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Practical Insights into Decision-making for Shoreline Clean-up of Oil Spills

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PRACTICAL INSIGHTS INTO DECISION-MAKING FOR SHORELINE CLEAN-UP OF OIL SPILLS

John R. Harper

Dobrocky Seatech Ltd.
9865 West Saanich Road
P. O. Box 6500
Sidney, British Columbia
V8L 4M7

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SUMMARY

Offshore oil spills present complicated problems in terms of minimizing environmental and economic impacts and in terms of implementing activities to mitigate the effects of spills. During the spill, time for making decisions may be very limited, and confusing or conflicting information may be provided by technical advisers. As such, a response operation to an oil spill requires a rapid decision-making process that (a) can assimilate a wide-range of environmental and technical data (in some cases, very limited in scope), (b) will lead to effective implementation of countermeasures, and (c) will minimize the effects of spills.

This study has two primary objectives: first, to document decision-making in previous spills related to the protection and clean-up of shorelines, and second, to provide recommendations that will improve future oil spill response.

The report is written in a format to answer questions that the On-Scene Commander (OSC), or designated shoreline response co-ordinator, might have to resolve during a spill. This study was primarily concerned with shoreline countermeasures and does not directly address offshore containment, dispersant use, etc., although these components will affect decisions about shoreline protection and clean-up.

Pre-spill planning was identified by individuals involved with previous spills as the major activity that could facilitate decision-making at the time of the spill. Pre-spill planning addresses the question: What can the OSC (or shoreline response co-ordinator) do prior to the spill to improve response to the spill? The pre-spill planning may be considered in terms of two major areas:

- organizational planning, in which (a) individuals who will interact with the OSC (or shoreline response co-ordinator) are identified and (b) lines of authority between individuals are established (e.g., environmental advisers, logistics specialists, clean-up crews, etc.); and

- resource identification, in which environmental, human, and logistical resources (e.g., equipment or contractors) are identified and inventoried for the potential areas of concern.

Not conducting these activities may significantly delay a response; a greater amount of time will be required to obtain and assimilate information for choosing the best response alternative. For example, if the environmental resources of the potential spill impact area are not previously identified, then potential spill scenarios cannot be selected, response equipment cannot be identified or tested, and appropriate contractors cannot be selected.

During an offshore spill, it may be possible to prevent oil from reaching the shoreline by containment and collection or by deflecting oil away from it; these are termed shoreline protection strategies. Unfortunately, these strategies have rarely been successful in previous spills. In most cases, oil has reached the shoreline prior to any protection equipment being set up. For the protection schemes to be successful it is critical not only to identify techniques that may require very rapid implementation but also to test potential strategies to see if they actually work.

Protection strategies can be identified prior to a spill but how they are implemented cannot be finalized until it occurs. Additional information will be required to determine protection priorities, including:

- spill characteristics;
- potential spill impact zone and time of impact;
- environmental conditions at the time of the spill and conditions predicted for the immediate future; and
- equipment suitability under the existing and predicted environmental conditions.

Other information, such as shoreline character, appropriate equipment, and time to mobilize personnel, can be identified during the pre-spill planning phase.

Shoreline clean-up is defined as the recovery and disposal of oil that has contaminated the shore, and shoreline clean-up strategies address the appropriateness of clean-up techniques, tradeoffs between natural versus mechanical/manual recovery, and logistical limitations (either manpower or equipment). The clean-up operations are typically one of the most expensive and visible components of the spill response, and therefore are the most scrutinized.

Typical questions faced by the OSC (or shoreline response co-ordinator) are: What are the clean-up priorities? How clean is clean? What are the disposal options? Will more harm be caused by the clean-up than by the spill itself? Again, pre-spill information can be used to assist in reaching decisions between trade-offs; sensitivities of resources to the effects of spills can be defined prior to the spill; appropriate clean-up techniques and equipment can be identified; disposal sites may be identified; and appropriate environmental advisers can be selected to provide timely assistance during the clean-up operation.

The principal pieces of information that are not available prior to the spill and that are needed to establish priorities for clean-up are:

- oil distribution and type of contamination;
- potential shore access;

- environmental conditions at the time of the spill and those predicted for the near future; and

- potential for recontamination after cleaning.

The most successful clean-up operations have established priorities for clean-up early in the spill and have then adhered to them throughout the clean-up; this technique provides a defensible, consistent rationale for the allocation of equipment and manpower.

Pre-spill planning is a part of the spill response-process that offers the greatest potential to streamline the decision-making process during the spill. In particular, the organizational structure and individuals' responsibilities of the shoreline response team (advisers, supervisors, clean-up crews) can be outlined for various spill types, and the environmental, human, and logistical resources can be inventoried. With this information, alternative protection and priorities for clean-up can be evaluated for a variety of potential spill conditions so that once spill conditions are known, priorities can be established quickly and the response can be implemented rationally. It is important that the response strategies be tested regularly through gaming or field trials.

Another component in the process of responding to spills that has the potential to improve future shoreline countermeasure response is post-spill reporting. Although debriefing meetings are frequently held after a spill, much useful information is not recorded. The lack of post-spill reporting available during this study necessitated the use of interviews to acquire detailed information on spill operations and decision-making. A standard post-spill report is recommended that summarizes principal spill features, problems encountered, effective and ineffective countermeasures, human resources, and cost summaries (preferably plotted as a function of time), and recommendations for future response operations. Reports of this type were only rarely encountered during this study, yet provided a significant insight into the decision-making process.

An additional comment by a number of those interviewed is that scientific research should play a role in the response process. Although studies have considerably improved our overall ability to predict the fate of oil on shorelines, considerable uncertainty exists in numerous areas about the long-term fate of oil in the coastal and nearshore zones, and targeted research should be an integral part of the process of responding to spills.

RÉSUMÉ

Les nappes d'huile au large présentent des problèmes complexes en termes de minimisation de l'impact sur l'environnement et l'économie, et en termes de mise en oeuvre des activités pour atténuer l'effet des nappes. Au cours de ces dernières, le temps pour prendre des décisions peut être très limité et des informations peu claires et contradictoires peuvent être fournies par les conseillers techniques. Comme telle, une opération, en réponse á une nappe d'huile, demande de prendre des décisions rapides qui (a) soient capables d'assimiler une grande diversité de données environnementales et techniques (dans quelques cas, très limitées en portée), (b) conduiront á mettre en oeuvre des contremesures efficaces et (c) minimiseront les effets des fuites.

Cette étude a deux objectifs principaux: - en premier, documenter la prise de décision des nappes précédentes en ce qui concerne la protection et le nettoyage des rivages; - en second de fournir des recommandations qui amélioreront les réponses aux futures nappes d'huile. Le rapport est écrit pour répondre aux questions que le "responsable du site" (on-scene commander: OSC) ou le coordinateur pour les actions á prendre sur les rivages, peuvent avoir á résoudre pendant une nappe. Cette étude était premièrement dirigée sur les contremesures á prendre sur le rivage et non pas directement portée sur les actions au large, utilisation de détergent, etc..., quoique ces composants affecteront les décisions á propos de la protection et du nettoyage des rivages.

Les plans de prénappes étaient identifiés par des personnes impliqueés avec les précédentes nappes comme une activité majeure qui pourrait faciliter les prises de décisions au moment d'une nappe. Les plans de nappes posent la question suivante: Que doit être capable de faire le OSC (ou le coordinateur pour les actions á prendre sur les rivages) avant la nappe pour améliorer les réponses en cas de nappe? Le plan de nappe peut être considéré selon deux actions majeures:

- Un plan d'organisation, dans lequel (a) les personnes qui travailleront avec le OSC (ou le coordinateur pour les actions á prendre sur les rivages) sont identifiées et (b) sont établis les liens d'autorité entre les individus (par. ex. les conseillers - en environnement, les spécialistes en logistique, les équipes de nettoyage, etc...); et.

- Une identification des ressources disponibles dans laquelle les ressources en environnement, logistique et personnel (par ex. équipements, matériels ou entrepreneurs) sont identifiés et inventoriés peur la zone concernée.

