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Department of Environment
Environmental Protection Service
Pacific Region

WEST COAST OIL SPILL COUNTERMEASURES STUDY
YEAR II

Regional Program Report 81-22

by

Frederick G. Beech
David A. Betts
Suling Hum
Steve G. Pond

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ABSTRACT

This report analyses the results of the second year of a two year program aimed at improving oil spill countermeasures on the Pacific coast of Canada. During Year I, two high risk areas were identified as warranting further study. In Year II, oil spill scenarios were formulated for both of these areas in an effort to identify potential improvements in response capability. Two workshops attended by individuals representing U.S. and Canadian government agencies and private contractors were convened to imitate the decision-making process that would ensure following major oil pollution incidents. Subjects addressed were response organization, resource protection, equipment deployment, dispersant application, logistics, manpower requirements and cleanup costs.

Observations pertinent to the improvement of response capability on the Pacific coast were subsequently identified and included in the report.

RÉSUMÉ

Dans le présent rapport on a consigné les résultats obtenus durant la deuxième année d'un programme de deux ans destiné à renforcer les moyens d'enrayer les dangers provoqués par les nappes de pétrole le long de la côte canadienne du Pacifique. Au cours de la première année on a identifié deux secteurs de resques majeurs en vue d'une étude plus poussée. Durant la deuxième année, on a formulé des scénarios pour chacun de ces deux secteurs dans le but de chercher les moyens d'augmenter l'efficacité du processus d'intervention. Des représentants d'organismes gouvernementaux canadiens et américains ainsi que d'entreprises privées ont participé à deux ateliers afin de reproduire le processus de prise de décision censé se dérouler en réponse à un accident de grande ampleur dû à la pollution par le pétrole. Parmi les sujets examinés il faut citer l'organisation des moyens d'intervention, la protection des ressources, le déploiement du matérie, L'application du dispersant, les problèms de logistique, les besoins en main d'oeuvre et le coût de la remise en état. Toutes les observations résultant de l'étude et intéressant la recherche de moyens d'intervention plus efficace ont été consignées dans le rapport.

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1.0 INTRODUCTION

1.1 Scope and Objectives

In the first year of the West Coast Oil Spill Countermeasures Study EPS examined spill potential and cleanup capability in coastal British Columbia. In this study we undertook an in-depth examination of the oil spill countermeasures capability in the two areas thought most deserving of special study: the northeast coast of Vancouver Island and the southern Georgia Strait.

Year II of the Countermeasures Study was intended to assess the existing level of response capability for a moderate spill near Northeast Vancouver Island and for a major spill in southern Georgia Strait in order to identify a reasonable level of additional spill countermeasures and logistical response to ensure moderate resource protection and shoreline cleanup. As subobjectives we attempted to determine what equipment and manpower would be necessary to counteract the effects of a large spill and what the costs of such an operation might be. The final objective was to provide the actual decision makers with some experience in making the necessary decisions by means of a workshop, described in appendix C.

The northeast Vancouver Island scenario concentrated on Johnston, Broughton and Queen Charlotte Straits and adjacent waterways. The southern Georgia Strait scenario included the southern Gulf Islands and southeast Vancouver Island.

1.2 General Methodology

In order to simulate the conditions under which response capability could be tested, hypothetical spill scenarios were presented to a representative group of people in two workshops, held 3-4 Oct., 1979 and 12-13 Feb., 1980. Workshop participants were organized into two main groups: resource advisors and spill response decision-makers. An On-Scene-Commander (OSC) was appointed to coordinate decisions concerning where countermeasures were required, what kinds of response were warranted and which areas required cleaning up. The OSC was in fact the Regional Marine Emergency Officer of the Canadian Coast Guard and thus was experienced in commanding oil spill responses of this type.

Scenarios were chosen to test spill response to the largest oil spill that could reasonably be expected in the two areas, based on previously obtained data. Dates of the spill were selected to allow examination of response in summer (northeast Vancouver Island scenario) and winter (southern Georgia Strait scenario); weather regimes hypothesized were those which had actually occurred on the dates selected and were typical summer and winter "blows" which occur several times a year.

The choice of only two scenarios of the multitude possible had the advantage of allowing a fairly detailed look at the type, feasibility, and cost of countermeasures available. The drawback to this was that the full range of possible spill locations, sizes, weather regimes and biologically sensitive seasons was not examined.

Data on oil spill equipment, contingency planning, countermeasures techniques and response logistics had been previously obtained in the West Coast Oil Spill Countermeasures Study - Year I. Details on site specific protection and cleanup problems were derived from existing oil spill countermeasures maps. Additional resource information was assembled with cooperation from other federal and provincial government agencies, universities, private individuals and local communities. In addition, the two were workshops composed of many individuals with a high level of expertise on natural resources and special concerns to residents of the affected areas. The contributing individuals and groups are named in Appendix E; their efforts are gratefully acknowledged.

2 BEHAVIOUR OF BUNKER C AND CRUDE OIL IN THE MARINE ENVIRONMENT

For the purposes of the oil spill workshop simulations, number 6 fuel oil (bunker C) was chosen for the northeast Vancouver Island scenario and a typical crude oil from the Peace River district of British Columbia was chosen for the southern Georgia Strait scenario. While these oils are representative of products commonly used on the Pacific coast, it should be noted that there are many other types of crude oil and oil products that have widely diverse chemical and physical characteristics.

Bunker C, the residual oil left after higher hydrocarbon fractions have been distilled, is widely used on the British Columbia coast in pulp mills, cement plants and power plants. It is a thick, black oil that congeals when cooled. It is highly viscous, low in solubility, relatively non-volatile when cool and high in specific gravity. At ambient sea and air temperatures, bunker C is semi-solid and thus requires heat to maintain fluidity and combustion.

When spilled into sea water, bunker C congeals rapidly, forming a tar-like substance. It is relatively stable, hence resistant to natural weathering. It cannot be efficiently dispersed with chemicals nor does it burn easily when in contact with the water. Because of its high specific gravity, it may sink to the bottom or to a subsurface layer where it is difficult to detect or recover. It is relatively non-toxic to marine organisms but can cause high mortality due to its smothering effect on intertidal and benthic fauna.

The impact of bunker C on shorelines can be severe. It tends to be sticky, adhering to most surfaces it contacts. This same "stickiness" prevents it from penetrating very deeply into porous substrates such as sand or pebble beaches, but surface contamination can be extremely persistent, particularly in low energy marine environments. In higher energy environments, wave action may induce the formation of tar balls, semi-solid balls of oil mixed with fine sediment which generally sink but may be deposited on beaches, or the bunker C layer may be subsequently covered with fresh sand or gravel forming a sub-surface pavement-like layer that may later be exposed when surface materials are washed away.

Containment, cleanup and disposal of spilled bunker C poses many vexing problems. Containment in low current waterways with minimum wave heights is generally no difficult, unles the material sinks. Recovering it from the water is another matter. Most present-day mechanized cleanup equipment is not effective in recovering large amounts of heavy fuel. Its surface tension and high viscosity combine to frustrate the principles on which most modern skimming devices are based; it rapidly clogs belts, discs and pumps that are usually capable of recovering lighter oils and it tends to entrain floating debris. As time passes, specialized recovery equipment decreases in effectiveness in cleaning up a spill of this type. Ultimately, the operation becomes a very labour-intensive and costly beach-cleaning effort.

Light Peace River crude has a low viscosity, low pour point, low specific gravity and a relatively high potential for emulsification in water. The constituent chemical components of this crude tend to be the lighter, more volatile fractions in the class of hydrocarbons known as aromatics. These fractions are generally more toxic than other crude oil components, although they do tend to evaporate rapidly, leaving the less toxic, residual fractions in the water.

In addition to evaporation, crude oil components break down through the processes of photo-oxidation, dissolution and microbial action. These processes are not insignificant. Over a period of 72 hours, over 50 percent of the original volume of crude oil may be lost from an oil skick. With the removal of easily-weathered crude oil components, the physical characteristics of the residue are altered such that removal from the water becomes increasingly difficult. The potential for formation of water-in-oil emulsions creates added complications for cleanup. With sufficient agitation from waves, oil at the slick edge is entrained in emulsion thereby increasing the amount of material which must be removed and disposed of. Eventually, the volume of this emulsion may exceed that of the original volume of oil spilled. The degree to which the above-mentioned processes occur depend on the impact of wind, waves, current, precipitation, sunlight and temperature.

Environmental conditions hypothesized for the southern spill simulation were conducive to several of the weathering processes described above. Strong southeast winds generated sea states that increased the rate of evaporation, dissolution and emulsification of the oil. Heavy precipitation augmented these processes. Degradation of oil by bacteria and oxidation, however, was impaired by low air and water temperatures and lack of direct sunlight.

Much of the oil washed up on beaches in the southern Georgia Strait scenario could conceivably have been either a well-weathered crude oil residue or the water-in-oil emulsion commonly known as "chocolate mousse". Neither substance can easily be recovered with conventional mechanical skimmers.

3.0 NORTHEAST VANCOUVER ISLAND BUNKER C SPILL SCENARIO

3.1 Background Preparation

The northeast coast of Vancouver Island was identified in the West Coast Oil Spill Countermeasures Study - Year I as an area where spill risk was deemed high enough to warrant the acquisition of additional cleanup equipment to improve response preparedness.

In preparation for the scenario, baseline resource data were assembled and mapped for the area. Generalized social and economic values were readily available; biological inventories and shoreline classification schemes were more difficult to obtain owing to the lack of comprehensive, published research data. Material gathered during Year I of the Countermeasures Study provided information on equipment supplies, logistic requirements, manpower, contingency plans and emergency contact personnel.

A spill scenario was outlined for the Ocean Physics Division of the Institute of Ocean Sciences which provided a seven-day forecast of slick movement consistent with actual tidal and weather conditions during the week of July 9, 1979. The slick forecasts were then presented to the workshop participants who proceeded to determine appropriate countermeasures.

The scenario presumed that a barge carrying 5000 tons of bunker C fuel was wrecked on Stephenson Islets, a group of rocks located in Johnston Strait at 49°34'50" North, 126°49'40" West. Winds were moderate to fresh easterlies, varying from 5 to 20 mph throughout the week following the wreck. It was postulated that no lightering vessel was available and thus cargo fuel transfer was not attempted, and that the barge was a total wreck, releasing most of its oil over the first three days. The movement of the resulting oil slicks are shown in Figure I.

