3.3.3.3 | Larger Watercourses | Boom Deployment River Bed Anchor

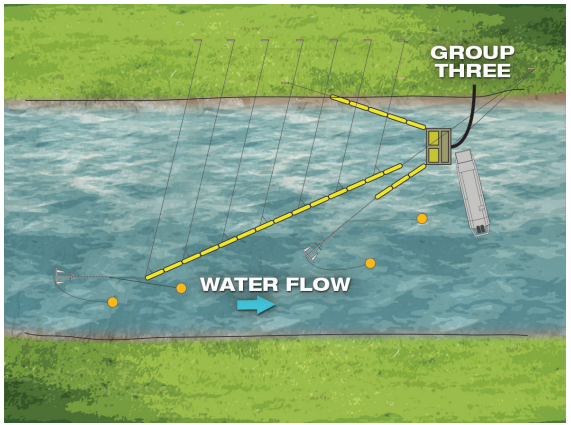


Diagram 3.3.3.3c Boom Deployment River Bed Anchor: Diversion booms installed. Boat installing skimmer (Group Three) at the downstream end of the diversion booms.

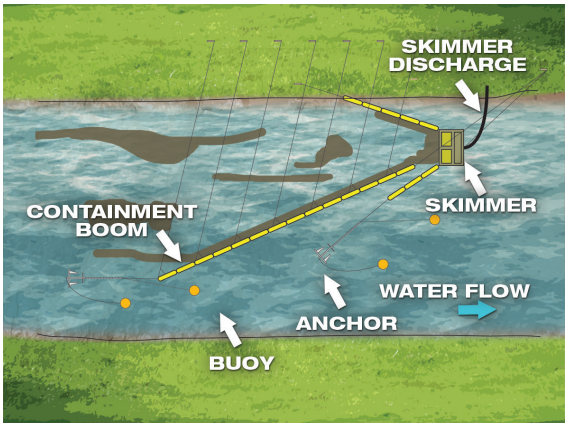


Diagram 3.3.3.3d Boom Deployment River Bed Anchor: Completed diversion and collection installation

Tips: - Note the overlapping booms at the skimmer. Easier to install than a single boom leg connected directly to the skimmer.

- Boom shape can be held at the optimum angle with intermediate control lines running to shore.

3.3.3.3 | Larger Watercourses | Boom Deployment River Bed Anchor

Watch Your Step

Call Before You Dig

Observe "No Anchor" Zones

Purpose: To install a spill containment and recovery deployment at a river bank location using river bed anchored boom and a skimmer.

Application: To install a collection and recovery system in a moving watercourse.

Environmental Considerations: Anchor deployment may disturb the stream bed. Avoid unnecessary disturbance. Ensure minimal disturbance of shoreline.

Equipment Required: Boats (workboat and safety boat), anchor assemblies, booms, ropes, carabiners, tow bridles (single and double designs, if available), sideline bridles, shore anchor pins, sledge hammers/post drivers, skimmers, pumps, hoses, temporary liquid storage devices.

Optional But Recommended: Laser rangefinder, three-way manifold to permit easy changing from delivering to or from temporary liquid storage tank to vacuum truck or tank truck

Operation:

Note: This description involves using stub booms (outboard and shore protection) rather than joining the containment boom length directly to the skimmer. It has been found that there is less site congestion during assembly when the two modules (containment boom and recovery) are built simultaneously but deployed separately (better manpower utilization). The containment boom angle can subsequently be adjusted easily without disturbing the recovery component. A responder can connect the main boom length directly to the skimmer or even run it past the skimmer to shore, although the latter presents more opportunities for the spill to escape the skimming device.

3.3.3.3 | Larger Watercourses | Boom Deployment River Bed Anchor

Compute or determine stream speed, boom angle and calculate the length required for the containment boom.

Note: A safety boat, deployed downstream of the work area, is advisable when available and should remain on station throughout the activities that are on, in or near the water.

Anchor Deployment and General Equipment Assembly Note that there are potentially many pieces to a midstream diversion/collection system. Whenever possible, the installation of individual components overlapping one another will be easier than placing a single, integrated unit.

