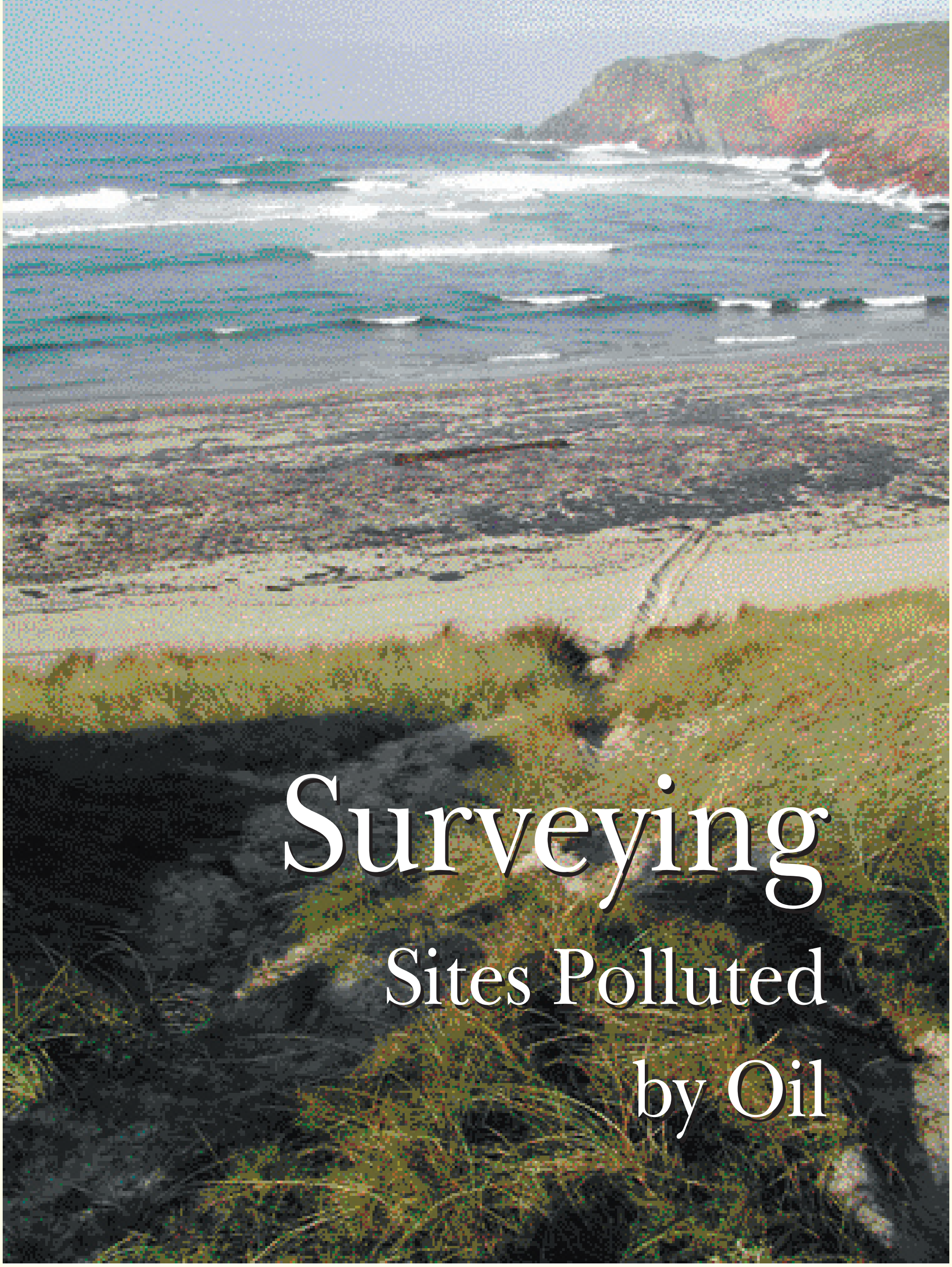

Surveying Sites Polluted by Oil

AN OPERATIONAL GUIDE
FOR CONDUCTING
AN ASSESSMENT
OF COASTAL POLLUTION

Cedre

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AN OPERATIONAL GUIDE
FOR CONDUCTING
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This Guide written by *Cedre* has been produced with financial support from Total and the French Ministry of the Environment and Sustainable Development. It supersedes and replaces the one published in 2000.

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Cover page photo:
A survey conducted during the Prestige *spill in Galicia, Spain*
December 2002
Source: Cedre

Purpose of this guide

Conducting a reconnaissance survey and an assessment of an oil spill are crucial when responding to accidental oil spills. A survey is the only way to assess the extent of the spill in addition to deciding which areas should be given priority for clean-up. In addition, it helps authorities to decide which techniques and resources are most suitable.

When an oil spill reaches the coastline, reports on how much of the coastline has been polluted and how heavily the coastal sites are affected are very often so inadequate as to be of little use to decision makers.

This guide seeks to present a coastal survey method likely to produce a useable, short and yet complete report that can be used as a basis for filling in an operational coastal report form.

In the first instance, surveys usually require either a spotter aircraft or a helicopter which provide an overall idea of the full extent of the spill. However, a field visit will be needed in order to produce a satisfactory appraisal of the situation and that is what this guide sets out to describe. Readers are invited to refer to the *Cedre* guide on aerial observation* for more details on aerial survey of an oil spill.

For response to be rapid and effective, there has to be a fair assessment of the size of the spill and precise indications regarding the physical, ecological and economic details for each polluted site. Ideally, coastal features could usefully be included and mapped in a coastal atlas which should be part of the contingency plan. If so, aerial observation will simply serve to confirm the facts or not, as the case may be.

Imaging assets such as cameras and digital cameras will afford real time data capture which can then be relayed to the competent authorities where officials will be in a better position to realise how serious the spill is on the ground.

Such data will prove useful and serve as an additional item as part of a qualitative spill assessment but cannot possibly replace the quantitative approach described in this guide.

This guide will not address the assessment of the potential impact of pollution nor will it look at long term monitoring techniques for the fate of spilled oil. Such matters require specialist knowledge and involve other experts who will not be referred to in this document.

** Operational Guide: Aerial Observation of Oil Pollution at Sea (2004).*

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What you will need to know

Why conduct surveys?

Defining sites

Describing pollution

Goals of reconnaissance surveys

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The objectives of a reconnaissance survey are:

- to confirm alerts or sightings and provide more detailed information if necessary
- to single out mistaken cases of pollution
- to assess the extent and size of a spill
- to appraise the extent of the most visible damage caused by an oil spill depending on how sensitive a site is
- to help officials define their response priorities
- to assess response options, resources and techniques
- to monitor developments and the spill (repeated surveys).

Survey

Nature and types of coastline

Substrates

 The nature of the substrate is essential as it will determine, inter alia, response options and the extent to which oil has penetrated the ground. The coastline is made up of hard materials such as **rocks** or bed rock and/or more loose materials such as **sediment**.

 Sediments are ranked according to their grain size :

- mud or silt (< 0.063 mm)
- fine to coarse-grained sand (< 2 mm)
- gravel (< 25 mm)
- pebbles or broken stones (< 500 mm)
- boulders (> 500 mm).

 Depending on the degree of exposure to wave energy, beach sediment can be well sorted (homogeneous) or heterogenerous and, when heterogenerous, one or two types of sediment can predominate on various sections of the beach. Alternatively, the entire foreshore can be made up of mixed sediments.

Exposure

 This defines the amount of energy which is conveyed by waves and dissipated upon reaching the coastline.

 Coastlines can thus be ranked according to mode of exposure ranging from **exposed** (or wave beaten) to **sheltered**.

 In the event of a spill, this energy produces a **natural cleaning** process which will be quicker or slower depending on the amount of wave energy reaching the shoreline. The speed with which natural cleaning processes occur will define the amount of time the oil will remain on the shoreline, a notion still called oil persistence or **remanence**.

 Initially, the intensity of the wave energy reaching the shoreline can be assessed by a number of indicators dealing with sediment types, the shape and grain size of sand or the presence of flora and fauna (more difficult in the latter case) (cf. figure 1).

- When there are silty deposits, the shoreline is of the sheltered type.