Ne pas établir ces éléments peut entraîner un délai significatif dans la réponse; un temps considérable sera nécessaire peur obtenir et assimiler les informations afin de choisir la meilleure

alternative. Par exemple, si les ressources environnementales du lieu potentiel de nappe ne sont pas connues auparavant, le scénario de nappes éventuelles ne pourra pas être selectionné, la réponse en terme de matériel ne pourra être ni connue ni testée et les entrepreneurs ne pourront pas être sélectionnés.

Au cours d'une nappe au large, il peut être possible d'empêcher l'huile d'atteindre le rivage en la contenant et en la récupérant ou en la déviant et en la gardant loin du rivage; elles sont désignées comme des stratégies de protection du rivage. Malheureusement, ces stratégies ont rarement obtenu de succès lors des précédentes nappes. Dans la plupart des cas, l'huile a atteint le rivage avant que n'importe quel type de protection soient couronnés de succés, il n'est pas seulement critique d'identifier les techniques qui demandent á être mises en place très rapidement mais aussi de tester le potential de la stratégie pour voir si il fonctionne.

Les stratégies de protection peuvent être connues avant une nappe, mais comment leur mise en oeuvre pourrait elle être prédite avant qu'elle ne se produise? Des informations supplémentaires seront requises afin de déterminer les actions prioritaires, incluant:

- les caractéristiques de l'huile
- la zone d'impact d'une nappe potentielle et le delai d'impact
- les conditions de l'environnement au moment de la nappe et les prédictions pour un futur immédiat; et
- les équipements appropriés selon les conditions environnementales existantes et prédites.

D'autres information, telles les caractéristiques du rivage, l'équipment adéquat et le délai pour mobiliser le personnel, peuvent être connues au cours du plan de la phase de la nappe.

Le nettoyage du rivage est défini, comme le ramassage et le stockage de l'huile qui a pollué les côtes et les plans de nettoyage du rivage avec les techniques de nettoyages approprieés, un compromis entre la récupération mécanique et manuelle et les limites de la logistique (soit la main d'oeuvre ou l'équipement). Les opérations de nettoyage sont les plus chères et les plus visibles lors de nappes, et par conséquent ce sont elles qú il faut examineer á fond.

Les questions typiques éxamineés par le OSC (ou le coordinateur pour les actions á prendre sur le rivage) sont: quelles sont les priorités de nettoyage? Comment le nettoyage est fait? Quelles sont les options pour le stockage? Le préjudice sera-t-il plus important par le nettoyage ou par le nappe elle-même? De plus, les informations de prénappe peuvent être utilisées pour aider les prises de décision entre les différents partis en présence. La sensibilité des ressources aux effets de la nappe peut être déterminée avant toute nappe; les techniques et les équipments appropriés pour le nettoyage peuvent être déterminés. Les sites de stockages peuvent aussi être connus; et les conseillers appropriés en environnement peuvent être selectionnés pour fournir une assistance effective dés le début des pérations de nappes.

Les prinicipales informations qui ne sont pas disponibles avant la nappe et qui sont indispensables pour établir les priorités de nettoyage sont:

- la répartition de l'huile et le type de contamination
- l'accessibilité des rivages
- les conditions environnementales au temps de la nappe et les prédictions pour le futur immédiat
- la potentialité de contamination nouvelle aprés le nettoyage.

Les opérations de nettoyage les plus couronnées de succès ont établi une priorité pour un nettoyage précoce après la nappe et ont persisté dans celui-ci tout au long du préjudice; cette technique fournit une defense raisonnable et consistante peur la répartition de l'équipement et de la main d'oeuvre.

Les plans de prénappes sont un processus de réponse aux nappes qui offre le plus grand potentiel pour profiler le processus de prise de décision durant la nappe. En particulier, la structure de l'organisation et les responsabilités personnelles au sein de l'équipe sur le rivage (conseillers, responsables, équipes de nettoyage) peut être décrit pour différent type de nappes et l'inventaire en environnement, logistique et ressources humaines peut être établi. Avec cette information, des alternatives de protection et des priorités pour le nettoyage peuvent être évaluées pour différentes conditions de nappe potentielles, aussi quand un type de nappe est connu, les priorités peuvent être établies rapidement et l'action peut être mise en oeuvre de manière rationnelle. Il est important que la stratégie d'action soit testée régulièrement tout au long des campagnes d'essais et d'exploitation.

Une autre composant dans le processus de réponses aux nappes qui a la faculté d'améliorer l'action de contremesures sur le rivage sont les rapports post-nappes. Quoique les meetings d'informations sont fréquemment tenus aprés une nappe beaucoup d'informations utiles ne sont pas enregistrées. L'absence de rapport post-nappe disponible au cours de cette étude a nécessité l'utilisation de reportages pour obténir des informations détaillées sur les décisions prises et sur les opérations de nappes. Un rapport post nappe standard est recommandé. Il resume les principales caracteristiques de la nappe, les problèmes rencontrés, les contremesures efficaces et inefficaces, les ressources en hommes et un résumé du côut de l'opération (préferentiellement tracé en fonction du temps), ainsi que des recommendations pour les futures opératious semblables.

Un commentaire supplémentaire par ceux qui furent interviewés démontre que la recherche scientifique devrait jouer un rôle dans le processus de réponse. Quoique les études ont considérablement améliori notre capacité globale á prédire le devenir de l'huile sur les rivages, une grande incertitude demeure dans de nombreuses zones á propos du sort á long terme de l'huile dans les zones côtières et littorales, et les recherches sur ces cibles devrait faire partie intégrale du processus d'action contre les nappes.

INTRODUCTION

This report reviews a study to develop guidelines to making decisions on shoreline countermeasures for oil spills (Environmental Studies Revolving Fund Project 171-99-04). Information reviewed came from existing reports on response during spills, and from interviews with individuals who have been involved in spill clean-up.

Two points regarding the report format require emphasis. First, the report is written in a format for use by the On-Scene Commander (OSC) who is ultimately responsible for decisions made at the time of the spill. However, the decision-making authority may be delegated during the spill, and, as such, the decision guidelines will be of use to a wide range of response personnel involved with shoreline countermeasures. Secondly, the interviews focused on specific spills (Table 1) to provide a case-by-case examination of specific events that occurred during each spill. Problems or situations that have occurred in the past and may occur again in the future are identified. The particular spill event in which problems arose is not important in that the object of the project is to improve future operational response for shoreline clean-up; therefore, names of spill events are not used.

This study focused on oil spill shoreline countermeasures and, as such, did not attempt to address the broader issues of response planning. Many of the decisions required in shoreline countermeasure operation have bearing on seemingly unrelated operation. For example, the potential for effective clean-up of a given section of coastline, either naturally or by clean-up operations, may figure significantly in the decision to use dispersants offshore. Therefore, the review covers a wide-range of response operations even though shoreline countermeasures are the common theme.

It is likely that many of the points made in the report will be known to seasoned response personnel through experience on previous spills. However, at least a few situations not encountered by experienced personnel are also addressed and will serve as a useful starting point for inexperienced personnel.

The study has two primary objectives:

(1) to document decision-making in previous spills related to the protection and clean-up of shorelines; and

(2) to provide recommendations that will improve future shoreline response.

TABLE 1

Spills included in this review

Spill	Year	Location
ARROW	1970	Chedabucto Bay, N.S.
IRISH STARDUST	1973	Alert Bay, B.C.
GOLDEN ROBIN	1974	Bay of Chaleur, N.B.; Que.
METULA	1974	Straits of Magellan, Chile
NEPCO 140	1976	Thousand Islands, St. Lawrence Seaway
Canada Fish Company	1977	Steveston, B.C.
LEE WANG ZIN	1978/79	Southeastern Alaska
KURDISTAN	1979	East Coast, N.S.
		St. Lawrence Seaway, Ont.
Port aux Basques (Shore tank)	1982 (?)	Port aux Basques, Nfld.
Port aux Basques (Ship)	1982	Port aux Basques, Nfld.
Mackenzie River Spill	1983	Norman Wells, N.W.T.
STAR LUZON (Burrard Narrows Drydock)	1983	Vancouver, B.C.
Swan River Spill	1983	Swan Hills, Alta.
SIFNOS	1984	Montreal, Que.
SUNDANCER	1984	Vancouver Island, B.C.
ERAWAN/SUN DIAMOND	1975 (?)	Vancouver, B.C.
UNIACKE/VINLAND	1984	Sable Island, N.S.
Clearwater River Spill (pipeline)	1984 (?)	Clearwater River, Alta.

