APPENDIX F

EMERGENCY RESPONSE PLAN
CONTAINMENT, RECOVERY and CLEANUP

This appendix contains portions of an uncontrolled copy of the Enbridge Energy Partners, Inc. Emergency Response Plan (ERP). Please note that the ERP is typically an active, controlled document that is updated annually and is subject to U.S. Department of Transportation, (DOT), Pipeline and Hazardous Materials Safety Administration (PHMSA) audits and reviews. The sections included in this appendix is an uncontrolled copy and therefore updates will not continue to be included in this copy. In addition, PHMSA has the mandate to conduct physical inspections, as well as program inspections of management systems, procedures and processes to ensure the the Enbridge ERP remains in compliance.

Enbridge transports several different types of petroleum liquids in its existing Lakehead System as described in this ERP document. The LSr Project discussed in this Environmental Assessment is currently scheduled for light to medium crude oil service. If a release from the operation of the LSr pipeline were to occur, the emergency response procedures outlined in Section 4 of this document would be enacted.

Other types of petroleum liquids identified in this ERP do not apply to the proposed LSr Project which is the subject of this Environmental Assessment.

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04 Containment, Recovery and Cleanup

Purpose

Prompt and effective response during an emergency is accomplished through planning and training. Proper preparedness minimizes risk to the public and employees, and limits damage to property and the environment.

NOTE: For information on emergency response training and exercises, see Book 1: General Reference.

Legislation

Canada

National Energy Board (NEB):

- Onshore Pipeline Regulations

Environment Canada

- Environmental Emergencies Regulations

United States

Code of Federal Regulations (CFR):

- Title 29, Part 1910—Occupational Safety and Health Standards
- Title 49, Part 194—Response Plans for Onshore Oil Pipelines

United States Code:

- 33 USC 1321—Oil and Hazardous Substance Liability, (j) National Response System, (7) Area Drills

Related Standards

Industry

CAN

Canadian Standards Association (CSA):

- Z731, Emergency Planning for Industry

USA

National Preparedness for Response Exercise Program (PREP) Guidelines

Requirements

Emergency Response Equipment

Location

Regions are responsible for ensuring emergency response equipment is located at strategic locations along the pipeline system.

Mobile Emergency Response Units

Mobile emergency response units must include containment and recovery equipment for both land and water-based releases.

NOTE: For specific locations and equipment inventories of emergency response units, contact the appropriate regional office.

Inspection and Maintenance

Regions are responsible for ensuring (a) minimum inventories of emergency response equipment are available, and (b) the equipment is in good working condition.

Inventory emergency response equipment after an emergency response exercise. Replace or restock degraded or missing items immediately.

Conduct routine maintenance on emergency response equipment in accordance with manufacturer's instructions.

Safety Equipment

Adequate safety equipment, firefighting equipment and first aid equipment must be available (a) at the release site and (b) at each containment site (see Book 2: Safety, Tab 14, Safety Equipment).

Hazardous Materials Spill Kits

USA

If hazardous materials are stored in drums at a site, a hazardous materials spill kit must be available at the site.

Company vehicles transporting more than 200 L (CAN) or 119 gal (USA) of fuel or liquid hazardous materials to unattended locations and/or right-of-way (ROW) work sites should be equipped with:

- a shovel
- 30 m^2 (36 sq yd) of 6-ml polyethylene sheeting
- 25 kg (55 lb) of absorbent

Co-operative/Mutual Aid Resources

Cooperative agreements with other organizations, mutual assistance groups, and associations provide the company with access to additional emergency response equipment and services.

For a list of cooperatives and equipment and services available, see the applicable regional Emergency Response Directory.

Contractors and Suppliers

For a list of emergency contractors and suppliers of mobile equipment, containment equipment, cleanup equipment and other supplemental resources, see the applicable regional Emergency Response Directory.

 USA

Oil Spill Removal Organization (OSRO)

Safety & Environment in conjunction with the regions are responsible for establishing an OSRO master service agreement to meet worst-case discharges, as required under CFR 33, Part 154 and Part 155.

NOTE: For more information, see U.S. Coast Guard Oil Spill Removal Organization Classification Program, Oil Pollution Act of 1990 (OPA 1990), Section 4202.

 USA

Spill Response Exercise

NOTE: For information on the frequencies required for spill response tabletop exercises, deployment exercises, and water, land and ice exercises, see Book 1: General Reference.

Oil spill response exercises must be conducted by regions and comply with the National Preparedness for Response Exercise Program (PREP) Guidelines, triennial cycle requirements, including:

- annual tabletop exercises conducted annually

NOTE: One tabletop exercise every three years must (a) involve a worst case discharge scenario and (b) include the participation of any OSRO under contract with the company.

- annual equipment deployment exercises conducted annually
- annual unannounced exercises (either tabletop or equipment deployment) conducted annually
- unannounced exercises initiated by RSPA
- areas exercises initiated by the US Coast Guard, Environmental Protection Agency (EPA) or industry

NOTE: In the USA, during each triennial cycle, all 15 core components outlined in the PREP Guidelines must be exercised at least once. Credit may be taken for an actual spill response if the objectives were met, components of the response were evaluated and records were maintained.

External Agencies

The regions should establish liaisons to improve communications and mutual cooperation with public officials, government agencies and other public service organizations who can/will provide assistance, but who are not part of the mutual aid association.

External response agencies and representatives from public agencies (e.g., police and fire departments, response teams, environment and natural resources departments) should observe and/or participate in company emergency training exercises.

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02-Emergency Response Actions

Purpose

This tab provides general emergency response actions for all types of releases.

Legislation

Canada

National Energy Board (NEB):

- Onshore Pipeline Regulations

United States

Code of Federal Regulations (CFR):

- Title 29, Part 1910—Occupational Safety and Health Standards
- Title 49, Part 194—Response Plans for Onshore Oil Pipelines

Related Standards

CAN

Industry

Canadian Standards Association (CSA):

- Z731, Emergency Planning for Industry, latest edition

Corporate

Enbridge Inc. Environment, Health and Safety Policy
Transportation Group Environmental Policy
Transportation Group Health and Safety Policy

Purpose

This standard provides the communication protocol for reporting emergencies or suspected emergencies to protect the safety of workers and the public and to control potential impacts as effectively and quickly as possible.

Scope

This standard applies to emergencies involving product releases, fires, explosions, bomb and security threats, and injuries.

Requirements

Any reported or observed emergency or possible emergency situation, or abnormal operating condition must be given an emergency status until the report is confirmed or negated.

Responsibilities

NOTE: For an overview of emergency notification, see Figure 1. For notification specific to the region, see the applicable Emergency Response Directory.

Control Center

When an emergency or suspected emergency report is received from the public, police, or an employee, notify:

- local police, if required
- regional management
- Shipper Services

NOTE: For information on Control Center responsibilities for emergency notification, see the Edmonton Control Center (ECC) Procedures database. This includes responding to, investigating and correcting abnormal operations, including:

- unintended valve closure or shutdown
- increase or decrease in pressure or flow rate outside normal operating limits
- loss of communications
- operation of a safety device
- any other malfunction of a component, deviation from normal operation, or employee error that could cause a hazard to persons or property

Regional Management

Initial Response

Upon notification of a reported emergency:

- Record information provided by the caller.
- Dispatch a-first responder-to investigate the report.
- Ensure the police have been alerted.
- Maintain contact with the first responder.

Confirmed Emergency

If an emergency is confirmed:

- Activate the Incident Command System (ICS), and mobilize response personnel and equipment as required (see 02-02-03, Incident Command System).
- Update police and advise whether further assistance is required.
- Notify senior management, or designate.
- Notify affected departments as required (e.g., Safety & Environment, Pipeline Integrity, Public Affairs, Human Resources).
- Notify other pipeline and utility companies as appropriate.

 USA

- Notify the Radiation Safety Officer (RSO), if applicable.
- Notify appropriate government agencies and initiate reports (see Book 1: General Reference, Tab 02, Incident Reporting).

First Responder

Initial Response

Upon notification of a reported emergency:

- Proceed immediately to the area of concern and begin exploration (see 02-02-02, First Responder).
- Maintain constant or scheduled contact with regional management/on-call person.

Confirmed Emergency
If an emergency is confirmed:

- Assume the role of the Incident Commander and remain onsite until relieved by appointed personnel.

NOTE: For more information on responsibilities of the Incident Commander, see 02-02-03, Incident Command System.

- Assure the health and safety of people, and evacuate if necessary and safe.
- Secure the site (see 02-02-05, Site Security and Control).
- Meet and cooperate with local emergency response agencies (police or fire department). Obtain assistance in securing the site and evacuation if necessary.
- If possible, take mitigative measures to reduce the impact or risk of emergency (e.g., block culverts/sewers, dam ditches, shut down ignition sources).
- Meet and advise response personnel arriving at the site.
- Document key events (see 02-02-09, Incident Records).

Unconfirmed Emergency
If unable to confirm an emergency, notify regional management/on-call person and remain onsite until advised.

Senior Management

Confirmed Emergency
Upon notification of a confirmed emergency:

- Notify the chairman of the Crisis Management Team as required.
- Notify other senior management as required.
- Provide corporate direction to regional management as required.
- Provide additional corporate resources to support emergency operations as required.
- Ensure next of kin are notified.

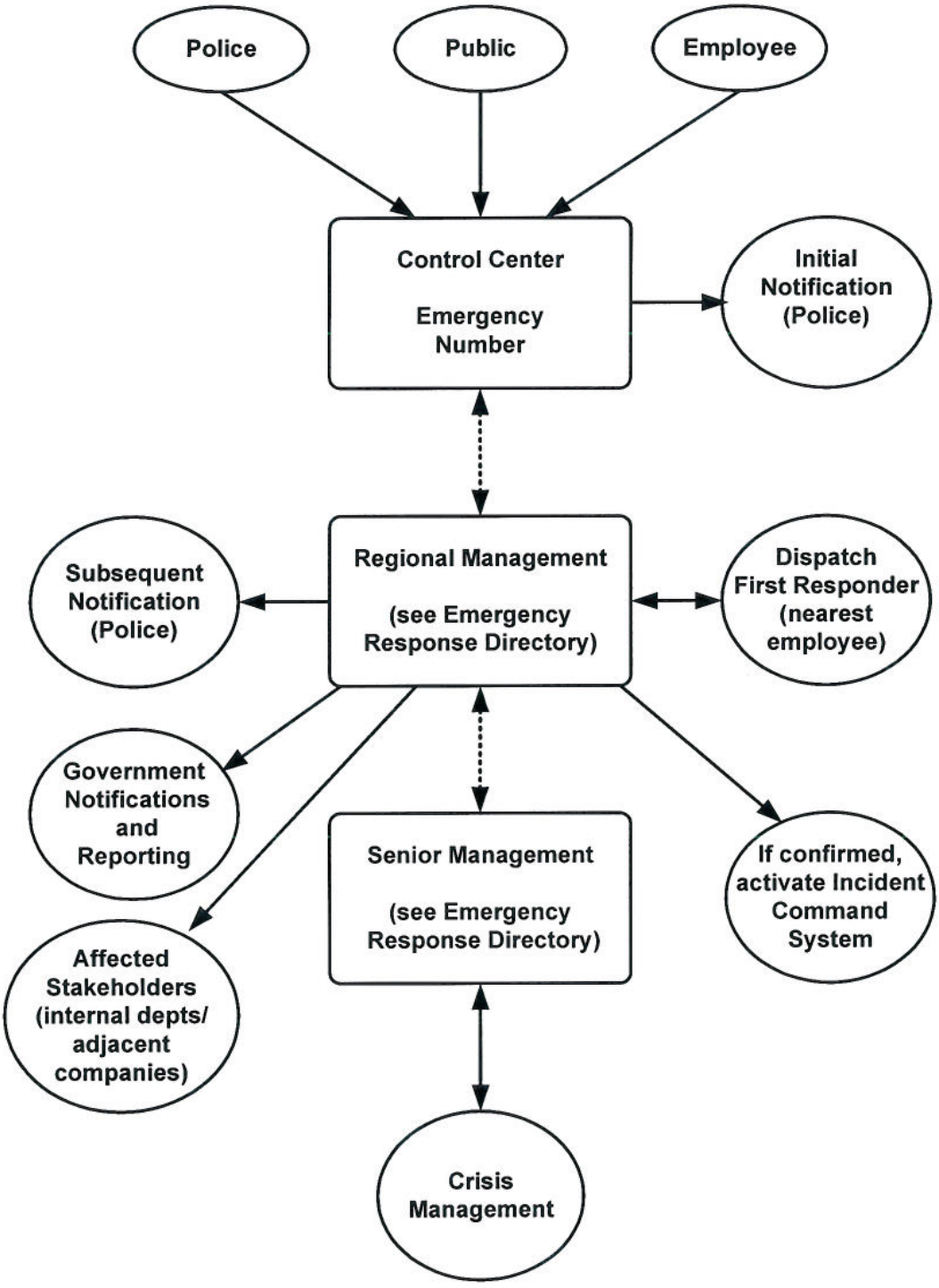

Figure 1
Emergency Notification Chart

04-Containment, Recovery and Cleanup

Purpose

This tab outlines various containment, recovery and cleanup strategies and the criteria for selecting them.

Before selecting a cleanup technique, assess the impact and implementation requirements of each cleanup technique. If the impact of the preferred technique is unacceptable or the technique cannot be implemented, choose the next preferable technique.

Legislation

Canada

National Energy Board (NEB):

- Onshore Pipeline Regulations

United States

Code of Federal Regulations (CFR):

- Title 29, Part 1910—Occupational Safety and Health Standards
- Title 49, Part 194—Response Plans for Onshore Oil Pipelines

Related Standards

CAN

Industry

Canadian Standards Association (CSA):

- Z731, Emergency Planning for Industry, latest edition

Corporate

Enbridge Inc. Environment, Health and Safety Policy
Transportation Group Environmental Policy
Transportation Group Health and Safety Policy

Requirements

Initial Response

When selecting containment, recovery and cleanup techniques for releases on land, consider:

- amount and type of product released
- product movement (spreading and penetration)
- resource requirements
- equipment availability
- time to get equipment and personnel onsite, and to deploy equipment
- site accessibility for equipment and personnel
- potential environmental effects
- weather conditions (e.g., wind speed and direction, temperature, weather forecast)
- topography
- soil type and vegetation cover
- time of year
- direction(s) of natural drainage in the release area and areas of natural accumulation;
- distance separating the released product and open water, and time for the product to reach open water
- wildlife in the area
- groundwater resources (depth and flow direction)
- wells in the vicinity

Developed Areas

The company's right-of-way (ROW) traverses populated and developed urban areas, including both towns and cities. Associated with this urban development are civil infrastructure works, which often include storm sewer runoff collection systems. If a release occurs in or near a developed area, both liquid products and NGL's could escape through the storm sewer collection intakes. To minimize this potential risk, check (and cover if necessary) any storm sewer inlets in the area that could compromise release containment.