- The average grain size is an indication that **the coarser the grain, the more wave energy there is** and the more the beach is exposed. However, this cannot be significant unless beach sediment grain sizes are relatively consistent. In effect, an even coverage of coarse-grained sediment characterises the efficiency of the sorting action exerted by waves but is an even surer indication of high energy wave action. Conversely, an even coverage of broken stones on sandy-silty sediment substrates will tell you that the site is not all that exposed to wave energy.

- Sediment appearance will also tell you about the type of beach exposure: sharp angle or chipped stones (such as broken stones) will be the hallmark of very little energy whereas smooth or rounded stones (pebbles, for instance) are more an indication of high mechanical abrasion.

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- The presence of plant and animal species that are characteristic of wave beaten sites (narnacles or limpets, for instance) or sheltered areas (the brown seaweed *Ascophyllum nodosum*, for instance) is also highly significant.

- The slope of a beach is governed by sand grain size and wave energy. Generally, the more the exposed the beach is to wave action, the coarser the average sediment grain and the steeper the beach slope.

- Signs of erosion at the upper end of the beach (a definite sign that the coastline is receding) or of coastline defences (spurs, riprap, walls) are the telltale signs of an exposed shoreline.

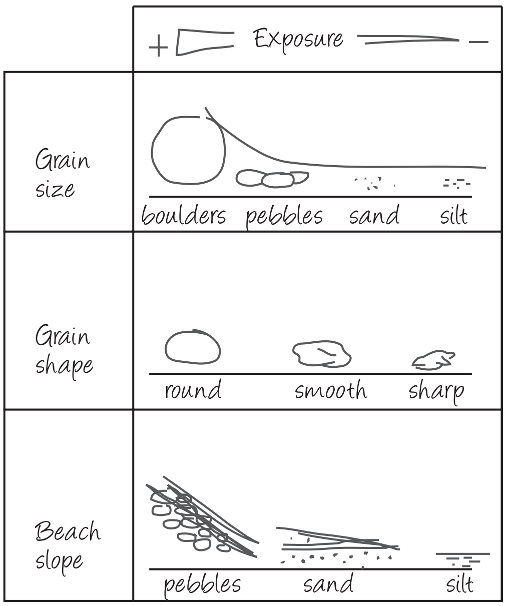

Figure 1: characteristics of sediment and beaches depending on exposure

Shoreline classification

Using the usual classification of shoreline substrates such as rocks, boulders, pebbles, fine and coarse-grained sand, silt and marshland, several types of shoreline can be defined, providing one takes into account the degree of exposure to hydrodynamic forces (exposed or sheltered mode).

Plates 1 et 2 illustrate a few of the main coastal types (exposed or sheltered), that you are likely to find in temperate climates.

The average natural persistence of oil (or remanence) and ecological sensitivity vary with the types of coastline and the nature of the spilled oil.

In order to initially address these two operational items, it is generally accepted that coastline types should be divided into ten classes according to similarity (table 1). This is called the ESI or Environmental Sensitivity Index. An ESI can be adapted to suit the local specificities of an oiled area and the pollutant concerned as was the case during the *Amoco Cadiz* spill (1978) which involved a light crude that covered the beaches on the north coast of Brittany (table 2).

category	Types of coastline
1	Exposed rocky headlands
2	Eroding wave cut platforms
3	Exposed fine-grained sandy beaches
4	Exposed coarse-grained sandy beaches
5	Exposed tidal flats with compact fine sediment
5a	Exposed tidal flats with coarse-grained sand and pebbles
6	Exposed pebble beach
6a	Exposed sandy or gravel beach
7	Boulders
8	Sheltered rocky shores
9	Sheltered sandy-silty to silty tidal flats
10	Salt marshes

Table 1: classification of coastlines depending on ESI (Environmental Sensitivity Index -ESI-, Gundlach and Hayes - 1978)

	Category	Type of coast	Oil accumulation	Duration of pollution
EXPOSED	1	Exposed rocky headlands	Waves beating against rocks prevent oil from being deposited during storms.	A few days to a few weeks
EXPOSED	2	Eroding wave-cut platforms	Accumulation on upper part of foreshore.	A few weeks to a few months
EXPOSED	3	Fine-grained sandy beaches	Beds of oil form in the sediment and migrate slowly downwards. Emulsion into interstitial water.	1 to 2 years
EXPOSED	4	Exposed medium to coarse-grained sandy beaches	Beds of oil form in the sediment; downward migration is rapid. Emulsion into interstitial water.	1 to 3 years
EXPOSED	5	Exposed gravel and pebble beaches	Fast migration of the oil downwards. Very little or no deposit on the surface.	3 to 5 years
SHELTERED	6	Rocky coasts	Accumulation of oil in cracks and crevices. Rocks covered with a thin film of oil.	3 to 5 years
SHELTERED	7	Fine to medium-grained sandy beaches	Percolation to the substratum. Pollution of the subtidal area by the tides (mixing of oil and deposits). Formation of a fast-hardening crust at the surface after one year.	> 5 years
SHELTERED	8	Coarse-grained sandy and pebble beach	Fast percolation to the substratum. After one year, formation of a crust of pebbles and oil.	> 5 years
SHELTERED	9	Tidal and mud flats	Deep percolation due to buried organisms and the interstitial water movements.	> 10 years
SHELTERED	10	Salt marshes	Formation of a crust on the surface. Migration into the deposits.	> 10 years

Table 2: classification applied to an actual spill: ESI index created after the Amoco Cadiz *spill in 1978 which released light crude oil on the northern shores of Brittany*
(from Berné S., Marchand M., D'Ozouville L. Pollution of Sea Water and Marine Sediments in Coastal Areas. Ambio Vol 9, *p.287-293.)*

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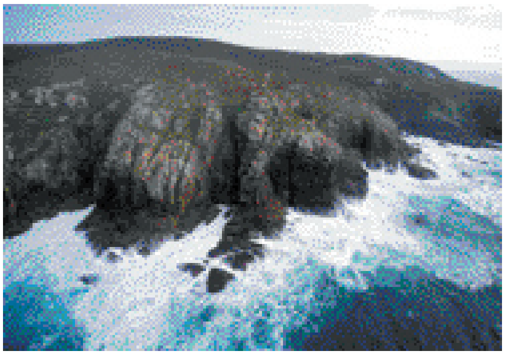
Exposed sites

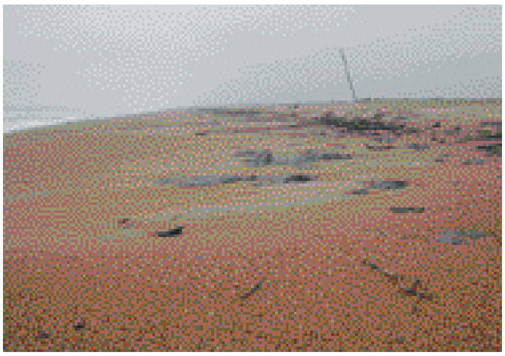


1. Cliffs (ESI 1)

2. Rocky platform (ESI 2)

3. Manmade structure (ESI 2)

4. Fine-grained sandy beaches (dunes) (ESI 3)



5. Coarse-grained sandy beaches (ESI 4)

6. Mixed sediments (ESI 5)

7. Pebble beach at the upper end of a creek (ESI 6)

8. Boulders (ESI 7)

Plate 1: types of exposed coastlines

Photo source: Cedre

Sheltered sites

1. Rocky platform (ESI 8)

2. Manmade structures (ESI 8)

3. Sandy-silty tidal flats (ESI 9)

4. Mixed coarse-grained sediment (ESI 9)

5. Mixed fine-grained sediment (ESI 9)

6. Silty-sandy tidal flats (ESI 9)

7. Mud flats (ESI 9)

8. Salt marshes (ESI 10)

Plate 2: types of sheltered coastlines

Photo source: Cedre

Types of oil arrivals

Influential factors

Apart from the **quantities spilled**, several factors have an effect on the nature of the pollutant and more particularly the types of oil arrivals on the coastline, such as:

- **the characteristics of the pollutant:** its viscosity and its stickiness depend on the nature of the pollutant but also on its evolution in the marine environment

- **the characteristics of the coastline:** meaning the nature of the substrate, the morphology and the exposure of the site, the presence of all sorts of debris along the coast, the season or more precisely the period of the coastal sedimentary cycle (briefly stated, when summer comes, sand tends to migrate towards the upper part of the beach (beach accretion) and then when winter comes, the sand tends to shift back down towards the lower part of the beach (retreat of beach)

- **sea and weather conditions** at that point in time and mainly sea state and seawater temperature in addition to wind can cause partial covering of the stranded oil by a thin layer of fine dry sand.