PRE-SPILL PLANNING

Numerous activities can be conducted prior to a spill to improve effectiveness of shoreline countermeasures (shoreline protection and clean-up activities) during a spill. The pre-spill planning is discussed in two parts: (a) organizational planning (personnel interactions and responsibilities during a spill) and (b) operational planning (pre-spill identification of resources, potential response actions, and logistics identification). Only planning activities related to shoreline countermeasures are discussed.

ORGANIZATIONAL PLANNING (IDENTIFYING THE RESPONSE TEAM)

Sincere attention to organizational or continency planning prior to a spill can provide substantial benefits at the time of the spill, primarily in the establishment of a clear line of authority and the identification of linkages between other individuals. Pre-spill identification of linkages and of chains of command will allow rapid dissemination of information and execution of activities at the time of a spill.

Spill situations vary tremendously in scope, and response efforts will vary accordingly. In some situations, the OSC will assume the role of shoreline response co-ordinator as well as other activities; in other cases, the OSC may delegate authority to one or more shoreline response co-ordinators, who in turn delegate to field supervisors, and so on. In the following discussion, it is recognized that one individual might assume the responsibility of several of the roles outlined in Figure 1 and that only the largest spills would require an individual for each role.

A complex organizational structure is outlined in Figure 1. The shoreline response coordinator may require technical advice from **environmental advisers** either (a) before impact to refine protection priorities or (b) after impact to establish clean-up strategies and priorities. In previous spills, the environmental advisers (coastal geomorphologist, spill modellers or oceanographers, meteorologists, and marine ecologists) have been used during both the pre-spill planning and the response to the spill extensively to assist in countermeasure planning. It is important that contact be established with potential advisers prior to a spill so that they are familiar with specific features of the potential impact area. In the case of harbour spills or operational type spills, these types of individuals are comparatively easy to access and, are likely to be familiar with environmental conditions of the area. For potentially large impact areas, pre-spill familiarity with an area will significantly improve technical input from advisers.

Operational assistance may be provided by a variety of response personnel (see Fig. 1): in many cases, these individuals will serve the entire response effort operation (e.g., offshore co-ordinator); however, they are identified herein because the shoreline response co-ordinator will

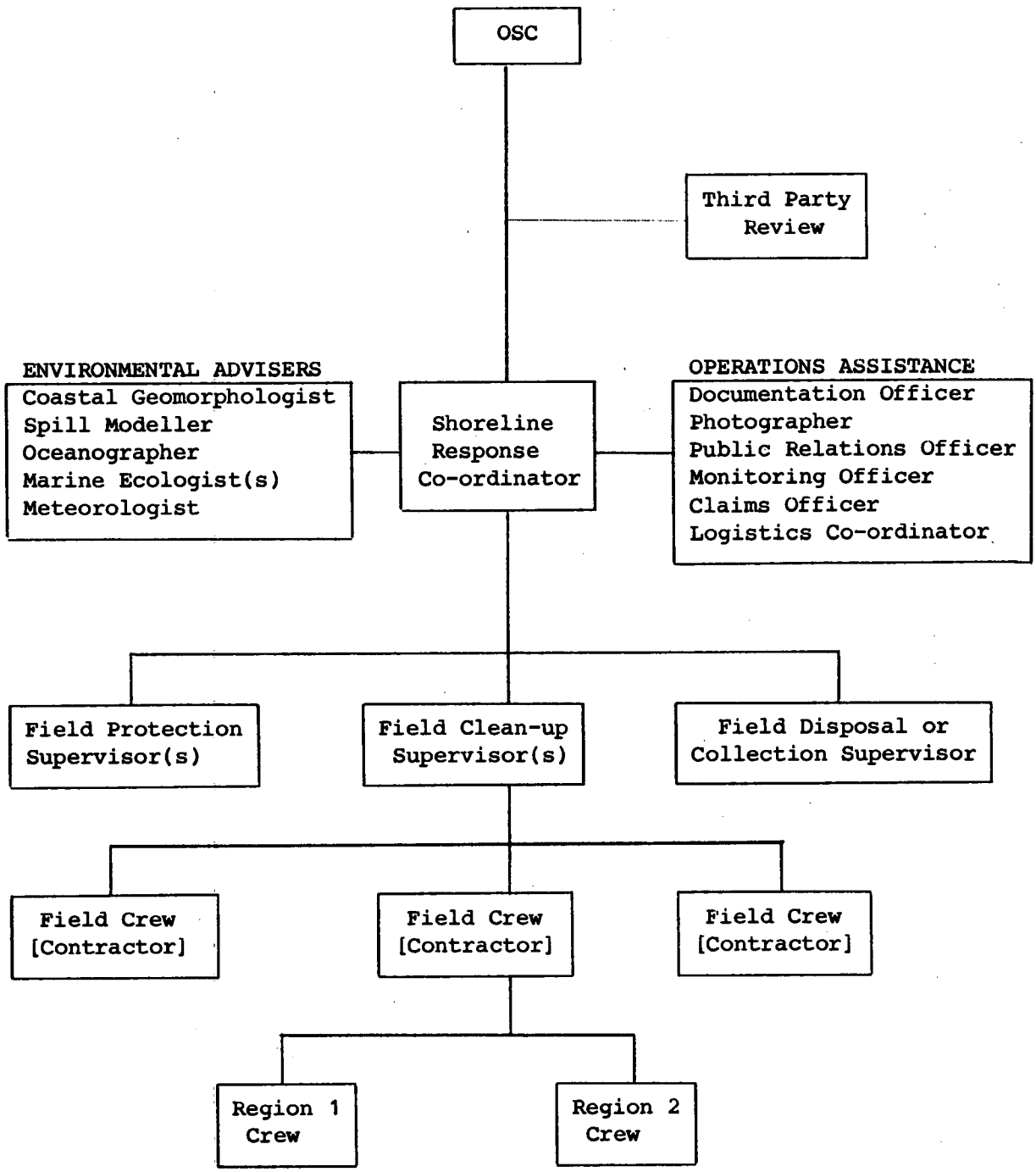

Figure 1. Interactive relationships of a shoreline response co-ordinator. (One individual may assume several of the roles if the spill is small.)

interact with them directly and will depend heavily upon them during the spill. A documentation officer and photographer are important because their records provide the primary means of defending decisions after a response action. They are also used to substantiate claims made to the spiller's insurance company.

OPERATIONAL PLANNING (ACTIVITIES CONDUCTED PRIOR TO A SPILL)

In this section, activities that can be conducted prior to a spill to improve response effectiveness are identified and discussed.

Pre-spill Meetings

The most consistent recommendation by previous spill response personnel was the need to have pre-spill meetings and drills, that serve to establish a common understanding and trust which facilitates communication at the time of a spill. The establishment of a common understanding of spill problems and logistics is particularly important because during a spill an individual may be too involved in a specific task to have an overall appreciation of the response activities. Meetings or drills provide opportunities for individuals to see and participate in a wider scope than is possible during a spill. The drills also allow notification procedures to be tested and gaming at the exercise allows identification of potential problem areas. Contractors, who are on call, should participate in the meetings as well.

Experienced personnel emphasize the need to conduct operational exercises in the potential impact area if possible. The benefits of this are obvious. A further recommendation is that shoreline protection techniques, such as exclusion booming or diversion booming, be attempted in as many locations as possible. In some spills, oil did not go where expected nor did booms perform as expected. Exercises have the benefit of verifying the effectiveness of a proposed technique.

Pre-spill Identification of Environmental and Human-Use Resources

Information on environmental resources should be collected, catalogued, and summarized into a manageable format prior to a spill. Graphical presentation on maps with tables is a common format, although computer graphics with data bases have also been used. As a minimum it is helpful to illustrate:

- coastal morphology and substrate;
- wave exposure;

- vulnerable biological resources;

- natural accumulation areas; and

- vulnerable human-use areas or resources.

It is also important to identify seasonal variability in any of the resources (i.e., a spill at an occupied seabird colony would have a very different impact if the colony were unoccupied). Natural accumulation areas, possibly identified by log accummulations, provide indicators of where oil may collect. Other information may be required for specific locations (e.g., current speeds will influence booming strategies).