Containment

When containing releases on land, attempt to:

- confine the affected site to as small an area as possible
- prevent the product from leaving the site

- prevent surface water runoff from leaving the site
- prevent the product from reaching a major river
- minimize the cost of recovery and cleanup

Contain releases on land using either one or a combination of the following techniques:

- earth or sand dikes
- sorbent dikes
- snow/ice dikes
- trenches
- culvert blocks
- bell holes

For guidelines on selecting containment techniques for releases on land, see Table 1.

Recovery

Once contained, recover the product released on land using suction and/or pumping. For guidelines on selecting recovery techniques for releases on land, see Table 2.

Cleanup

After as much free product is recovered as possible, begin site cleanup using one or a combination of the following techniques:

- manual cleanup
- sorbents
- in-situ burning (see 04-02-10, In-Situ Burning)
- pumping
- high-pressure flushing
- low-pressure flushing
- steam cleaning
- abrasive blasting
- heavy equipment

For guidelines on selecting cleanup techniques for releases on land, see Table 3.

Heavy Equipment

⚠WARNING: Handling product-saturated material and/or free product with heavy equipment increases the risk of fire and/or explosion at the site.

During cleanup operations, use only Gradalls, backhoes or trackhoes. Do not use any other heavy equipment (i.e., bulldozer, front-end loader, bobcat) unless a written hazard assessment has been (a) conducted by a competent worker and (b) approved by the Incident Commander.

NOTE: For more information on a competent worker, see Book 2: Safety, Terms and Definitions.

Before using heavy equipment for cleanup operations in areas containing product-saturated material and/or free product:

- ensure as much free product is recovered as possible
- assign safety watch(es) to heavy equipment in operation

NOTE: For more information on safety watches, see Book 2: Safety, Terms and Definitions.

- continuously monitor hazardous vapors within and near heavy equipment in operation
- ensure there is a clear path for heavy equipment operator egress

NOTE: Consider using materials as a fire blanket (e.g., sand, clean soil) to cover small amounts of free product, if practical.

In addition, consider implementing the following measures, if practical:

- fitting heavy equipment blades/buckets with a nonsparking material (e.g., Teflon, brass) unless prevented by site conditions (e.g. deeply frozen soils, bedrock)
- obtaining external firefighting services and equipment

Table 1
Containment for Releases on Land

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
earth dike	• temporary containment in all seasons, using material commonly available	• availability of sufficient earth or sand • season—useful only when the ground is not frozen • moisture of earth—useful only in dry areas	• possible surface disturbance, which may cause excessive erosion, especially on steep slopes	• work crew—a four-person crew with a bulldozer can build 5 m (16 ft) of dike per hr • earth-moving equipment • earth, sandbags, sand or gravel • shrub brush—to supplement material in dike
sorbent dike	• temporary containment in all seasons	• availability of sufficient sorbent • may become impractical and expensive for large releases	• sorbents must be disposed of in an environmentally acceptable manner	• work crew • sorbent—sorbent boom is best • storage and disposal facility for used sorbents
snow/ice dike	• to contain product on flat surface in winter • to stop product movement on slopes, and to direct product to collection area	• availability of sufficient snow and water	• possible surface disturbance, which may cause excessive erosion, especially on steep slopes in spring	• work crew— four-person crew with bulldozer can build 10 m (30 ft) of dike per hour • earth-moving equipment • equipment to spray water • snow and water
trenches	• on sloping terrain, to intercept product moving on the surface or subsurface	• availability of equipment • season—may be impossible to excavate frozen earth or permafrost • soil depth in some areas may be too thin to create a trench • if product penetrates below 50 cm (20 in.), may need to excavate and remove soil from site	• surface disturbance, which may cause erosion on steep slopes	• operator or work crew—can produce 30 m (100 ft) per hr using heavy equipment in summer, half that in winter • earth-moving equipment • hand tools (e.g., shovels)

Table 1—*continued*
Containment for Releases on Land

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
culvert blocks	• to stop movement of product from migrating through culverts or other drainage structures	• availability of culvert block material	• temporary disruption of surface water drainage • water levels must be monitored to ensure washouts do not occur	
bell holes	• to prevent further migration of released product • to provide a means of collecting product using vacuum truck or pump suction hose	• availability of equipment • season—may be impossible to excavate frozen earth or permafrost • soil depth in some areas may be too thin to create a trench • if product penetrates below 50 cm (20 in.), may need to excavate and remove soil from site	• surface disturbance • risk of product penetrating further into soil	• heavy excavating equipment • hand tools (e.g., shovels)

Table 2
Recovery for Releases on Land

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
suction	• to recover free product from dike, trench or bell holes in areas accessible by heavy equipment	• availability of equipment • accessibility of site for vacuum truck	• possible surface disturbance from heavy equipment	• operator • vacuum truck
pumping	• to recover product from dike or trench in areas not accessible by heavy equipment • to move the product through hoses to storage	• availability of equipment • availability of nearby storage	• possible surface disturbance	• operator • power supply • pumping unit • storage unit—port-a-tank, fuel bladder, storage tank or lined, excavated sump

Table 3
Cleanup for Releases on Land

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
manual	• in areas not accessible by heavy equipment • on mud, gravel and cobble areas where product contamination is light or isolated and penetration is slight	• availability of personnel—labor intensive and time consuming • degree of contamination	• removal of up to 5 cm (2 in.) of soil • removal of shallow organisms and vegetation; however, more rapid re-population of organisms than with other excavation techniques	• work crew • hand tools (e.g., rakes, shovels, wheel barrows) • storage and disposal facilities
sorbents	• to remove pools of product from mud, boulders, rock or man-made structures • most frequently used for final cleanup	• availability of sufficient sorbent • presence of weathered product—not as effective on weathered product • season—not practical in winter	• minimal surface disturbance caused by foot traffic • sorbents must be disposed of in an environmentally acceptable manner	• work crew • sorbent • disposal facility for used sorbent
in-situ burning (see 04-02-10, In-Situ Burning)	• when other techniques are not suitable or would cause more disturbance to area • decision to burn should be made as soon as possible to utilize the presence of light ends in the product	• suitability of site to contain a controlled burn • fire hazard rating—low hazard is necessary • government approval is required • weathered product can be extremely hard to ignite	• burning of surface vegetation and surface soils	• work crew • firefighting equipment
high-pressure flushing	• to remove product coatings from rocks, boulders and man-made structures • to direct released product to areas for collection by skimmer and/or pump	• availability of equipment • accessibility of site for equipment • availability of water supply • season—not applicable in winter	• surface disturbance • removal of soil organisms	• work crew • pressurized equipment • downslope containment and recovery facilities • water supply
low-pressure flushing	• in more sensitive areas, to direct released product to a recovery area	• as above	• as above, but to a lesser degree	• as above

Table 3—*continued*
Cleanup for Releases on Land

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
excavation by bulldozer	• to remove product-contaminated mud, gravel, soil or vegetation	• availability of equipment • accessibility of site for heavy equipment • season—difficult in frozen soil	• removal of 10-25 cm (4-10 in.) surface material, which may cause erosion or surface instability • removal of all shallow organisms and vegetation • slow re-population	• work crew and operator • bulldozer, fuel trucks to haul soil • area to store excavated material
excavation by front-end loader	• as above	• as above	• as above, but excavation may be to depth of 50 cm (20 in.)—rubber-tired loader causes less surface disturbance than bulldozer • slow re-population of organisms	• work crew and operator • front-end loader, fuel • area to store excavated material
excavation by backhoe/trackhoe/ Gradall	• as above	• as above	• as above	• work crew • backhoe, fuel trucks to haul soil • area to store excavated material
steam cleaning	• to remove product, coatings from boulders, rocks and manmade structures • to flush product to area for collection by skimmer and/or pump	• availability of equipment • accessibility of site for equipment	damage to surface vegetation and shallow organisms from heat	• work crew • steam truck • water supply • downslope containment and recovery facilities
sand blasting	• to remove thin accumulations of product residue from manmade structures	• availability of equipment • accessibility of site for light equipment • availability of sufficient supply of sand	• addition of sand residue to the environment • potential recontamination, erosion or deeper penetration into soil • destruction of surface vegetation and shallow organisms	• work crew • pressurized sandblasting equipment • downslope containment and recovery facilities • sand

Purpose

Containment, recovery, and cleanup of product released in wetlands can be the most difficult of all land-based operations. This is due to the wide variety of soil and vegetation cover in wetlands, and the sometimes limited access for heavy equipment and workers. In addition, water levels in wetlands fluctuate depending on several factors, including soil and vegetation, time of year, and source of water, which further complicates recovery and cleanup.

Requirements

Initial Response

When selecting containment, recovery, and cleanup techniques for releases in wetlands, consider:

- amount and type of product released
- product movement (spreading and penetration)
- resource requirements
- equipment availability
- time required to get equipment and personnel onsite, and to deploy equipment
- site accessibility for equipment and personnel
- potential environmental effects
- weather conditions (wind speed and direction, temperature, weather forecast
- topography
- time of year
- direction(s) of natural drainage in the release area and areas of natural accumulation
- distance separating the released product and open water, and time for the product to reach open water
- wildlife in the area
- aquatic habitat and vegetation
- water level
- aquatic vegetation

Containment

When containing releases in wetlands, attempt to:

- confine the affected site to as small an area as possible
- prevent the product from reaching a major river
- minimize the cost of recovery and cleanup

- prevent additional contamination of vegetation

Contain releases in wetlands using one or a combination of the following:

- earth or sand dike
- snow/ice dike
- trenches
- containment booms
- containment weirs

NOTE: For information on constructing containment weirs, see 04-02-04, In Rivers.

For containment techniques for releases in wetlands, see Table 1.

Recovery

Once contained, recover the product released in wetlands using one of the following:

- suction
- pumping
- fresh-water flushing
- product skimmer

For recovery techniques for releases in wetlands, see Table 2.

Natural Recovery

Natural recovery may be preferable to manual cleanup, depending on:

- amount, location, type, and persistence of the product
- nature and uses of the area
- impacts of various cleanup methods on the area and on native animal and plant species

Consider natural recovery if:

- cleanup activities are more harmful than allowing the product to recover naturally
- it will not cause further harm to environmentally sensitive areas of the site or adjacent shoreline area
- presence of the product is acceptable in terms of the area's use

Cleanup

If the site is not left to recover naturally, begin site cleanup using one of the following techniques:

- manual cleanup
- sorbents
- in-situ burning (see 04-02-10, In-Situ Burning)

For cleanup techniques for releases in wetlands, see Table 3.

Table 1
Containment for Releases in Wetlands

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
earth or sand dike	• to reduce product penetration into organic layer by raising water level of affected area • to float product to surface for easy recovery	• accessibility of site for equipment • availability of personnel—may be labor intensive and expensive if access to site is limited • availability of earth, sand, or gravel	• physical damage to sensitive area	• work crew • earth-moving equipment • earth, sandbags, sand, or gravel
snow/ice dike	• to reduce product migration in winter	• availability of sufficient snow and water	• possible physical damage to sensitive area	• work crew—a four-person crew with bulldozer can build 10 m (30 ft) of dike per hr • equipment to spray water • snow and water
trenches	• around the perimeter of the release site to prevent further spread of product and water	• availability of equipment • availability of personnel—may require labor intensive manual trenching if access to site is limited • accessibility of site for heavy equipment	• physical damage to sensitive area—keep trenches shallow and narrow to minimize site disturbance	• operator or work crew • earth-moving equipment • hand tools (e.g., shovels)
containment weirs	• to allow water movement from site while containing surface product • to maintain constant water level at release site for easy product recovery	• accessibility of site for equipment • availability of construction materials	• physical damage to sensitive area	• work crew • earth-moving equipment • earth, sandbags, sand, or gravel • culvert material
containment booms	• to prevent migration of product without affecting water movement	• availability of equipment • water depth	• none	• work crew • containment boom

Table 2
Recovery for Releases in Wetlands

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
fresh-water flushing	• to gather product that is on the water surface in open areas not obstructed by extensive vegetation • to move product to suitable collection point for recovery • can be used in conjunction with trenches	• availability of equipment • accessibility of site for equipment	• physical damage of sensitive area • start as soon as possible to prevent product from penetrating deep into the layers of exposed organic material	• work crew • pressurized equipment • water supply (either warm or cold)
suction	• to recover free product from water or trench using vacuum truck or tank truck	• availability of equipment • accessibility of site for heavy equipment	• possible surface disturbance from heavy equipment	• operator • vacuum truck or tank truck
pumping	• to recover product and water from trench in areas not accessible by heavy equipment • to move the product through hoses to storage	• availability of equipment • availability of onsite storage for product/water mixture	• surface disturbance in sensitive area	• work crew • power supply • pumping unit • storage unit—port-a-tank, fuel bladder, storage tank, or lined excavated sump
product skimmer	• to remove product from water surface	• water depth • product slick thickness—works best with thick slick • presence of debris and aquatic vegetation—works best when free of debris and seaweed	• none	• work crew • power supply • suction skimmer, float weir skimmer, disc or drum skimmer • storage facility

Table 3
Cleanup for Releases in Wetlands

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
manual	• to clean up small product areas or areas where heavy equipment would cause significant environmental damage • to squeeze released product from organic material for recovery in trenches • to cut protruding vegetation below the water line a maximum of 5-10 cm (2-4 in.)	• availability of personnel—labor intensive and time consuming • degree of contamination • water depth, presence of vegetation, and stability of subsurface soils	• shoreline disturbance from foot traffic • cut vegetation will return the next year if root system was not damaged	• work crew • hand tools (e.g., shovels, buckets, hand rollers, squeegees) • storage and disposal facilities
sorbents	• to clean up small amounts of product in isolated areas	• availability of sufficient sorbents • season—not practical in winter	• little environmental damage, other than shoreline disturbance caused by foot traffic • dispose of sorbent in environmentally acceptable manner	• work crew • sorbents • disposal facility for used sorbent
in-situ burning (see 04-02-10, In-Situ Burning)	• to reduce product volume when other techniques are not suitable or would cause more damage to area • in areas where heavy equipment would cause significant environmental damage • in areas unsafe for cleanup crews • the decision to burn should be made as soon as possible to utilize the presence of light ends in the product; weathered products can be extremely hard to ignite • only as a last resort	• suitability of site to contain a controlled burn • fire hazard rating—low rating is necessary • government approval required • volatility of product—high volatility is necessary • penetration depth—shallow penetration is necessary	• burning of surface vegetation and surface soils	• work crew • firefighting equipment

Purpose

Muskeg is one of the most difficult environments in which to conduct emergency operations. More damage can be caused by cleanup than was caused by the release. If a release in muskeg does not appear to threaten other sensitive areas, cleaning up only the easily accessible areas and leaving the rest of the site to recover naturally is recommended.