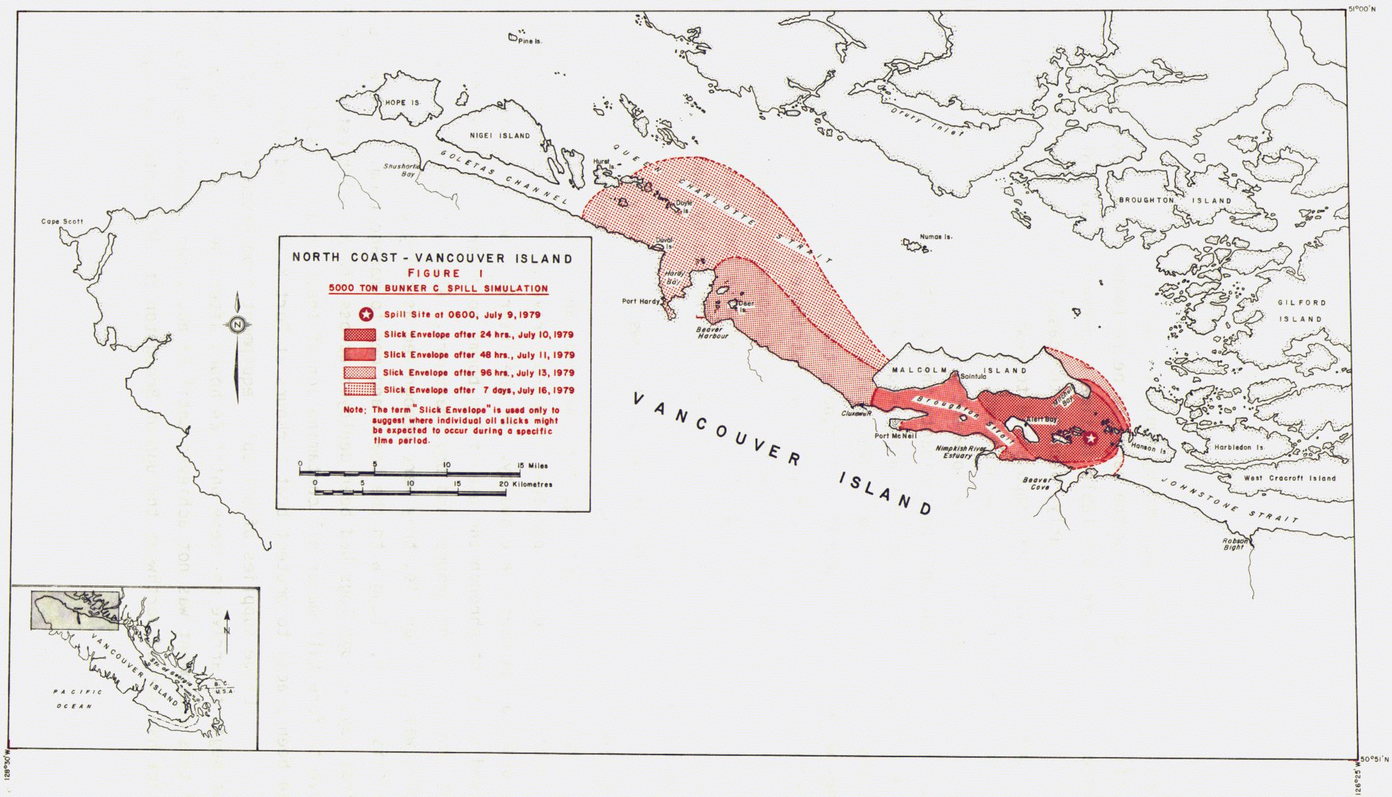
3.2 Response from Workshop Attendees

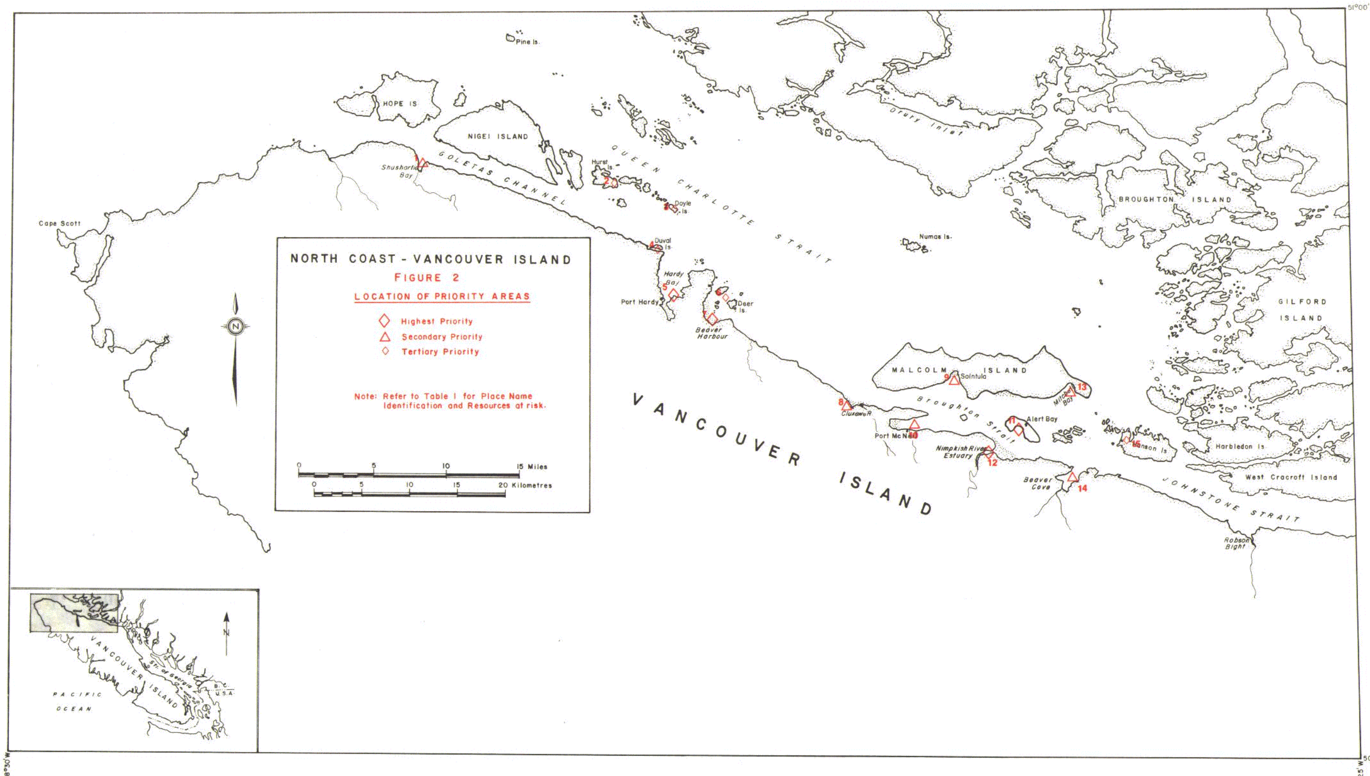
The initial response to an event of this nature, according to participants, would be to survey the vessel damage and to determine the means by which it could be salvaged. Concurrently, efforts would be made to restrict the loss of oil to the area around the casualty site, if possible. Salvage of the fuel barge would require pumping equipment and another vessel to transfer sufficient cargo to allow the barge to be refloated. In this scenario, it was deemed that none were available in time to prevent breakup of the casualty and loss of its cargo. Similarly, because the casualty carried no spill containment equipment on board, it was impossible to restrict the spread of spilled fuel to the immediate vicinity of the accident.

The seven-day slick movement prediction, provided in sequential time periods allowed workshop participants the opportunity to designate in advance, areas of particular importance which required protection from the advancing oil slicks. Owing to an initial unavailability of cleanup and protective equipment, they were further requested to designate the priority of each site so that the on-scene commander could appropriately distribute his limited equipment. As more equipment became available from outside sources, areas of lower priority were subsequently protected. Priority areas with their respective environmental values and their priority designations as determined by concensus of the participants are in figure 2.

The workshop reponse was as follows: the only available oil containment boom in the area was quickly utilized to protect the boat harbour at Port McNeill. While more equipment was available from southern British Columbia, it was determined that it would arrive too late to protect high priority areas near the casualty. In the interim, local forestry companies were asked to assist through the use of log booms to divert oil slicks from estuaries, booming grounds and boat harbours. Although the effectiveness of log booms was questionable, they were recognized as being available in large supply in this region, along with the boats and men to manage them. By the end of the first day, enough logs had been deployed across the Nimpkish estuary and Beaver Cove to forestall major oil contamination of these areas and sufficient oil boom had been placed to protect boat harbours at Port McNeill and Alert Bay.

Large supplies of oil spill equipment from Vancouver and Victoria did not begin to arrive on-scene until 24 hours after the spill and major deployment of this equipment was not achieved until 48 hours had passed. By this time the slick had spread northwest throughout Broughton Strait, contaminating many miles


NORTH COAST - VANCOUVER ISLAND
FIGURE I
5000 TON BUNKER C SPILL SIMULATION
Spill Site at 0600, July 9, 1979
Slick Envelope after 24 hrs., July 10, 1979
Slick Envelope after 48 hrs., July 11, 1979
Slick Envelope after 96 hrs., July 13, 1979
Slick Envelope after 7 days, July 16, 1979
Note: The term "Slick Envelope" is used only to suggest where individual oil slicks might be expected to occur during a specific time period.
0 5 10 15 Miles
0 5 10 15 20 Kilometres
51°00'N
50°51'N
128°30'W
126°25'W
VANCOUVER ISLAND
MALCOLM ISLAND
BROUGHTON ISLAND
GILFORD ISLAND
NIGEI ISLAND
HOPE IS.
Pine Is.
Numas Is.
Cape Scott
Shushartie Bay
GOLETAS CHANNEL
QUEEN CHARLOTTE STRAIT
Drury Inlet
Port Hardy
Hardy Bay
Beaver Harbour
Port McNeil
Sointula
Broughton Strait
Nimpkish River Estuary
Alert Bay
Beaver Cove
Hanson Is.
Harbledon Is.
West Cracroft Island
JOHNSTONE STRAIT
Robson Bight
PACIFIC OCEAN
VANCOUVER ISLAND
U.S.A.
N



NORTH COAST - VANCOUVER ISLAND
FIGURE 2
LOCATION OF PRIORITY AREAS
Highest Priority
Secondary Priority
Tertiary Priority
Note: Refer to Table 1 for Place Name Identification and Resources at risk.
0 5 10 15 Miles
0 5 10 15 20 Kilometres
Cape Scott
Pine Is.
HOPE IS.
NIGEI ISLAND
Shushartie Bay
GOLETAS CHANNEL
Hurst Is.
QUEEN CHARLOTTE STRAIT
Doyle Is.
Duval Is.
Hardy Bay
Port Hardy
Deer Is.
Beaver Harbour
Numas Is.
Drury Inlet
BROUGHTON ISLAND
GILFORD ISLAND
MALCOLM ISLAND
Sointula
Mitchell Bay
Cluxewe R.
Port McNeill
Broughton Strait
Alert Bay
Nimpkish River Estuary
Beaver Cove
Harbledon Is.
West Cracroft Island
JOHNSTONE STRAIT
Robson Bight
VANCOUVER ISLAND
PACIFIC OCEAN
Str. of Georgia
B.C.
U.S.A.
N
51°00'N
50°51'
128°30'W
126°25'W
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

TABLE 1

ENVIRONMENTALLY SENSITIVE AREAS - NORTH-EAST VANCOUVER ISLAND

Map No.

1. Shushartie Bay
   - waterfowl, seabirds
   - shellfish, herring spawn

2. Hurst Island
   - seabirds, marine mammals

3. Doyle Island
   - marine mammals

4. Duval Island
   - marine mammals

5. Hardy Bay
   - commercial/recreation use
   - seabirds, shellfish
   - mudflats, herring spawn

Map No.

6. Deer Island
   - Indian reserve, residential
   - marine mammals

7. Beaver Harbour
   - Indian reserve, residences
   - shellfish, shorebirds
   - mudflat environment

8. Cluxewe River
   - Indian res., estuary
   - shellfish, herring

9. Sointula
   - commercial waterfront
   - residential, shellfish
   - log booms

Map No.

10. Port McNeil
    - industrial/commercial waterfront
    - seabirds, shellfish
    - log booming, log storage

11. Alert Bay
    - commercial waterfront
    - Indian reserve, residences
    - seabirds, shore birds

12. Nimpkish River Mouth
    - salmon river, seabirds
    - federal wildlife refuge
    - Indian reserve

13. Mitchell Bay
    - residential, commercial waterfront

14. Beaver Cove
    - extensive log booming/storage
    - ferry dock

of shoreline. Booms and skimmers were deployed to protect high priority areas and to replace log booms. Sweeps were made continuously in an attempt to recover individual slicks at sea, although this effort was largely unsuccessful owing to high currents and sea states. Several mud flats were trenched and dyked with backhoes to prevent backshore contamination; this effort was judged to be fairly effective. Diversion of oil away from important areas was initially effective, but the lack of experience and training of boat oper- ators coupled with the problem of repositioning booms in tidal changes resulted in some shoreline contamination.

By the end of the first week, most attempts at offshore recovery of oil had been abandoned and the main effort was turned to shoreline cleanup, the recovery of oil trapped in sheltered bays, rehabilitation of oiled wildlife and the cleaning of boats, logs and marine installations.

Oiled debris was burned in situ and placed in several existing permitted landfills. Site selection criteria and potential sites are given in Appendix C. Suitable landfill capacity was soon exhausted and much of the remaining material was temporarily stockpiled to allow time to develop an adequate disposal method; participants did not go so far as to identify the method.

The bulk of the effort in this scenario was assumed to have been spent in shoreline cleanup. The effort peaked from 3 weeks to 7 weeks following the spill, which allowed time for gradual organizational buildup and also for the oil to diminish in some areas by weathering and to concentrate in other shoreline areas by natural processes. The total cost of cleanup was roughly calculated at $5-10 million dollars. Supporting data describing in more detail the necessary materials and manpower as well as the basis of the cost calculations are presented in Appendix A.

4 SOUTHERN GEORGIA STRAIT OIL SPILL SCENARIO

The oil spill simulation for the southern Strait of Georgia was designed to test present regional capacity to deal with a major spill from a crude oil tanker. Although the possibility of such an accident is statistically remote, the expanding volume of crude oil deliveries which may occur in Washington State waters over the next ten years indicates a need to assess deficiencies in oil spill cleanup capability.

Large tanker deliveries of crude oil occur nearly daily to American refineries in Puget Sound. In addition, there are occasional exports of crude oil from Vancouver Harbour and the rare import of refined products by tanker to Vancouver. Should either the Trans Mountain or Northern Tier projects be constructed, there would be a dramatic increase in the volume of crude oil delivered through Juan de Fuca Strait.

It should be recognized that British Columbia relies heavily on national and international equipment sources for major oil spills. Although this places British Columbia at some disadvantage in respect of immediate availability of emergency materials, it is probably the most cost-effective means of ensuring preparedness for an extremely unlikely event. The main drawback of this system is the loss of response time involved in mobilizing outside resources, transporting them to the coast, preparing them for local transport and deploying them on-scene.

4.1 Background Preparation

As for the previous scenario, baseline resource data were assembled and mapped. The scenario assumed a large tanker outbound from Vancouver which had grounded on the eastern tip of Tumbo Island, 48° 48' 00" N, 123° 02' 48" W. This location was chosen in order to give the Canadian On-Scene-Commander absolutely clear jurisdiction over the disposition of the casualty and the ultimate cleanup of the spill. Had the spill occurred in American waters, the U.S. Coast Guard would have had lead agency status. Twenty thousand tons of light gravity Peace River crude oil were deemed to have spilled from the casualty over a 24-hour period. The month of December was chosen in order to test response capability during adverse climatic conditions.

The reader should appreciate the fact that for the purposes of this simulation, a worst case scenario was envisioned. It is conceivable that in a real event the loss of oil from a stranded vessel might be quickly arrested and contained within the immediate vicinity of the casualty. Such a scenario would not meet the objectives of this study. It was therefore pre-determined that all of the oil released from the casualty would be allowed to escape. This in no way is meant to reflect upon the capability of oil spill response agencies on the West Coast to arrest a release of oil before it becomes a major problem.