Logistics

Numerous logistical problems can be resolved by the shoreline response co-ordinator prior to the spill. These include:

- identification of contractors and establishment of contracting rates;

- identification of local equipment that may be used during a spill (e.g., Environmental Protection Service of Environment Canada maintains regional and national inventories of equipment);

- identification and resolution of potential jurisdictional problems, ultimately with a written agreement;

- identification, purchase, and distribution of equipment components that may not be located locally but that may be required immediately upon alert;

- identification of safety problems that may face response crews (e.g., during one spill, the OSC became significantly concerned about the health effects on shoreline clean-up crews working in areas of heavy sewage pollution);

- identification of disposal sites; pre-spill knowledge of disposal sites minimizes handling of oil and debris (temporary storage sites are not required) and will assist in making tradeoffs during the spill (e.g., if disposal is too expensive, alternative clean-up techniques may be required).

A special explanation of jurisdictional interaction problems during spills is required because the problems have arisen on many spills, but because of the sensitive nature of these problems they are seldom identified or resolved. An example of a past jurisdictional problem is associated with the Ports Canada Corporation, which assumes responsibility for spills within regulated harbours but which often has not assumed responsibility once a slick leaves the port. Consequently, a second agency or group must respond leading to two response efforts and possibly two

OSC's for the same spill. Similar problems have arisen when a spill crosses district boundaries, resulting in separate response efforts for the same spill. It is important that potential problem areas be identified and resolved in writing prior to a spill so that response actions may be immediate during the early, critical phase of a spill. A model agreement is the Canadian - U.S. Joint contingency plan (CANUSAC).

Documentation

Development of a conceptual documentation plan prior to a spill will assist with rapid implementation during the spill. The lack of map documentation is notably absent on most spills. Some systematic but simple mapping program, with daily or weekly illustration of oil distribution, location of clean-up operations, location of protection equipment and "cleaned" shorelines, is important, particularly in substantiating claims and evaluating environmental impact. Development of checklists (Tables 2 and 3) prior to a spill may be helpful for later documentation and for quickly identifying key information necessary to reach a decision. These records should be kept throughout the spill and archived following the spill.

Response personnel who deal frequently with chronic spills recommend extensive photo-documentation to substantiate claims either to the spiller or to the spiller's insurer. Appropriate photographic and/or video equipment (such as industrial-quality, low-light video cameras) and operators should be identified prior to a spill. Cost-accounting documentation is also essential.

Pre-spill Decision-Making

Some preliminary decisions about response options may be made prior to a spill. For example, time-limited decisions must be flagged. An example is the use of dispersants, which generally must be applied to a spill within 24 hours to be effective; the complexity of shoreline clean-up in an area may figure significantly into a pre-spill decision to use dispersants. Other types of pre-spill decisions are:

- decisions about protection and clean-up equipment that are appropriate for the area; and

- decisions about protection priorities (protect most sensitive resources first, e.g., water-intake structures, aquaculture sites, and marshes).

The use of sensitivity analyses is a controversial aspect of pre-spill decision-making. Some response personnel feel that sensitivities can only be defined at the time of the spill and, as a result, rely heavily on the use of environmental advisers to specify sensitivities. Interestingly, most OSC's found sensitivity mapping helpful during spill operations, although they also caution that sensitivity analyses must be flexible to

Table 2

Shore-zone contamination and sensitivity check-list (from Owens, 1977).

1. Impact Factors

Type of oil: _____

Is oil on shore?

YES - Volume stranded _____

NO - Volume of spill _____

Expected persistence of oil: Days _____ Months _____ Years _____ Decades _____

Month of year: _____

Can clean-up be effective? YES/NO

Would clean-up have an impact? YES/NO

If YES, describe: _____

2. Shore-Zone Character

Shoreline type: _____

Rare or endangered species: Absent _____ Present _____

Waterflow: Absent _____ Present _____ Use of area _____

Mammals: Absent _____ Present _____ Use of area _____

Commercial species: Absent _____ Present _____ Use of area _____

Recreational species: Absent _____ Present _____ Use of area _____

Cultural resources: Archaeological sites _____

Fishing/Hunting _____

Historical sites _____

Other _____

Natural biological recovery potential: <1 yr _____ Years _____ Decades

Natural geological recovery potential: <1 yr _____ Years _____ Decades

Recreational use of shore zone:

None _____ Low _____ Moderate _____ High _____ Very high _____ Describe _____

Commercial use of shore zone:

None _____ Low _____ Moderate _____ High _____ Very high _____ Describe _____

3. Impact Potential

Biological impact of oil:

None _____ Low _____ Moderate _____ High _____ Very high _____ Describe _____

Impact of oil on rare or endangered species:

None _____ Low _____ Moderate _____ High _____ Very high _____ Describe _____

Biological impact of clean-up:

None _____ Low _____ Moderate _____ High _____ Very high _____ Describe _____

Geological impact of clean-up:

None _____ Low _____ Moderate _____ High _____ Very high _____ Describe _____

Table 3

Shoreline clean-up check-list (from Owens, 1977)

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1. Oil and Shore-Zone

Type of oil: _____

Depth of penetration: _____

Volume of stranded oil: _____

Shoreline type: _____

Shore-zone sediments: _____

Shore-zone exposure and wave-energy levels: _____

_____

Is ice or snow present in the shore zone? YES/NO

Amount of sea ice (in tenths) _____/10 Ice foot: Present _____

Absent _____

Depth to frost table: _____

2. Clean-up or Natural Recovery?

Estimated persistence of oil:

Days _____ Months _____ Years _____ Decades _____

Would continued presence of oil be undesirable in terms of?

(a) Biological processes YES/NO

(b) Recreational activities YES/NO

(c) Commercial activities YES/NO

Is the level of contamination unacceptable? YES/NO

Would oil migrate onto other shoreline sections YES/NO

Is immediate clean-up necessary YES/NO

What is the most effective/efficient clean-up method for the shoreline section? _____

Continued ...

Table 3 (Continued)

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3. Clean-up Feasibility

Are satisfactory equipment and sufficient manpower available? YES/NO

Is the shoreline accessible for equipment and/or personnel? YES/NO

Can equipment operate effectively in the shore-zone? YES/NO

Would the degree of clean-up be satisfactory? YES/NO

If the most preferred clean-up method is unfeasible or would incur damage (see "4" below), what is the next suitable alternative method? _____

---

4. Clean-up Damage

Would the level of biological damage be acceptable? YES/NO

Would the level of geological damage be acceptable? YES/NO

Impact of clean-up on unique cultural features:

None _____ Low _____ Moderate _____ Severe _____ Critical _____

Impact of clean-up on recreational activities:

None _____ Low _____ Moderate _____ Severe _____ Critical _____

Impact of clean-up on commercial activities

None _____ Low _____ Moderate _____ Severe _____ Critical _____

NOTES:

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accommodate other operational problems that may arise. The benefit of pre-spill sensitivity analyses is that they simplify complex environmental problems so that non-scientific response personnel, which the shoreline response co-ordinator and OSC usually are, can have a rapid, simplified picture of the most significant environmental problems. During pre-planning meetings, response personnel often develop their own concensus of sensitivity levels. These analyses are not a substitute for expert advice at the time of the spill.

SPILL RESPONSE ACTIVITIES

This section of the report describes activities that should be conducted by the shoreline response co-ordinator during a spill. Recommendations are summarized in terms of (a) the field operations, and (b) day-to-day activities.

FIELD OPERATIONS

Protection and Clean-up Priorities

A variety of schemes have been used to establish protection and clean-up priorities at the time of the spill. Each spill event requires its own priorities and it is usually not possible to pre-define these priorities. It is notable that in almost all the spills reviewed, there were very few instances of successful protection schemes, particularly for larger spills. Although protection schemes have not been widely successful, there is considerable incentive to attempt protection, especially where a small effort, such as booming a harbour or marsh entrance, can significantly reduce potential ecological damage and clean-up costs.

The fundamental approach to establishing priorities has been that **oil should not inflict hardships.** In general, this approach has meant that commercial operations, which could be affected by oil, have been protected or cleaned first because closure of these facilities could result in loss of employment. **Each company or response agency has its own policy related to minimizing hardship.** Examples of operations that fall under this general hardship category are:

- fish-processing plants or hatcheries with water-intake structures;
- some fisheries (e.g., shellfishing);
- areas for the recovery of Irish moss;
- areas with livestock that could be contaminated;
- chemical plants with water-intake structures;
- public water intakes or supplies; and
- public beaches or other coastal tourist attractions.