3.3.3.4 | Larger Watercourses | BoomVane™ Deploying Containment/Recovery/Deflection Modes

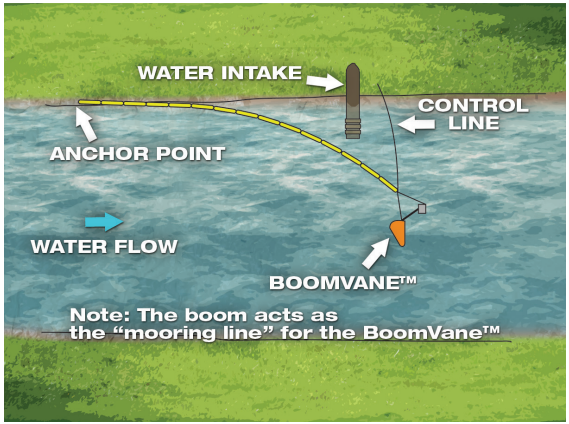


Diagram 3.3.3.4a BoomVane™ Deploying Containment/ Recovery/Deflection Modes

Example 1: BoomVane is used to tend the downstream end of a boom intended to divert oil away from the shoreline.

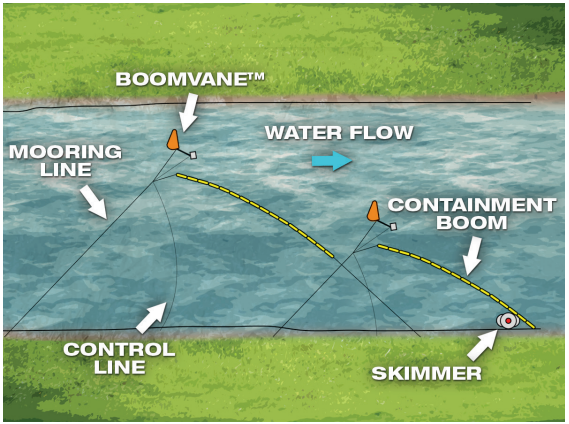


Diagram 3.3.3.4b BoomVane™ Deploying Containment/ Recovery/Deflection Modes

Example 2: BoomVanes are used to tend the upstream ends of booms being used to divert oil out of the main stream to a collection area. A cascade system is shown.

3.3.3.4 | Larger Watercourses | BoomVane™ Deployment Containment/Recovery/Deflection Modes

BoomVanes can be used in place of ground tackle when deploying deflection and diversion booms.

More comprehensive information may be found in the BoomVane Operation & Service Manual and the BoomVane Shore-based Deployment Geometry and Quick Reference Tables.

Tips: - A BoomVane can be "walked" into deep water more easily if rolled on its side, with the float facing away from the person deploying it.

- Secure mooring points and proper mooring line lengths are critical to the deployment and use of BoomVanes. Tables found in BoomVane manuals will aid in locating anchors and determining proper line lengths. Diagrams 3.3.3.4a and b highlight some techniques that can utilize the capability of the BoomVane.

Purpose: To deploy boom quickly in a river to contain/recover/deflect a spill.

Application: Used in place of midstream anchors when there is sufficient current; useful when boats are not available to set anchors or when there is limited access

Environmental Considerations: If using a tree as an anchor, protect the tree bark from chafing by employing a piling bridle or sorbent boom as a liner.

Equipment Required: Boom, BoomVane(s), control line, mooring line, short line to connect BoomVane's bridle to connector plate (optional), downstream boom/shore anchor line, tow bridles (2), shore anchor pins, if required

Sledge hammer/post driver, if applicable, skimmer, pump, hoses, temporary liquid storage device (bladder, tank, vacuum truck)

PFDs, waders, safety harnesses and lifelines

Operation:

1. Place boom along water's edge in the desired deployment location. Linking together the boom sections along the shore in slight zigzag provides the boom for the curve that will be created once the BoomVane deploys the boom. Attach upstream and downstream end (tow) bridles to boom ends.

3.4 | Open Water

Oil containment and recovery systems in Open Water environments and large river systems require dedicated vessels with deep draft, high volume skimmers, storage barges, and heavier containment boom. In rivers, oil usually travels downstream. However, oil can travel upstream, such as at the mouth of a river, where an incoming tide can reverse its flow. Wind speeds, currents, ice, and ambient temperature may also have an effect on the direction and character of oil in Open Water situations. Containment and recovery tactics such as special oil storage boom, equipment for recovering oil in ice, and high volume pump skimmers for very large and deeper water bodies are addressed in this section.