Guidelines

Initial Response

When selecting containment, recovery and cleanup techniques for releases in muskeg, consider:

- amount and type of product released
- product movement (spreading and penetration)
- resource requirements
- equipment availability
- time required to get equipment and personnel onsite, and to deploy equipment
- site accessibility for equipment and personnel
- potential environmental effects
- weather conditions (e.g., wind speed and direction, temperature, weather forecast)
- topography
- time of year
- direction(s) of natural drainage in the release area and areas of natural accumulation
- distance separating the released product and open water, and time for the product to reach open water
- aquatic habitat and vegetation
- wildlife in the area
- groundwater resources (depth and flow direction)
- wells in the vicinity
- water level

Containment

When containing releases in muskeg, attempt to:

- confine the affected site to as small an area as possible
- prevent the product from leaving the site
- prevent surface water runoff from leaving the site
- minimize the cost of recovery and cleanup

- prevent additional contamination of vegetation

Contain releases in muskeg using one or a combination of the following techniques:

- trenches
- earth or sand dike
- containment booms
- containment weirs

For guidelines on selecting containment techniques for releases in muskeg, see Table 1.

Recovery

Once contained, recover the product using suction and or pumping (see Table 2, 04-02-01, On Land).

Natural Recovery

In certain circumstances, natural recovery may be preferable to manual cleanup, depending on:

- amount, location, type and persistence of the product
- nature and uses of the area
- impacts of various cleanup methods on the area and native animal and plant species.

Consider natural recovery if:

- cleanup activities are more harmful than leaving the oil to recover naturally.
- it will not cause further harm to environmentally sensitive areas of the site or adjacent shoreline
- presence of the product is acceptable in terms of the area's use

Consult local government agencies as necessary to determine whether natural recovery is acceptable in the jurisdiction.

Bioremediation in Northern Boreal and Subarctic Environments

Bioremediation, a form of natural recovery, has been found to occur in northern environments. In bioremediation, various components microbiologically degrade in the soil. Although bioremediation rapidly uses up the indigenous supplies of soil nutrients necessary for bioremediation such as nitrogen and phosphorus, fertilization can be used to promote the rate of bioremediation. For example, adding lime creates a more neutral soil condition and encourages a larger soil microbe population, which enhances oil breakdown. Soil analysis will determine the appropriate amendments needed to enhance bioremediation.

Cleanup

Once most of the product is recovered, begin site cleanup using one or a combination of the following techniques:

- sorbents
- fresh-water flushing
- in-situ burning

For guidelines on selecting cleanup techniques for releases on muskeg, see Table 2.

Table 1
Containment for Releases in Muskeg

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
trenches	• to prevent further spread of product and water	• accessibility of site for heavy equipment	• physical damage to sensitive area	• work crew • earth-moving equipment • hand tools—if manual trenching required (e.g., shovels
earth or sand dike	• to reduce product penetration into organic layer by raising water level of affected area • as access road to aid in product recovery	• water depth—effective if water table already high • availability of earth, sand or gravel • construction costs high if constructed in remote area	• physical damage to sensitive area • future problems caused by spilled product trapped under the dike being pushed into muskeg	• work crew • earth-moving equipment or hand tools • earth, sandbags or gravel
containment booms	• to prevent migration of product from site	• availability of equipment	• none	• work crew • containment boom
containment weirs	• to allow water movement from site while containing surface product • to maintain constant water level at release site for easy product recovery	• availability of construction materials • construction costs high if constructed in remote area	• physical damage to sensitive area	• work crew • earth-moving equipment • earth, sandbags, sand or gravel • culvert material

Table 2
Cleanup for Releases in Muskeg

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
sorbents	• to clean up small amounts of product or sheen in isolated areas	• availability of sufficient sorbent • season—not practical in winter • soil penetration—does not remove all product that has penetrated into muskeg	• little environmental damage, other than surface disturbance caused by foot traffic • dispose of sorbent in an environmentally acceptable manner	• work crew • sorbents • disposal facility for used sorbent
fresh-water flushing	• to remove product coatings from vegetation, and to reduce the amount of product soaking into muskeg by speeding up product movement • increases amount of product/water to be recovered	• availability of equipment • accessibility of site for equipment • product penetration—flushing slow if oil already soaked into muskeg • suitable if water table high	• minimal surface disturbance to sensitive area	• work crew • pressurized equipment • water supply • containment recovery facilities
in-situ burning (see 04-02-10, In-Situ Burning)	• to remove product coatings from vegetation without disturbing drainage pattern of muskeg • when other techniques are not suitable or would cause more disturbance to area	• suitability of site to contain a controlled burn • fire hazard rating—low rating is necessary • government approval required • volatility of product—high volatility is necessary • penetration depth—shallow penetration is necessary	• burning of surface vegetation and surface soils	• work crew • firefighting equipment

Purpose

Containment of a product released in a river requires careful selection of control points and response strategies, which may change depending on weather and river conditions. Once released product reaches a river or stream, the rate of contamination is greatly increased.

Guidelines

Initial Response

When selecting containment, recovery, and cleanup techniques for releases in rivers, consider:

- amount and type of product released
- resource requirements
- equipment availability
- time required to get equipment and personnel onsite, and to deploy equipment
- site accessibility for equipment and personnel
- potential environmental effects
- weather conditions (e.g., wind speed and direction, temperature, weather forecast)
- water conditions (e.g., velocity, currents, turbulence)
- areas of natural accumulation
- containment sites and control points
- aquatic habitat and vegetation
- wildlife in the area
- rate of oil slick movement

Control Point Selection

Knowing the rate of oil slick movement greatly assists in selecting an appropriate control point for containment and recovery operations.

The rate of oil slick movement in a stream or river depends on:

- surface currents
- season
- wind conditions

Surface Currents
Oil moves at the same speed as the surface current. Since the speed of surface current varies across a river, oil moves faster in the main current (which tends to follow the deepest part of the river) and slower in a sidechannel or backwater.

To measure surface current, drop an object in the main current and calculate the time it takes to travel a measured distance along the shoreline. (The usual distance measured is 30 m [100 ft]). For conversion to current speed, see Table 1, 04-03-01, Deploying River Boom.

Seasons
The seasons impact current, which is characteristically faster in spring, because of spring runoff, and slower in the summer.

Wind Conditions
Wind conditions determine (a) the course a slick takes on a large river and (b) which side of the river the slick will move toward or follow.

Containment

When containing releases in rivers, attempt to:

- confine the product as close to the release source as possible
- prevent the product from reaching a major river
- minimize the cost of recovery and cleanup

If containment in a major river is necessary, use techniques that are shore-based to take advantage of predetermined control points.

Contain releases in rivers using one or a combination of the following techniques:

- containment booms
- diversion booms
- sorbent booms
- earth dikes
- containment weirs

For containment techniques for releases in rivers, see Table 1.

Aerial Surveys

Aerial surveys can assist in selecting the appropriate containment technique. Aerial surveys can:

- determine the location and extent of the release more quickly than ground observation
- locate small pockets of product that may be missed by other methods
- determine the effectiveness of booms by identifying any product surfacing downstream of booms

Booms

Boom configuration and the method of deploying boom depend in part on the location of control points. Typical methods for deploying river boom involve using anchors/boats or using BoomVane (see 04-03-01, Deploying River Booms).

Dikes and Containment Weirs

Dikes and containment weirs can be constructed on intermittent drainage channels or on relatively narrow or shallow rivers to contain the flow of product. A dike can extend above the water and out from one shoreline, or from one shoreline to the other.

For dikes that extend from one shoreline to the other, maintain the flow of water by installing an inverted culvert through the center of the berm (see Figure 1). This will keep the water from overflowing the berm.

Recovery

Once contained, recover the product using one of the following:

- suction
- pumping
- product skimmer

For recovery techniques for releases in rivers, see Table 2.

Cleanup

Once most of the product is recovered, begin site cleanup either manually or using sorbents.

For most spills, both manual cleanup and sorbents are used as cleanup progresses, and each has specific limitations depending on the location of the release and the existing climatic conditions.

For cleanup techniques for releases in rivers, see Table 3.

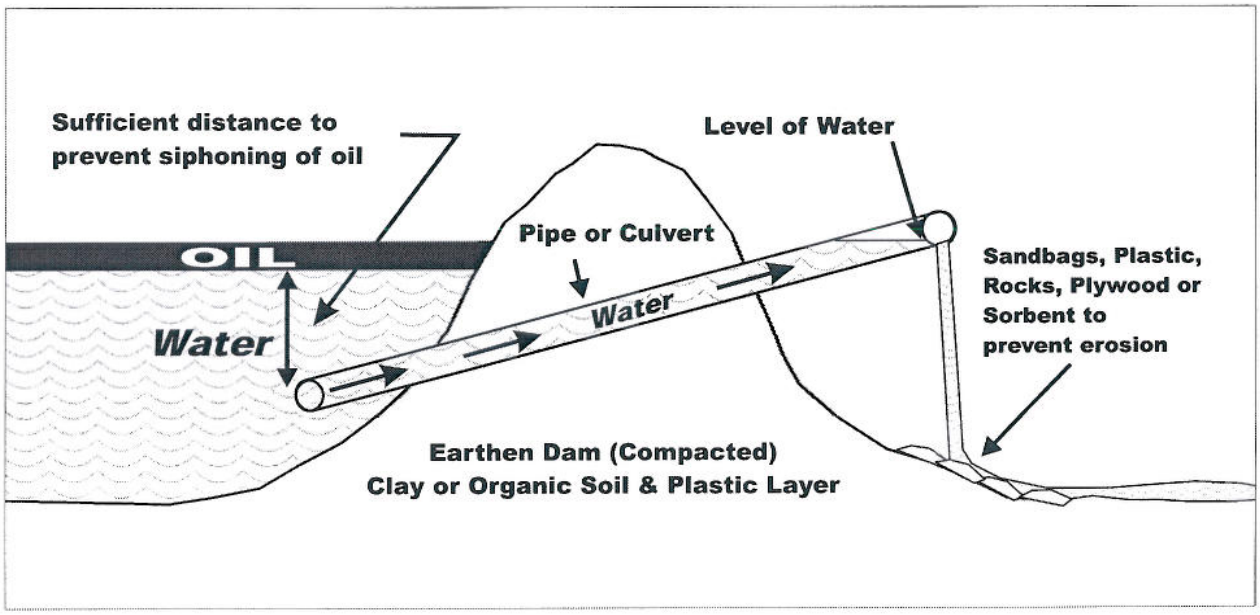

Figure 1
Inverted Containment Weir

Table 1
Containment for Releases in Rivers

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
containment booms	• where release enters water or if product is traveling down one shoreline	• current speed—must be less than 0.6 mi/hr (1.0 m/s)	• minor disturbance at anchor points	• work crew—a three-person crew can deploy 90 m of boom per hr • booms—length totaling 1.5 to 2 times slick diameter • work boat and safety boat • storage site for recovered product and water or for BoomVane
diversion booms	• in large or swift rivers to divert slick to calmer water for recovery	• current speed—must be less than 4 mi/hr (2.0 m/s)	• minor disturbance at anchor points	• work crew—a three-person crew can deploy 90 m of boom per hr • boom for diversion • work boat and safety boat or BoomVane
sorbent booms	• across narrow rivers • behind containment boom to absorb sheen	• current speed—must be less than 0.5 m/s • degree of contamination—must be minor	• minor disturbance at anchor points	• work crew • sorbent boom • work boat and safety boat • disposal containers or incinerator for used sorbent
earth dike	• across very shallow streams and intermittent creeks	• availability of sufficient earth	• damage at excavation and construction sites	• work crew or operator—a 10×4×2 m berm takes 1 hr to build • earth-moving or digging equipment • boom recovery device and storage area for recovered product • sandbags, liner material sheets of metal or wood
containment weirs	• in shallow streams and creeks to slow upstream velocity and to allow water movement from site while containing product • to maintain constant water level at release site	• availability of personnel—may require constant maintenance in fast-flowing streams • availability of construction materials	• surface disturbance	• work crew • earth-moving equipment or shovels • culvert material

Table 2
Recovery for Releases in Rivers

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
suction	• to recover free product from water or trench	• availability of equipment • accessibility of site for heavy equipment	• possible surface disturbance from heavy equipment	• operator • vacuum truck or tank truck
pumping	• to recover product and water from trench in areas not accessible by heavy equipment • to move the product through hoses to storage	• availability of equipment • availability of onsite storage for product/water mixture	• surface disturbance in sensitive area	• work crew • power supply • pumping unit • storage unit—port-a-tank, fuel bladder, storage tank, or lined excavated sump
product skimmer	• to remove product from water surface • with a boom set up downstream to capture leaking past the skimmer	• water depth • oil slick thickness—works best with thick slick • presence of debris and aquatic vegetation—works best when free of debris and seaweed • turbulence—best on calm water	• none	• work crew • power supply • suction skimmer, float weir skimmer, disc or drum skimmer • storage facility

Table 3
Cleanup for Releases in Rivers

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
manual	• to clean small release areas or areas where heavy equipment would cause significant environmental damage • to squeeze released product from organic material for recovery in trenches • to cut protruding vegetation below the water line a maximum of 5-10 cm (2-4 in.)	• availability of personnel—labor intensive and time consuming • degree of contamination • water depth, presence of vegetation and stability of subsurface soils	• shoreline disturbance from foot traffic • cut vegetation will return the next year if root system was not damaged	• work crew • hand tools (e.g., shovels, buckets, hand rollers, squeegees) • storage and disposal facilities
sorbents	• to clean up small amounts of product in isolated areas • near the shore and ahead of an advancing slick • to control sheen escaping containment boom	• availability of sufficient sorbents • season—not always practical in winter	• little environmental damage, other than shoreline disturbance caused by foot traffic • dispose of sorbent in environmentally acceptable manner	• work crew • sorbents • disposal facility for used sorbent

Purpose

Product releases in lakes form slicks and spread into shapes that are determined by surface currents and prevailing winds. If not contained, the slick develops streamers or long lines of product.

The direction of wind and currents must be considered when selecting control points or recovery areas. These sites should be located downwind of the release source. Winds or lake currents can assist recovery operations by moving the slick to one shoreline. Oil tends to concentrate in bays or coves where the surface movement is limited.