Loss of revenue from these areas can result in substantial indirect losses of local revenue. Additional priority areas are:

- environmentally sensitive areas;
- privately owned shorefront; and
- areas of occasional public use.

To date, remote areas that are not environmentally sensitive have been left to clean naturally.

Public pressure is significant in influencing clean-up priorities. Establishment of a defensible criteria at the beginning of a spill provides for systematic clean-up efforts, and for avoidance of the "putting out fires" approach. In general, when scope and rationale of the clean-up operations is explained to the public, either through local governments or in community meetings, clean-up criteria will be accepted.

The question **"when is the clean-up complete?"** is a logical extension of the priority system in that it represents the response stage when there are no more clean-up priorities. Again, different criteria have been used in different spills to answer the question.

All criteria have been used to end cleanup in at least one spill:

- when complaints stop;
- all reasonable or practical clean-up efforts have been undertaken;
- inspections indicate that all visible oil has been removed;
- remaining oil (if any) unlikely to inflict hardship to humans or to wildlife prior to natural degradation.

As mentioned previously, the shoreline response co-ordinator or the OSC is often the primary spokesperson because as the person in charge and because the shoreline is the most visible part of the spill to the general public. The information about the spill must be conveyed through this invididual, whose strength of character has a significant influence in convincing the public that all reasonable steps have been taken.

Environmental Advisers

One of the problems faced by the OSC and shoreline response co-ordinator may be conflicting advice among environmental advisers, each of whom is keen to see their special interests protected, and whose concerns cannot be addressed simultaneously.

Frank and free discussion between the OSC and the advisers as well as among themselves is essential for the successful resolution of the problem. An example from one spill is the conflict between bird ecologists, who advocated cleaning a salt marsh prior to migratory birds arriving, and ecologists and geomorphologists, who argue that virtually any clean-up in a marsh will cause permanent damage to the ecology of the marsh. During the course of this project, the author witnessed a spill where the same problem was resolved by cutting marsh grass along the seaward edge, where most of the oil was stranded; this procedure removed most of the stranded oil with minimal harm to the marsh in that (a) only a small percentage of the marsh was cut, (b) it was cut during late fall and would quickly regrow the

following spring, and (c) substrate damage was minimized because cutting was done from boats. The procedure successfully removed most stranded oil prior to the arrival of migratory waterfowl, which frequent the area in large numbers.

Another example of a potential problem was during a spill when a large amount of oil was coming ashore and the question arose as to whether clean-up operations should wait until there was no risk of recontamination. In this case, a coastal geomorphologist identified a strong potential for oil burial because of beach sedimentation cycles so that clean-up was implemented immediately and was continued as oil arrived on the shore. The knowledge of seasonal beach sedimentation processes significantly influenced the clean-up response.

In some cases, there is significant potential for conflicting environmental advice. Often if the advisers are confronted with the situation in the field, the problem can be quickly resolved. The danger is that the OSC or shoreline response co-ordinator, who is invariably operationally oriented, is confronted with conflicting advice and then regards the advisers as indecisive, and ignores their further advice. This seems to be the root of a problem: OSCs frequently expressed that environmental advisers are often indecisive, and environmental advisers frequently expressed that OSC's are insensitive to environmental problems! Close interaction before and during the spill is important to resolving the problems.

As working experience of both the OSC and advisers increases, a mutual understanding of each others problems may reduce the conflict, but it nevertheless remains a significant operational problem in the early portion of many spills.

DAY-TO-DAY ACTIVITIES

Numerous points of interest about the day-to-day operations during a spill response were recorded during the interviews. They are noteworthy, yet not easily categorized, and, as such, listed as follows:

- ownership must be established for shore access and signed releases obtained;
- local owners can be encouraged to clean their own property by supplying materials and guidance;
- a local operations centre may be appropriate for an onshore clean-up operation;
- good communications to the operations centre by either by radio or phone (speaker phone very helpful) is essential; at least two lines are required (one in, one out);

- personnel should be hired locally through contractors;

- fixed-price bids for clean-up do not work well because there are too many unknowns in a clean-up operation; supervision of contractors working on an hourly rate is preferable;

- oil spill response is not a fire-drill response; an accurate picture of the problem is important prior to initiating the most effective response action;

- restricted access may be necessary in the interest of public safety or to facilitate logistics; at one spill a local airport was closed to facilitate air lifts; roadblocks may also be required;

- do not trust trajectories; be prepared to protect special areas even if possibility of impact is remote;

- each field crew should have at least two radios with dedicated call numbers;

- increase clean-up efforts during periods of good weather to facilitate clean-up;

- a daily accounting of costs must be maintained; time sheets of contractors must be signed daily;

- resourceful tradeoffs can reduce conflicts (e.g., oiled beach sediments have been used for improving roads and runways; a new road was constructed to an unoiled beach as an alternative to cleaning a previously heavily used beach, which would have been difficult to clean);

- continuous clean-up may be required where oil burial by natural sedimentation is probable;

- check-lists assure that essential response actions are taken;

- although the foreshore is Crown land and controlled by provinces (except in the Arctic), there have been no jurisdiction problems in dealing with foreshore problems; and

- field-crew supervisors are scarce.

SPILL POST-MORTEM

POST-MORTEM MEETINGS

A post-spill meeting of the shoreline response crew, including appropriate advisers and contractors (see Figure 1), is an important part of the spill evaluation. As in the overall spill organization, the post-mortem meeting provides a means of improving future spill response efforts. The following are appropriate for review:

- effectiveness of shoreline response organization; identify weaknesses and potential improvements;
- effectiveness of operational pre-planning; what should have been done that was not done; what pre-spill activities were unnecessary?
- were pre-spill protection priorities adequate or useful? and
- how could countermeasures be improved or was clean-up too good?

Post-mortem spill reports are extremely helpful in improving spill response efforts for people not directly involved in the spill. Unfortunately, these reports are generally not available because any admission of weakness or failure, which must be recorded if the problem is to be avoided in the future, could possibly lead to litigation. The very items that need to be identified to improve future spill response are typically not identified, therefore assuring that the mistake will be repeated in the future. For example, in some spills covered during the interview process, it was apparent that political interference or interference from response team superiors not directly involved in the spill definitely reduced the efficiency of the response effort, yet these problems were never identified in a post-mortem report. In another spill, it was clear that an OSC was not qualified (by several accounts) to direct the response yet this is understated in operations reports (so the question remains, how do you remove an incompetent OSC?). To date, informal verbal discussions have remained the principal means of adequately conveying this important information.

The rarity of succint post-mortem reports that address operations during the spill is unfortunate. Considerable insight into problems is contained in the few reports that exist (it was notable that the reports that did exist were usually isolated copies or notes extracted from someone's personal files!). It is highly recommended that short, candid reports on the spill response successes and failures become an essential part of the spill response process. The essence of this report should be to identify problems so they are avoided in the future rather than to delegate blame.

POST-SPILL MONITORING

To date there have been few post-spill monitoring programs that document either the effectiveness of a clean-up or the long-term fate of oil on shorelines. This is unfortunate because (1) most clean-up programs are probably very effective, and (2) the long-term fate of oil on shorelines is probably not as significant as is generally supposed, but unfortunately there is no comprehensive scientific data to support the premise.

The shoreline response co-ordinator may want to integrate a monitoring program as part of the clean-up operation, documenting:

- pre-spill oiling levels;
- pre-cleanup oiling levels;
- immediate post-cleanup oiling levels; and
- long-term post-cleanup oiling levels.

Budgets and human resources must be allocated early in the spill to make such a program effective over the longterm. Guidelines for establishing a shoreline monitoring propram are described in a separate report (Harper and Owens, 1985). A number of the interviewers emphasized the need to target long-term research programs, particularly for large spills, as part of the spill response; often, the cost of such a monitoring program respresents a very small fraction of the response budget.