The parameters can be very varied which only goes to explain why oil arrivals can look so different, and why oil can be reclaimed by the sea or may reappear.

Typology

A pollutant comes in many forms by the time it beaches (cf. plate 3); such forms can be categorised as follows:

- **massive arrivals** that form an evenly spread, thick **slick** (several mm to several cm), that can also spread continuously or discontinuously over a wide area of coastline (several hundred square metres); oil coatings look like wide vertical **bands** on hard vertical surfaces, the width of the band being determined by the viscosity (0.1 to 2 cm).

- **sporadic arrivals** that will combine various aspects from two categories or more depending on whether:

a) *the oil is deposited on the surface,* in the form of:

- **patches** (1 m to 30 m)
- **patties** (10 cm to 1 m)
- **tarballs** (< 10 cm)
- **micro tarballs** (less than 1 cm)
- **ribbons** of oil when only small quantities have beached at the low water mark once the waves recede
- brown **foam** deposited on very exposed beaches resulting from intense wave action by waves presenting sheen to a greater or lesser extent pushing the foam to the coast (but only very small quantities are involved)
- oil projected onto hard surfaces (**splashes, spots**)
- **sheen** on the water surface or **oily film** on the beach.

b) *the oil has penetrated into the substrate (or naturally buried),* in the form of:

- **a layer of polluted sediment**, either on the surface, or covered by clean sediment that can vary between a few centimetres to a few dozen centimetres thick.
- **alternate layers** of sizeable thicknesses (0.5 to 5 cm) of oil or oiled sand alternating with layers of clean sand.
- **masses of oil trapped** in boulders or riprap at various depths depending on the infrastructure involved (can be more than a metre).

Furthermore, the pollutant can also be deposited on sundry debris or be trapped in mats of seaweed or sea grass washed up on the beach.

Splashes and spots on rocks

Nomenclature – pollution survey

To avoid confusion regarding arrivals of oil and so as to have consistency in reconnaissance survey reports, the following wording should be used:

<table>
<tr><th>On beaches</th><th>On rocks
and assimilated</th><th>Dimensions</th></tr>
<tr><td colspan="2">Sheen (on water)
Spray or oily film (on beach)</td><td rowspan="2">Not appropriate</td></tr>
<tr><td>Ribbon</td><td>Mottling</td></tr>
<tr><td>Micro tarball</td><td rowspan="2">Splashes</td><td>< 1 cm</td></tr>
<tr><td>Tarball</td><td>from 1 cm to 10 cm</td></tr>
<tr><td>Patty</td><td>Spot</td><td>from 10 cm to 1 m</td></tr>
<tr><td colspan="2">Patch</td><td>from 1 to 30 m</td></tr>
<tr><td>Slick</td><td>Band - Slick</td><td>> 30 m</td></tr>
</table>

*N.B.: The average **size of oil arrivals** and **oil thicknesses** should be specified.*
(For example, tarballs: 5 cm in diameter on average and about 1 cm thick, patches: one 15 m and another about 25 m, roughly 2 cm thick.)

1. Slick

2. Band

3. Patches

4. Patties and tarballs

5. Tarballs and micro tarballs

6. Ribbons

7. Superficial infiltrates

8. Alternate layers (buried)

Plate 3: types of oil arrivals on the coastline

Photo source: Cedre

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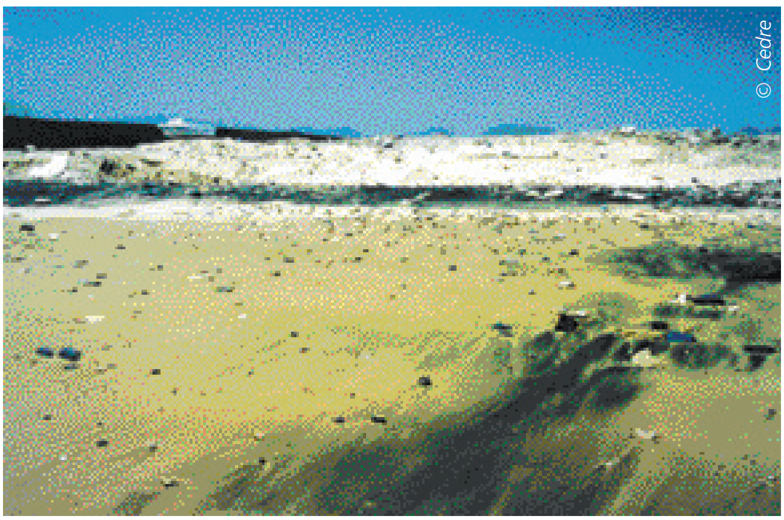
Mistaken pollution

In some cases, natural biological or mineral phenomena are mistaken for oil. The following examples can be quoted:

- black lichen (*Verrucaria maura*) which forms dark crusts on rocks on the upper level of the beach
- ancient formations of peat outcroppings half way down the foreshore
- concentrations of dark coloured minerals
- seaweed and sea grass deposits
- the shiny appearance of some dark coloured rocks.

Outcrops of peat



Mineral deposits

What to do before leaving on assignment

Preparing for an assignment

What to take with you

Preparing the assignment

A survey assignment has great strategic importance which is why it is vital to be well prepared. Before going on site, the observer has a number of things to do and a few recommendations to follow.

Definition of the survey area

The coastline will be divided up whilst ensuring compatibility for resource availability (manpower, vehicles) and the amount of time needed to conduct a survey of the entire area. Such limits will have to be defined if possible with existing geographic entities or areas with consistent substrates or the extent to which the coastline has been polluted by the spill. The smallest administrative division (commune, district etc.) can be used as a basic framework in so far as it covers the same administrative framework as the one that applies to potential observers. In a set-up like this, each observer will be responsible for an area of the coastline.

Defining the itinerary

The principle is that the coastline has to be inspected systematically; this may not always be possible for a number of reasons (not enough observers for a section of the coastline that is too vast or too steep, tidal ranges or daylight times...). In cases such as these there will be a need to optimise which will mean choosing appropriate sites to visit.

There are a few rules to abide by before setting out on your tour of inspection.

- **Find out the results of the most recent survey, especially the last flight over the area** the previous day or on the morning of the same day: an aerial observation from a helicopter will tell you how seriously the coastline has been oiled or not as the case may be, including places that are hard to reach on foot. This will also help you to decide where to conduct a survey on the very first day of a spill and thereafter, and identify arrivals of oil on sites that have not been inspected or that are no longer being inspected on a daily basis or because the site in question is in an area that has not been oiled.

- **Study the configuration of the coastline on a map** (including weather reports from the previous day or same day, prevailing currents) and identify sites that are more likely to trap floating debris and oil (creeks, bays, coves, spurs); list all sites known to be likely candidates for accumulating debris or macro waste (wrecks of all sorts, seaweed beds, etc...).

- **Factor in response operations** that have already been conducted, are underway or are soon to be conducted.

Time and duration of surveys

- Carrying out a survey will often depend on unavoidable factors and times: weather conditions, vehicle availability, daylight hours, tidal data, relaying observations to the command post.

- Oil floating near a coastline will be easier to spot under grazing light conditions (early morning and late afternoon).

- Do not rush surveys, particularly at nightfall and even when the oil has already beached.

- On some sites (hard to reach or hilly and craggy), carrying out your survey at high tide will afford a more accurate quantification of oil floating on the surface and allow much better quantification if the previous survey at low tide only gave an approximation of the quantities spilled.