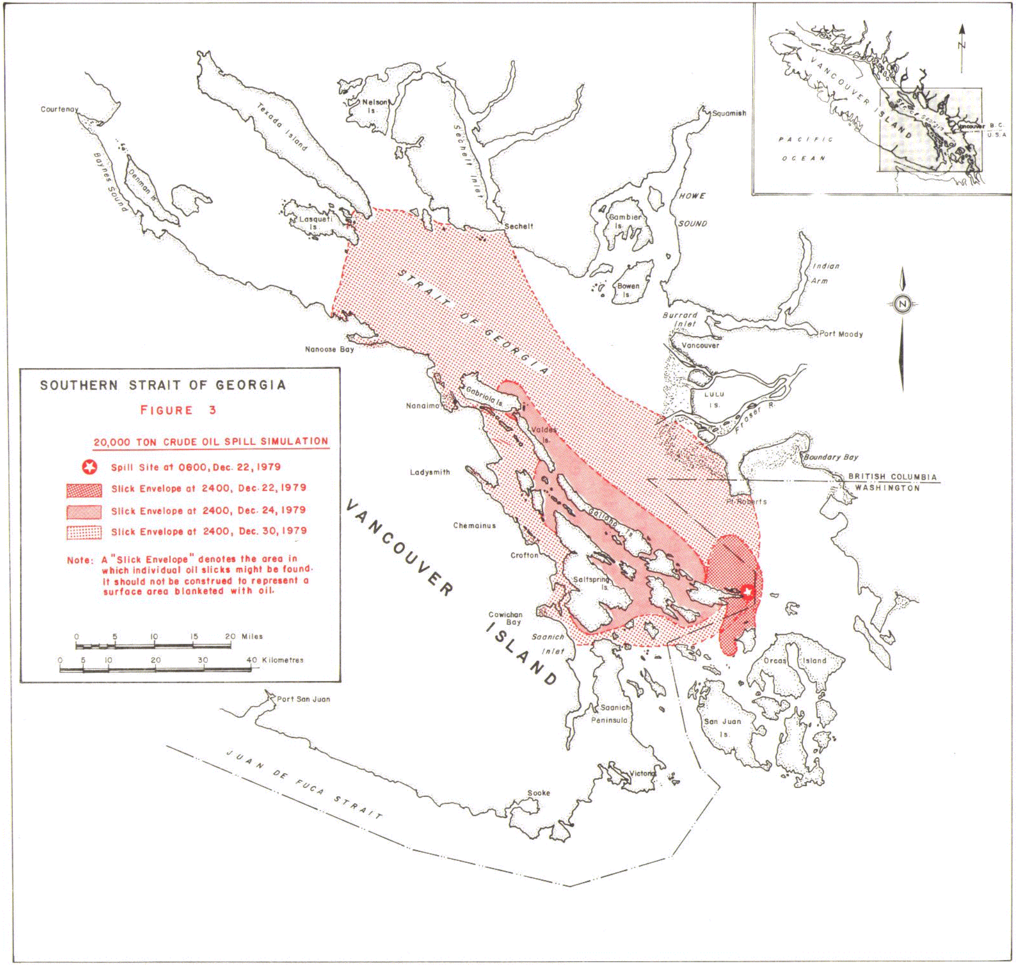
Weather for the scenario was that actually recorded for the period. Forecasts of slick trajectories were prepared by the Ocean Physics Divsion of the Institute of Ocean Sciences. Prevailing winds from the southeast drove the bulk of the oil to the northwest (Figure 3). As containment of the slick near the casualty was purposely deemed to be ineffective, most of the outer (north coast) shorelines of the Gulf Islands were exposed to free-floating slicks.

4.2 Response from Workshop Attendees

The initial response was to prevent further pollution from the wreck by refloating and towing the ship to Victoria; this was accomplished during the calm of the first day and a half.

Gale force winds then drove the oil slicks northwest; it was deemed impossible to prevent oil from entering major passes on the ebb tides. Strategy over the first eight days was directed at placing devices to protect sensitive areas and, when weather permitted safe boat operation, skimming free-floating oil in those sensitive areas. The work force by Day six was 55; no beach-cleaning was attempted. Attendees could not determine the effectiveness of shoreline protection measures within the study area as strong winds and currents made it doubtful that booming devices could operate effectively. However some techniques were thought to be workable; these are elaborated below.

Chemical dispersion was ruled out from the start within the inner Gulf Islands because of shallow depths and sensitive biological resources. On the outer exposed waters of the Strait of Georgia, it was attempted in the vicinity of the casualty, at first on an experimental basis and then, as weather


SOUTHERN STRAIT OF GEORGIA
FIGURE 3
20,000 TON CRUDE OIL SPILL SIMULATION
Spill Site at 0600, Dec. 22, 1979
Slick Envelope at 2400, Dec. 22, 1979
Slick Envelope at 2400, Dec. 24, 1979
Slick Envelope at 2400, Dec. 30, 1979
Note: A "Slick Envelope" denotes the area in which individual oil slicks might be found. It should not be construed to represent a surface area blanketed with oil.
0 5 10 15 20 Miles
0 5 10 20 30 40 Kilometres
STRAIT OF GEORGIA
VANCOUVER ISLAND
JUAN DE FUCA STRAIT
BRITISH COLUMBIA
WASHINGTON
Courtenay
Baynes Sound
Denman Is.
Texada Island
Lasqueti Is.
Nelson Is.
Sechelt Inlet
Sechelt
Squamish
HOWE SOUND
Gambier Is.
Bowen Is.
Indian Arm
Burrard Inlet
Port Moody
Vancouver
Lulu Is.
Fraser R.
Boundary Bay
Pt. Roberts
Nanoose Bay
Nanaimo
Gabriola Is.
Valdes Is.
Galiano Is.
Ladysmith
Chemainus
Crofton
Saltspring Is.
Cowichan Bay
Saanich Inlet
Saanich Peninsula
Victoria
Sooke
Port San Juan
Orcas Island
San Juan Is.
PACIFIC OCEAN
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conditions deteriorated, over a wider area. The decision to attempt dispersant spraying was not unanimous - biologists concerned with fish stocks expressed grave reservations, but eventually adopted the opinion of the majority of resource managers for this specific incident.

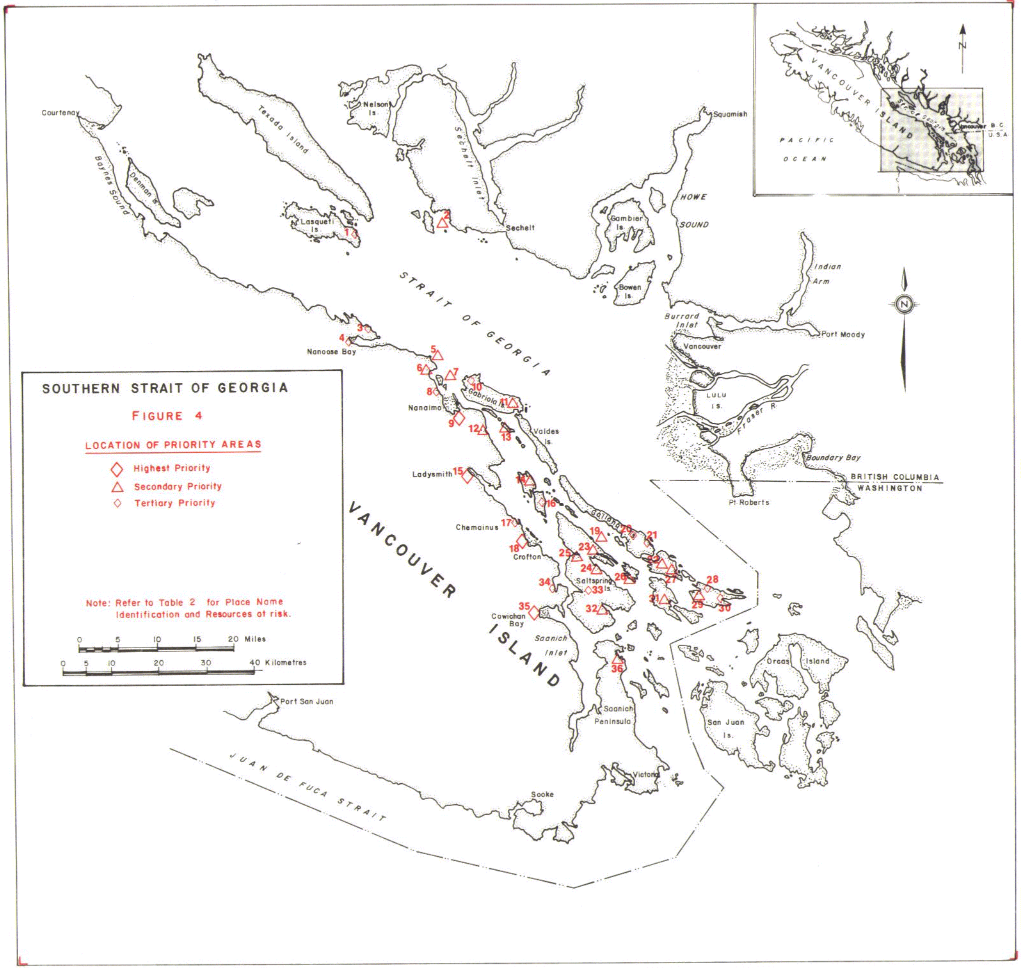
Owing to extremely adverse weather conditions and the requirements of the exercise, the oil spill could not be managed at the source, spreading uncontrollably into the Gulf Islands. Besides dispersants, the only option available to the workshop participants was the protection of high priority features lying in the path of oncoming slicks. As in the northern scenario, these areas were assigned priority ratings for protection. The On-Scene Commander was thereby able to dispatch his limited resources to the areas in greatest need of protection, as equipment became available. Figure 4 shows priority site locations and their environmental features.

Beach cleaning was presumed to begin on the eigth day when significant recontamination was unlikely. Cleanup was presumed to last six months, peaking during the first 30 days when 300 persons were assumed employed, and diminishing thereafter. The total cost of the cleanup was calculated to be approximately $30,000,000.

Attendees did not deal in detail with the question of how to dispose of oil and oiled debris. Material was burned in situ where possible and landfilled where not.

4.2.1 Protection of Priority Areas: The following sections describe selected sites that are representative of those that warranted protection. Protection techniques are usually dependent on specific site conditions; the following examples are solutions to typical problems encountered during the exercise. The main environmental considerations are presented in Figure 4.

Cowichan Bay: The exclusion of oil from Cowichan Bay was rated as crucial because of high biological productivity of the Cowichan estuary,



SOUTHERN STRAIT OF GEORGIA

FIGURE 4

LOCATION OF PRIORITY AREAS

◇ Highest Priority
△ Secondary Priority
◇ Tertiary Priority

Note: Refer to Table 2 for Place Name Identification and Resources at risk.

TABLE 2

ENVIRONMENTALLY SENSITIVE AREAS IN GEORGIA STRAIT

#	Place
1.	Lasqueti Island - park, marina,recreation - shellfish, marine mammals
2.	Welcome Passage - park, marinas, recreation - shellfish, marine animals
3.	Nankiveh Islands - marina, recreation - seabirds, shellfish, herring
4.	Nanoose Bay - Indian/ecological reserves - residences, marina, DND dock - shellfish, herring, tidal flats
5.	Hammond Bay - ecological reserve, residences - recreation, shellfish - salmon and herring
6.	Departure Bay - residential, recreation - commercial waterfront - biological station, salt water intakes - salmon fry, herring spawn
7.	Newcastle Island - park, archaelogical site - log booming, marina - seabirds, shellfish
8.	Nanaimo Harbour - residential, commercial, industrial - marinas, deep sea docks - recreational waterfront - shellfish, oyster lease - herring spawn, marina
9.	Nanaimo River - extensive estuary - Indian reserve, log booming - salmon acclimation area
10.	Decanso Bay - park, residences - ferry terminal, recreation - marina, oyster lease - shellfish, herring
11.	Degen Bay - Indian res., residences - shellfish, seals, marina
12.	Boat Harbour - residences, archaelogical site - shellfish, salmon fry
13.	Pirates Cove - park, arch. site, shellfish - herring spawn
14.	North Cove - residences, seabirds - shellfish, herring spawn
15.	Ladysmith Harbour - commercial/industrial waterfront - marinas, log booms - shellfish, herring spawn
16.	Kuper Island - park, Indian reserve
17.	Chemainus - commercial/industrial - forest operations - ferry terminal - seabirds, shellfish - herring spawn
18.	Shoal Islands - Indian res., park, marina - log booms, shellfish - tidal flats, seabirds
19.	Walker Hook - park, arch. site, seabirds - oyster beds, beach
20.	Montague Harbour - park, residences - marina, arch. site - oyster beds, beach
21.	Whaler Bay - ecol. reserve, residences - marina, arch. site - seabirds, oysters

TABLE 2 (Cont'd)

ENVIRONMENTALLY SENSITIVE AREAS IN GEORGIA STRAIT

#	Place
22.	Miners Bay - ferry terminal - seabirds, sport fishing
23.	Long Harbour - residences, ferry term. - marina, shellfish
24.	Ganges Harbour - residences, marina - shellfish, herring spawn - seabirds, arch. site
25.	Booth Inlet - tidal mud flats - archaeological site
26.	Prevost Island - herring spawn - shellfish, seabirds - archaeological site
27.	Horton Bay - marina, residences - seabirds
28.	Lyall Harbour - ferry terminal - seabirds, shellfish - herring spawn
29.	Boot Cove - residences - seabirds, oysters - herring spawn
30.	Narvaez Bay - seabirds, arch. site - Indian reserve
31.	Pender Islands - park, ferry terminal - oysters, seabirds - marina, log booms - ecological reserve
32.	Fulford Harbour - park, residences - ferry terminal - oysters, herring - seabirds
33.	Burgoyne Bay - park, residences - barging, log booms - marina - herring, oysters
34.	Maple Bay - residences, marina - beach, herring spawn
35.	Cowichan Bay - Indian reserve - industrial waterfrontage - log booming, barging - marina, townsite - extensive estuary - shellfish, herring spawn - seabirds, waterfowl

extensive log storage and the presence of marinas. Protection was difficult owing to the width of the bay and its exposure to southeast winds over a considerable fetch of open water. A boom across the mouth of the bay would have certainly failed in the prevailing weather and sea conditons. The method that eventually seemed most effective was to string boom along the outermost line of pilings normally used to moor logs. This technique meant that the longest stretch of unsupported boom was just over 300 feet along a front that held 7,000 feet of boom. In addition, strings of logs were moored adjacent to the boom to provide support and to suppress waves. The outflow of the Cowichan River was believed adequate to keep this barrier stable against inflowing wind and tide.

A similar technique was believed to be effective on other estuaries affected by the slick, most notably, the Nanaimo River estuary.

Inlets: It was judged to be possible to prevent extensive shoreline contamination by blocking off the entrance to inlets, provided that the tidal exchange did not generate rapid currents and the inlet mouth was not too wide. One example, Booth Inlet on Saltspring Island, was considered to be protected in this way with only a modest amount of equipment - approximately 500 feet of boom and a portable skimmer.