3.4.1 | Open Water | NOFI Current Buster® 2 & NOFI Current Buster® 4

Hazard Management

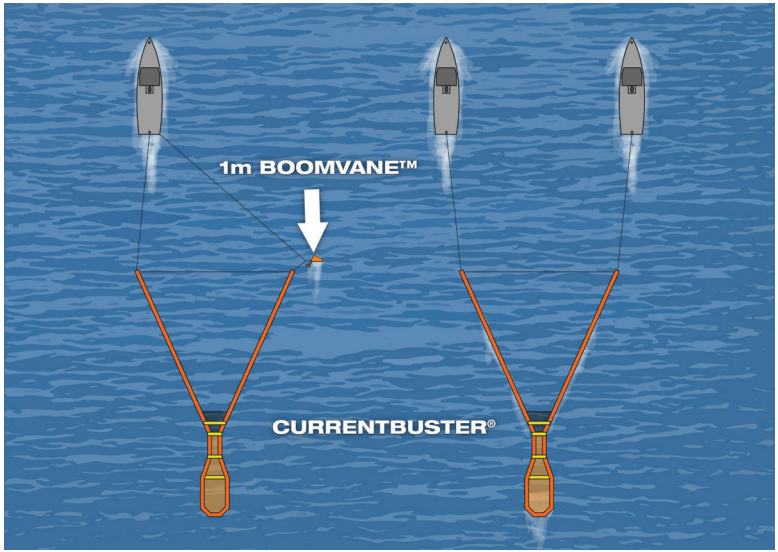


Diagram 3.4.1a NOFI Current Buster® Technology Shown with a Single Vessel Configuration with BoomVane™ (Left) and NOFI Current Buster® Technology Shown with a Double Vessel Configuration (Right).

3.4.1 | Open Water | Containment | NOFI Current Buster

Purpose: To contain and collect oil at speeds ranging from 0.5 up to 3 knots in reasonable weather conditions.

Application: Both the NOFI Current Buster® 2 and 4 are capable of open and inland shallow water recovery and containment of oil. The NOFI Current Buster® 2 is also useful for inland river and stream applications in both a standard towing configuration and a stagnant/fixed application to shore or a structure such as a bridge or pier.

Environmental Considerations: Consider environmental sensitivities such as vegetation, rare plant and animal species, sensitive soils and shorelines, critical habitat, and fisheries regulations before deploying the equipment.

Equipment Required: QualiTech Environmental Containerized system with contents consisting of: NOFI Current Buster® 2 or 4, hydraulic reel, hydraulic power pack with regenerative blower for inflation, two vessels equipped for towing (150 hp minimum recommendation).

Optional Equipment: Backpack blower equipped with Monsun inflation adaptor, QualiTech Inland River Anchor System, NOFI Integrated Pump System, NOFI Light System for night operations, Elastec BoomVane™

Operation:

1. Deploy with guide booms first and retrieve with separator to allow water to flow freely out of the system without forming water pockets.
2. The integrated Front Sweep net is weighted and will therefore sink. When deploying in shallow water the net may snag on the bottom. In such unfavorable conditions a rope may be tied around the sweep arms and the netting to prevent the net from sinking. NOTE: This rope must be cut prior to operation.

3.4.1 | Open Water | Containment | NOFI Current Buster® 2 & 4

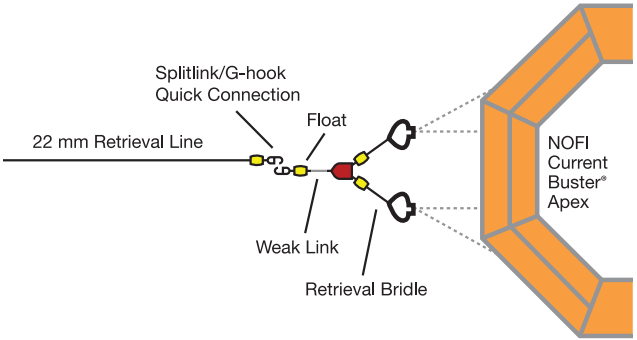


Diagram 3.4.1b NOFI Current Buster® Retrieval

Operation/Retrieval:

- The retrieval line is connected to the retrieval bridle by a G-Hook (split-link) connection.
- Retrieving may be done with any accessible equipment e.g. forklift, crane, winch, a car's towing hook, etc.
- If the system is retrieved to a boom reel, it must be wound up firmly. A vessel or a vehicle may assist in maintaining tension in the system while it is being retrieved. When winding up the towlines, make sure that the towlines do not get stuck in between the boom reel's sidewalls and the boom system itself, due to risk of jamming the towlines.

Application:

- When towing begins, the separator fills slowly with water. An initial speed of 2 to 3 knots is recommended in order to fill up the separator. During this filling process the separator bottom may appear unstable but the system will still collect oil.
- If the towing stops, the ballast in the separator will impede the separator bottom from floating up. Some water will escape, and when the towing begins again, it will take a few minutes to reach the normal filling level.
- Even if the speed through the water and oil type varies, no adjustments of the system are required.