Before departure

- Make sure you have the equipment you need (appropriate quantity) and that it is in correct working order (batteries, both heavy and light duty).
- Make sure permission has been granted to visit certain sites (MoD facilities, private property).
- Ensure compatibility between the time of visit and tidal data.
- If you have to inspect a site or an area that may include an element of risk (islets, cliffs, marshes, quick incoming tides, risk of being hemmed in by the sea): always give an indication of when you expect to return and take a cell phone and if necessary a VHF handset with you as well if cell phone coverage is likely to be inadequate.

List of equipment

The following list shows the categories of equipment that may well be needed, at least in the observer's vehicle. The observer will select the equipment he deems necessary, which may vary according to his experience or how he usually conducts field inspections (not including survey work) and of course will depend on prevailing conditions and his objectives for the field survey trip. He may also wish to take along other equipment that is not listed here.

Clothing

- Clothing with enough pockets or a back-pack
- Boots or walking shoes
- Rainproof clothes
- Gloves

Bearings

- Topographical survey map (1:25000) and possibly an admiralty chart
- Documents included in the contingency plan: maps from an atlas, detailed plans of port infrastructures
- GPS handset or similar

NB: When the coastline is long with the same features all the way along it (such as a long stretch of dunes) and oil arrivals are staggered over time, plan on installing landmarks, such as wooden stakes, so as to be able to measure distances.

Note taking

- Note pad
- Clipboard
- Plastic page covers (in case of rain)
- Photocopies of topographical survey maps (1/25000) and aerial photographs or coastal orthophotographs (available in 1/5000 format and downloadable from the internet)
- Blank standard survey report forms (make sure you have enough of them, 1 per site)
- Drawing paper, pencil (don't use felt tip pens or ink pens, as they will fade or run if it rains)
- Eraser and pencil sharpener
- Dictaphone (optional): for those used to using them, but a written report will be needed later. Make sure all the relevant details have been included.

Photography (mainly concerns observers reporting their findings to the command post or entrusted with monitoring)

- Digital camera or 35 mm silver film camera (with date stamp if possible) with a strap or a pocket belt
- Camcorder with strap: can prove very useful at the command post to show how things have changed since the last survey
- Memory cards, recharged batteries, film, camera cassettes

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Communications

- Mobile phone (check coverage for the survey area) or use a VHF handset on some sites if necessary
- Contact details (telephone number and possibly a fax number or an e-mail address)

Facilitating observation

- Binoculars
- Polarising sunglasses or the relevant filter for your camera so as to see oil on the water surface
- Garden trowel or foldable shovel with short handle
- Plastic covered "Nomenclature" sheet

Quantification

- Measuring tape or rope
- Graduated ruler (for measuring distances with the scale on a map)
- Graduated ruler (for measuring the thickness of oil or polluted surfaces)

Sampling

- Glass recipients
- Aluminium trays
- Spatulas, spoons
- Sorbent, polyurethane sponge, teflon film
- Aluminium sheets
- Solvent
- Labels, indelible pens/pencils
- Elastic bands, plastic bags (packages)

Miscellaneous

- Watch
- Weekly timetables for tides
- Bags to carry documents and sensitive equipment
- Crates or cardboard boxes for samples and tools
- Rags and special soap
- Something to drink and a snack
- Compass
- Torch

Survey

What to do during the assignment

Observing
Measuring
Taking notes
Taking samples

Survey forms for polluted sites

Site survey form

Each site must be reported on a detailed survey form.

An example of a standard form can be found below (cf. figures 2 & 3).

The section to cover are as follows:

Identification

- of the incident
- of the site
- of the survey
- of the observer.

Environmental characteristics of the site

(unusual or well known)

- physical
- ecological
- socio-economic.

General characteristics of the beach

(beach, essentially)

- types of substrates
- sizes.

Characteristics of the pollutant and the spill

- colour, appearance, viscosity
- types of oil arrivals and location on the beach
- size, distribution, volume
- expected trend (viscosity, washed back out to sea...).

Operational characteristics of the site

- accessibility
- is the site easy to work on
- storage facilities for recovered waste.

The survey forms should include drawings of the site (profile and a map with a scale) mentioning the spill and photos if possible that can be used for reference purposes afterwards.

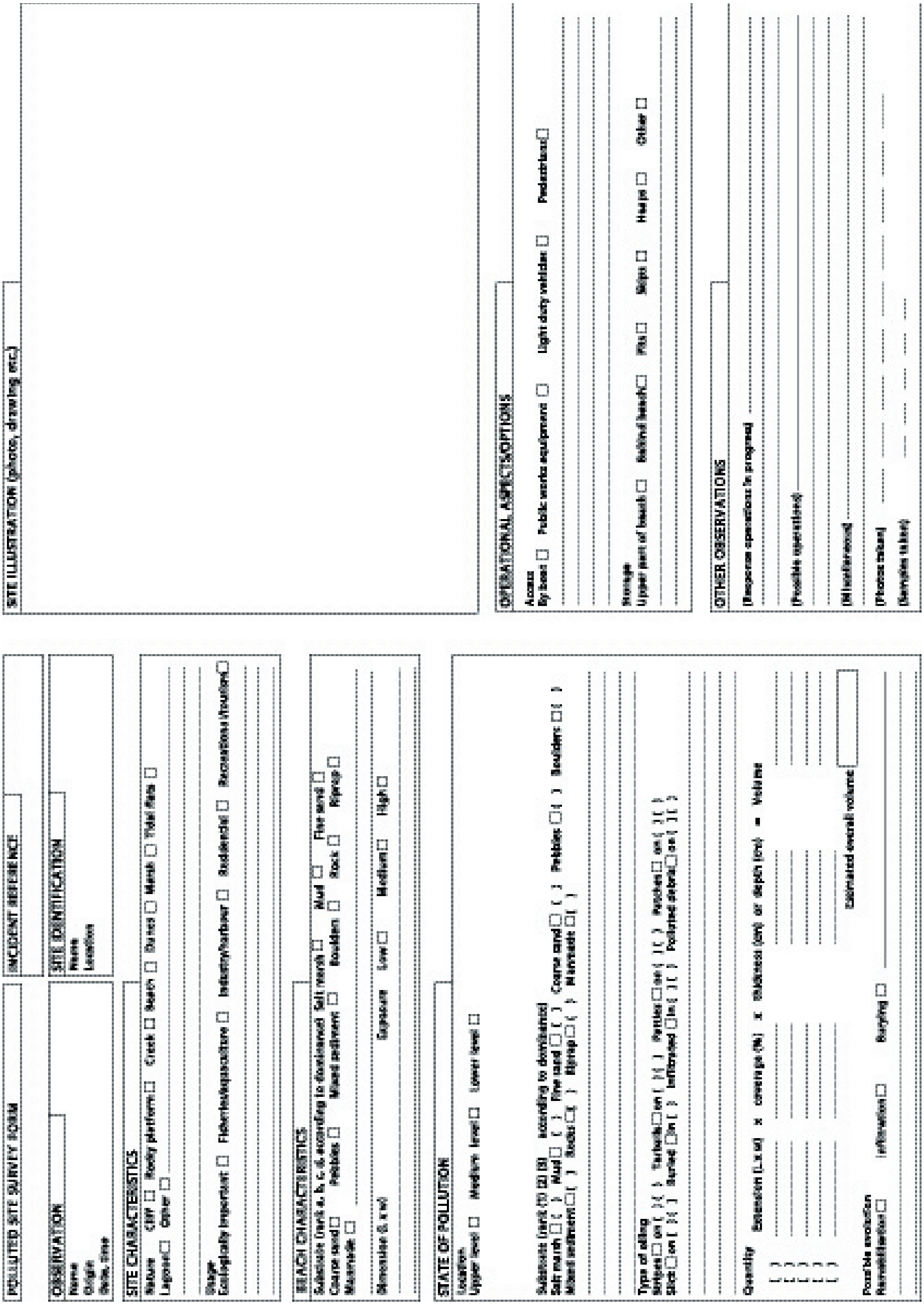
Chapter C2 explains how to fill in the form, section by section.

General thematic "survey" map

Once the observer has inspected all the relevant sites, he must submit his survey forms and a summary of the surveys he has conducted. The summary consists of one single map, if possible, that sums up all the information collected for the area in terms of estimated quantities of beached oil, the nature of the pollution (such as heavy emulsions, buried oil, arrivals of polluted seaweed, etc.).