Bays: Two techniques were judged to be successful in minimizing oil contamination of bays. In bays too wide to boom off, deflection booms were stationed at an angle to winds and currents to divert oil away. For example, in Montague Harbour four overlapping booms set several hundred feet apart cascaded surface oil into the center of the channel. In wider bays where deflection was impossible, sweeps consisting of two booms joined to a skimmer at the apex of a parabola were used to chase slicks that threatened to come ashore. This method was not effective in bays subjected to heavy oiling, but in areas more remote from the spill source, they were considered successful.

Sand and Mud Flats: At Shoal Islands, extensive sand and mud flats at the mouth of the Chemainus River could have been protected by booming passages between offshore barrier islands using locally available log booms supplemented by oil containment boom. There were several other concepts considered useful in protecting these flats. For example, an upstream dam on the Chemainus River was opened periodically releasing water to partially hold back oil that was advancing on incoming tides. Another method was that of trenches dug midway between high and low tide lines. Excavated beach material was used to construct a berm on the upper side of the trench to protect the upper beach levels. Oil collected in the ditch was recovered with small portable skimmers and vacuum trucks.

Passes: For the most part, it was considered impossible to prevent slicks from entering passes where tidal currents frequently exceeded a speed of five knots. In some cases, deflection booms were utilized to divert oil into calmer waters for recovery.

At one location, Boat Passage, it was considered feasible to build a dam across the entire mouth of the channel to prevent oil from entering a high value area on the ebb tide. This technique was not practical at other sites owing to excessive depths or channel widths.

4.2.2 Shoreline Cleanup

Cleanup techniques were not dealt with on a site-by-site basis during the oil spill simulation except for a general discussion on equipment, manpower and technique.

First priority for beach cleanup was given to areas of high environmental sensitivity such as the Cowichan River estuary. Second priority was given to beaches and harbours used by the public. Third priority was given to the cleanup of industrial waterfronts.

In general, exposed rocky coasts were left uncleaned unless oil threatened to contaminate adjacent areas. Pocket sand and cobble beaches were cleaned where necessary using manual labour. More extensive sandy beaches were cleaned with graders and front end loaders. Cobble shorelines were the most difficult to clean. Removal of material was too onerous a task and the final, if unsatisfactory solution, was to flush them with copious amounts of water to remove as much oil as possible recovering it as it entered the water. Pilings, docks and breakwaters were cleaned with abrasives and steam where feasible. Occasional use of dispersants was authorized in low productivity harbour areas. Cleaning of oiled mud flats and salt marshes was the most vexing problem faced by cleanup crews. Flushing with low pressure/high volume water pumps was done where possible, some cutting of oiled vegetation was tried and one marsh was assumed to be burned off after assurances were provided that wildlife would not be adversely affected and that vegetation would recover. Many other low energy environments were left uncleaned because it was felt that cleanup might produce more adverse effects than those produced by oil contamination.

4.2.3 Disposal of Oil and Oily Debris

Disposal of oil, emulsions and oiled debris was largely unresolved by workshop participants. There were adequate supplies of garbage bags, truck tanks and other collection devices made available, but the ultimate disposition of material was not decided. The two alternatives considered (other than refining pure recovered oil) were incineration and landfilling.

An independent detailed study of potential landfill sites was carried out by consultants to this project. Their report discussed the suitability of several sites where landfill of oil and oily debris would not have adverse effects on groundwater or recontaminate the sea. Criteria such as local acceptance and land ownership were not addressed. The sites they selected are presented in Appendix 3. It should be emphasized that their report names these sites strictly on the basis of their technical suitability.

5 DISCUSSION

There is much new information presented in this study. Potential spill costs, criteria and potential locations for debris disposal, and the format of the workshops employed are discussed in the appendices, which should be consulted.

There are a number of interesting aspects of this study that bear discussion.

The methodology of the study consisted of taking two scenarios, each with specific circumstances, and studying in some detail the response as described by those persons who life would be responsible in real life.

The prime disadvantage of this is the hard truth that each major spill is unique, and there is no reason to believe a major spill, if one happens, and the response to it would resemble either scenario. There are study methodologies which avoid this problem, which perhaps should be undertaken in the future. On the other hand by studying spill response in some detail a greater appreciation of specific problems emerges.

Notwithstanding the limitations of the study, the authors believe that for major spills in water between Vancouver Island and the Canadian mainland, there is no question that spill response activities conducted quickly at the pollution source are much more cost effective than more remote protective or cleanup actions. In the relatively confined waterways between Vancouver Island and the mainland there is very little time (hours to a few days) for evaporation/dispersion to significantly reduce the environmental impact of oil, as would be the case in a more open setting. Large areas may be contaminated in a relatively short time, in which event shoreline protection activities are necessary at an early stage. The authors observed a number of things that could improve the capability of controlling oil spills at a source for these two scenarios. In no particular order, and not considering the cost-effectiveness of each, these are:

- acquire and strategically deploy more offshore oil containment boom.

- acquire dedicated lightering equipment. Rapid dispatch of a lightering vessel to the scene would have mitigated the amount of oil spilled.

No dedicated lightering vessel exists on the Canadian West Coast, although there is one in Puget Sound. In this specific situation, a vessel of opportunity would had to have been hired and likely the Coast Guard oil transfer pumping system shipped to the same. A vessel of opportunity might lack the necessary fittings and equipment to make an efficient transfer and it would be costly to clean after contamination from cold, semi-solid bunker oil.

- acquire more modern offshore skimmers.

- acquire modern high volume pumps such as the Thune-Eureka pumping system.

- give more consideration to the use of oil dispersants at the pollution site. Each situation however must continue to be considered on its own merits.

- give more consideration to burning the oil at source. This of course is an extremely difficult judgement for the source-owner or the government agency in that known costs of burning a ship (for example) must be compared to the unknown risk of being unsuccessful at containing the spill by other means.

- consider a requirement for oil product barges to carry oil boom.

It is not suggested that it would be practical to do all the above and it is understood that the Coast Guard and maritime industry are constantly making small improvements in these areas. What we are doing here is re-emphasizing the fact that 'source control' improvements will go further in preventing oil spill damage.

A second area where there is an opportunity to improve oil spill response is in the pre-planning of site-specific shoreline protection and cleanup measures. Because of the relatively short time available during an actual incident to decide on such matters, the difficulty in accessing the proper expertise and the problem of staff turnover and training, the importance of such pre-planning becomes obvious. EPS has completed an additional study in this area which will soon be published as "A Guide to Shoreline Protection and Cleanup Manuals".

A third area where we wish to make some observations is in the protection and cleanup of shorelines. At the time of the study supplies of oil spill cleanup equipment in northern Vancouver Island were very limited, although this is improving due to the efforts of the oil companies. Very little equipment in Vancouver is packaged for dispatch by air, although there are excellent receiving facilities at Port Hardy. At least 24 and possibly 48 hours could have been saved had aerial delivery been possible. On the other hand, boom stored at the Coast Guard base in Victoria is in air transportable slings. Also, the larger pieces of equipment in Vancouver are designed for marine transportation, a situation that is heavily influenced by tide and weather factors. Delivery by road is often both faster and more predictable. Equipment should be designed such that it can be moved by air, boat or road, depending upon which provides the fastest delivery.

Log booms are ubiquitous on the West Coast. Their main drawback as oil booms is their lack of height, their shallow draught and the separation between individual logs in a string. Nevertheless, they are extremely strong, their characteristics in water are well understood by local boat operators and they are available throughout the British Columbia coast. Given these qualities, it would be useful to have materials available that could be used on short notice to adapt log booms to oil spill containment and diversion devices.

Existing industrial and municipal disposal sites can rarely accommodate a large influx of oiled debris and beach materials, especially on short notice. Removal of oiled beach material cannot begin until satisfactory disposal sites have been determined, preferably in advance of a spill. Identification and agreement on several sites on the coast suitable for large scale disposal of oil and oiled debris should be considered, including perhaps abandoned mines and quarries.

It is difficult to use the data from this study to determine unequivocally whether all, some or none of the major oil spills which could occur in the two study areas could be contained, or, if not, what environmental consequences would result. The methodology employed, i.e., providing rather specific conditions in a workshop setting, precludes obtaining such answers unless a larger number of scenarios were examined.

APPENDIX A

COST BREAKDOWN

OF

- A 5,000 TON BUNKER "C" SPILL - near Northeast Vancouver Island

INTRODUCTION

Department of Fisheries and Oceans Statistical Area 12, at the north end of Vancouver Island, was selected as a critical area for an oil spill workshop in 1979. That workshop involved a step-by-step simulation of a 5,000 ton Bunker "C" cleanup operation commencing July 9, 1979. During the three day exercise, the timing and placement of oil spill equipment used for the operation were logged on spill projection maps.

The scenario upon which this cost estimate is based is as follows:

- Oil barge carrying 5,000 tons Bunker C aground on Stephenson Islet,
  126°49'40" N 50°34'50" W

Time - 0600 hours PST, 9 July 1979
Spill - Entire cargo (5000 tons Bunker C) lost over 24 hours.

It was decided that a detailed cost breakdown of the equipment and manpower would be worthwhile. This report presents that detailed breakdown, discusses the assumption made and draws reference to real operations for validity. The components and assumptions have been checked with the petroleum industry. It is thus hoped that a relatively comprehensive cost analysis of the spill was made by using this data. However, any further cost analysis must take into account the limits of this endeavor. As an example, the cleanup was terminated after simulating 124 days. No further costs were assumed to have been incurred after that period other than those for equipment. If this had been a real spill, it might have conceivably involved various long term restoration projects. The progression of the cleanup operation during the workshop was strictly adhered to for this cost breakdown. Assumptions such as the use of a kiln in burning operations or dispersant use would significantly change the cost outcome. Again, it must be remembered that these costs are for this specific cleanup operation in this particular location.

Exhibit A-I presents a summary of spill cost estimates for each component. Exhibit A-II is the detailed cost breakdown. A-III indicates the magnitude of equipment and labour deployment at each stage of the cleanup operation.

METHODOLOGY

The numbers of men and amount of equipment were taken from selected simulation charts and were based on activities during distinct time periods. Changes in the magnitude of the actions taken would not strictly conform to these time periods and the figures presented are therefore a mean average for them. Exhibit A-III illustrates the relationship between components as the activities increase during the initial period following the spill and taper off as the cleanup winds down.

Costs for government personnel and equipment were not calculated. Although Coast Guard equipment and that of other agencies would be deployed, it is difficult to determine the actual extent of on-scene government involvement. It is likely, however, that with the exception of Canadian Coast Guard equipment and labour, the governmental role would be primarily one of managing and monitoring. This aspect of cleanup was not considered in detail during the workshop, although a rough estimate of 3 - 4 million dollars was suggested. This is probably not an unrealistic figure when taking into account equipment, manpower and administrative activities. Although cost recovery would take place, care would have to be taken to avoid the "double taxation" aspect of costing.

ASSUMPTIONS

Both a helicopter and a fixed wing float plane would be required on scene. It was assumed that the helicopter would be used for eight hours per day for the first two weeks, two hours per day for the next two weeks and two hours per week for the remaining twelve weeks. Fixed wing aircraft costs are calculated on a per diem basis as a minimum of four hours time is charged per day. While the duration of the operation was set at 124 days, it was assumed that most flight time would be accumulated early. The spread of the spill would require tracking and the impacted areas would have to be identified. Both aircraft could be used to deploy critical personnel and equipment in emergency situations. The fixed wing cost quoted is for a Cessna 180 with pilot.

The collection and disposal of oiled debris was the major aspect of the entire operation. It involved the use of dump trucks, transfer vehicles such as flatdecks for moving equipment, front end loaders, bulldozers, small boats(fish and boom boats), tugs, barges and a great deal of labour. Four disposal sites were identified during the simulation and it was assumed that four major impacted areas would be worked simultaneously at the height of the operation. There would be a bulldozer at each disposal site responsible for burying the loads that would be continually supplied by three dumptrucks working each beach.

There would be one or possibly two loaders servicing these trucks at each collection site with the remainder used for loading and spreading replacement sand and gravel. Barges would be used to transfer some equipment from Vancouver and Victoria but primarily for collecting debris from beaches inaccessible to the disposal trucks. In addition, two oil barges would be needed during the initial period to contain oil collected by the skimming units. The tugs employed would be involved in booming, but would primarily be responsible for the relocation of barges as needed. Small boats would handle most of the booming operation and more would therefore be required during the initial period. Experience with smaller spills has shown that some boats are retained on a stand-by basis.

The number of boomsticks required was estimated during the simulation. Owing to a reluctance to purchase outright, it was assumed that they would be cleaned. The amount of miscellaneous equipment was a "best guess" estimate based primarily on the number of labourers plus allowance for loss and damage.

The figure of 20,070 tons of replacement sand and gravel was arrived at by determining that 58 miles of coastline would be affected, of which 14.4 miles would be sand and shingle beach. The amount on each beach requiring replacement was assumed to be a tidal zone 15 feet wide with a depth of infiltration of 0.5 feet. The gravel was estimated to weigh approximately 75 pounds per cubic foot and the cost was listed at five dollars per tonne.

The spill operation took place in mid-summer. It was assumed that a 10-hour day would be worked with two hours overtime paid at time and one half for labour, supervisors and equipment operators. Foremen would number approximately 10% of the labour force at any one time. The nature of the operation, its reliance on diverse specialized equipment and manpower and its financial scale necessitated a core of experienced personnel to act as superintendants. These individuals would have the expertise to deal with marine problems, the logistics of moving and operating heavy equipment and the efficient organization of the labour force. They could be hired from the oil industry, tow boat companies and the construction industry. A rate of $25 per hour for these individuals was considered cost-effective in an operation of this size.

Motel accommodation was available in the area, although there would have been some difficulty in securing sufficient units in the middle of the tourist season. It was thought, however, that the vacancy rate would increase quickly as fishermen and sun-seeking families retreated from the advancing spill. Tent camps could have been established if necessary until bunk trailers and more permanent facilities were set up. They would resulted in a considerable savings per individual.

