIRE: Direction Régionale de l'Industrie, de la Recherche et de l'Environnement
EWC: European Waste Catalogue
HazMat: Hazardous Materials
HDPE: High Density Polyethylene
HWIP: Household Waste Incineration Plant
LDPE: Low Density Polyethylene
NCV: Net Calorific Value
PCB: Polychlorinated Biphenyl
PCT: Polychlorinated Terphenyl
PPE: Personal Protective Equipment
WTS: Waste Tracking Slip

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