IT applications and archiving

In some instances, the information collected by observers can be entered into a GIS (Geographic Information System). When the environmental and operational details of all of the sites have been entered, simplified survey forms can be used to facilitate data entry. Examples of such forms can be found in figures 4 (site survey form) and 5 (summary or sectoral survey form).



POLLUTED SITE SURVEY FORM
INCIDENT REFERENCE

OBSERVATION
Name
Origin
Date, time

SITE IDENTIFICATION
Name
Location

SITE CHARACTERISTICS
Nature Cliff ☐ Rocky platform ☐ Creek ☐ Beach ☐ Dunes ☐ Marsh ☐ Tidal flats ☐
Lagoon ☐ Other ☐
Stage
Ecologically important ☐ Fisheries/aquaculture ☐ Industry/harbour ☐ Residential ☐ Recreational/tourism ☐

BEACH CHARACTERISTICS
Substrate (rank a, b, c, d according to dominance) Salt marsh ☐ Mud ☐ Fine sand ☐
Coarse sand ☐ Pebbles ☐ Mixed sediment ☐ Boulders ☐ Rock ☐ Riprap ☐
Manmade ☐
Dimensions (L x w) Exposure Low ☐ Medium ☐ High ☐

STATE OF POLLUTION
Location
Upper level ☐ Medium level ☐ Lower level ☐
Substrates (rank (1) (2) (3) according to dominance)
Salt marsh ☐ ( ) Mud ☐ ( ) Fine sand ☐ ( ) Coarse sand ☐ ( ) Pebbles ☐ ( ) Boulders ☐ ( )
Mixed sediment ☐ ( ) Rocks ☐ ( ) Riprap ☐ ( ) Manmade ☐ ( )
Type of oiling
Stripes ☐ Tarballs ☐ Pancakes ☐ Patches ☐
Slick ☐ Buried ☐ Infiltrated ☐ Polluted debris ☐
Quantity
Extension (L x w) x coverage (%) x thickness (cm) or depth (cm) = Volume
Estimated overall volume
Possible evolution
Remobilisation ☐ Infiltration ☐ Burying ☐

SITE ILLUSTRATION (photo, drawing etc.)

OPERATIONAL ASPECTS/OPTIONS
Access
By boat ☐ Public works equipment ☐ Light duty vehicles ☐ Pedestrians ☐
Storage
Upper part of beach ☐ Behind beach ☐ Pits ☐ Skips ☐ Heaps ☐ Other ☐

OTHER OBSERVATIONS
(Response operations in progress)
(Possible operations)
(Miscellaneous)
(Photos taken)
(Samples taken)

Figure 2: a (blank) survey form for polluted sites

C1

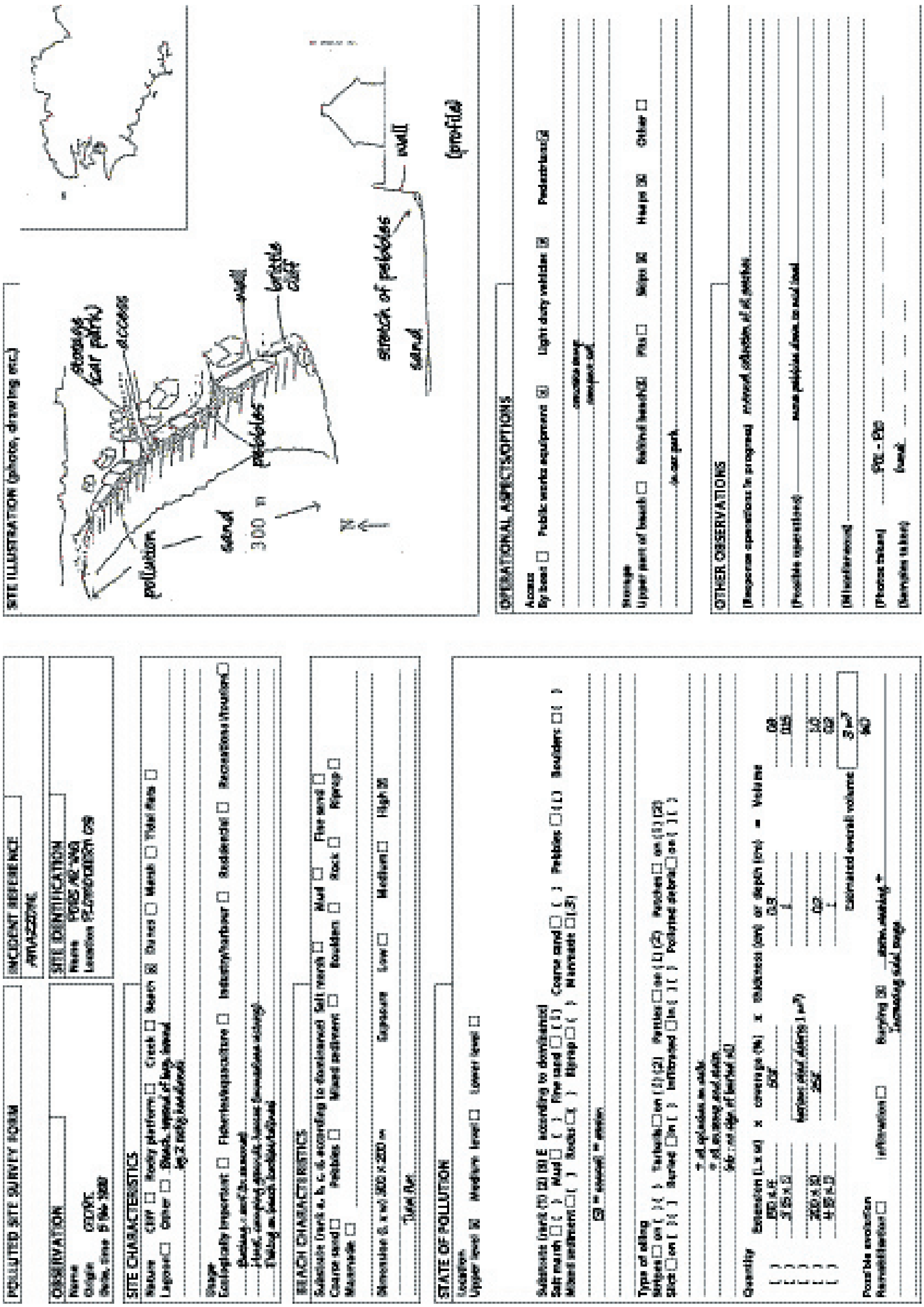


Figure 3: a survey form for polluted sites (filled in)

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POLLUTION SURVEY FORM SITE REPORT	INCIDENT:	OBSERVER: DATE/TIME:

SITE		
	Name / commune, district.../ GPS coordinates	
	Description (*) + observations:	

	POLLUTION			
	Type (**)	Observations	Extension / Volume L (m) x w (m) x thickness (cm) x %	Global estimation/ site
Rocks				
Boulders				length (m)
Peebles				
Mixed sediments				
Coarse sand				
Fine sand				
Mud				volume (m^3)
Salt marshes				
Rip rap				
Manmade structures				
Stranded debris and seaweed				

* types of coastline: cliffs, rocky flats, rocky creek, boulders, stretch of pebbles, small beach, dunes, tidal flats, marshes, banks, etc

** types of pollution: (i) on the surface: sheen, ribbon, micro tarballs, tarballs, patties, patches, slick (projected onto rocks: mottling, splashes, spots, patches) (ii) buried or infiltrated

Figure 4: simplified survey form (site survey form)

C1

C1

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POLLUTION SURVEY FORM SUMMARY/SECTOR REPORT	INCIDENT:	OBSERVER: DATE/TIME:

SECTOR	
	Name/location or sector:
	Description (*) + observations:

	SITES OR SUB/SECTORS		POLLUTION		
N°	LOCATION (name, location, or GPS coordinates)	TYPE (*)	TYPE (**)	EXTENSION (L x w x thickness x %)	VOLUME Estimation (m^3)

* types of coastline: cliffs, rocky flats, rocky creek, boulders, stretch of pebbles, small beach, dunes, tidal flats, marshes, banks, etc

** types of pollution: (i) on the surface: sheen, ribbon, micro tarballs, tarballs, patties, patches, slick (projected onto rocks: mottling, splashes, spots, patches) (ii) buried or infiltrated

Figure 5: simplified survey form (summary or sectoral form)

Filling in the form

Identify

- The accident
- The site: name (stating, where necessary, whether it is the northern or the southern end of a very long beach), location (nearest town or village)
- The observation: date, time, tidal information (indicating how many hours after high tide: HT + 1, HT + 4...)
- The observer: name, where he works (organisation and department) and phone number.