Burrard Clean was assumed as the major contractor in the operation and would have supplied most of the specialized equipment. Their cost was calculated from a supplied cost list which included a large and a small skimmer, an equipment trailer, 5,000 feet of boom, a communications trailer with two operators, two 18 feet work boats with two crewmen each, a portable lighting unit with operators and miscellaneous smaller pieces of equipment. The cost of using all of this amounted to $20,000 per day. It decreased through the spill period as slicks were mopped up and less equipment was required. An additional 10% was added to the Burrard Clean total to account for fuel, repairs, cleanup and replacement of damaged material.

Estimates of this type usually include an additional 10 - 15% to cover unforeseen costs. This has not been added here on account of the great deal of speculation which went into many of the figures. While there may be a degree of error of plus or minus 20% in the total, it is probably safe to assume that the cost projection is, if anything, low.

SUMMARY & CONCLUSIONS

Total costs for the cleanup of the spill amounted to $6,103,731 - an average of $49,223 per day. The major costs were for labour and the services of Burrard Clean, both of which were in the neighbourhood of $1.5 million. The cost per barrel was $183 which is relatively low compared with previous smaller spills. This could mean that the estimate is low or that there are certain economies of scale in a larger operation.

Quick estimates made during the workshop indicated that costs could run to $100,000 per day. Although this is double the figure arrived at, it may not be unrealistic if Coast Guard and other governmental costs are included.

Much of the cost was taken up in the disposal of oil and debris and it may be the case that on-site burning of fouled driftwood and sorbent material would have been a more economical alternative. Further, the use of a kiln could be a more economical means of cleaning sand and gravel beaches.

The final cost of some 5 - 10 million dollars would be only a portion of the total cost charged to the pollutor. Private damage suits brought by affected industries and individuals against those responsible have in the past been proportionately larger. Although the area impacted is relatively remote, there is an active commercial and sports salmon fishing industry during the summer months. Interference with these activities would certainly have resulted in very high claims.

EXHIBIT A-1

SPILL COST SUMMARY

- A 5,000 ton Bunker C spill near the Northeast Vancouver Island

Aircraft		73,870
Trucks - Dumpers	278,585	
- Flatdecks	70,176	
- Pickups	89,960	
Total		438,721
Loaders		225,720
Bulldozers		130,130
Small Boats		618,750
Tugs		83,520
Barges		107,800
Boomsticks		40,000
Misc. Equipment		142,000
Sand & Gravel		100,350
Labour		1,617,880
Meals & Accommodation		552,500
Foremen		245,520
Meals & Accommodation		81,900
Superintendents		176,550
Meals & Accommodation		38,520
Burrard Clean		1,430,000
		6,103,731

EXHIBIT A-II

SPILL COST BREAKDOWN

	NO./AMOUNT	TIME/DIST.	RATE Per Hour Day	SUB-TOTAL	TOTAL
AIRCRAFT					
Fixed Wing	1	30 Days	$ 385.00/day	11,550	
Helicopter	1	164 Hours	380.00/hour	62,320	73,870
TRUCKS					
	1	2 Days		693	
Dumpers (disposal)	2	3 Days		2,079	
	8	18 Days	31.50 per hr.	49,896	
	12	31 Days	346.50 per day	128,898	
	6	30 Days		62,370	
	3	15 Days		15,592	
	3	15 Days		15,592	
	1	10 Days		3,465	
					278,585
Flatdecks					
(Equipment Transfer)	5 trips/90 days	200 miles	$.50/mile	45,000	
(Operating Costs)	2 23	"	"	6,600	51,600
(Rental)	5	90 Days	$36.00/day	16,200	
	2	33 Days	"	2,376	
					18,576
Pickups	15 trips/100 days	100 miles	$0.25/mile	37,500	
(Operating Costs)	10 23	"	"	5,750	
					43,250
(Rental)	15	100 days	$27/day	40,500	
	10	23 days	"	6,210	
					46,710

EXHIBIT A-II (cont.)

	NO/AMOUNT	TIME/DIST.	RATE Per Hour	RATE Day	SUB-TOTAL	TOTAL
LOADERS	1	2 Days	$ 30/hr	$330/day	660	
	2	3 Days			1,980	
	6	18 Days			35,640	
	8	31 Days			81,840	
	6	30 Days			59,400	
	4	15 Days			19,800	
	4	15 Days			19,800	
	2	10 Days			6,600	
						225,720
BULLDOZERS	1	3 Days		$ 385.00	1,155	
	2	18 Days			13,860	
	4	31 Days			47,740	
	4	30 Days			46,200	
	2	15 Days	$ 35.00	$ 385.00	11,550	
	1	15 Days		"	5,775	
	1	10 Days		"	3,850	
						130,130
SMALL BOATS	20	18 Days	$ 50.00	$ 550.00	198,000	
	10	31 Days		"	170,500	
	10	30 Days		"	165,000	
	5	15 Days		"	41,250	
	4	15 Days		"	33,000	
	2	10 Days		"	11,000	
						618,750
TUGS	2	7 Days	$120.00	$2880.00	40,320	
	2(24hrs/wk)	15 Weeks	"	"	43,200	
						83,520
BARGES	3	4 Days		$ 280.00	3,360	
	4	18 Days		"	20,160	
	6	31 Days		"	52,080	
	2	30 Days		"	16,800	
	2	15 Days		"	8,400	
	1	15 Days		"	4,200	
	1	10 Days		"	2,800	107,800

EXHIBIT A-II (cont.)

	NO./AMOUNT	TIME/DIST.	RATE Per Hour	RATE Day	SUB-TOTAL	TOTAL
BOOMSTICKS	20,000'	$100/50'				40,000
MISC. EQUIPMENT						
Sorbent	1,000 cases		@ $40.00		40,000	
Bags(Plastic)	10,000		@ $ .10		1,000	
Barrels	1,000		@ $ 8.00		8,000	
Shovels	500		@ $ 9.00		4,500	
Rakes	500		@ $15.00		7,500	
Forks	500		@ $12.00		6,000	
Rubber Suits	1,000		@ $75.00		75,000	
						142,000
SAND & GRAVEL	20,070 Tonnes		@ 5.00			100,350
LABOUR	20	2 Days	$ 8.00	$88.00	$ 3,520	
	40	3 Days			10,560	
	125	18 Days			198,000	
	300	31 Days			818,400	
	150	30 Days			396,000	
	75	15 Days			99,000	
	50	16 Days			70,400	
	25	10 Days			22,000	
						1,617,880
Accommodation Motels	20	2 Days		$30.00	1,200	
	40	3 Days			3,600	
	125	18 Days			67,500	
	100	31 Days			93,000	
Bunk Trailers	5	1 Month	$1,500 per month		7,500	
	4	1 Month			6,000	
	3	1 Month			4,500	
	1	1 Month			1,500	
						184,800
Meals and Inc.	18,385 Man-Days			$20.00		367,700

EXHIBIT A-II (cont.)

	NO./AMOUNT	TIME/DIST.	RATE Per Hr.	Per Day	SUB-TOTAL	TOTAL
SUPERVISORS Foremen	2	2 Days	$12.00	$132.00	528	
	4	3 Days			1,584	
	13	18 Days			30,888	
	30	31 Days			122,760	
	15	30 Days			59,400	
	8	15 Days			15,840	
	5	16 Days			10,560	
	3	10 Days			3,960	
						245,520
Accommodation	2	2 Days		$30.00	120	
	4	3 Days			360	
	13	18 Days			7,020	
	30	31 Days			27,900	
						35,400
Meals & Inc.	1860 Man-Days		$25.00 per day			46,500
Superintendants	6	90 Days	$25.00 per hr.		148,500	
			$275.00 per day			
	3	34 Days			28,050	
						176,550
Accommodation	6	90 Days	$30.00 per day		16,200	
	3	34 Days			3,060	
						19,260
Meals & Inc.	642 Man-Days		$30.00 per day			19,260

	NO./AMOUNT	TIME/DIST.	RATE Per Hr.	RATE Per Day	SUB-TOTAL	TOTAL
BURRARD CLEAN		30 days		$20,000	600,000	
		45 days		10,000	450,000	
		50 days		5,000	250,000	
					1,300,000	
Replacement, Fuel, Repairs, Cleanup			10%		130,000	
						1,430,000
					TOTAL	6,103,731

EXHIBIT A-III

DEPLOYMENT OF EQUIPMENT & LABOUR BY STAGE

	Trucks (Disposal)	Loaders	Bulldozers	Small Boats	Barges	Labour	Foremen
July 9 - 10	1	1				20	2
11 - 13	2	2	1		3	40	4
14 - 31	8	6	2	20	4	125	13
Aug. 1 - 31	12	8	4	10	6	300	30
Sept. 1 - 30	6	6	4	10	2	150	15
Oct. 1 - 15	3	4	2	5	2	75	8
16 - 31	3	4	1	4	1	50	5
Nov. 1 - 10	1	2	1	2	1	25	3

This numerical breakdown is intended to display the relationship between equipment & labour at each stage of the cleanup effort. It does not detail daily breakdowns for all components as some, such as aircraft and transfer vehicles, are more general estimates. Explanations for these are provided in the text.

APPENDIX B

COST BREAKDOWN

OF

A 20,000 TON CRUDE OIL SPILL - in Southern Georgia Strait

INTRODUCTION

The second workshop of the West Coast Countermeasures Study, held February 12-13, 1980, was conducted with two major goals:

1. To simulate the main activities of the command structure responsible for containment, cleanup and disposal of an oil spill.

2. To identify a reasonable level of additional existing spill countermeasures and logistical response needs to ensure moderate resource protection and cleanup.

This appendix addresses the second goal by providing cost estimates of the countermeasures equipment and personnel prescribed during the workshop.

As with the cost breakdown for the first workshop, these estimates are subject to strict limitations. The scenario outlined in Table B-I, and the assumptions made and the constraints imposed by the duration of the simulation all act in this regard. The estimates are site and situation specific.

This appendix acts in accordance with and as an extension of the costing methodology utilized in Appendix A. Where evident, unit costs have changed owing to inflation.

The main body of this appendix is broken down into three sections: Methodology, Assumptions and Summary and Conclusions. For clarity, the assumptions have been divided into several categories: General, Countermeasures, Cleanup and Labour. However it should be remembered that during a spill event, all assumptions have an effect on each other and cannot strictly be considered independently. The text is followed by the exhibits in which costs are detailed. Exhibit B-I presents a summary of spill cost estimates for each component, Exhibit B-II provides a detailed breakdown and Exhibit B-III summarizes the timing and magnitude of labour and equipment deployment at each stage of the cleanup operation.

The scenario upon which this cost estimate is based is as follows:

- 50,000 DWT tanker, M.V. Black Gold is outbound from Burrard Inlet, Vancouver, B.C. headed for Eastern Canada.
- The tanker suffers a major fire in the engine room. This results in a total loss of power and a subsequent loss of control.
- Tanker runs aground on the eastern point of Tumbo Island.

Coordinates:	48	48	N
	123	03	W

Time: 0400 hours PST, December 22, 1979

Spill: 20,000 tons of crude oil over a period of 20 hours

METHODOLOGY

The numbers of men and amount of equipment were taken from selected simulation charts and were based on activities during distinct time periods. Changes in the magnitude of the actions taken would not strictly conform to these time periods and the figures presented are therefore a mean average for them. Exhibit B-III illustrates the relationship between components as the activities increase during the initial period following the spill and taper off as the cleanup winds down.

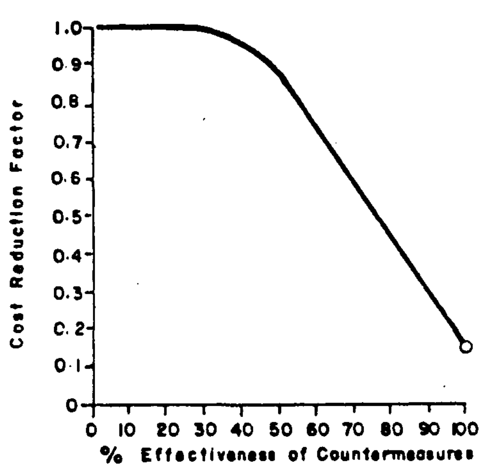
Costs for government personnel and equipment were not calculated. Although equipment from Department of National Defence, Coast Guard and other government agencies would be deployed, it is difficult to determine the actual extent of on-scene government involvement. It is likely, however, that the governmental role would be primarily be one of management and monitoring. Although replacement, repairs and overtime charges would undoubtedly be charged to the pollutor, it was suggested that for the purposes of this cost estimate, government personnel and equipment would not be considered. During this workshop, the bulk of the Canadian Coast Guard equipment from Prince Rupert, Vancouver and Victoria was called upon. Also, two U.S. spill contractors were asked to assist as well as the U.S. Pacific strike team with their support equipment. Again, U.S. government costs were assumed to be absorbed by them.

The simulation embodies two distinct phases: countermeasures tactics employed immediately after the spill and cleanup operations. Costs of the latter are largely dependent upon the effectiveness of the first. In order to assist in the calculations of cleanup costs, a hypothetical curve was used to demonstrate this relationship (Table B-I), subject to the assumptions below. Decisions regarding cleanup methods for various shoreline lengths, hence cost, are based upon the information provided in the Environmental Protection Service report Coastal Environments of Canada: The Impact and Cleanup of Oil Spills, summarized in Table B-II.

During the course of the workshop wrap-up, the effectiveness of the various countermeasures was subjectively determined. The problem of costing out cleanup for oiled shoreline which was "protected" then came to light during the cost analysis phase. Table B-II is used to reduce the actual protected shoreline to an effective shoreline length; for example, 10 miles of shoreline which is 50% protected reduces to 8.8 miles of typically oiled beach of said type.

Table B-II - EFFECTIVE SHORELINE (MILES)

Type	A Unprotected	B Protected Actual	C Effective	D Effective Total (A & C)
Mud	12.75	23.80	18.31	31.06
Sand Beach	80.75	48.80	19.98	100.73
Cobble Beach	27.75	8.60	4.61	32.36
Rock	223.75	25.00	20.32	244.07



Assumptions

- A basic fixed cost for any cleanup;
- Cleanup efficiency varies directly with the quantity of oil deposited;
- Density of oil dealt with by countermeasures is constant;
- Ratio of countermeasure to length of shoreline is constant;
- All types of shoreline follow the same cleanup cost/ countermeasures ratio.