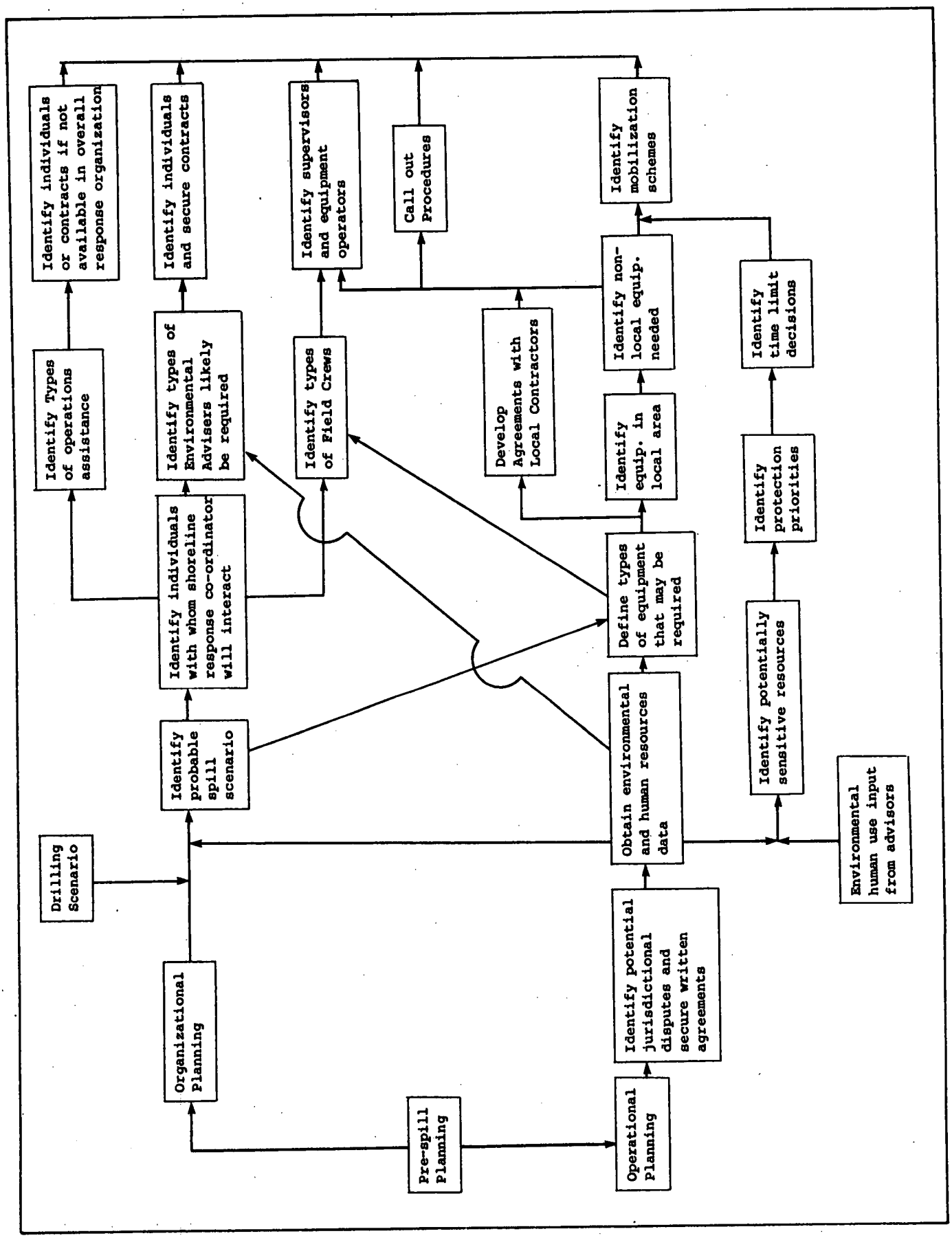

Figure 2. Critical path diagram for pre-spill planning elements.

DECISION-MAKING GUIDELINES

The previous discussions provide a review on spill planning and operations, based on first-hand experience, and do not address decision-making per se. In this section, a brief review is provided on how this information is incorporated into the decision-making process.

PRE-SPILL PLANNING

The decision-making process involves a series of questions with a series of answers. In the case of a shoreline countermeasure program, the series of questions may ultimately lead to an implementation of a field activity. Figure 2 provides an example of a critical path diagram to answer the question "what can be done prior to a spill?" The diagram identifies a number of activities that can be conducted to improve preparation for a spill. More importantly, the diagram illustrates the consequences of not conducting certain activities and as such assists in decision-making process by identifying critical information.

For example, Figure 2 illustrates the importance of having environmental resource data of an area; without such a data base available to a shoreline response co-ordinator (or OSC), the following limitations in planning become apparent:

- a probable spill scenario cannot be defined;
- potential environmental advisers can be only generally identified;
- the types of spill protection and clean-up equipment that may be required cannot be identified;
- contractors with necessary equipment or expertise cannot be identified;
- special or sensitive resources cannot be identified nor can protection priorities be pre-spill defined.

The consequence of not compiling an adequate resource data base is that these activities, which will need to be completed prior to any response effort, will have to be completed during the early part of the spill and may significantly delay response efforts. The ARROW spill provides a good example of a spill response in which there was virtually no prespill planning and all of the activities outlined in Figure 2 were completed after the spill had occurred.

SPILL PROTECTION PRIORITIES

Prior to spill impact, the shoreline response co-ordinator may be required to implement protection strategies to minimize harm. As a result of limitations in equipment, personnel, or time, a shoreline response co-ordinator will undoubtedly be forced to assign protection priorities at the time of a spill. A general methodology is outlined in Table 4 and is similar in format to previously designed decision charts (Foget et al. 1979). The shoreline co-ordinator is forced to ask a series of questions such as: is it technically feasible to protect the shore; will major hardships or environmental damage occur if the shoreline is not protected; and is it too late to implement protection? An important part of the decision-making process is the information requirements to reach a decision (see Table 4). The most notable feature of the information requirements is that most can be determined prior to the spill. Principal unknowns to be identified at the time of the spill are:

- spill characteristic (volume, oil type, oil form);
- approximate area of impact;
- approximate time of impact; and
- environmental conditions (sea state, tidal range).

Other response information can be determined with a moderate degree of accuracy prior to the spill with the exception of public input, which is acquired typically at the time of the spill.

An additional observation of interest is that protection or clean-up operations focus to a large extent on human-use concerns of coastal resources, yet there is seldom pre-spill identification of public concerns. During the spill operation, the shoreline response co-ordinator may rely extensively on advice by specialists on environmental concerns, but is faced with the need to interpret public concerns himself, in spite of the fact that public concerns have traditionally been the major factor influencing clean-up activities.

The problem is not easily resolved and will probably be the most complicated issue the shoreline response co-ordinator may face. There are means of providing pre-spill human-use input, however, which have not been used in Canada (to the author's knowledge), but have been used overseas. In Britain, for example, local communities provide sensitivity maps of coastal resources as part of routine planning. [1]Although the sensitivities do not necessarily translate directly into protection priorities, they do provide the co-ordinator with a valuable index of what the community considers important. Such knowledge would significantly improve pre-spill planning efforts.

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[1]Owens, E.H., Geoscience Services Ltd., personal communication, 1984.