Guidelines

Initial Response

When selecting containment, recovery and cleanup techniques for product releases in lakes, consider:

- amount and type of product released
- resource requirements
- equipment availability
- time required to get equipment and personnel onsite, and to deploy equipment
- site accessibility for equipment and personnel
- potential environmental effects
- weather conditions (e.g., wind speed and direction, temperature, weather forecast)
- water conditions (e.g., velocity, currents, turbulence)
- aquatic habitat and vegetation
- rate of oil slick movement

Containment

When containing releases in lakes, attempt to:

- confine the product as close to the release source as possible
- contain the product before it becomes too wide for effective containment
- prevent the product from reaching a major river
- move the product toward the shore
- minimize the cost of recovery and cleanup

The oil slick will spread over the water's surface and remain in open water if there are no currents or if conditions are calm. If the oil slick remains in open water, it must be contained and moved toward the shore for recovery.

There are several techniques for deploying booms; each release situation is different and may require a number or combination of the techniques. The most commonly used technique involves deploying boom around the product release using boats (see Figure 1).

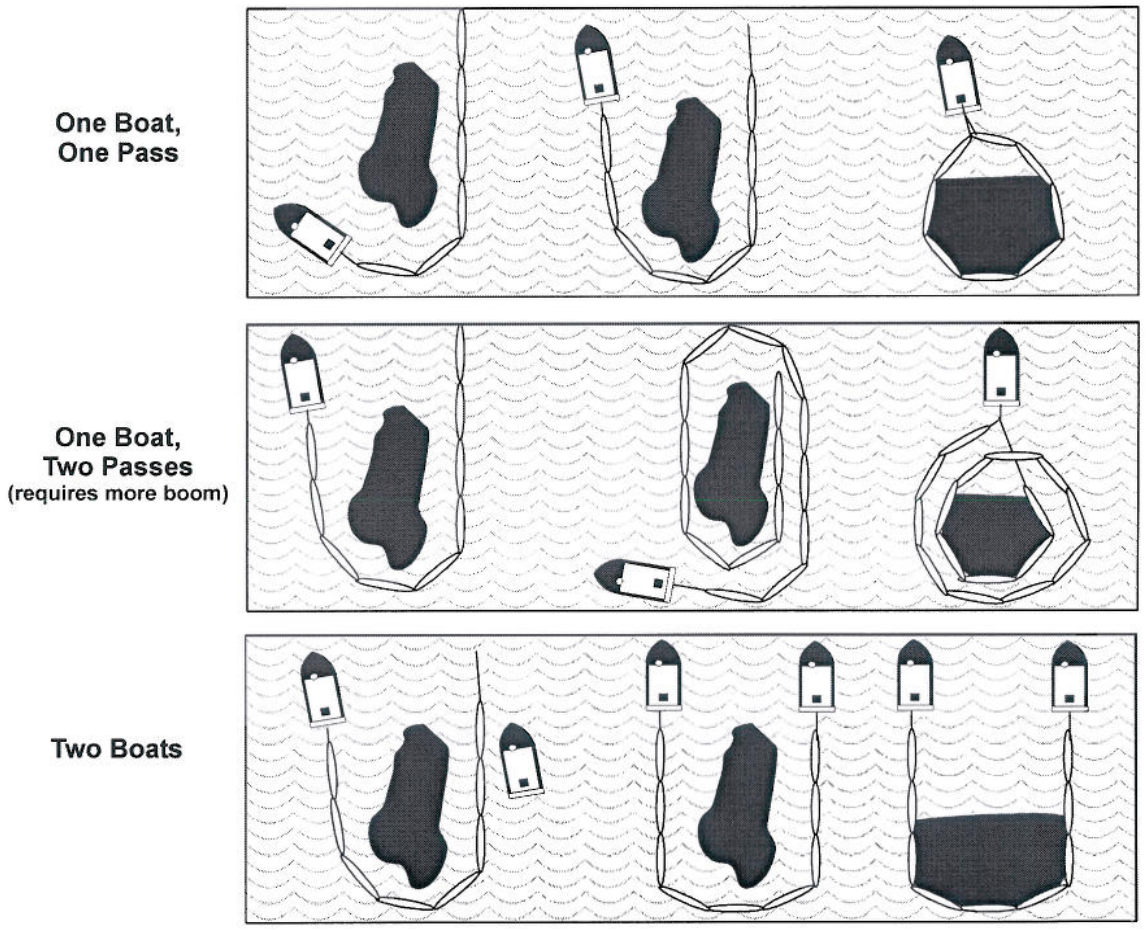

Figure 1
Containment in Lakes using Boats and Boom

Recovery

Recovery techniques for releases in lakes are similar to those for rivers (see Table 2, 04-02-04, In Rivers).

Cleanup

Cleanup techniques for releases in lakes are similar to those for rivers (see Table 3, 04-02-04, In Rivers).

Purpose

Product released on ice spreads outward. The extent of spreading is determined by the roughness and slope of the ice surface, and wind direction.

Guidelines

Initial Response

When selecting containment, recovery and cleanup techniques for releases on ice consider:

- amount and type of product released
- product movement (spreading and penetration)
- resource requirements
- equipment availability
- time to get equipment and personnel onsite, and deploy equipment
- site accessibility for equipment and personnel
- potential environmental effects
- weather conditions (e.g., wind speed and direction, temperature, weather forecast)
- topography
- direction(s) of natural drainage
- distance separating released product from open water
- ice thickness at the release site

Major factors that determine containment operations on ice are (a) type of ice at the site and (b) actual ice thickness.

Type of Ice

Clear ice, sometimes called blue ice, is clear, well-compressed and does not contain air pockets. Blue ice is very strong and has a high load-bearing capacity. White ice, or snow ice, has many air pockets and a much lower load-bearing capacity.

Effective Ice Thickness

The ability for ice on a river, stream or lake to support the weight of people and equipment is determined by the effective ice thickness, which is based on the thickness of blue ice and white ice present.

To calculate effective ice thickness, use the formula:

clear ice thickness + ½ white ice thickness = total effective thickness

e.g., The release site has 20 in. of clear, blue ice and 10 in. of snow ice.

20 in. clear + 5 in. snow ice = 25 in. effective ice thickness

NOTE: If water lies between layers, use the depth of only the top layer of white ice.

Table 1 shows the effective ice thickness required for continuous travel and for working on ice.

Temperature also affects the load-bearing capacity of ice. To allow the ice to withstand the permissible loads in Table 1, daily air temperatures must be constant, below the freezing point of water (i.e., 0°C [32°F]) for a certain length of time. The length of time required for constant temperatures of various ice thicknesses is as follows:

- less than 20 in. thick—temperature must be constant for three days
- between 20 and 40 in. thick—temperature must be constant for four days
- more than 40 in. thick—temperature must be constant for five days

Sudden drops in temperature can cause thermal stressing or cracking of ice, requiring temporary load restrictions for three to five days after the drop. Thawing due to warm temperatures also affects ice conditions. Table 2 shows the increases in effective ice thickness required for travel or working on ice under these conditions.

Table 1
Ice Thickness and Permissible Loads

Weight Bearing Capacity for Continuous Travel[1]		
Permissible Load	Effective Ice Thickness (in.)	
	Lake	River
one person on foot	2.0	2.4
group, in single file	3.1	3.5
passenger car 2,000 kg (4,400 lbs)	7.1	8.3
light truck 2,500 kg (5,500 lbs)	7.9	9.1
medium truck 3,500 kg (7,700 lbs)	10.2	11.8
heavy truck 6,800–8,000 kg (15,000–17,500 lbs)	13.8	16.1
9,000 kg (20,000 lbs)	15.0	17.3
23,000 kg (50,000 lbs)	24.8	28.7
45,000 kg (99,000 lbs)	31.5	36.2
68,000 kg (150,000 lbs)	39.4	45.3
109,000 kg (240,000 lbs)	49.2	56.7
Weight Bearing Capacity for Stationary Loads and Working on Ice[2]		
Permissible Load	Effective Ice Thickness (in.)	
	Lake	River
1,000 kg (2,200 lbs)	7.9	9.1
2,000 kg (4,400 lbs)	11.8	13.8
4,000 kg (8,800 lbs)	17.7	20.5
8,000 kg (17,600 lbs)	23.6	27.2
23,000 kg (50,000 lbs)	43.3	50.0
45,000 kg (99,000 lbs)	59.1	68.1
68,000 kg (150,000 lbs)	70.9	81.5
109,000 kg (240,000 lbs)	90.6	104.3

NOTES

1 Does not apply to parked loads, or where ice faults are evident.

2 Applies to loads that are stationary on ice for more than 2 hrs.

Table 2
Temperature Drops and Ice Thickness

Temperature Drop	Increase in Effective Ice Thickness
5°C (10°F) or less	multiply 1.4 × effective ice thickness
5°C to 10°C (10°F to 20°F)	multiply 2.0 × effective ice thickness
10°C (20°F) or more	multiply 2.4 × effective ice thickness

NOTES

Under thawing temperatures where the average air temperature exceeds 32°F, increase the effective ice thickness by 20% or reduce the allowable weight on the ice by 1/3.

Containment

When containing releases on ice, attempt to:

- confine the affected site to as small an area as possible
- prevent the product from reaching flowing water or a major river
- minimize the cost of recovery and cleanup

Contain releases on ice using one or a combination of the following techniques:

- earth dike
- sorbent dike
- snow/ice dike

For guidelines on selecting containment techniques for releases on ice, see Table 3.

Recovery

Recovery techniques for releases on ice are similar to those on land (see Table 2, 04-02-01, On Land).

Cleanup

The appropriate technique for cleaning up product released on ice depends on the:

- depth of release product
- depth of snow cover
- condition of the ice surface (smooth or rough)
- increased viscosity of the oil (due to low winter temperatures)

Once most of the product is recovered, begin site cleanup using one of the following techniques:

- manual cleanup
- sorbents
- steaming the ice surface

For guidelines on selecting cleanup techniques for releases on ice, see Table 4.

Table 3
Containment for Releases on Ice

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
earth dike	• where earth is available	• availability of unfrozen earth • must remove earth before spring breakup	• virtually none	• work crew • earth-moving or digging equipment • hand tools (e.g., shovels)
sorbent dike	• for relatively small releases	• availability of sufficient sorbent (impractical for large release volumes)	• virtually none	• work crew • sufficient sorbent • storage and disposal facility for used sorbent
snow/ice dike	• for rivers or lakes in winter	• availability of sufficient snow and water • effective ice thickness (determines equipment accessibility)	• virtually none, but any released residue will reach water during break-up	• work crew—a four-person crew can build 10 m (30 ft)of dike per hr • earth-moving equipment (e.g., bulldozer) • snow and water • equipment to spray water

Table 4
Cleanup for Releases on Ice

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
manual	• if product is very thick and/or mixed with snow • suitable for large releases	• equipment availability • effective ice thickness will determine equipment accessibility	• during spring melt, product in the snow may be skimmed off for recovery	• work crew • ice or snow removal equipment (e.g., backhoe, bulldozer, shovels) • dump trucks • lined containment cell for storing contaminated snow or ice
sorbents	• for small releases or to absorb product remaining after manual removal	• availability of sufficient sorbent • oil viscosity—sorbents do not work well on viscous oil • sorbents may freeze to ice surface	• minimal surface disturbance caused by foot traffic • sorbents must be disposed of in an environmentally acceptable manner	• work crew • sorbents • disposal facility for used sorbent
steaming ice surface	• to melt ice surface	• availability of equipment • effective ice thickness will determine equipment accessibility	• none	• work crew • steaming equipment

Guidelines

Initial Response

When selecting containment, recovery and cleanup techniques for releases under ice consider:

- amount and type of product released
- ice thickness
- rate of product movement
- resource requirements
- equipment availability
- time to get equipment and personnel onsite, and to deploy equipment
- site accessibility for equipment and personnel
- potential environmental effects
- weather conditions (e.g., wind speed and direction, temperature, weather forecast)
- time of year

Containment

When containing releases under ice, attempt to:

- prevent the product from reaching a major river
- minimize the cost of recovery and cleanup

Product movement under ice is slower than in open water. Because wind does not influence product movement, slicks follow the main current of the river and tend to stay in the center of the channel, although released product can become stranded in irregularities in the underside of the ice.

To estimate the location and speed of released product, drill test holes. If the ice is relatively thin, the location of the release can be also determined by aerial surveys or by observing surfacing product at cracks or open areas in the ice.

For guidelines on selecting containment techniques for releases under ice, see Table 1.

Ice Slotting on Rivers

Once the product is located, containment may be attempted using ice slots (see Figure 1).

For thick ice, cut ice slots using a backhoe or ditch witch; or, for thin ice, use portable chainsaws with ice blades. The angle at which to cut the slot is determined by the velocity of the river. The width of the ice slot should be approximately equal to the ice thickness.

Ice blocks can be very heavy and unwieldy (i.e., 1 cubic foot of ice = 53 lbs). Remove large ice blocks using heavy equipment or push the blocks under the ice (if water depth is sufficient). Remove small blocks using ice tongs.

To improve the efficiency of ice slots, place plywood sheets on the downstream side of the trough and freeze them in place. The plywood acts as a boom to direct product to the skimmer. This technique is particularly useful if the water level drops below the edge of the ice surface.

Before undertaking any work, consider ice thickness and its ability to support the weight of workers and equipment. Determine the thickness of the ice by drilling holes.

NOTE: For more information on effective ice thickness, see 04-02-06, On Ice.

Ice Slotting on Still Water

For releases under ice in still water conditions (e.g., lakes, sloughs), cut slots into the ice and place skimmers into them. To increase the rate of product recovery, auger holes into the ice at a distance from the skimmer slots. Connect a pump to a manifold that is attached to hoses. Place a hose into each auger hole and circulate water to direct the slick toward the skimmer slots (see Figure 2).

Recovery

Once contained, recover the released product under ice using a drum skimmer or a skimmer that is heat traced to prevent freezeup. Take the recovered material directly to a tanker truck, portable storage tank, fuel bladder or other storage device.

Cleanup

To clean up product releases under ice, physically remove the contaminated ice blocks and store in a contained area.