Table B-11 - SHORELINE RESTORATION METHODS

	CHEMICAL DISPERSANTS	HYDRAULIC HIGH-PRESSURE	HYDRAULIC LOW-PRESSURE	STEAM CLEANING	SANDBLASTING	MIXING	MECHANICAL REMOVAL	MANUAL REMOVAL	SORBENTS	BURNING	CROPPING
Rock Surfaces	+	+	✓	+	+	-	-	✓	+	-	+
Man-Made Structures	+	✓	✓	✓	✓	-	-	✓	+	-	-
Unresistant or Unconsolidated Cliffs	-	x	x	x	x	-	x	x	x	-	-
Coarse Sediment Beaches	+	+	+	x	x	+	+	✓	+	x	-
Sand Beaches	+	x	x	x	x	+	✓	✓	✓	x	-
Intertidal Coarse Sediments	+	+	+	+	x	+	+	✓	+	x	-
Intertidal Sand	+	x	x	x	x	x	+	+	+	x	-
Intertidal Mud	+	x	x	x	x	x	x	+	+	x	-
Marshes	x	x	✓	x	x	-	x	✓	+	+	+

✓ Recommended

x NOT Recommended

\+ Applicable and possibly useful

\- Not Applicable

ASSUMPTIONS

General:

For costing purposes, all countermeasures and other cost-recoverable operations were deemed to have ceased after 191 days. It would be inevitable that some areas would require long term restoration, while others not cleaned could at some future be given a cleanup priority date. Costs for long term fate and effects monitoring such as oyster lease quality control also were not considered. Such activities, further substantiate that this cost analysis is only a portion of the total cost charged to the pollutor. An estimate of the direct cleanup costs provided by American and Canadian governments was 14.4 million dollars.

The Burrard Clean spill cooperative, based in Vancouver, was the primary spill contractor. Western Environmental of Portland, Oregon, and Crowley Environmental of Seattle, Washington, were requested on scene as subcontractors. Their costs were considered to be the same as for the prime contractor. However, their services were the first to be phased out of the operation to enable them to reestablish their home bases as soon as possible. A cost of $20,000 per contractor per day was derived for use of their skimmers, booms, lighting, communications, miscellaneous equipment and, associated operators, including 10% for cleanup and damages. Miscellaneous equipment, was a best guess estimate based primarily on the number of labourers.

Countermeasures:

During the height of activities, it was considered that each contractor would require a helicopter for eight hours per day for reconnaissance, surveillance and deployment activities. Maximum use of a fixed wing with floats would occur during the first two weeks at twelve hours/day. Costs quoted are for a Cessna 180 with a pilot; standby time was also considered, as there probably would be need for extra surveillance and emergency transportation. The deployment of men and equipment for beach cleaning was accomplished with a total of six flatbed trucks plus one pickup truck for each eleven man crew. Peak use of small boats was early in the operation to coincide with initial response activities.

Tugs were used to move the casualty (M.V. Black Gold) to Esquimalt, deploy Coast Guard equipment, position booms and provide barges for the various skimmers. A minimum of three oil barges were required to contain the oil-water mixture collected by the skimmers. A fourth barge was required for deployment of Coast Guard equipment. A total of eight thousand gallons of dispersant were considered to have been used before spraying applications ceased owing to the decreasing effectiveness on the oil as it weathered and emulsified. The first four thousand gallons of dispersant were local Coast Guard supplies which required replacing. Log-booming was requested for many sensitive areas; 37,000 feet of boom sticks were positioned which later were considered more economical to purchase outright rather than clean.

Small incinerators as described in P.A.C.E. Report No. 79-3 were used to clean minor or remote sand beaches. Their cost included a tractor without operator, which was utilized for other work as well.

A rotary kiln as described by Stevenson and Kellogg was fabricated and on site by February 1. Cost estimates included labour, transportation to site and heavy equipment to clean sand beaches in a swath fifteen wide by three inches deep. The kiln's capital cost of $200,000 was added to other costs in Exhibit B-II. Costs were adjusted to March, 1980. The longer cleanup time required by this method was deemed appropriate owing to the time of the year, lack of disposal areas and minimization of debris collection. Over and under air incinerators were employed to dispose of debris. There were very few areas which could physically accommodate uncontrolled burning adjacent to the high water mark on the Straits of Georgia and Juan de Fuca. Only accretion beaches, accretion terminals, and relatively stable gravel and sand beaches were suitable for open burning. It was assumed that this kind of shoreline had sufficient materials above the high water mark to allow for shallow trenching of an area of at least 100 by 20 metres. This would create a shelf of sandy gravelly material above the high water mark, relatively unaffected by erosion and groundwater contamination, to allow for uncontrolled burning.

Shoreline re-oiling cleanup costs were not considered as shorelines were assumed to not be cleaned until recontamination had been minimized. In very sensitive or heavily-impacted areas this might not have been the case. Most rock faces, which are a predominant feature of the Gulf Islands, were left to natural cleaning. Low pressure hydraulic hoses were used in priority areas in conjunction with skimming units. Manual labour was used for the cleanup of cobble and mud areas. Miscellaneous heavy equipment was employed to assist manual labour at an average rate of $30.00 per hour dump trucks at $30.00 per hour, and flatbeds at $136.00 per day.

Barges were used during cleanup to assist crews, collect and dispose of oiled debris and feed kiln operations. Two barges were used in conjunction with bunk trailers for portable accommodations.

Labour:

Three bunk trailer units, each consisting of seven trailers and housing forty men, formed local bases of operation. The other cleanup workers were housed in motels. No difficulty in finding accommodation was foreseen during the season of the scenario. Because of the time of year, labour was provided on the basis of an eight hour workday with no overtime. Foremen numbered approximately 10% of the labour force at any one time. Supervisors knowledgeable in dealing with marine problems, the logistics of moving and operating heavy equipment and the efficient organization of labour were hired from the oil industry, tow boat companies and the construction industry. As with the northern scenario, their expertise in these situations was considered well worth their cost.

SUMMARY AND CONCLUSIONS

Total costs for the cleanup of this spill amounted to $14,189,939, not including contingencies or costs borne by Canadian or U.S. governments which would be charged to the polluter. For ease of comparison to the results of the first workshop the following discussion is based on this figure. However it is likely that government costs would be large, possibly equalling the privately paid costs; the Canadian Coast Guard oil spill equipment and personnel probably have been extensively used in the early stages.

The average daily cost was $74,293, greater than the estimate for the northeast Vancouver Island scenario. The average cost of cleanup of "effective shoreline" was $6.57, but if rocky shore, which was largely allowed to self-clean, is excluded, the cost is $16.37.

The costs per barrel of oil spilled in this scenario ($107) were lower than that calculated for the northeast Vancouver Island scenario ($183). This may reflect use of incinerators rather than hauling to landfill, and logistics savings (lower costs of doing business close to a major population center). There were also some economics of scale evidenced by the minimal increased cleanup time of this large - spill scenario as compared with the smaller northeast Vancouver Island scenario.

EXHIBIT B-I

SPILL COST SUMMARY

- A 20,000 Ton Crude Oil Spill in Southern Georgia Strait

CONTRACTORS	5,360,300
AIRCRAFT	499,832
TRUCKS - Dump	156,500
- Flat-Bed	85,952
- Pick-Up	160,992
HEAVY EQUIPMENT (Not including Incinerator Support)	82,320
SMALL BOATS	2,767,600
TUGS	1,195,200
BARGES	294,840
BOOMSTICKS	12,950
INCINERATORS & SUPPORT EQUIPMENT	
- Large Kiln	436,000
- Small Incinerators	50,000
DISPERSANT & AUXILLARY EQUIPMENT	70,000
LABOUR	1,376,000
- Accommodation	209,700
- Meals & Incidentals	430,000
FOREMEN	207,840
- Accommodation	30,600
- Meals & Incidentals	54,125
SUPERVISORS	170,400
- Accommodation	25,560
- Meals & Incidentals	25,560
MISCELLANEOUS EQUIPMENT	466,000
BOAT PASSAGE DAM	21,668
TOTAL	$14,189,939

EXHIBIT B-II

SPILL COST BREAKDOWN

ITEM	DEC. 22-29	JAN.	FEB.	MAR.	APR.	MAY	JUNE	TIME/RATE	SUBTOTAL	TOTAL
days	7	33	29	31	30	31	30			
CONTRACTORS ($/day)										
Burrard	20,000/day	20,000	15,000	10,000	5,000	4,000	1,000	Add 10%	2,033,900	
Western	20,000	20,000	15,000	7,000	2,000	-	-	" "	1,663,200	
Crowley	20,000	20,000	15,000	7,000	2,000	-	-	" "	1,663,200	5,360,300
AIRCRAFT										
fixed wing	12 hr/day x 2 wk., then $432/day min. chrg.							$432/day min.	91,332	
helicopter	3 x 8 hr/day 168	792	58	31	26 hrs. over 3 months			1075 hr @ $380	408,500	499,832
TRUCKS (units/day)										
disposal		8	3	3	3	2	1	626 days @ $240/day	156,500	
equipment transfer	6	6	3	3	3	2	2	632 days @ $136/day	85,952	
pick-ups	13	40	16	14	14	7	5	3,096 days @ $52/day	160,992	403,444
HEAVY EQUIPMENT (see assumptions)										
	-	4	2	2	2	1	-	343 days @ $240/day	82,320	82,320

EXHIBIT B-II (Cont'd)

ITEM	DEC. 22-29	JAN.	FEB.	MAR.	APR.	MAY	JUNE	TIME/RATE	SUBTOTAL	TOTAL
days	7	3	29	31	30	31	30			
INCINERATORS (see assumptions)										
10 Pace incinerators								5 @ $10,000	50,000	
1 Trecan rotary incinerator - available 01 February								$200,000 + + $236,000	436,000	486,000
SMALL BOATS (boats/day)										
	22/20, 23-24/50, 25-29/99	30-15/6, 16-31/50	40	40	20	20	10	6919 days @ $50/hr	2,767,600	2,767,600
TUGS (boats/24 hr.)										
	22/4, 23-24/4, 25-29/6	30-15/6, 16-31/5	5	4 @ 24 hr./wk.		2 @ 24 hr./wk.		415 days @ $120/hr	1,195,200	1,195,200
BARGES (barges/day)										
	22/4, 23-24/4, 25-24/6	10	10	5	5	2	1	1053 days @ $280/day	294,840	294,840

DISPERSANT & AUXILLARY EQUIPMENT

2 days 9527 @ 2000 gal/day
2 days OILSPERSE 43 @ 2000 gal/day

8000 dal. @ $8.12/gal = $65,000 & $5,000 — 70,000

EXHIBIT B-II (Cont'd)

ITEM	DEC. 22-29	JAN.	FEB.	MAR.	APR.	MAY	JUNE	TIME/RATE	SUBTOTAL	TOTAL
days	7	3	29	31	30	31	30			
BOOMSTICKS			Total	37,000 ft.				@ $0.35/ft.	12,950	12,950
MISCELLANEOUS EQUIPMENT										
Sorbant				3,500 cases				@ $40.00	140,000	
Plastic Bags				1,000,000				@ $00.10	100,000	
Barrels				5,000				@ $ 8.00	40,000	
Shovels				1,000				@ $ 9.00	9,000	
Rakes				1,000				@ $15.00	15,000	
Forks				1,000				@ $12.00	12,000	
Rubber Suits				2,000				@ $75.00	150,000	466,000
BOAT PASSAGE DAM	($4,629\ yd.^3$, 250 ft.)				Unit Cost Construction				13,668	
					Unit Cost Removal				8,000	21,668

EXHIBIT B-II (Cont'd)

ITEM	DEC. 23-29	JAN.	FEB.	MAR.	APR.	MAY	JUNE	TIME/RATE	SUBTOTAL	TOTAL
days	(6)	(33)	(29)	(31)	(30)	(31)	(30)			
LABOUR (men/day)										
	50	300	100	100	100	50	25	21,500 @ $64	1,376,000	
accommodation - motels	50	180	-	-	-	-	-	6,240 nights @ $30	187,000	
- bunk-units		3	3	3	3	2	1	15 mo. @ $1,500	22,500	
meals & incidentals								21,500 days @ $20	430,000	2,015,700
FOREMEN (men/day)										
	5	30	0	10	10	5	3	2,165 days @ $96	207,840	
accommodation - motels	5	30	-	-	-	-	-	1,020 nights @ $30	30,600	
meals & incidentals								2,165 days	54,125	292,565
SUPERVISORS (men/day)										
	8	8	6	4	4	2	2	852 days @ $200	170,400	
accommodation - motels	8	8	6	4	4	2	2	852 days @ $30	25,560	
meals & incidentals								852 days @ $30	25,560	221,520
									TOTAL	$14,189,939
									CONTINGENCIES	2,128,490
										$16,318,429

EXHIBIT B-III

SUMMARY OF LABOUR & EQUIPMENT DEPLOYMENT

	Trucks (Disposal)	Heavy Equipment	Incinerator & Crew	Small Boats	Barges	Labour	Foreman
DEC. 22	-	-	-	20	4	-	-
23-24	-	-	-	50	4	50	5
25-29	-	-	-	99	6	50	5
DEC. 30- JAN. 15	8	4	-	99	10	300	30
JAN. 16-30	8	4	-	50	10	300	30
FEB. 01-29	3	2	1	40	10	100	10
MAR. 01-31	3	2	1	40	5	100	10
APR. 01-30	3	2	1	20	5	100	10
MAY 01-31	2	1	1	20	2	50	5
JUNE 01-30	1	-	1	10	1	25	3

This numerical breakdown is intended to display the relationship between equipment & labour at each stage of the cleanup effort. It does not detail daily breakdowns for all components, as some, such as aircraft and transfer vehicles, are more general estimates. Explanations for these are provided in the text.