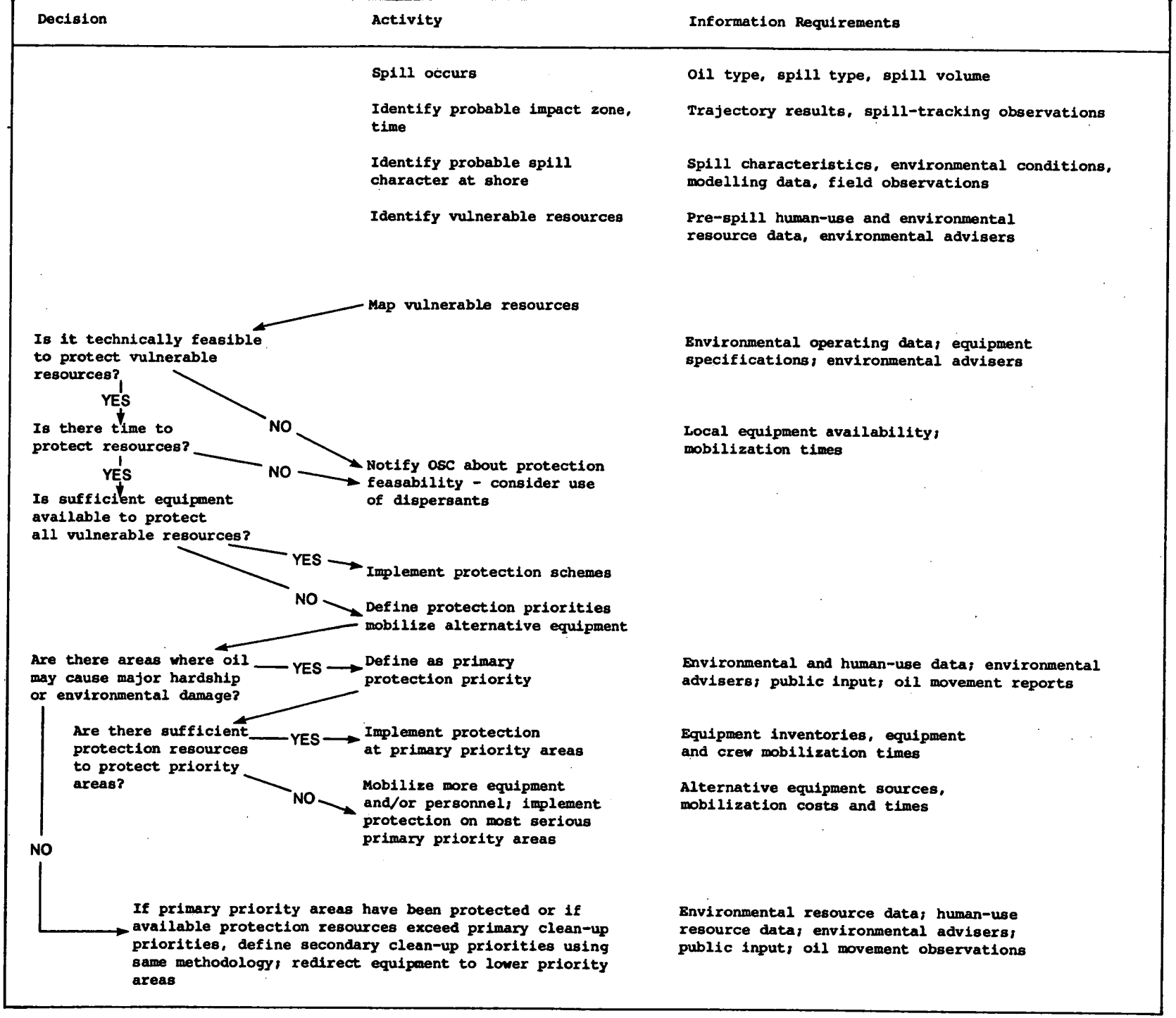

Table 4. Shoreline Protection Strategies.

SPILL CLEAN-UP PRIORITIES

During or following impact, the demand for clean-up resources (equipment and personnel) will probably exceed that available, and clean-up priorities will have to be established. A general rationale for establishing such priorities is outlined in Table 5 and is similar in format to previous examples (Foget et al. 1979). Much of the required information relative to decisions can be determined prior to the spill with the principal unknowns including:

- location and type of contamination;
- environmental conditions (including coastal processes); and
- public concerns.

As in the determination of protection priorities, most required information for decision making (see Table 5) can be determined prior to the spill, although in past spills, much of the environmental background or resources and response logistics were determined at the time of the spill.

DISCUSSION OF DECISION GUIDELINES

Decisions during a spill response may be easy or difficult to make, but all have a common feature - decisions require adequate background information to evaluate tradeoffs. Seemingly difficult decisions often become simple in the light of an adequate information base. The flow charts indicate that much decision-making information can be generated prior to the spill.

Experienced response personnel similarly advocate extensive pre-spill planning, including testing of organizational structures and of information bases. Thus, the single most-important activity that will improve decision-making at the time of a spill is pre-spill planning, both in identification of organizational structure and resource identification.

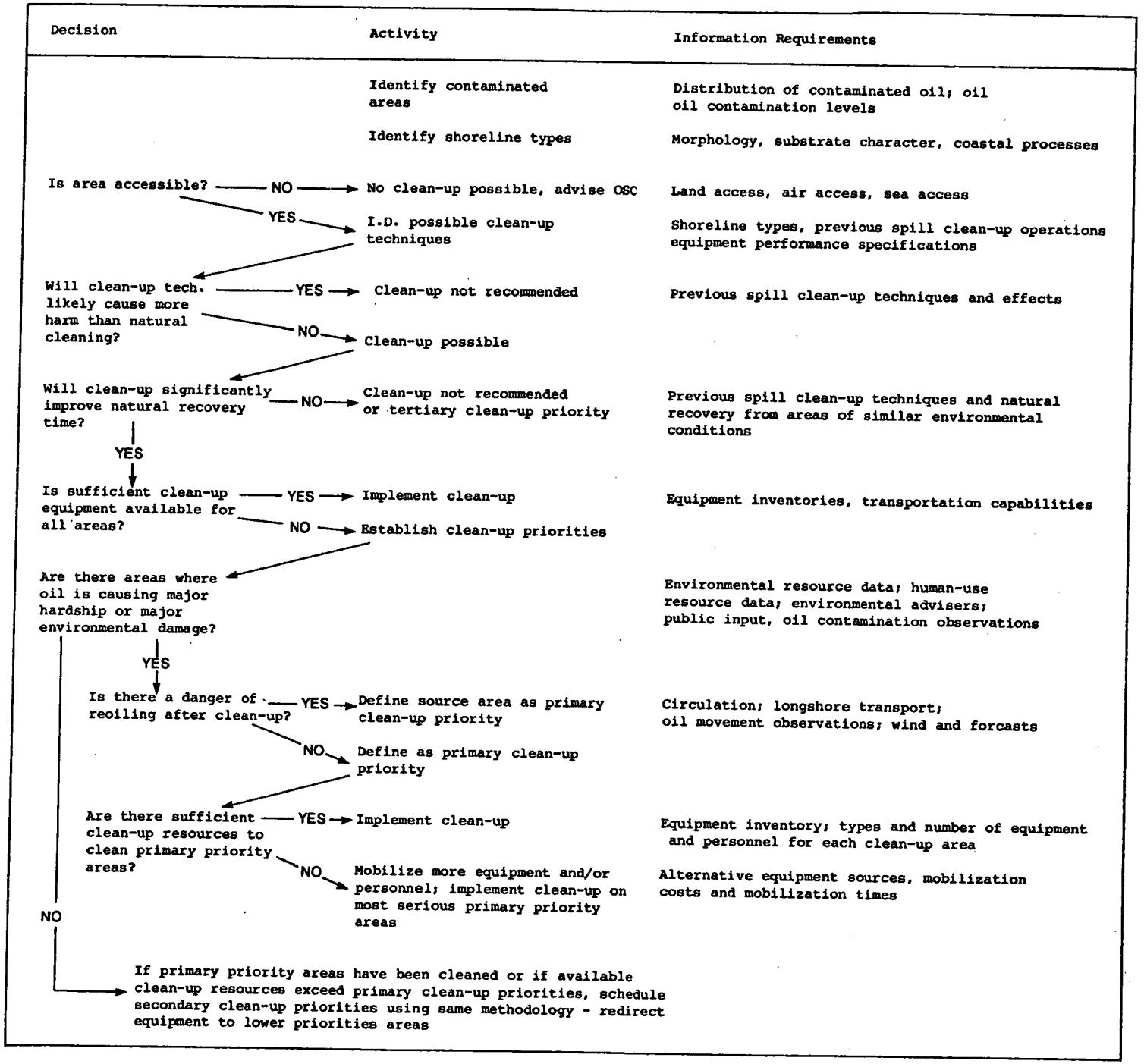

Table 5. Shoreline Clean-up Strategies.

CONCLUSIONS

Seven principal conclusions of the study are:

1) The decision-making process can be significantly improved by having adequate information available; in general, the more technical information that is available, the clearer are the tradeoffs.

2) The most consistent recommendation of personnel experienced in responding to spills is to plan prior to a spill and to conduct pre-spill exercises. The major portion of environmental, human-use, and logistics resource information can be collected prior to a spill, thereby simplifying and expediting the decision-making process at the time of the spill.