Overall characteristics of the site

By this we mean the most salient features of the site and an indication of seasonality.

- **Physical characteristics (cf. A2):** state whether it is a cliff area, a creek, a beach at the upper end of a bay, a long beach with dunes, a sandy spit, a pebble beach, a salt marsh
- **Ecological and socio-economic characteristics:**
  - tourism (seaside resort, campsite nearby)
  - populated (no, low, medium, high density, permanent or seasonal population)
  - aquaculture (pens, parks, basket traps at sea or on the foreshore, basin with a water intake on the beach)
  - artisanal fisheries (fishing harbour...)
  - professional harvesting (shellfish, worms, seaweed, glasswort...)
  - leisure activities (boat shed, marina, fishing on foot, bathing, walking, sailing, surfing, diving...)
  - flora: sea grass, seaweed, marshes...
  - fauna: fish (spawning grounds, nurseries...), birds (nesting areas, reproduction, resting, migration...), mammals (reproduction areas, resting...)

General features of the foreshore

- **Nature of the substrate**
  - Mention the nature of the various foreshore substrates: rocks, boulders, pebbles, gravel, coarse or fine-grained sand, mudflats, marshes, manmade structures (quays, seawall, groins, riprap ...)
  - Rank them by dominance (a, b, c...).
- **Types of foreshore**
  - State the size (L x w) of the beach
  - State how exposed it is to swell and wave action (low = sheltered beach; high = beach is exposed to heavy wave action most of the time)
  - Note the presence of rivers on the foreshore, or of run-off (resurgence of the ground water table...)
  - Note the slope of the beach (steep, average slope, slight slope).

The characteristics of the pollutant and the pollution

- **The location of the pollutant:**
  - in relation to the beach (lower, mid and upper parts of the beach)
  - in relation to the affected substrate(s): here again the substrates should be ranked according to how polluted they are (1, 2, 3...).

- The appearance of the pollutant:
  - colour, stickiness, viscosity.
- The type of arrivals (cf. A3):
  - mentioning which substrates are involved, their ranking (1, 2, 3...) and possible presence of polluted debris.
- The quantity of pollutant that can be found in the substrates (cf. C3) (and globally) by indicating (and aggregating) assessments of pollution extension, thickness and depth. As far as polluted seaweed and debris are concerned, state the overall quantities and give an estimation of oil content or the degree of contamination (slight, medium, high).
- The possible evolution of the pollutant over the hours and days to come. The oil may be washed back out to sea with the next tide or may end up being buried by sand blown over the beach by the wind or the tide. Furthermore, even slight temperature increases can significantly change pollutant viscosity at any point in time.

The operational characteristics of the site

- Accessibility
  Give details on access and whether it is limited (is access sufficient for beach cleaners etc).
- Is the site easy to work on?
  Some land surfaces will not be compact enough to bear heavy loads such as machines and sometimes even pedestrians. Make a note of load bearing capacity whenever it seems slight.
- Manoeuvrability
  Indicate whether the beach is covered with rocky outcrops likely to hinder machines...
- Storage
  Mention whether the site affords areas for storage facilities and state the location (upper end of the beach, behind the beach, in a yard or a car park), available surface areas and type of storage (tanks, pits...).

  Other operational matters can be mentioned if the observer has been trained to respond to pollution. He may suggest possible clean-up techniques or any other item likely to have an effect on which techniques to choose, how to organise the worksite and responder safety: development work in progress, obvious signs of intense coastal erosion, possible landslides, or rock falls etc.

Drawing of the site and the pollutant

A survey report should include a hand drawing of the site and an indication of where the pollution can be found. A graphic representation of the beach (map and cross section) must be done as accurately as possible with indications of the main characteristics to be found on site (types of substrates, location, types and relative extent of polluted waste coverage and access); a graphic scale and compass directions should also be included.
When conducting a survey in a harbour area, detailed maps of the harbour must be obtained from the harbour authorities (this type of document should normally be available as part of the port contingency plan).

Quantifying pollution

It is almost impossible to ascertain how much oil has beached. The aim of the survey will be to provide a site by site estimate of oil and polluted waste quantities in order to give an overall idea of how serious the pollution is and an indication of where the oil and polluted waste are to be found along the coastline.
Here is how you can quantify the pollution:

On site

- Situate where the oil and oily waste are
- Estimate (for each site, if necessary):
  - (L) the length (in metres)
  - (w) the width (in metres): in the event of consistent, close swaths of oil that are of the same length and roughly parallel, width refers to the entire width of all of the swaths
  - (th) the average thickness of the pollutant (in metres) or polluted materials (sand, seaweed, waste)
  - (c) coverage (in %)
  - the characteristics of the pollutant (emulsion, fresh or weathered oil, viscosity, colour, stickiness) and polluted materials (sand, seaweed, other debris).
- Calculate the volume (in cubic metres) for each area:

(L) x (w) x (th) x (c)

- Add up the volumes if several areas have been affected.

In the area

- add up all of the volumes of pollutant and polluted materials for each site.

How to estimate measurements

Stretches of polluted beaches are notoriously hard to measure even if you use a measuring tape or a metering wheel. More often than not, observers will have to use a rough and ready measuring technique that will afford a reasonably accurate figure. The following are worthy of note:

Estimating distances

- **Long distances**
  - Locate distances on maps that have a scale (topographical map 1:25000). Stay clear of maps with smaller scales because depending on the type of coastline, they may turn out to be less accurate especially regarding the length of the coastline (simplified) and thus cause inaccuracies.
  - If you can drive along the beach, use the trip counter in your car.
- **Medium distances**
  - Use visual clues such as a football field, a swimming pool or a building you see every day or on a regular basis, for instance.
  - Locate objects that are on site or very close to the beach that can be used to measure distances (make a point of measuring them later).

C3

- **Short distances**
  - Count the number of steps you take to go from one end of the pollution to the other (you will need to know how long one step is and realise that the length of the step will increase when walking downwards and shorten when walking up a slope or after walking a long way and be shorter on soft ground as compared to hard ground surfaces).
  - For slicks floating along the water's edge, measure distances using the "stone throwing" technique (this technique is approximate as with the previous example).

Estimating thicknesses

- The average thickness of oil can be measured easily and accurately enough with a ruler.
- For oil floating on the water surface, the "stone throwing" technique will afford a rough estimate of slick thickness by carefully observing the stone when it falls on the oil.

C3

Estimating oil coverage on the beach

This is probably the hardest parameter of all to assess. There is no point trying to obtain an accurate estimation of oil coverage, as oil distribution on the surface of the beach will not be even and may be affected by the tides. The idea is to obtain a quick acceptable estimate of the average oil coverage on the beach.

- Choose one or more representative parts of the beach in terms of oil coverage.
- Define a quadrate (of 1 m² or more) using tape or frames.
- In your mind's eye, collect all of the pollutant into one even surface, visualising it in one corner of the quadrate (cf figure 6), seeking to fill half of the quadrate then a quarter of it, etc.
- Then assess how much of the surface is covered with oil.

Visual clues can also be used (cf. figure 7).