APPENDIX C

CRITERIA AND LOCATIONS FOR DISPOSAL OF OILY WASTES

Northeast coast of Vancouver Island

CRITERIA AND LOCATIONS FOR DISPOSAL OF OILY WASTES in Northeast Vancouver Island

The recommended disposition of oily wastes (in order of priority) is:

a) reclaim as much oil from the waste, and use directly as much of the oily waste itself as possible; consider pulp mill boilers (hog fuel);

b) where possible, burn, incinerate, or pyrolyze the remaining oily debris;

c) employ very long term anaerobic storage (for example: sanitary landfill or direct burial), together with adequate groundwater quality monitoring. Since fine grained soils (for example: clays and silts) have more surface area per unit weight and more sorptive capacity than coarse grained soils (for example: sand and gravel), long term sites should be located, wherever possible, on fine grained soil. Fine grained soils are rare in this area. Where poor soil conditions may result in hydrogeologic connection to groundwater, leachate collection and treatment shall be employed.

Note 1: It is desirable that groundwater not be polluted either by the material disposed of, or by its decomposition products.

Note 2: Large volumes of hog fuel may be available for:

a) mixing into debris to absorb oil,

b) assisting in combustion of debris.

TABLE C-1

COMPARISON OF LAND DISPOSAL METHODS FOR OIL SPILL DEBRIS

Method	Operating Factors: Equipment Needs	Operating Factors: Flexibility	Environmental Factors	Estimated Costs
Land Cultivation	tractor, rototiller, disc, harrow, or plow	- adaptable to many areas - requires no special skills - access road may be req'd	- minimal hazards if runoff controlled; - no danger to groundwater; - no spontaneous combustion problems; - land may be tied up for disposal only temporarily (2-3 years).	\$4 to \$8 per cy (not including cost to construct access roads, if any)
Landfilling with refuse	use equipment available at landfill; generally a D-6 sized track dozer or larger	- for relatively small volumes of debris most landfills can readily accept; - many landfills available; - stockpiling usually unnecessary	- improper landfill location may cause undue threat of oil pollution; - refuse can act as sorbent to impede flow of oil and contaminated water from site; - possibility of spontaneous combustion; - continuous long-term dedication of land to waste disposal.	\$0.80 to \$3.00 per cy
Burial	1 - D-8 sized tractor or larger. 1 backhoe may be necessary.	- stockpiling may be necessary; - access road may be required.	- oil will remain undegraded at site for more than 100 years; - a plot of land, heretofore unused for waste disposal, will be dedicated for such long-term usage.	\$1.50 to \$5.00 per cy (not including cost to construct access road, if any)

TABLE C-II

POTENTIAL LANDFILL SITES - NORTHERN VANCOUVER ISLAND

General Location and Type of Site	Site Description	Position
Port Hardy Municipal Refuse	adjacent to Glen Lion Road 4 miles from dock, gravel substrate - 5 acres available	50° 42' 15" N 127° 31' 45" W
Weldwood, Union Bay Refuse	Gilford Island less than 1 acre	50° 43' 55" N 126° 29' 20" W
Rayonier, Port Alice Refuse	not applicable	50° 23' 00" N 127° 27' 04" W
MacMillan Bloedel, Sayward, Refuse	not applicable	50° 23' 25" N 125° 37' 30" W
Crown Zellerbach, Kokish, Refuse	3 miles from dock adjacent to Kokish River glacier till substrate 2 acres available	50° 30' 00" N 126° 51' 52" W
Alert Bay Municipal Refuse	1.5 miles from dock in town limits elevation 250'	50° 35' 15" N 126° 55' 00" W
Tahsis Co., Zeballos, Refuse	not applicable	50° 02' 31" N 126° 48' 26" W
Moore Logging, Winter Harbour, Refuse	west coast Vancouver Island	50° 32' 00" N 128° 02' 03" W
Rayonier, Mahatta River Refuse	Quatsino Sound	50° 27' 26" N 127° 52' 48" W
Port Hardy,	6 miles from Port Hardy dock of trees; glacial till substrate drains to Port Hardy estuary	50° 41' 10" N 127° 26' 00" W

TABLE C-II (cont.)

General Location and Type of Site	Site Description	Position
Canfor, Atluck Refuse	not available	48° 43' 45" N 124° 43' 45" W
Canfor, Nimpkish Valley, Refuse	not available	50° 17' 04" N 126° 52' 18" W
Canfor, Beaver Cove, Refuse	west coast Vancouver Island	50° 02' 57" N 126° 21' 48" W
Canfor, Woss Refuse	west coast Vancouver Island	50° 12' 12" N 126° 37' 07" W
Rayonier, Holberg Refuse	not applicable	50° 40' 13" N 128° 00' 26" W
Friell Logging, Kashult Inlet, Refuse	not applicable	50° 05' 53" N 127° 17' 31" W
Port McNeill, Village Site, Refuse	3 to 5 miles from wharves, drains to Cluxewe River, 5 acres available without clearing sand gravel substrate	50° 35' 30" N 127° 09' 20"
Bay Forest Products, Chamiss Bay, Refuse	10 mi. from Port Alice near Alice Lake, approx. 20 miles from Port McNeill	50° 31' 20" N 127° 25' 32" N
Pioneer Timber, Coal Harbour, Refuse	near mill on Rupert Inlet	50° 36' 50" N 127° 30' 40" W
MacMillan Bloedel, Tracey Harbour, Refuse	north side Queen Charlotte St.	50° 51' 16" N 126° 50' 10" W

TABLE C-II (cont.)

General Location and Type of Site	Site Description	Position
Comox-Strathcona, Sayward, Refuse	not available	50° 18' 47" N 125° 56' 10" W
Weldwood, Thompson Sound, Refuse	west coast Vancouver Island	50° 15' 40" N 127° 30' 53" W
Canfor, Beaver Cove, Refuse	2 miles from Beaver Cover, ¼ mile from Kokish River, near rail and transmission line, 1 acre available, glacial till substrate	50° 31' 12" N 126° 52' 50" W
Rayonier, Jeune Landing, Refuse	Port Alice	50° 27' 30" N 127° 30' 55" W
Port Alice, Jeune Landing, Refuse	not available	50° 26' 35" N 127° 29' 25" W
Sointula Dump, Malcolm Island	5 miles from dock in Rough Bay, sandy till substrate 1 acre available, cleared	50° 38' 10" N 126° 58' 30" W

APPENDIX D

CRITERIA AND LOCATIONS FOR DISPOSAL OF OILY WASTES

in the southern Georgia Strait area

APPENDIX D

CRITERIA AND LOCATIONS FOR DISPOSAL OF OILY WASTES IN THE SOUTHERN GEORGIA STRAIT AREA[1]

Guidelines were developed for the selection of burial and landfill sites; briefly, the site requirements were:

1) fine-grained surficial materials;
2) gentle slope;
3) not near wells and surface water bodies;
4) not near buildings and farmlands; and
5) not in wetlands or areas subject to flooding.

Initially, 58 burial sites and 69 landfills were considered; 15 burial sites and nine landfills were investigated by air and on the ground to verify conditions. Finally, one existing landfill and six potential burial sites were recommended for more detailed investigation. These sites are at, or near:

Port Mellon landfill
Cowichan Bay
Sooke
Gambier Island
Langdale
Roberts Creek
Sechelt

Possible sites for open burning of oily debris were considered, especially in relation to the temporary air pollution problem. Existing incinerator facilities were examined, with recommendation of two which could handle oil spill debris. The Council of Forest Industries' incinerator at Port Mellon is located right by a landfill suitable for temporary storage of oily debris

1 This is a synopsis of "Site Selection Guidelines and Local Identification for the Disposal of Oil Contamination Debris Resulting from an Oil Spill in Southeastern Coastal B.C.", a report prepared by TERA Environmental Consultants for EPS, March 1980.

and incineration could be conducted over a convenient period of time. The Regional District of Cowichan Valley has incinerators near Duncan which would be available for oily wastes as long as there was little non-combustible material in it.

Potential Sites for Open Burning

There are very few areas which could physically accommodate uncontrolled burning adjacent to the high water mark of the Strait of Georgia and the Juan de Fuca Strait. Only accretion beaches, accretion terminals, and relatively stable gravel and sand beaches in the study area could be suitable for open burning. It is assumed that this kind of shoreline has accreted sufficient materials above the high water mark to allow for shallow trenching of an area of at least 100 by 200 metres. This would create a shelf of sandy gravelly material above the high water mark, relatively unaffected by erosion and groundwater contamination, to allow for uncontrolled burning.

Following is a list of potential open burning sites, based on their physical characteristics alone. Additional climatic restrictions are discussed below:

Craig Bay, Vancouver Island
Nanoose Harbour, Vancouver Island
Penelakut Spit, Kuper Island
Walker Hook, Saltspring Island
Saanichton Bay, Sannich
Esquimalt Spit, Esquimalt
Thormanby Island, Malaspina Strait
Centennial Beach, Delta
English Bluff, Delta
Garry Point, Richmond
Blackie Spit, Surrey
Iona Island, Richmond.

Of the 12 sites listed above, only a few can be regarded as suitable when considering climate. For the five Lower Mainland sites, potential pollution of urban areas and interference with visibility for air traffic make these sites questionable. Similar problems would be encountered with the two sites in the Victoria area (Saanichton Bay and Esquimalt Spit). That would leave only the Gulf Island sites such as Walker Hook, Penelakut Spit, Thormanby Island, Craig Bay and Nanoose Harbour.

The Lower Mainland and Victoria sites are accessible both from land and water, and may be convenient for temporary storage of oily wastes for later disposal as they are flat, unvegetated, and consist of coarse textured materials permitting easy clean up after temporary use. All locations in the list above would be suitable for controlled incineration in a portable burner.

APPENDIX E

FORMAT OF THE WORKSHOPS

APPENDIX E

FORMAT OF THE WORKSHOP

Background

The West Coast Oil Spill Countermeasures Study - Year I identified two areas of particular vulnerability to the effects of a significant oil spill. One area was a region located off the northern tip of Vancouver Island; the other, the southern Strait of Georgia. As a follow-up to Year I, Year II focussed on these two areas with a view to assessing the capability and adequacy of countermeasures for an oil spill of moderate or major proportion.

The most effective means of assessment would have been by a full-scale deployment of manpower and equipment. The associated costs, however, would have been prohibitive. Thus, a workshop format was selected as the best alternative. To this end, the workshop was devised to simulate a command decision-making structure. Regular personnel and agencies which normally responded to oil spill incidents were invited to participate, as explained in the early portions of this report.

Goals and Objectives

Workshop goals included the following:

1. To simulate the main activities of the command structure responsible for containment, cleanup and disposal of an oil spill. By so doing, the following objectives were met:

   (a) to quantify the existing level of protection and cleanup by estimating environmental damage done and the approximate cost of countermeasures equipment and personnel;

(b) to experience the group work process of spill response concerning:

 (i) oil spill countermeasures deployment;
 (ii) designation of priority areas for protection and "write-off"; and
 (iii) resolution of questions on disposal sites and methods; and

2. To identify a reasonable level of additional existing spill countermeasures and logistical response to ensure moderate resource protection and cleanup.

Scope

This study examined a moderate spill off the northern tip of Vancouver Island and a major oil spill off the southern Strait of Georgia area. Hypothetical spill scenarios were drafted for each area. The geographic boundaries of the scenarios defined the outer limits of interest to workshop attendees.

Realism was encouraged through the participation of representatives from agencies regularly involved with oil spill containment and cleanup countermeasures. The role played by each attendee was as outlined in existing regional and national contingency plans. All decisions during the workshop were expected to be as true to life as possible.

To facilitate workshop deliberations, relevant background information on biological and socio-economic resources, trained manpower, communications hardware and systems, spill countermeasures equipment, contingency plans and other documentation relevant to the scenarios were compiled by Environmental Protection Service (EPS) staff. These were made available to workshop attendees. Contributions of personal knowledge and experience to workshop deliberations were also encouraged.

Method

Two base scenarios were drafted by EPS in consultation with federal government hydrographic and atmospheric experts. One of the scenarios depicted a moderate spill off the northern tip of Vancouver Island; the other, a major spill in southern Strait of Georgia. Each of the scenarios were then subdivided into four critical time periods. For the southern scenario, for example, the time frames were:

1. December 22, 1979 (0400 - 2400 hours);
2. December 23, 1979 (000 hours) to December 24 (2400 hours);
3. December 25, 1979 (000 hours) to December 29 (2400 hours);
4. December 30, 1979 (000 hours) to the end.

During the workshop, each of the above periods was dealt with independently using the questions shown in Exhibit E-I. To assist workshop participants, relevant background information on biological and socio-economic resources, oil spill countermeasures equipment (including those from U.S. sources), manpower, communications hardware and systems, logistical support, contingency plans and disposal locations and criteria were compiled by EPS staff and made available to the workshop.

Two workshops were held. The first one, October 3 and 4, 1979, dealt with a moderate spill situation off the northern tip of Vancouver Island. It served as a trial run and tested the clarity of the questionnaire as well as the workshop procedure. Participation for that initial effort was restricted to a small select group from EPS and one representative from the Department of Transport. The latter was designated On-Scene-Commander (OSC) for the two-day workshop duration.

The second workshop was held on February 12 and 13, 1980. It comprised some 25 participants from numerous agencies (Exhibit E-3). The majority of agencies which were invited to nominate attendees were those involved on a regular basis in oil spill countermeasures and prevention on the B.C. coast.

During the second workshop, participants were encouraged to work both as individuals and ultimately, as a cohesive unit. Existing contingency plans outlined the terms of reference for action. To simulate the decision-making process during an actual spill, four interest groups with the following responsibilities were established:

1 On-scene command

This sub-group was responsible for making decisions concerning the actions necessary for dealing with each of the four critical time periods. Decisions were required on matters concerning spill countermeasures equipment, manpower and communications deployment, site identification for priority attention, and write-off and disposal areas and methods.

In the course of their deliberations, this sub-group was expected to seek and incorporate advice from the remaining three subgroups: emergency response, biological resource information and other resource information.