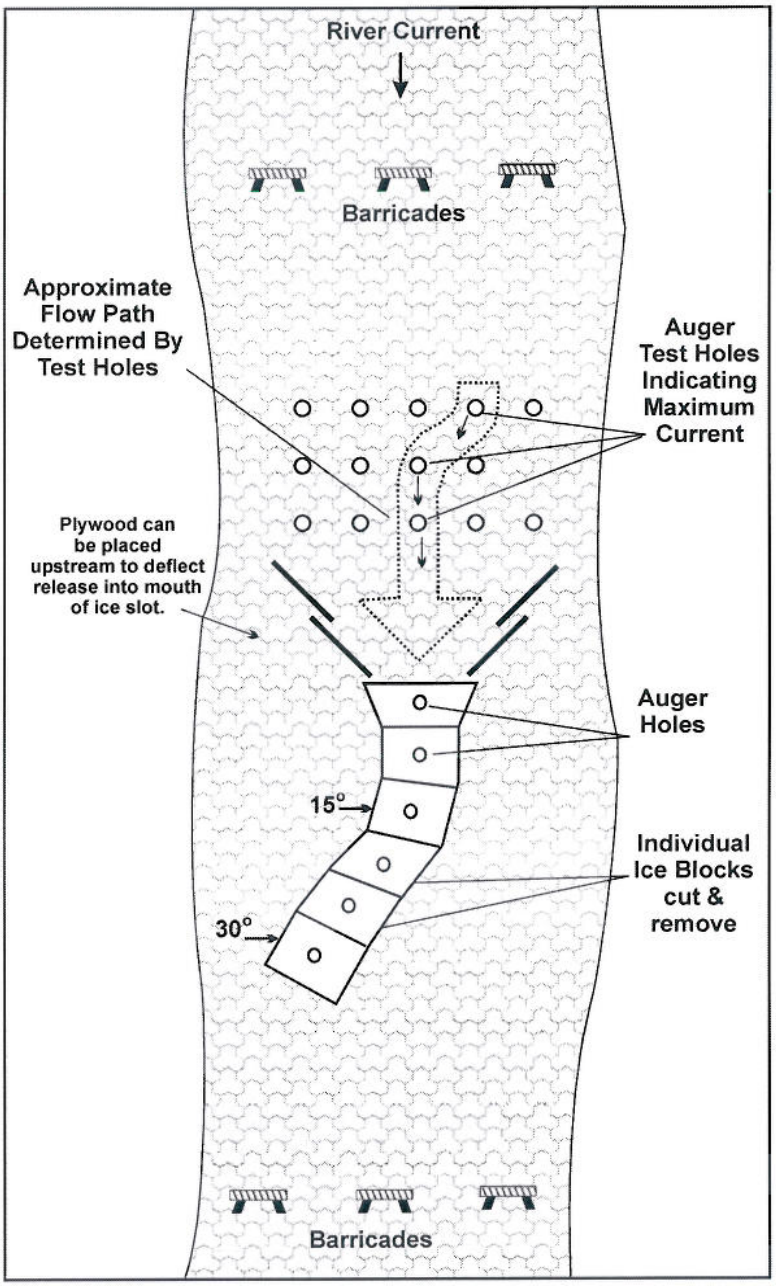

Figure 1
Ice Slotting on Rivers

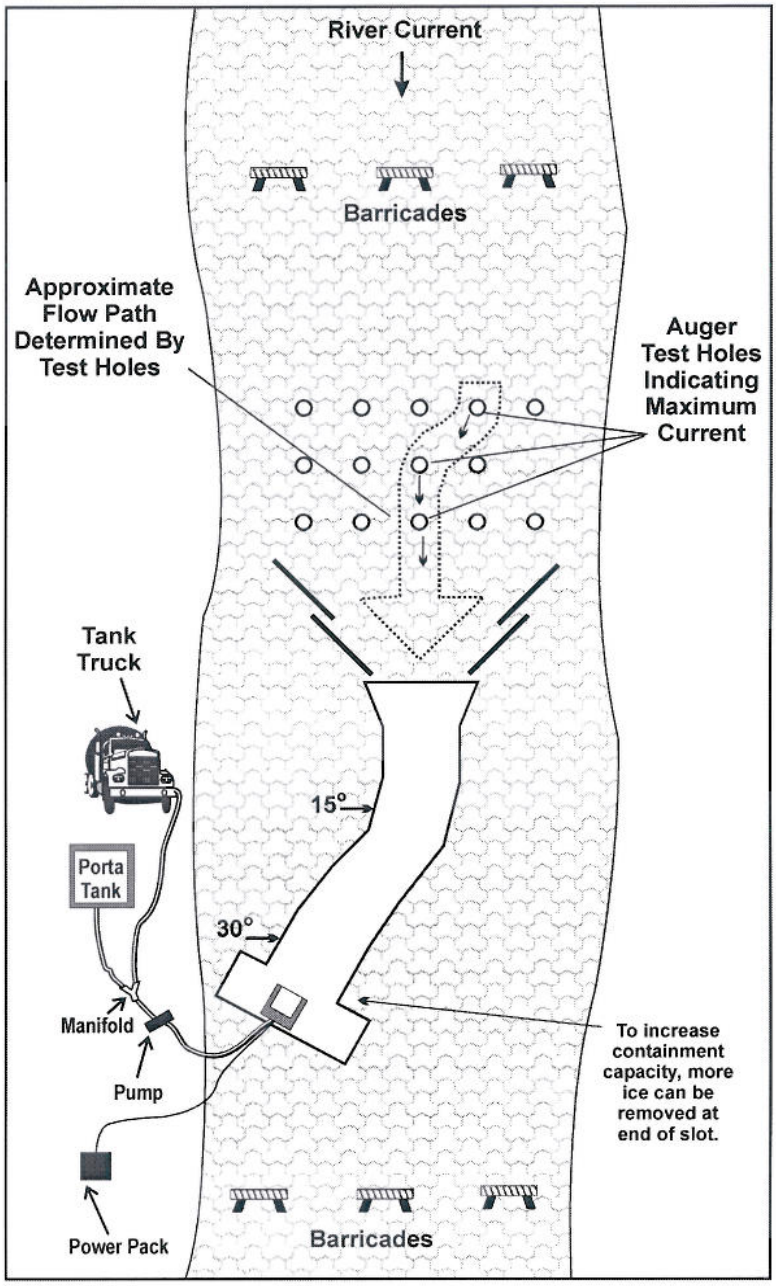

Figure 1—*continued*
Ice Slotting on Rivers

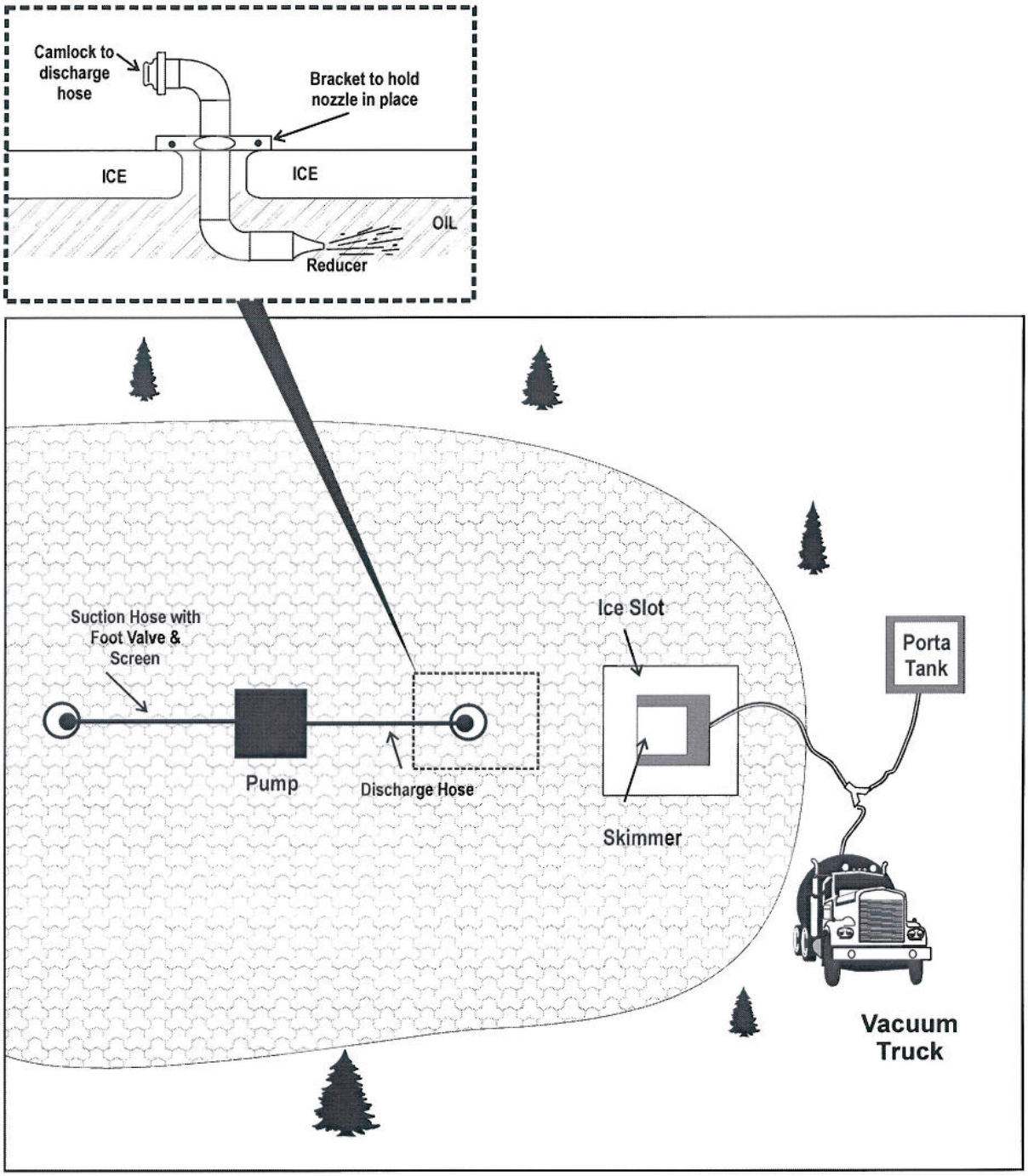

Figure 2
Ice Slotting on Still Water

Table 1
Containment for Releases Under Ice

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
ice slotting (rivers)	• for rivers	• effective ice thickness—dual axle tanker truck weighs 10 tonnes and can be supported on 0.5 m of ice; a D-8 Cat can be supported on 0.9 m of ice • ability to locate released product—location of release must be confirmed	• total recovery of released product is unlikely and cleanup likely will be required in spring and summer conditions • ice slots pose a threat to wildlife and people. Ensure ice slots are barricaded.	• work crew—a three-person crew can slot up to 50 m per hr under favorable conditions • chain saws or ditch witch, if available • recovery device such as skimmers/pumps/vacuum trucks • steam—to ensure lines do not freeze
ice slotting (still water)	• lakes, sloughs or any other still water conditions	• as above	• as above	• as above

Purpose

Responding to released product during freezeup or breakup is the most difficult scenario. When product is mixed with floating ice or is covered by a thin ice layer, ice interferes with the collection of the product and can damage containment and recovery equipment. The presence of ice also makes the safe use of boats hazardous.

Guidelines

Initial Response

When selecting containment, recovery and cleanup techniques for releases during freezeup or breakup, consider:

- amount and type of product released
- rate of product movement
- resource requirements
- equipment availability
- time to get equipment and personnel onsite, and to deploy equipment
- site accessibility for equipment and personnel
- potential environmental effects
- weather conditions
- time of year
- containment sites and control points
- aquatic habitat
- water conditions

Containment

When containing a release during freezeup or breakup, attempt to:

- deflect the ice from the containment equipment and recovery area
- prevent the product from reaching a major river
- minimize the cost of recovery and cleanup

Containment techniques for releases during freezeup or breakup are similar to those in rivers and on ice (see Table 1, 04-02-04, In Rivers, and Table 3, 04-02-06, On Ice).

Before attempting containment, deflect the ice using one or both of the following:

- log boom—leave space between the logs for released product and water to pass, while diverting the ice. The boom consists of 3 m (10 ft) logs cabled together with 1 m (3.5 ft) spacing. Anchor the log boom upstream of a conventional containment boom (see Figure 1).
- ice boom—upstream of the release site and containment site, to hold back upstream ice.

Recovery

Recovery techniques for releases during freezeup or breakup are similar to those in rivers and on land (see Table 2, 04-02-04, In Rivers, and Table 2, 04-02-01, On Land).

Cleanup

Cleanup techniques for releases during freezeup or breakup are similar to those in rivers and on ice (see Table 3, 04-02-04, In Rivers, and Table 4, 04-02-06, On Ice).

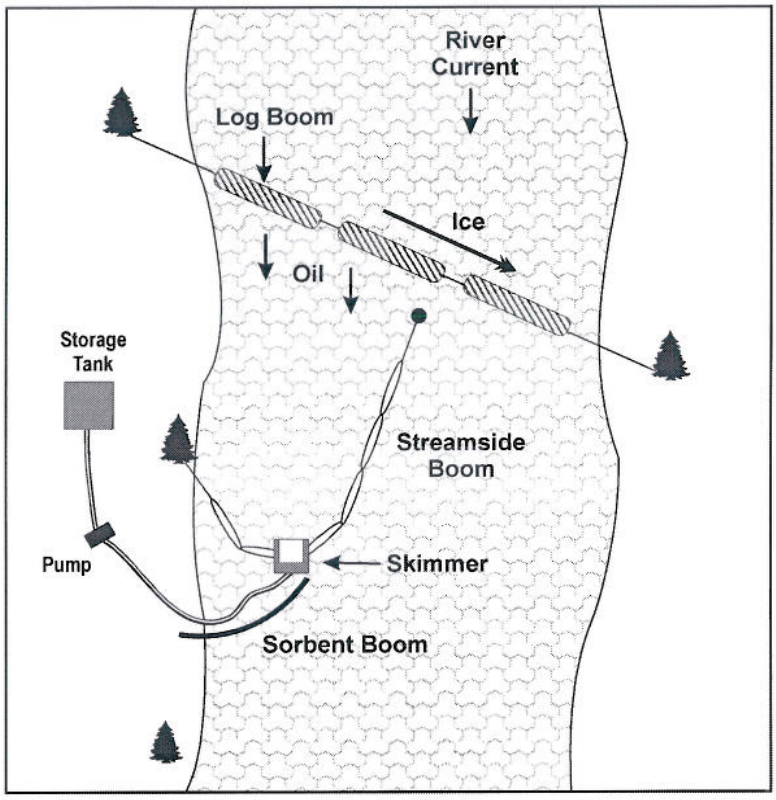

Figure 1
Log Boom Configuration

Purpose

If a released product that reaches a river cannot be totally contained, it may be necessary to protect the following sensitive downstream areas from contamination:

- community water sources
- special habitats
- historical sites
- shorelines
- other specially designated areas

Guidelines

Initial Protection

When selecting protection techniques for sensitive areas, consider:

- priority areas
- feasibility of protection techniques
- rate of product movement
- site accessibility for equipment and personnel
- equipment availability
- time required to get equipment and personnel to the protection site and to deploy equipment
- stream characteristics (e.g., current speed, volume)
- channel configuration (e.g., width, depth)
- man-made structures (e.g., culverts, water intakes, bridges, docks)
- backwater areas or side channels
- shoreline configuration, vegetation and material

Identification

Conditions specific to the released product greatly determine the ranking of sensitive areas that need protection. To identify the most sensitive areas at risk from released product or from associated containment and cleanup activities, consult environmental sensitivity maps and determine the rate of released product movement. Table 1 shows the ranking of environmentally sensitive areas that require protection.