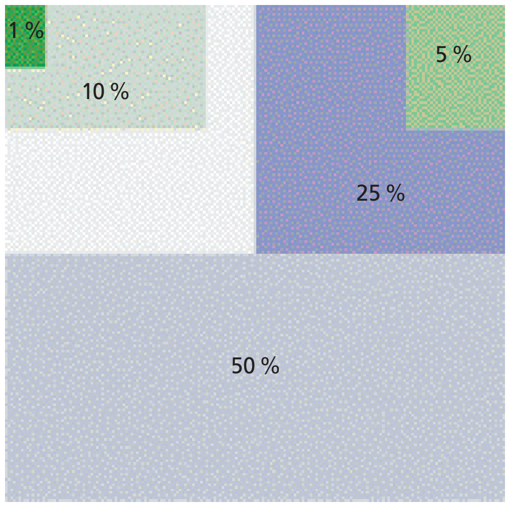

Figure 6: percentages of the total surface area for various subdivisions of a square (adapted from POLSCALE, 1998)

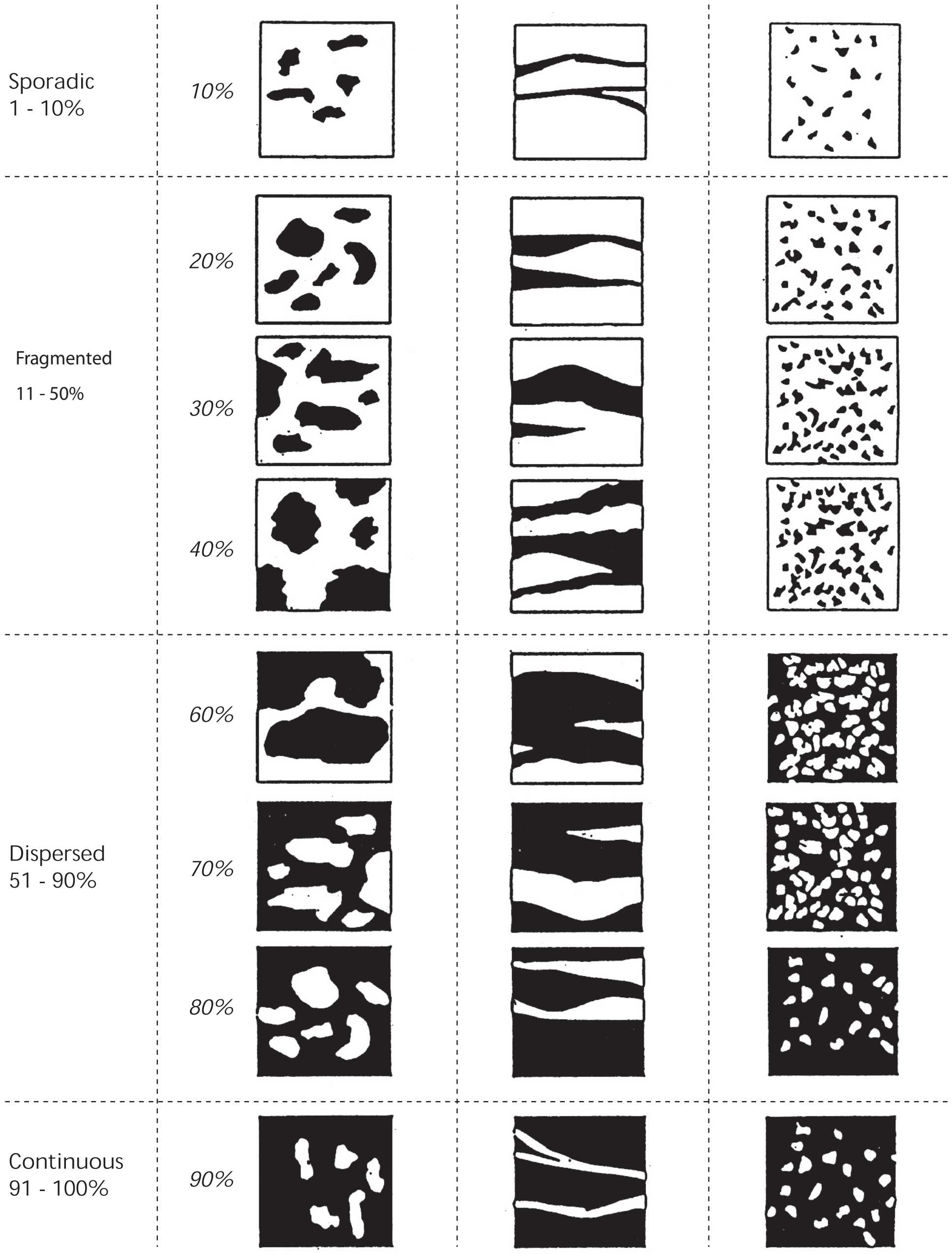

Figure 7: Visual clues
(Source: OWENS, E.H. and G.A. Sergy, 1994)

Special case: buried oil

Surveying buried oil is a special case that deserves careful attention.

Beached oil can be covered sooner or later by sand or seaweed. You are urged to check that there is no buried oil on your beach by digging holes at various locations along the beach in transects that are laid out at right angles to the water's edge.

Buried oil can involve all types of pollutant and will affect sandy or pebble beaches in particular in addition to port infrastructures and seawalls made of rocks or boulders where oil can sometimes penetrate very deeply.

How has the pollution disappeared?

Oil can be buried or covered in several ways:

- when seaweed strands on the beach
- when sand is blown very quickly by the wind over a very long foreshore especially when there are dunes nearby which will make the oil disappear under a fine layer of dry sand
- when dunes collapse during heavy storms (e.g. the *Erika*)
- when clean sand or pebbles are carried in by the tide or by other natural regular phenomena (transit and especially beach accretion)
- when a pollutant infiltrates sediment layers (sand, pebbles and riprap).

This process is very variable in terms of extent and speed and often only involves a few patches of oil.

However, very infrequently, this kind of phenomenon affects relatively long stretches of coastline, especially when low viscosity oil reaches a beach during a period of intensive beach accretion. In this instance, layers of anywhere between a few millimetres and several centimetres of more or less heavily polluted sand and pebbles will be buried under a much thicker layer of clean sand and pebbles (ranging from a few centimetres to several decimetres).

How to proceed

1. Searching for possible occurrences of buried oil

Conduct a random check at 2 or 3 locations down the beach (dig holes) where oil can be seen on the surface.
If buried oil is found, make a rough estimate of the quantities by digging more holes in the sand.
If the buried oil looks like an enormously long layer that covers virtually the entire stretch of the beach, carry out the following steps.

2. Assess to what extent oil has spread all over the beach

In this case, the survey will have to be methodical.

Transversal extension (width)

- Cordon off transects along the beach profile;
  - dig neat vertical holes at regular intervals (every 2 to 5 metres depending on how wide the oil patches are) and ensure the holes are deep enough (at least 1 metre down to bedrock or runoff water level)
  - stake out the extension area as accurately as possible.

Vertical extension (thickness)

- Report the characteristics of the pollution as it appears in each of the holes along a transect:
  - measure the thickness of successive layers of clean and polluted sand
  - describe the colour and the appearance of the pollutant.

Linear extension (length)

- Systematically repeat the transects all the way along the beach:
  - at regular intervals (every 20, 50 or 100 metres depending on the length of the beach) when oil is uncovered; check to see if the polluted layer extends from one transect to the next (intermediate check).
  - Identify exactly how far the pollution goes. When the last transect does not include any oil, go back half way to the previous transect and check again (intermediate check) and so on until the exact contour of the buried oil is detected.
  - When buried oil is detected, it must be marked out very clearly and a short report written (including a map and stating just how far the buried oil extends, how deeply it has penetrated the beach and if possible an order of magnitude of the quantities involved) but sufficiently accurate so that the oil can be detected easily later on.

3. Monitoring developments over time

If the pollution is going to be monitored, data will have to be recorded in a more detailed manner (figure 8 gives an example of a report form). In this case transect locations will have to be indicated (using visual clues laid out in rows) or else be materialised on the spot (using stakes, for instance).
Samples should be taken at this stage for lab testing to ascertain the oil content in polluted sand layers.