The On-Scene Commander for the scenario and leader of this sub-group was Captain I. C. (Ian) Young from the federal Department of Transport.

2 Biological Resource Information and Other Resource Information

These two sub-groups were responsible for advising the On-Scene Commander on matters related to biological resource and socio-economic resource interests respectively. Their contribution and interpretation of technical information was intended to assist the On-Scene Commander in making decisions concerning priority protection, write-off areas, and disposal methods and locations.

Each of the sub-groups had a leader who was responsible for coordinating the deliberations of the sub-group and for conveying the sub-group concensus by way of the Regional Environmental Emergency Coordinator (Environmental Protection Service) to the On-Scene Commander.

3 Emergency Response

This sub-group was responsible for advising the On-Scene Commander on manpower and logistical support available to the spill countermeasures operation.

Information from this sub-group was transmitted directly to the On-Scene Commander by way of the Emergency Response sub-group leader.

To serve as support to the four sub-groups in the workshop, the following four positions were established:

(1) Control Group

This group participated only when requested to do so by any of the four interest groups to ratify assumptions made by them. The control group was asked to refrain from influencing sub-group decisions or direction.

(2) Observers

The role of the observers was to evaluate the effectiveness of the workshop in meeting its objectives. They were also charged with preparing recommendations for improving the workshop format and approach in the event of further exercises.

During the course of the proceedings, interest sub-groups were contacted by way of the control group. They were given an opportunity at the conclusion of the workshop to briefly address the group with summary comments.

(3) Recorders

The role of the recorders was to keep detailed written and graphic records of decisions reached by the main group. Flip charts, scenario maps and charts were used to record data.

(4) Workshop Leader

The role of the workshop leader was to stimulate and coordinate the discussion and decision-making process for the duration of the two-day workshop.

The contribution of the specific experience and expertise of each workshop participant was encouraged. In the event that workshop members required further information from their respective offices, telephone (portable and landline units) and radio transmitters were placed at their disposal.

Under the direction of the workshop leader, participants were guided through the questions prepared for the exercise. The same questionnaire was used for each of the four critical time periods. Each of the four interest sub-groups were responsible for responding to select questions. Flip charts were available for use in recording sub-group concensus. During the course of the workshop, sub-groups were also responsible for responding to ad hoc requests for advice raised by the On-Scene Commander and other sub-groups. Interaction between sub-groups was encouraged.

As stated earlier, each critical time period was dealt with on an individual basis. Detailed replies were desired. A typical approach to the questionnaire (Exhibit E-1) is represented as follows:

(1) On-Scene Command sub-group considers questions 1, 3, 4a and 5a. In preparing its response, the On-Scene Commander is expected to seek advice on matters of priority resources and areas of concern from the three technical sub-groups.

Simultaneously, the biological resource information and the other resource information sub-groups deal with questions 2 (a) and (b) plus 5(a). Their responsibility is to advise the on-scene command sub-group by way of the Regional Environmental Emergency Coordinator - Environmental Protection Services (REEC - EPS) with regard to resource concerns and priorities. They also respond to ad hoc questions raised by the On-Scene Commander. Any conflicts between the biological and the socio-economic sub-groups concerning important areas and resources for priority protection are resolved by the (REEC - EPS) prior to the transmission of information and opinions to the On-Scene Commander and his group.

The emergency response sub-group deals with questions 4 (a) and 5 (a). It also responds to questions and concerns raised by the on-scene command sub-group. It speaks directly with the on-scene commander and does not go through an intermediary.

(2) Following step 1, above, based on the advice and technical information received from the three sub-groups, the on-scene command sub-group is expected to develop a local action plan. The On-Scene Commander reveals those plans [questions 4 (b) and 5 (b)] to the

The three technical sub-groups are then given an opportunity to challenge the decisions of the on-scene command sub-group. Any changes resulting from the exchange are recorded.

(3) All sub-groups are assigned questions 6a, b and c. The questions are designed to assist in the evaluation of present spill countermeasures equipment, their adequacy and effectiveness, as well as further needs and estimated costs.

At the conclusion of the two-day workshop, participants were asked to respond to one final questionnaire containing the following query:

"Please note any comments/observations concerning general shortcomings, problems, etc., in oil spill preparedness and countermeasures affecting the study area. What can be done about them?"

Conclusions

Subject to the limitations of the technique used, considerable relevant and and detailed information was received. Participants had the opportunity to work together on concerns which in reality do surface or predominate during actual spill incidents.

The use of the workshop for data generation had limitations. Time compression presented the major problem. It was also difficult visualizing the consequences of decisions made and actions taken. Further, levels of familiarity and experience with spill countermeasures and response amongst workshop attendees were not uniform.

The method of the workshop was the most effective way of economically and realistically generating data for the study.

Recommendations

1. The method of the Workshop was satisfactory. It is recommended that further exercises be conducted.

   One of the exercises should involve a trans-boundary international episode. Active involvement should be encouraged from the Canadian, U.S. and B.C. governments, petroleum industry and spill cleanup firm sectors. A joint planning team consisting of representatives from the two countries and industry should be established to prepare for and manage the major exercise.

   Another workshop should address the issue of site-specific spill countermeasures during a major incident.

2. In an effort to maintain the data collected, a Pacific region Countermeasures Manual should be prepared.

3. The lessons learned in simulating an oil spill can be readily applied to a computer oil spill simulation. This should be investigated for both training and response purposes.

EXHIBIT E-1

Questionnaire

		Action
1.	Choose an operational headquarters	OSC
2.	a) Identify areas requiring protection. Give them in order of priority with supporting reasons for each case.	Support
	b) What area(s) could be left for natural cleaning? Give reasons. Advise OSC concerning recommendations for protection priorities and write-offs.	Support
3.	Where should major countermeasures activities be attempted? What special techniques should be employed?	OSC
4.	a) List resources (personnel, equipment, communications, logistics) needed to manage spill countermeasures. Where will they come from? How will they get there? How long will it take to: i) obtain ii) transport iii) deploy iv) operate Recode all decisions on the wall charts provided.	OSC
	b) Discuss above decisions with support team	OSC/ Support

NOTE: Resources may come from anywhere in Canada, United States and other countries.

EXHIBIT E-I Cont'd

			Action
5.	a)	Make decisions on disposal and alternative disposal methods and sites.	OSC
	b)	Consult with support team	OSC/ Support
6.	a)	List any primary and realistic shortcomings, mechanical failures, problems, etc., resulting from the above decisions. Deficiencies in contingency planning should also be considered.	OSC/ Support
	b)	What can reasonably be done about them to ensure moderate resource protection and cleanup?	OSC/ Support
	c)	Estimate the time required by 6(b) above for the rectification of the shortcomings.	OSC/ Support

Following general discussion, a, b, and c above should be submitted to the workshop recorders in written point form.

EXHIBIT E-2

WORKSHOP AGENDA

WEST COAST OIL SPILL COUNTERMEASURES STUDY - YEAR II
WORKSHOP
AT INTERNATIONAL PLAZA HOTEL, NORTH VANCOUVER, B.C.
12 - 13 FEBRUARY, 1980

Workshop goals are directed at the major spill situation occurring in the southern Georgia Strait and include the following:

1 To simulate the main activities of the command structure responsible for containment, cleanup and disposal of an oil spill. By so doing, the following objectives will be met:

1.1 to quantify the existing level of protection and cleanup by estimating environmental damage done and the approximate cost of countermeasures equipment and personnel.

1.2 To experience the process of:
- i) designating priority areas for protection and "write-off", and
- ii) resolving disposal sites and methods

2 To identify a reasonable level of additional existing spill countermeasures and logistical response needs to ensure moderate resource protection and cleanup.

Day 1

0830 Registration

0900 Opening Remarks

0910 Program Introduction
- Objectives
- Introduction & Scenario
- Participant Roles
- Background Data

0930 Coffee Break

EXHIBIT E-2

0940	Scenario - December 22 (0400 - 2400 hours)	All
1200	LUNCH	
1300	Scenario - December 23 (000 hours) to December 24 (2400)	All
1430	COFFEE BREAK	
1440	Scenario - December 23 (000 hours) to December 24 (2400)	All
1600	Adjournment for the Day	

Day 11

0900	Scenario - December 25 (000 hours) to December 29 (2400)	All
1000	COFFEE BREAK	
1010	Scenario - December 25 (000 hours) to December 29 (2400 hours)	All
1200	LUNCH	
1300	Scenario - December 30 (000 hours) to end	All
1430	COFFEE BREAK	
1440	Scenario - December 30 (000 hours) to end	All
1600	Closing Remarks and Adjournment S. G. Pond, Regional Environmental Emergency Coordinator	

EXHIBIT E-3

List of Participants

WEST COAST OIL SPILL COUNTERMEASURES STUDY - YEAR II
WORKSHOP
AT INTERNATIONAL PLAZA HOTEL, NORTH VANCOUVER, B.C.
ON 12 - 13 FEBRUARY, 1980

E. C. W. (El) Adams
Environmental Control Officer,
The Corporation of Delta,
4450 Clarence Taylor Crescent,
Delta, B.C. V4K 3E2

Al Ages,
Institute of Ocean Sciences,
9860 West Saanich Road,
P.O. Box 6000,
Sidney, B.C. V8L 4B2

Fred Beech,
Countermeasures Analyst,
Environmental Emergency Branch,
Environmental Protection Service,
Environment Canada,
3rd Floor, Kapilano 100 - Park Royal,
West Vancouver, B.C. V7T 1A2

Dave Betts,
Environmental Engineer,
Environmental Emergency Branch,
Environmental Protection Service,
Environment Canada,
3rd Floor, Kapilano 100 - Park Royal,
West Vancouver, B.C. V7T 1A2

F. D. (Fred) Cooper,
Regional Director (B.C.),
Emergency Planning Canada,
378 - 816 Government Canada,
Victoria, B.C. V8W 1W9

Captain Terence (Terry) Elworthy,
Assistant Harbour Master,
National Harbours Board,
Port of Vancouver,
1900 - 200 Granville Street,
Vancouver, B. C. V6C 2P9

Martyn J. Green,
Manager,
Burrard Clean Oil Spill,
500 - 1177 West Hastings Street,
Vancouver, B.C. V6E 2K3

Rick Harbo,
Biologist,
Habitat Protection Division,
Dept. of Fisheries & Oceans,
1090 West Pender Street,
Vancouver, B.C. V6E 2P1

Keith Hebron,
Senior Environmental Protection
Technician,
Environmental Emergency Branch,
Environmental Protection Service,
3rd Floor, Kapilano 100 - Park Royal
West Vancouver, B.C V7T 1A2

EXHIBIT E-3 (Cont'd)

Su Hum,
Environmental Emergency Biologist,
Environmental Emergency Branch,
Environmental Protection Service,
Environment Canada,
3rd Floor, Kapilano 100-Park Royal,
West Vancouver, B.C. V7T 1A2

John Millen, Chief,
Ecological Protection Group,
Environmental Protection Service,
Environment Canada,
3rd Floor, Kapilano 100-Park Royal,
West Vancouver, B.C. V7T 1A2

Commander H. N. (Harry) Hutchins,
Chief, Marine Environmental Protection Branch,
Thirteenth Coast Guard District,
U.S. Coast Guard,
915 Second Avenue,
Seattle, Washington 98174

L. (Len) Oddy,
Training Officer,
Environmental Emergency Branch,
Environmental Protection Service,
Environment Canada,
Hull, Quebec K1A 1C8

Gary Kaiser,
Survey Biologist,
Canadian Wildlife Service,
Environment Canada,
Box 340,
Delta, B.C. V4K 3Y3

G.W. (Ted) Oldham,
Assistant Regional Manager,
Coast Region,
Waste Management Branch,
B.C. Ministry of Environment,
1106 Cook Street,
Victoria, B.C. V8V 4S5

Dr. J. D. Kingham, Director,
Environmental Emergency Branch,
Environmental Impact Control Directorate,
Environmental Protection Service,
Place Vincent Massey,
Ottawa, Ontario K1A 1C8

Glen Packman,
Biologist,
Environmental Protection Service,
Environment Canada,
3rd Floor, Kapilano 100-Park Royal,
West Vancouver, B.C. V7T 1A2

M. O. (Barney) Lane,
Spill Control Coordinator,
Provincial Emergency Program,
Parliament Buildings,
Victoria, B.C. V8V 1X4

S. G. (Steve) Pond,
Regional Environmental Emergency, Coordinator,
Environmental Emergency Branch,
Environment Canada,
3rd Floor, Kapilano 100-Park Royal,
West Vancouver, B.C. V7T 1A2

K. M. (Ken) Meikle,
Head, Technology Development,
Environmental Emergency Branch,
Environmental Protection Service,
Environment Canada,
Hull, P.Q. K1A 1C8

John Rich,
Chairman,
Islands Trust,
Parliament Buildings,
Victoria, B.C.

EXHIBIT E-3 (Cont'd)

Bob Sherwood,
Resource Officer,
Ecological Protection Group,
Environmental Protection Service,
Environment Canada,
3rd Floor, Kapilano 100 - Park Royal,
West Vancouver, B.C. V7T 1A2

John Sainsbury,
Life Scientist,
Environmental Protection Agency,
1200 Sixth Avenue, (M/S 329),
Seattle, Washington 98101

Don Tillapaugh,
Conservation Officer,
Marine Resources Branch,
B.C. Ministry of Environment,
200 - 756 Fort Street,
Victoria, B.C. V8W 3A3

F. G. (Frank) Williams,
Chief, Weather Services,
Pacific Weather Station,
Atmospheric Environment Service,
Environment Canada,
1200 West 73rd Avenue,
Vancouver, B.C.

W. H. (Bill) Wolferstan,
Research Officer,
Environmental Land Use Committee,
Parliament Buildings,
Victoria, B.C. V8V 1X4

Captain J. C. (Ian) Young,
Regional Manager, Emergency Operations,
Marine Emergency Operations Centre,
Department of Transport,
1006 - 100 Park Royal,
West Vancouver, B.C. V7T 1A2