Table 1
Ranking of Environmentally Sensitive Areas

Type of Area	Relative Rank In-Season	Relative Rank Out-of-Season
community/domestic water supply	1	1
domestic fishing area	2	2
other fish habitat	2	3
waterfowl habitat	2	3
wildlife habitat	2	3
archaeological site	4	4

Protection

Protection techniques for sensitive areas are basically the same boom and dike configurations used for containing releases on a river, with more emphasis on diversion and deflection than on containment.

Use one or a combination of the following protection techniques in sensitive areas:

- exclusion booms
- diversion booms
- sorbent booms
- berms or dikes

For guidelines on selecting protection techniques in sensitive areas, see Table 2.

Water Sources

If a released product has the potential to threaten the water source of a community or individual:

- Immediately notify local and provincial/state agencies.
- Immediately notify all water users in the vicinity of the release.

NOTE: For contact information for licensed water users, see the applicable regional Emergency Response Directory. For nonlicensed water users, drive to households in the vicinity of the release, and downstream of the release (up to 25 km [16 mi] if necessary) and inform residents of the situation.

- Inform all water users that the water supply may be shut off and to arrange an alternate water supply as a safety precaution.

NOTE: Determine the party responsible for arranging the alternate water supply on a case-specific basis.

- Where possible, contain the product upstream of the water intake (if known).
- If the product cannot be contained, use a diversion boom to divert oil from the water intake (if known).

Natural Resources

Warn downstream residents of a product release that could affect the use of resources such as hunting, trapping and fishing.

NOTE: For telephone numbers of environmental agencies, communities and land managers (if applicable), see the regional Emergency Response Directory.

 **USA**

If significant adverse impacts to natural resources are anticipated, consider implementing the Natural Resources Damage Assessment (NRDA) procedures in the Emergency Response Directory.

Wildlife/Wildfowl

Areas of important wildlife habitat are located along the pipeline. Whenever a release occurs, make all reasonable efforts to prevent injury to wildlife and waterfowl (see 02-0-07, Wildlife Management).

ENB (NW)

Raptors

If a release occurs near a raptor nesting site, make every effort not to disturb the nests with helicopters or other aircraft.
If heavy equipment is anticipated in a raptor habitat, consult the Canadian Wildlife Service and the GNWT Department of Renewable Resources (for contact information, see the Emergency Response Directory).

Recovery

Recovery techniques for releases in sensitive areas are the same as releases on land (see Table 2, 04-02-01, On Land).

Cleanup

If a release has contaminated several areas, it may be necessary to assign a cleanup priority to each area and deploy limited resources accordingly. Consult local government agencies to determine corrective actions and appropriate cleanup methods.

Cleanup techniques for releases in sensitive areas are the same as releases on land (see Table 3, 04-02-01, On Land).

For guidelines on selecting cleanup techniques for shorelines, see Table 3.

Table 2
Protection in Sensitive Areas

Technique	Primary Use	Controlling Variables	Effects on Environment	Major Resources
exclusion booms	• across or around sensitive areas or at river or creek mouths	• current speed (less than 0.5 m/s or 1 knot) • height of breaking waves (less than 25 cm high)	• minor disturbance to substrate at shoreline anchor points	• work crew • containment boom • work boat and safety boat • 6 to 12 anchors plus anchor line and buoys
diversion booms	• deployed at an angle to the approaching released product to divert product to a less sensitive for recovery, across small bays, river or creek mouths	• current speed (between 0.5 and 1 m/s for single boom; between 1 and 2 m/s for cascading booms) • height of breaking waves (less than 25 cm high)	• minor disturbance to substrate at shoreline anchor points • possible heavy shoreline oil contamination on downstream side	• work crew • containment boom—(1.3 m of boom for each meter of deflection • work boat and safety boat • 6 to 12 anchors plus anchor line and buoys
sorbent booms	• on calm waters for sheen-type product releases	• turbulence • degree of contamination—minor, e.g., sheens, not slicks; not useful for emulsified product	• minor disturbance to shoreline at anchor points • sorbent must be disposed of in an environmentally acceptable manner	• work crew • sorbents • work boat and safety boat • anchors plus anchor line and buoys • storage and disposal containers • chicken wire or suitable fencing; iron pipe or wooden supports
earth berm/dike	• in wide, shallow streams and rivers, and relatively calm water • across a waterway to deflect released product to a location with adequate storage, and access for removal equipment	• availability of sufficient local supply of earth • stream or river depth—less than 0.5 m is ideal	• significant damage to excavation and construction sites • disturbance to local stream and substrate • berm can create eddy conditions between berm and shore—berm should not be located immediately upstream of sensitive area	• operator • work crew—a four-person crew can build 5 in. of dike per hr • earth-moving equipment

Table 3
Cleanup for Shorelines

Nature of Shoreline	Extent of Contamination	Key Requirements	Major Resources
sand or gravel, beaches, mudflats and banks	• pools		• manual removal, pumps, sorbents, vacuum trucks
	• tar balls		• manual
	• thick coating	• environmentally sensitive • insensitive and accessibility to equipment	• low-pressure flushing, manual removal • front-end loader, bulldozer, backhoe
steep cliffs, boulder beaches, manmade structures	• pools		• vacuum pump, sorbents
	• coating or film		• low-pressure flushing • presence of living organisms
	• tar balls		• manual removal, manual scraping, high-pressure flushing, steam clean, sand blast • no organisms present
vegetation	• coating	• environmentally sensitive (remains in vegetation)	• manual cutting, low-pressure flushing, natural recovery

Purpose

In-situ burning involves controlled burning of the product at the release site. When conducted properly under favorable conditions, in-situ burning:

- minimizes the adverse effect of the product release on the environment
- is a fast, efficient, and relatively simple response method
- reduces the need for storing and disposing of the product and generated waste

The key to safe and effective in-situ burning is (a) developing a detailed burn plan, and (b) ensuring all aspects related to site preparation, safety, environmental issues, and containment are adequately addressed.

Requirements

Assessment

Consider in-situ burning when:

- it is unsafe to contain and recover the product mechanically
- burning will prevent or minimize environmental impacts
- soils in the release area are wet or frozen
- mechanical equipment used for cleanup would cause a greater overall negative impact
- product released in water or on thin/broken ice is greater than 2-3 mm (1/10 in.)
- further mechanical cleanup is not possible
- controls are in place to ensure a safe and effective burn
- regulatory approval has been obtained

In-situ burning is not feasible when:

- landowner and regulatory approvals are not in place
- conventional response methods are possible with minimal environmental impact
- product released is less than 2 mm (1/10 in.) thick
- smoke and soot released during the burn will generate public concerns relating to the environment, human health, aesthetics, and safety that cannot be resolved
- fireguards for safe burning may create additional environmental damage that exceeds the impact of the release
- changing weather conditions could result in an uncontrolled secondary fire

Public Health/Safety
To assist in evaluating the feasibility of in-situ burning with regulators, public officials, and landowners, determine safe distances for public health and safety in relation to the location of the in-situ burn.

To calculate safe public distances, use the formula:

$$\text{safe distance} = \frac{\exp [2.5 + 0.0347 \times \text{fire size}]}{4.79}$$

Where:

exp	=	exponential factor (e^x)
firesize(m)	=	m^2
firesize(ft)	=	$ft^2/10.75$

Table 1 shows examples of in-situ burning calculations.

Table 1
In-Situ Burning Calculations

Impacted Area	Safe Distance	
	(km)	(mi)
250 m^2 (2700 ft^2)	0.08	0.05
500 m^2 (5400 ft^2)	0.50	0.30
750 m^2 (8100 ft^2)	3.2	2.0

Approvals
Regulatory authorization and notification must be obtained before in-situ burning.

Since the window of opportunity for in-situ burning is narrow, coordinate approval for in-situ burning through the representatives in the unified command group, or the appropriate regulatory agency.

NOTE: For more information on the unified command group, see 02-02-03, Incident Command System.

To obtain necessary approvals for in-situ burning:

- discuss the overall burn plan with landowners and appropriate regulatory agency(s), and obtain verbal consent
- contact other stakeholders in the vicinity (e.g., police department, fire department, recreational facilities, communities, neighbors)
- in high profile areas, notify the local media and assign a public relations officer to provide information and answer questions
- obtain a burn permit from the appropriate government agency(s)
- maintain ongoing communications with the lead government agency(s) and stakeholders, and provide timely followup information pertaining to the success of the burn and reclamation activities

In-Situ Burn Plan

Prepare a detailed in-situ burn plan that includes:

- overall strategy of the burn
- equipment and personnel requirements
- safety considerations for workers, residents, and the public
- potential impacts on the surrounding area
- environmentally sensitive areas within the burn and fireguard areas
- emergency contingency plan if the burn becomes uncontrolled
- map of the general burn area, including control measures and safety zones

Release Site

Include information about the release site and surrounding area, including:

- product released and associated characteristics (i.e., MSDS information)
- estimated volume released
- estimated size of the release potential for further migration
- environmental sensitivities within and adjacent to the release area, including:
  - waterbodies
  - land use
  - soil porosity
  - wildlife habitat

— groundwater usage
— livestock receptors (e.g., water wells)

In addition, assess off-site characteristics, including:

- current weather conditions and forecasts (immediate and long range)

NOTE: Pay particular attention to wind direction and speed, as well as storm potential.

- topographical features
- adjacent land use
- potential impacts from an uncontrolled burn on the surrounding area
- effects of smoke on the surrounding area
- precautionary evacuation required
- any other concerns

Site Preparation

Preliminary

Ensure the work area has been assessed for buried equipment through local one-call agencies and other resources (e.g., regulatory agency records, survey searches, land titles easement records), and/or by line locating.

Safety

In snow covered and frozen conditions, determine the outer edge to ensure a safe work site:

- Remove snow and debris as close to the perimeter of the release as possible.

- Before accessing any of the release area, determine the depth of ice and frost.

- Identify the location of fire control equipment (e.g., fire trucks, water pumps, extinguishers), and fireguard crews

Environmental

Restrict heavy equipment access to designated areas and routes.

Avoid disturbing soils that may be prone to erosion.

Remove and conserve top soil for final reclamation.

Ensure disturbed soil does not enter moving or standing bodies of water.

During fireguard construction:

- avoid mixing oil contaminated soil with clean material
- salvage merchantable timber removed as required
- use specialized equipment (e.g., tracked and low-pressure tire units) in high water table areas or muskegs where conventional equipment may damage organic soils

Containment

Construct a fireguard or berm around the site to protect the area adjacent to the released product.

When sizing the type and width of fireguard required, consider the extensive pre-heat capability of a hydrocarbon fire.

Dry Land

Clear all surface fuels for at least 30 m (90 ft) from the edge of the burn to the closest standing timber.

NOTE: This distance may be altered depending on site-specific circumstances for government-owned and private lands.

Wet/Inaccessible Areas

Remove trees, vegetation and organic soil manually if they interfere with the efficiency of the burn.

Remove trees outside of the fireguard area to eliminate the possibility of a secondary fire caused by sparks or radiant heat.

For adequate containment, the width of the hand-constructed fireguard depends on site-specific conditions and must be supplemented by additional containment methods.

A hand-constructed fireguard to a depth beyond the topsoil of 0.5 to 1.0 m in width may be sufficient if used to supplement other containment methods (e.g., a backfire).

NOTE: Only experienced personnel must use backfires to supplement hand fireguards.

In standing water, confine the released material to minimize shoreline impact.

Use available natural barriers (e.g., bare soil, bull rushes, sedges).

In muskegs, determine the outer boundary of the released product visually, on foot or by vehicle or aircraft.

In winter conditions, burning may generate significant volumes of water (possibly contaminated with unburned hydrocarbons) that must be contained and collected using trenches, berms, inverted weirs and other such devices. Plan containment and processing for these volumes of water in advance of the burn.

Construct secondary containment devices in areas of concern.

Health and Safety Precautions

NOTE: For information on general release site safety precautions, see 02-02-04, Safety Precautions.

In-situ burning presents unique health and safety concerns for emergency response personnel, including:

- fire hazards
- ignition hazards
- exposure to extreme heat

Before the in-situ burn operation, review the burn plan to ensure response personnel:

- clearly understand the responsibilities and hazards associated with the spill response
- are familiar with emergency response procedures and escape routes
- are familiar with the location and operation of all first aid, emergency. and safety equipment

In addition, ensure adequate supplies of firefighting equipment, personal protective equipment (PPE), and water are available onsite (depending on site-specific conditions and number of personnel involved).

Throughout the in-situ burn operation:

- Identify and continuously assess any hazards associated with the released product.
- Continually monitor the area surrounding the release site for flammable, toxic and oxygen-deficient atmospheres and other hazards.
- Approach the product release from upwind.
- Maintain a head count of all personnel onsite.

Ignition

Timing and Conditions

> ⚠WARNING: Since in-situ burning involves the intentional setting of a fire, great care must be taken to ensure the fire is controlled at all times.

Use experienced response personnel to oversee the burning activities and to monitor the burn plan.

Continually monitor weather activities and changes. Overall weather patterns should be stable, and burning should not occur when wind conditions are high (>10 km/hr on the Beaufort Wind Scale).

Do not ignite the product until the entire area is secured (02-02-05, Site Security and Control).

If the potential exists for secondary fires, ignite during a generally low-burning period of the day (i.e.,18:00 to 10:00 hrs)

If the product is heavy oil or is severely weathered, consider burning during the heat of the day (if safe).

Method

Response personnel must be a minimum of 90 m (300 ft) back from the site when the product is ignited.

To create a sustained burn long enough to ignite the product, ensure the point of ignition is between 2 to 3 mm (1/10 in.) thick.

Products with significant "light end" hydrocarbon components will likely ignite without an auxiliary fuel agent. A flare shell propelled from a safe distance is often an adequate igniter.

Products with significant "heavy end" hydrocarbons may require an auxiliary fuel agent. Generally, diesel and kerosene are considered the best igniters as the flame temperature is relatively high. Lighter products, such as gasoline, evaporate much faster than diesel which results in the faster cooling of the slick. Dry straw or kindling may be effective, but must be ignited in a safe manner.

To reduce the chance of fluid migration, ignite the outer edge of the product and allow the fire to burn from the outside in.

Use multiple ignition points where possible to spread flames throughout the release area and improve burn efficiencies. Igniters may include:

- flare shells
- jelled gasoline
- canister igniters
- aerial ignition devices
- propane torches

Allow the initial burn to complete without adding more fuel.

Monitoring

Monitor the local weather conditions and long-range forecasts on an ongoing basis.