C4

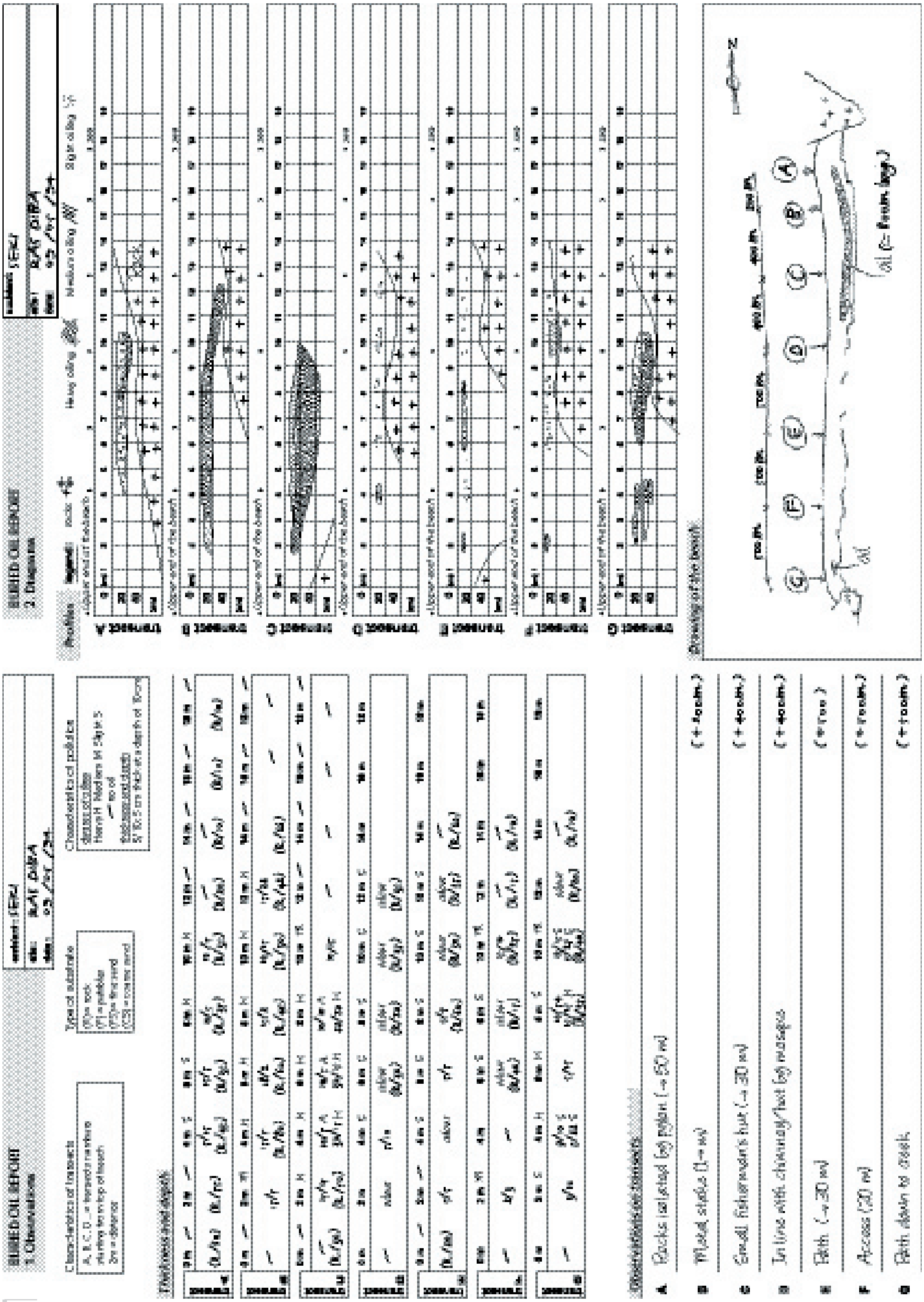

Figure 8: typical monitoring report form for buried oil

Taking samples

■ Why take samples?

- For various reasons:
  - operational: assess the determining physical characteristics prior to response (flash point, water content, viscosity...)
  - scientific: identify the components of the pollutant, ascertain how toxic they are and monitor developments
  - administrative: identify or substantiate a pollution
  - legal: identify the pollutant so as to find or confound the suspected polluter.

When oil has been found and especially if there are going to be legal proceedings, sampling will have to comply with a number of procedures.*

When it is simply a case of response operations, procedures are far less strict.

** Oil sampling and testing procedures in the marine environment are currently being standardised for Europe.*

■ Who is allowed to take samples?

In France, if samples are required for legal purposes, there must be three (one for lab testing, one for counter valuation and one for storage) and they can only be collected by a duly authorised and trained official. Otherwise samples can be taken by any operator.

■ Who can do the lab testing?

In France, samples required for legal or administrative purposes must be done by a qualified lab or expert who will use GC/MS to identify the oil sample (high resolution Gas phase Chromatography and Mass Spectrometry) compared with a reference sample.

The list and addresses of labs and court appointed experts can usually be found in the contingency plan.

However, the judiciary may elect another expert who is not appointed by the court.

■ What equipment will be needed?

When operational samples have to be taken, any recipient can be used.

When lab testing has to be conducted to identify the oil, the main problem will be that the pollutant may be contaminated by another oil left over in the recipients or the utensils that are to be used for sampling which will render the sample useless. Recipients and utensils therefore have to be not only clean but also made from non contaminating inert materials (such as glass, teflon, stainless steel, aluminium). Plastic should NEVER be used.

- Sampling
  - Use stainless steel spoons or spatulas (that you will clean with solvent immediately after use).
  - If the pollutant is fluid and very thin: use a sorbent sheet, a sponge made of polyurethane or a teflon film.
- Containers (the recipient to be used will depend a lot on the nature of the sample)
  - Fluid sample: glass jars with a wide neck and a lid complete with a teflon seal (if not available, use a "jam jar" and fit a piece of aluminium foil to encapsulate the underneath of the lid if it is made of metal or plastic. Whenever available use brown glass jars that will protect the oil from photo-oxidation; failing that, wrap the jar in an aluminium foil for example.
  - Consistent sample (fuel oil tar ball, polluted pebble, for instance): use an aluminium tray or a sheet of aluminium foil.
  - Wrap all containers up in a clean plastic bag.

- Protective clothing:
  - gloves (supple and oil resistant) and goggles/face mask if necessary.

Size of the sample

To ensure you have enough, especially if the pollutant is mixed with other materials (sediment, plants, feathers...), you are urged to take a bigger sample of polluted material than you normally would.

- To assess operational characteristics:
  - the minimum amount of oil to be sampled should be 300 grammes (because a number of tests will be conducted: 100 g at least for measuring viscosity, 30 g for measuring water content...) and efficacy testing of response products (such as dispersants or emulsion breakers) may be carried out.
  - the amount of polluted material to be sampled should be about 500 grammes.
- When seeking to identify pollutant compounds:
  - the minimum amount of oil needed will be 5 grammes
  - the amount of polluted material to be sampled must be about 100 grammes.

How to identify the oil sample

Each oil sample will have to be labelled stating oil characteristics and origin (cf. figure 9).

Highly recommended:
- two separate labels (one on the jar and another on the plastic bag)
- use water resistant pencils (graphite propelling pencil, indelible felt tip pen).

How to store the sample

- samples must be:
  - stored at positive cold temperatures (0° to 10°C)
  - shipped ASAP and if possible within a week.

Taking a sample

C5

GENERAL INFORMATION

Name:	Tel:
Position/org.:	Email:
Address:	Shipment date:

SAMPLE INFORMATION

Origin (name of site, commune/district...):	Observations (viscosity, colour, type of site [beach, rocks, harbour...]):
Date/time of collection	
Nature (type of pollutant, sediment, cobbles...):	
Sample n°:	

Figure 9: label for identifying a sample

BIBLIOGRAPHY AND USEFUL WEBSITES

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Polscale: a guide, reference system and scale for quantifying and assessing coastal pollution and clean-up operations in oil-polluted coastal zones. Brussels: European Commission. 118 p.

OWENS E.H., SERGY G.A. (2000)
The SCAT manual: Field guide to the documentation and description of oiled shorelines. Ottawa: Environment Canada. 108 p.

Useful websites

Centre of Documentation, Research and Experimentation on accidental water pollution (*Cedre*)
section on "response", [on-line]
http://www.cedre.fr

National Oceanic & Atmospheric Administration (US-NOAA)
section on "publications about Assessing Environmental Harm", chapter on "Shoreline Assessment Job Aid", [on-line]
http://www.response.restoration.noaa.gov

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