3) Potential jurisdictional problems about spill responsibility must be identified prior to a spill and agreements about agency and/or contractor responsibilities established in writing; jurisdictional problems continue to be a problem even in 1984.

4) Protection or clean-up priorities cannot be finalized until the time of a spill; the general guide used in past spills is that the oil (or contaminant) not inflict hardship or major environmental damage. Once a spill occurs, it is important to establish a rationale for establishing priorities of protection and clean-up efforts.

5) Pre-spill identification of human-use concerns is a significant problem; typically these concerns are only identified at the time of a spill through some type of public consultation process.

6) Documentation of response activities is important in the justification of decisions, which often figure significantly in litigation procedures or in insurance claims (i.e., archive notes and maps).

7) Post-spill reports, which summarize response activities, identify problems, and recommend improvements in the organizational structure or response, should be completed for each spill. The report should be in a standard format and should be the responsibility of the OSC. Few previous spills have had such a report.

APPENDICES

APPENDIX A

Individuals Interviewed During Project

INDIVIDUAL	COMPANY/AGENCY	SPILL INCIDENT	INTERVIEW TYPE	INTERVIEW DATE
BEECH, Fred	EPS, Vancouver	Burrard-Yarrows	P	4 Oct 84
BURGH, Coleen	DEC, Juneau	LEE WANG ZIN	P	4 Oct 84
CURRAN, Ken	CCG, Halifax	KURDISTAN	P	12 Sep 84
DUERDEN, Colin	EPS, Halifax	KURDISTAN	P	29 Aug 84
FOOTE, Tom	BIO	ARROW	P	6 Sep 84
GOODMAN, Ron	Esso	Norman Wells	P	19 Oct 84
HENDRY, Colin	CCG, Vancouver	SUNDANCER	P	4 Oct 84
HUME, Howard	Petro-Canada	Non-Specific	P	15 Oct 84
KOHLMAN, Dennis	Petro-Canada	SWan Lake	P	15 Oct 84
		Clearwater River	P	15 Oct 84
MACKAY, John	DPW, Charlottetown	ARROW	T	18 Oct 84
MACMILLAN, Blair	CCG, Halifax	KURDISTAN	P	11 Sep 84
McTAGGART-COWAN, Patrick	(Retired)	ARROW	P	16 Oct 84
MARGISON, Clayton	CCG, Prescott	NEPCO-140	P	15 Oct 84
MARTIN, Michael	EXPO-86, Vancouver	ARROW	P	19 Sep 84
MASON, Clive	BIO	ARROW	P	6 Sep 84
MILLER, Stan	APA	Port Aux Basque	P	7 Sep 84
PERCY, Roger	EPS, Halifax	UNIACKE/VINLAND	P	30 Aug 84
POND, Steve	EPS, Vancouver		P	4 Oct 84
RIVET, Claude	EPS, Montreal	SIFNOS	P	17 Oct 84
ROBERTSON, Ian	Ian Robertson Cons.		P	28 Sep 84
ROSS, Cal	Mobil	UNIACKE/VINLAND	P	31 Aug 84
SCARRATT, Dave	St. Andrews, N.B.	ARROW	T	18 Oct 84
STRIGHT, Rod	CCG, Halifax	KURDISTAN	P	11 Sep 84
SWISS, Jim	Dome Petroleum	KURDISTAN	P	5 Sep 84
			P	15 Oct 84
THOMAS, Martin	Univ. of N.B., Saint John	ARROW	T	19 Oct 84
VANDERKOY, Nick	Dome Petroleum	NEPCO-140	P	15 Oct 84
VANDERMEULEN, John	BIO	Non-Specific	P	7 Sep 84
YOUNG, Ian	CCG, Vancouver	IRISH STARDUST	P	4 Oct 84
		ERAWAN-SUN DIAMOND	P	4 Oct 84

APPENDIX B

BACKGROUND AND QUESTIONS USED IN INTERVIEW PROCESS

B.1 Introduction

The objective of this project is to develope guidelines that will aid in the decision making process for shoreline cleanup of oil spills; funding for the project was provided by the Environmental Studies Revolving Fund (ESRF). The purpose of the interview phase of the project is to document how and why decisions were made regarding shoreline protection and clean-up. The interviews will document portions of the decision-making process that are not normally recorded at the time of the spill. The results will provide insight into past decision-making structure and will be used to improve in future planning and response.

The questions are catalogued into four general areas:

- Organizational structure of the response team.
- Shoreline protection strategies.
- Shoreline clean-up strategies.
- Operational post-mortems.

B.2 Organization Structure of the Response Team

1. Who was the primary decision maker/advisor for shoreline countermeasures?

2. How much autonomy did Onshore coordinator have?

3. How did the OSC interact with the shoreline coordinator?

4. Was there a mechanism for subdividing and delegating countermeasure responsibilities if necessary? Geographically? Operationally?

5. How did the task force or advisors pass information to the shoreline coordinator?

6. What type of technical specialists were used (e.g. coastal processes specialists)? Were these helpful? How would you change this in future?

7. Was there adequate input by federal, provincial (state) agencies to the shoreline decision-making process? How did the province/federal governments perceive the functional relationship?

8. Were existing provincial/federal agreements delegating regulatory responsibilities adequate for this spill? Problem areas? Strengths?

9. Was there a mechanism to pass public input in the decision-making process? (public officials; direct resident input). Did it work? Were the requests implemented? Who determined and how were "unreasonable requests" accomodated?

10. Was legal input incorporated into the decision-making process?

11. How were decisions/interaction between offshore and onshore operations handled?

12. How do you see differences in organizational structure for onshore and offshore operations (e.g., everyone is a shoreline expert)?

13. As the cleanup operation progressed, how did the support to the decision-maker change and was this is a problem?

B.3 Shoreline Protection Strategies

1. Was there a preselected/predesignated priority system (i.e. sensitivity analysis)?

2. Were there predesignated decisions (e.g., critical water intake structures boomed immediately, without question)?

3. Were the preselected priorities used in determining countermeasure applications?

4. Were the priorities changed during the spill? Why? By whom? (By regulatory representatives?)

5. Were the priorities determined on the scene? How? By whom?

6. If there were no preselected priorities, would they have helped? What level or type of priorities would have been most useful?

7. Who should have responsibility for pre-pill planning?

8. Was implementation of shoreline countermeasures limited by time, equipment, personnel, costs?

9. Was any monitoring plan implemented prior to (or during) spill impact?

10. Did the shoreline countermeasure advisor have input into offshore containment decisions (e.g., use of dispersants)?

11. Were critical "time limited" decisions (e.g., period when dispersants would be most effective) flagged before the spill? Were they useful in determining response strategies? Logistics?

B.4 Shoreline Cleanup Strategies

1. Start of cleanup. Who determined (and why) when to start cleanup?

Where (and why was cleanup initiated? What were significant factors in determining initial cleanup strategies (political pressure; coastal processes concerns)?

2. Were local people hired?

3. How were slick pickers or contractors paid (piece rate; hourly wage)?

4. How were cleanup priorities determined? Were they changed during the spill? Why?

5. When was a cleanup terminated? Was it a cost decision? Was it a concensus by local community?

6. Were there constraints that limited or affected cleanup options? (Cost, labour, logistics, accessibility).

7. How did the cleanup operation wind down?

8. Were there predesignated disposal sites? How were they selected? Who selected them?

9. Did disposal options limit countermeasure options?

10. Were environmental constraints limiting in terms of options?

11. Did environmental effects result in clean-up that may have been more appropriate naturally?

12. Did countermeasures have more impact than spill? Would it have been possible to evaluate these before had sufficient information of technical advice been available?

B.5 Post Mortems

1. How were losses handled? Direct losses? Indirect losses?

2. Was the concept of compensation for claims a factor in cleanup or protection?

3. Did the on-scene commander have to consider litigation or compensation at the time of the spill? Did this affect the decision-making process?

4. Is a prespill information base useful? (e.g. logistics, resources identified).

5. How do you think decisions are made at spills?

6. Was a monitoring program initiated to document a cleanup effectiveness/long term fate of oil?

7. Who should be responsible for a monitoring program?

8. What was learned from the spill?

9. "Feeling Question". How did you feel about the decision-making process?

10. Do you think that given the same spill situation again, would the same problems arise again?

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