Be prepared to implement an emergency contingency plan if conditions suddenly change.

Maintain strict site security until all potential hazards are totally eliminated.

Use a fire watch on the entire perimeter of the site to ensure no secondary fires occur.

Visually monitor the migration of smoke from the burn.

Keep regulatory agencies, landowner(s), stakeholders, the public and the media informed throughout the burn operation.

Implement an ambient air monitoring program if required.

Post-Burn

As soon as possible after the burn has been completed:

- inspect the area to determine the success of the burn
- initiate soil sampling to determine the amount of residual oil contamination left onsite
- assess the burn site to determine remediation work required
- ensure the burn is totally completed and take action to extinguish all burning organic matter
- be aware of residual hydrocarbon areas that may still be hazardous
- keep the area secure until the inspection has been completed
- remove any safety hazards (e.g., trees, stumps, etc.)
- complete "spot burns" as required; however, conduct a thorough safety inspection before further burning
- ensure all aspects of the burn program are sufficiently documented.
- conduct a post-burn review
- ensure all stakeholders are satisfied with the response and planned followup reclamation program

Requirements

To contain and divert the product to a recovery point, position a boom at the appropriate angle in relation to the shoreline. This angle varies with the speed of the current. Generally, the faster the current, the smaller the boom angle. To determine the appropriate boom angle, see Table 1.

If the boom angle is too great for the current speed of the river, the boom will either break away from its anchors or allow the product to wash under it. Other factors to consider when determining the angle of boom deployment are:

- turbulence
- water depth
- depth of the boom skirt in the water

Trained personnel must supervise personnel working with the Boom Vane and related equipment.

⚠CAUTION: Use caution when working around and handling the lines. While deploying the Boom Vane, ensure personnel are on the shore side of the Boom Vane, boom and mooring line.

Table 1
Surface Current and Boom Deployment Angle

Time for Object to Travel 30 m (100 ft)	Current			Boom Angle
sec	km/hr	m/s	mi/hr	°
216	0.5	0.14	0.3	60
108	1.0	0.28	0.6	
72	1.5	0.42	0.9	
54	2.0	0.56	1.2	45
43	2.5	0.69	1.5	
36	3.0	0.83	1.9	
31	3.5	0.97	2.1	15
27	4.0	1.11	2.5	
24	4.5	1.25	2.8	
22	5.0	1.39	3.1	
18	6.0	1.67	3.7	

Personal Protective Equipment (PPE)

When working in water or at the water's edge, at the discretion of the Incident Commander, wear:

- hard hats
- hip waders
- life jackets, or a safety harness attached to an attended safety line

NOTE: For information on boat safety, see 02-02-04, Safety Precautions.

Markers

Clearly mark the work area with buoys both upstream and downstream of the site.

If a cable is strung across the water to hold the boom, clearly mark it with flag tape or hanging buoys.

Booms/Skimmers

Connect booms on shore and push them into the current to reduce the number of workers entering the water.

Once skimmers are in operation, enter the water only to clear debris from the inlet.

Towing

Secure the towline to the boat so that it can be released rapidly if necessary.

Connect the towline as close to the waterline as possible.

Always tow from the rear, never from the side.

Keep the towline within 30 in. of the long axis of the boat.

▲CAUTION: Never attempt a tow if the boat's power is inadequate.

Anchors

Anchors must be lifted overboard by two people.
In fast water, lay an upstream anchor only with the boat facing into the current.

Before fastening shoreline ropes, secure shoreline anchors.

Clearly mark anchor cables in the water with buoys.

Procedure

Using BoomVane

1. Determine a location for the oil recovery point, and then lay out the boom, BoomVane, and mooring line along shore (see Figure 1a).

2. Connect each component to the connector plate.

3. Anchor the mooring line and boom to shore.

4. Push the BoomVane from shore so that it free-floats towards midstream (see Figure 1b).

5. When the BoomVane has towed out and positioned the boom, adjust the mooring line to achieve the optimum boom angle (see Figure 1c).

6. If necessary, set up a second BoomVane in deflector mode (see Figure 1d).

7. When recovery is complete, or if necessary to allow vessels to pass, operate the control line to the BoomVane to bring the BoomVane back to shore (see Figure 1e).

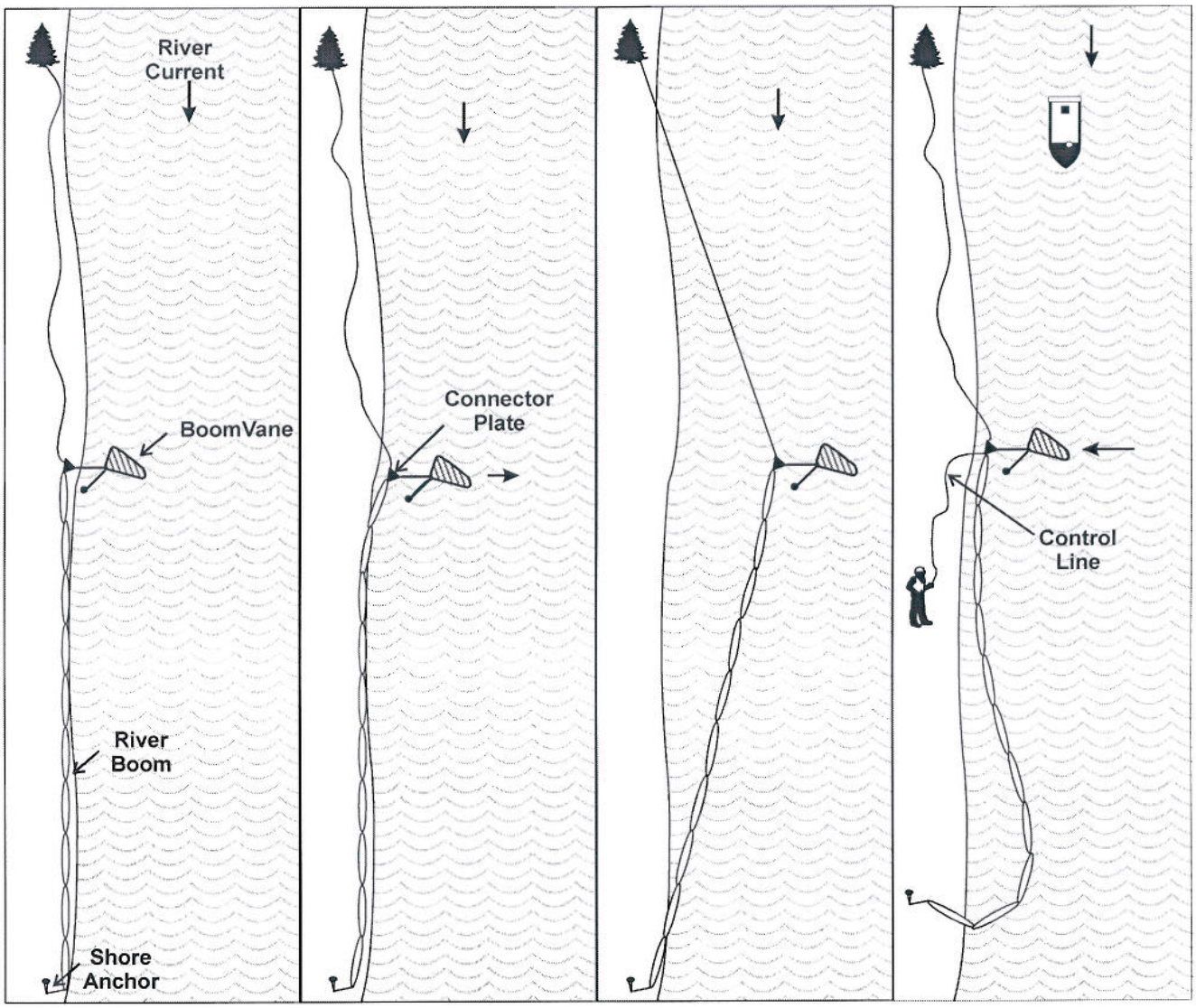

Figure 1
Deploying River Boom Using BoomVane

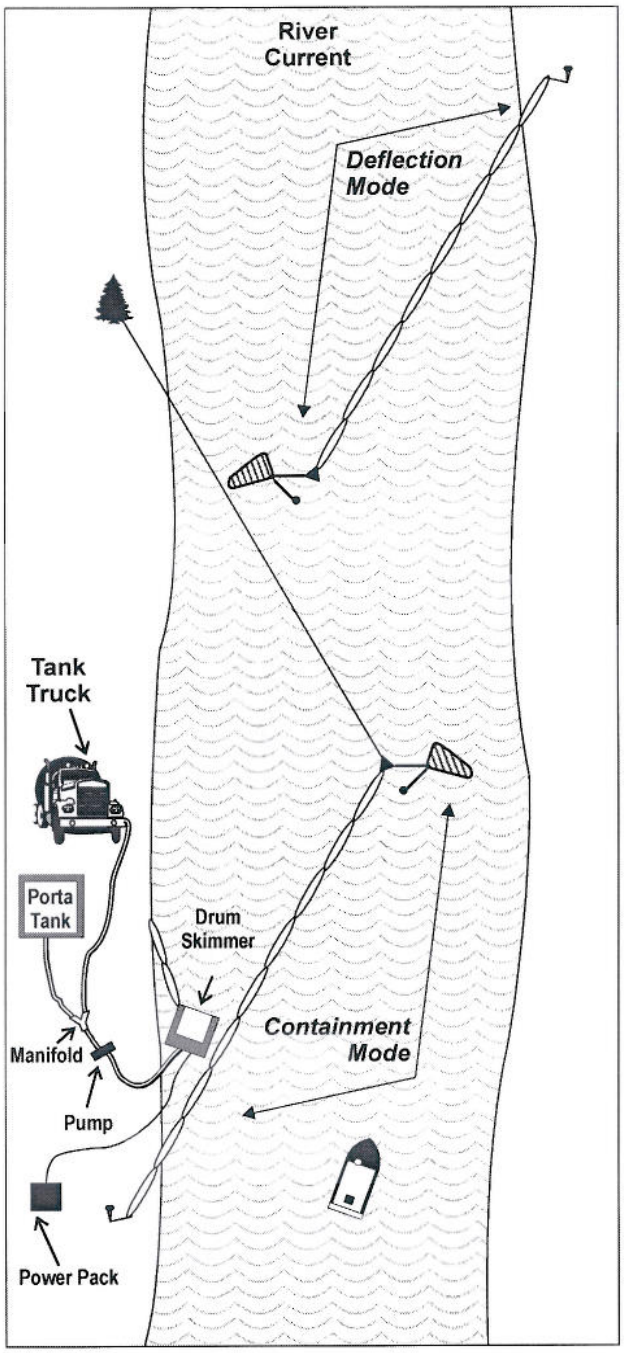

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Figure 1—*continued*
Deploying River Boom Using BoomVane

Using Boats

NOTE: The following equipment (e.g., colored ropes) is typical of the company's emergency response units.

1. Connect blue rope to four marker buoys and anchors.

2. Deploy two buoys upstream and two downstream of the control point to alert boat traffic of the situation (see Figure 2a).

3. Assemble two disk anchors and attach a recovery buoy with blue rope to the back of disk anchor #1.

4. Connect a ½ in. chain, 25 ft long, to each anchor, and then attach a 25-ft long cable sling to each chain (see Figure 2b).

5. Connect a marker buoy to the end of the cable on anchor #1 and load the anchor assembly into the workboat, leaving #2 anchor on shore.

6. Add up the total length of anchor hardware plus boom length (e.g., 100 ft of anchor hardware plus 250 ft boom).

7. Calculate 80% of the total in step 6, (e.g., 280 ft) then pace off this distance upstream from the chosen position for the skimmer (see Figure 2c).

8. With the distance paced off, establish a suitable landmark to mark this position, which will be the set point for anchor #1.

NOTE: Deploying anchor #1 requires visual reference to the upstream landmark and directions from the on-scene commander as to how far into the current to locate the anchor. The faster the current, the smaller the angle the boom should make with the shore (see Figure 2d).

9. Deploy anchor #1 from the workboat, and feed out the chain and cable as the boat drifts downstream (see Figure 2e).

NOTE: Do not set #1 anchor by pulling on it with the boat.

10. Load anchor #2 and proceed to the marker buoy attached to the cable end of anchor #1 (see Figure 2f).

11. Pick up the buoy and remove it from the cable, then connect the cable from anchor #1 to the back of anchor #2.

12. Connect the marker buoy to the cable on anchor #2, then drop anchor #2 and feed out the chain, cable and buoy.

13. Attach a suitable length of blue rope from the buoy to the bow of the boat, then set the 2 anchors by letting the boat drift backwards until snug and applying reverse power (see Figure 2g).

NOTE: If the anchors do not hold, more chain may be added.

14. Disconnect the boat from the marker buoy, assemble the boom sections in accordion fashion and place the boom in the water.

15. Connect a:
    - boom tow paravane on the lead end of the boom
    - tow bridle and green tow rope on the tail end of the boom
    - a handline bridle at each connector on the inside of the boom (see Figure 2h).

16. Using a length of blue rope, attach the short cable on the paravane to the quick release on the boat.

17. Tow the boom out to the marker buoy attached to the cable end of anchor #2, allowing the green rope at the tail end to remain slack (see Figure 2i).

18. Attach the long end of the paravane cable to the end ring on the marker buoy, using a carabiner.

19. Relay handling ropes from the shore and attach to the handling bridles on the boom, starting from the lead end and working downstream (see Figure 2j).

20. Pull on the ropes (shoreline crews) in a downstream direction to achieve as straight a line as possible on the boom.

21. When the boom is properly straightened, drive in the tie-off pins and attach the handling ropes (see Figure 2k).

22. Connect the skimmer to the main boom, and connect the shore-side boom and sorbent boom to the skimmer (see Figure 2l).

23. Attach the floater hose to the skimmer and to the pump (see Figure 2m).

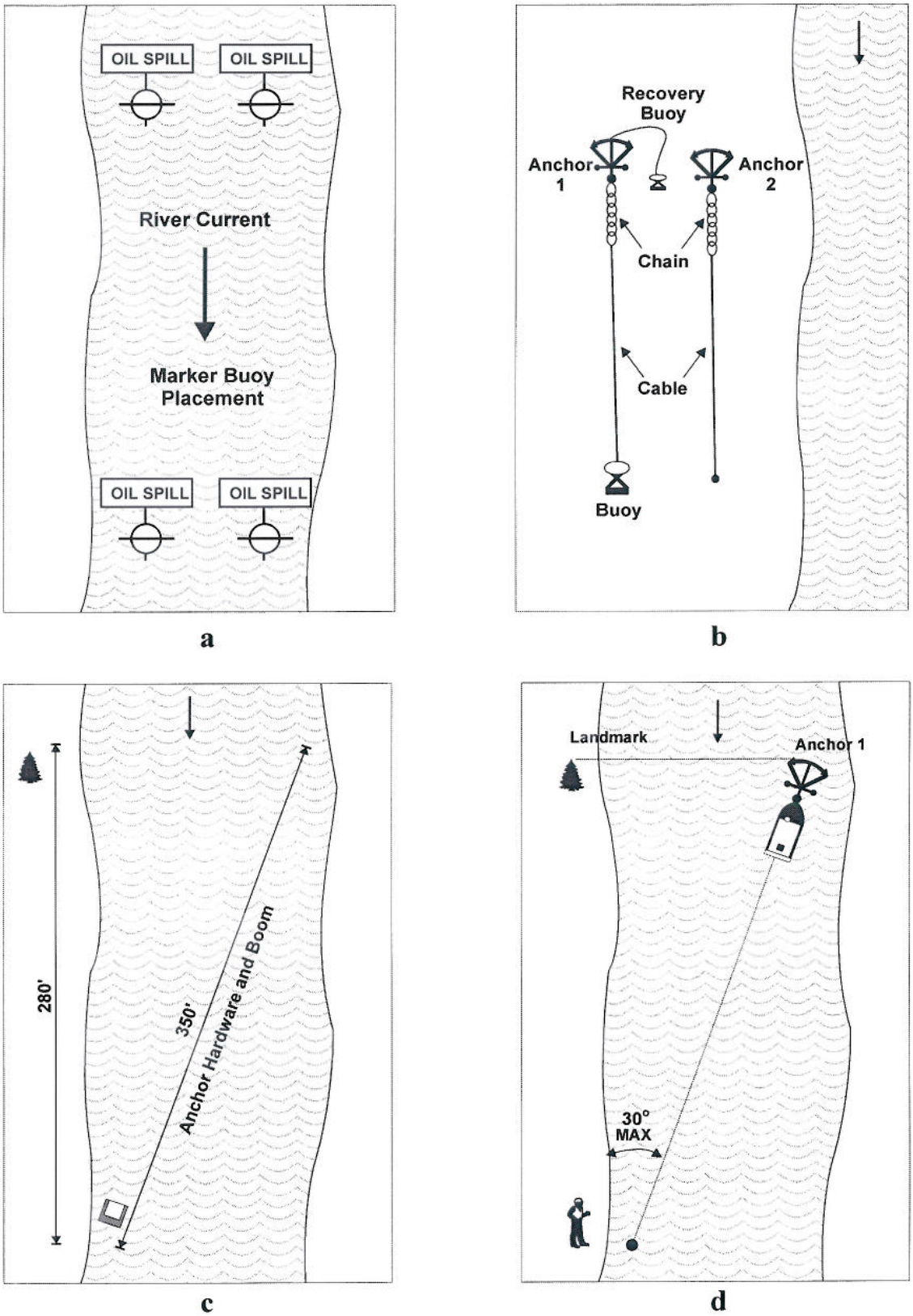
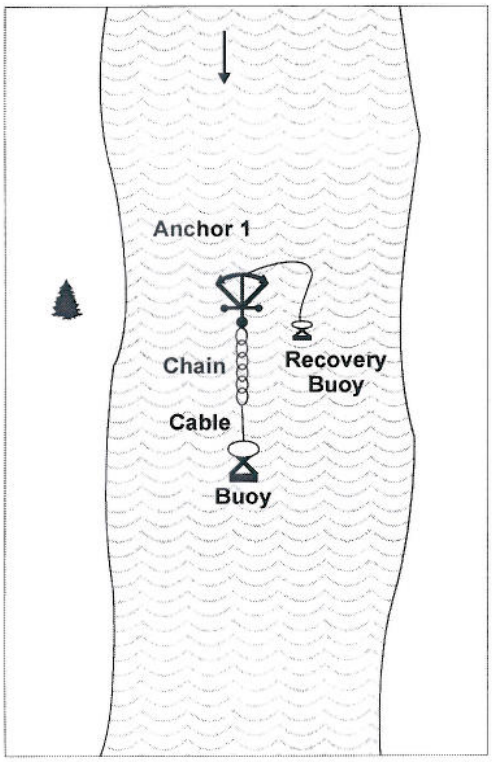


Figure 2
Deploying River Boom Using Boats



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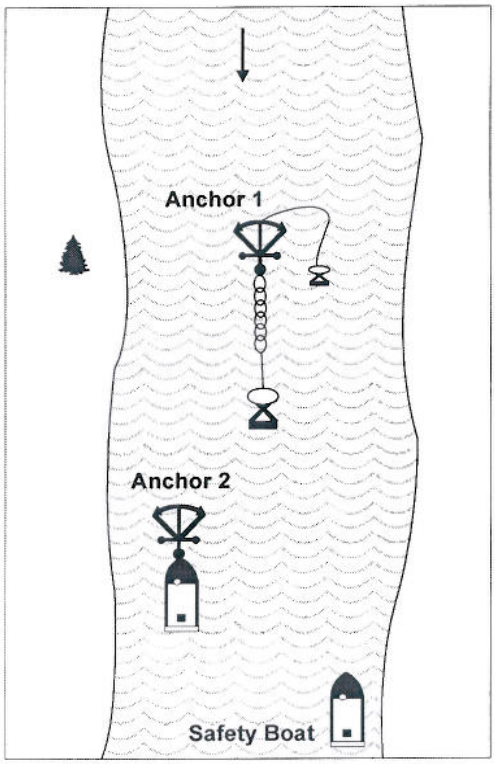

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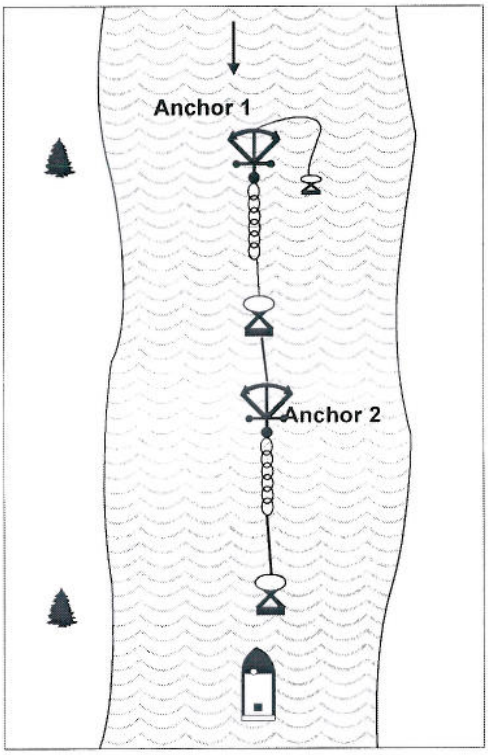

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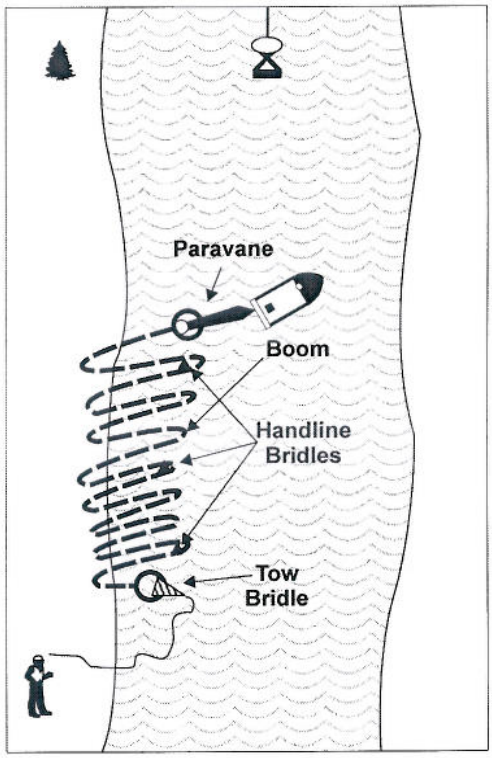

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Figure 2—*continued*
Deploying River Boom Using Boats

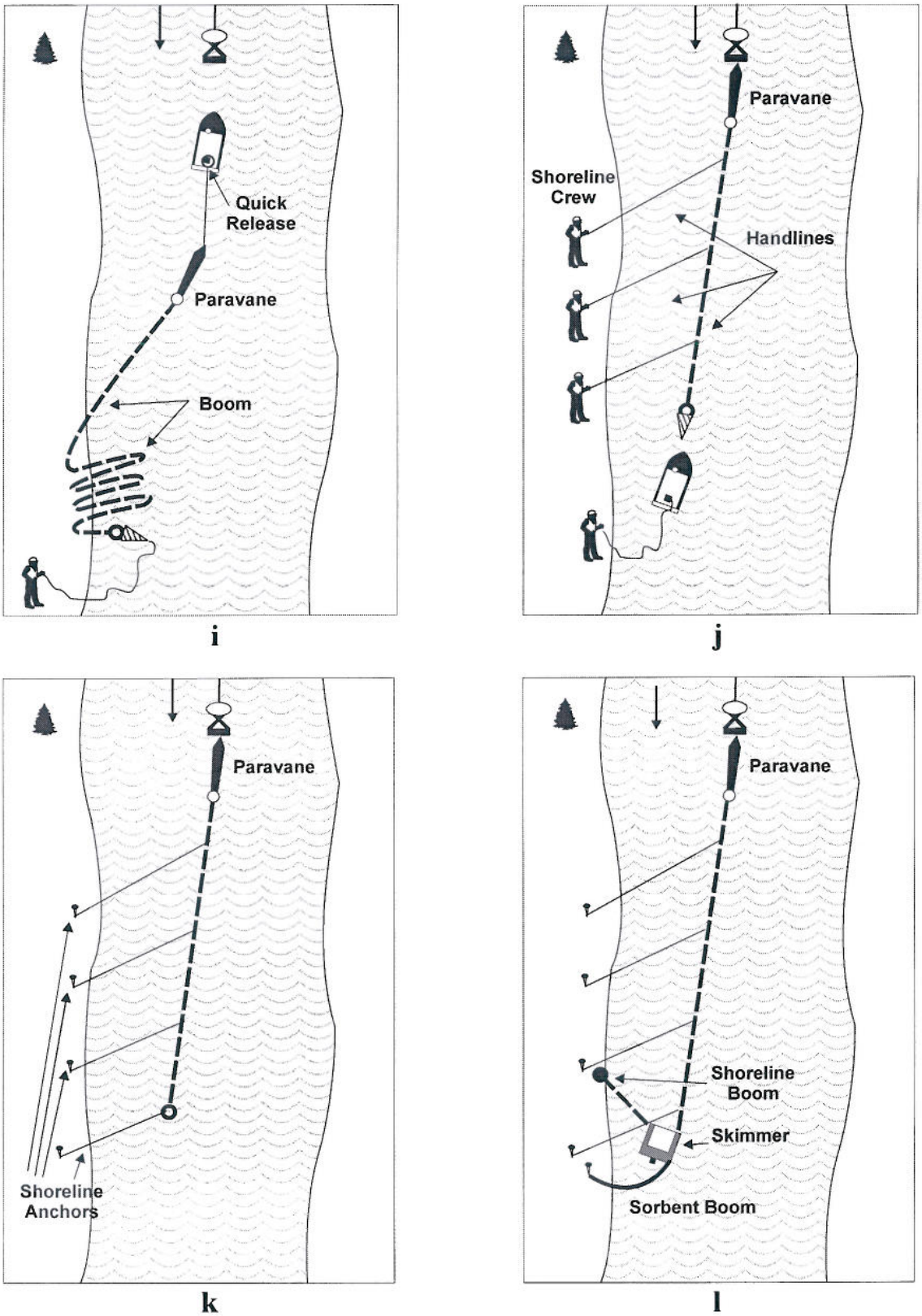

Figure 2—*continued*
Deploying River Boom Using Boats

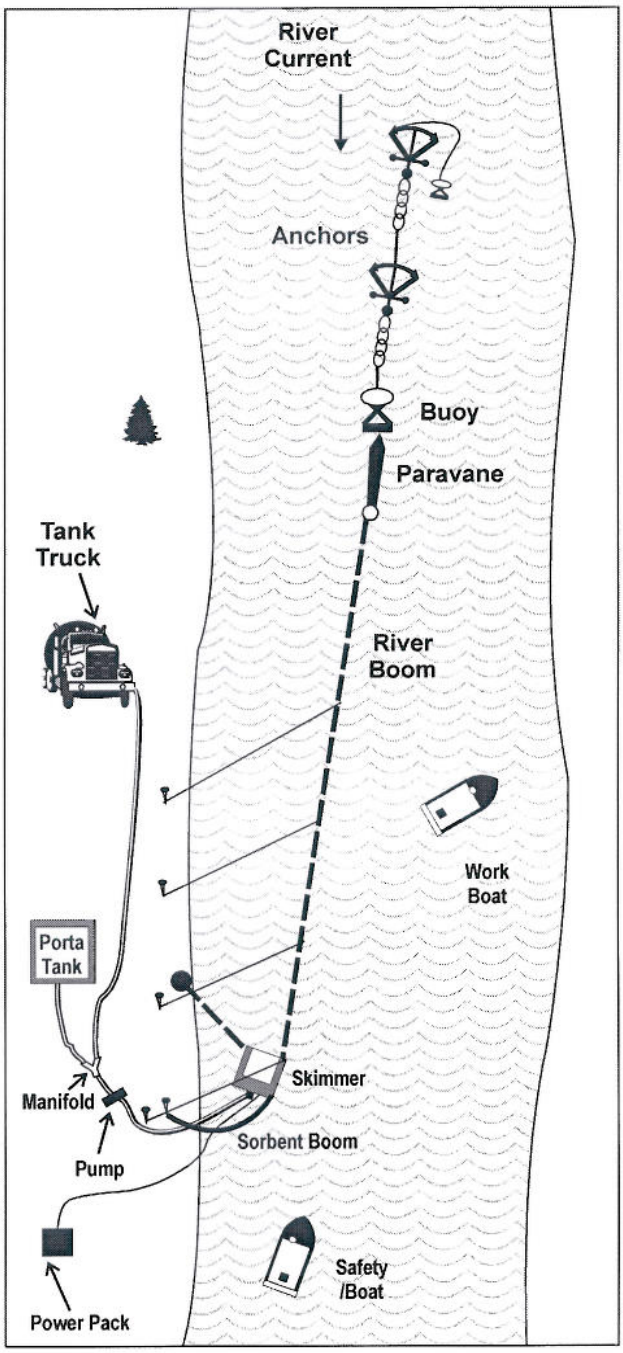

Figure 2—*continued*
Deploying River Boom Using Boats