3.4.1 | Open Water | Containment | NOFI Current Buster® 2 & 4

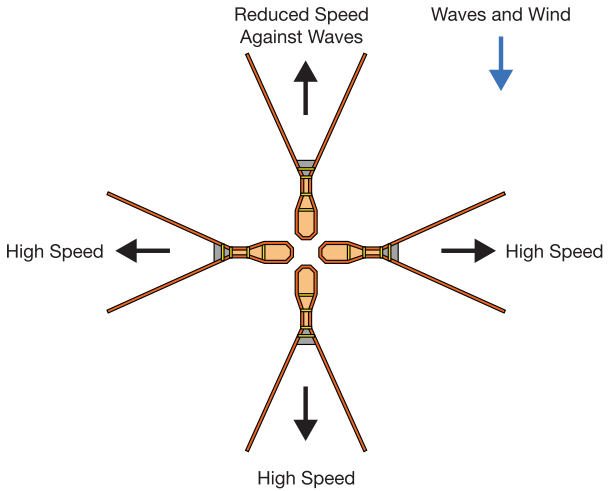


Diagram 3.4.1c NOFI Current Buster® Towing Speed

Operation/Towing Speed:

- The maximum towing speed is determined in two ways:
  1. The maximum oil collecting speed is 3 knots through water because significant loss of oil occurs. Operation at higher speed is not recommended. Note that in current exposed areas, a GPS reading will give wrong speed-reading against water.
  2. When towing directly against short-period waves, the speed should be limited to 1 to 2 knots to avoid splash-over in the stern.
- Normally higher speeds may be used when towing with the waves or at 90 degrees to the wave direction, compared to directly into the waves.

3.4.2 | Open Water | Containment | Sea Sentry II Oil Boom

Hazard Management

Isolation of Energized Systems

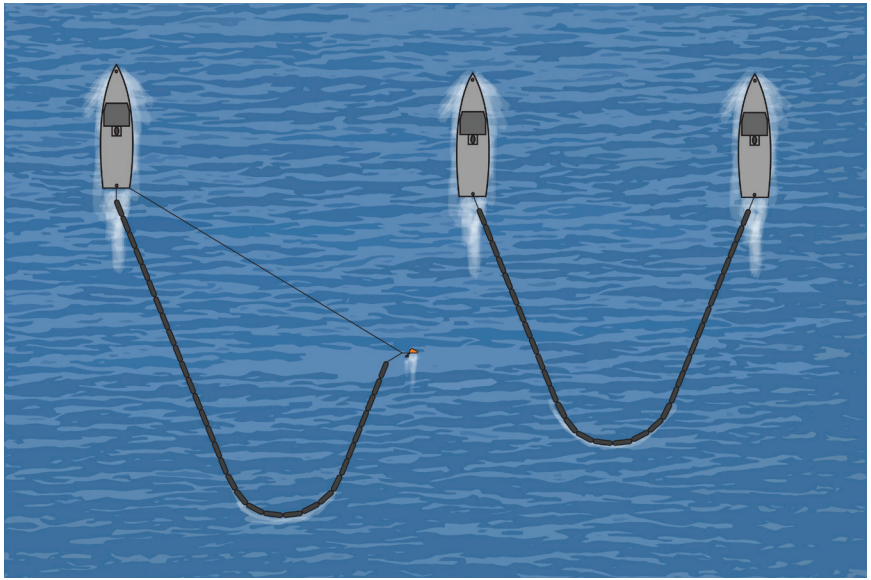


Diagram 3.4.2a Sea Sentry II Boom with Single Vessel / 1m BoomVane™ Configuration (Left)
Sea Sentry II Boom with Two Vessel Configuration

3.4.1 | Open Water | Containment | Sea Sentry II Oil Boom

Purpose: To contain and collect oil at speeds up to 0.8 knots in reasonable weather conditions and in high demanding environments.

Application: Heavy duty offshore application. Can be used for active towing and as protection boom for islands, sensitive areas such as hatcheries, etc.

Environmental Considerations: Consider environmental sensitivities such as vegetation, rare plant and animal species, sensitive soils and shorelines, critical habitat, and fisheries regulations before deploying the equipment.

Equipment Required: QualiTech Environmental Containerized System with contents consisting of: 550' of Sea Sentry II Oil Containment Boom, hydraulic reel, hydraulic power pack with regenerative blower for inflation, two vessels equipped for towing (300 hp minimum recommendation)

Operation/Development:

1. Deploy and recover with inflation valves facing up. Each air chamber is 15 feet / 4.6 metres in length and has two Monsun air valves per chamber. There are seven flotation chambers per 110 foot / 33.5 metres section of boom.
2. Stage the boom on land or on the deck of a vessel to inflate, or inflate the boom from the reel as it is deployed from land or sea.
3. The ballast chain will "sink" keeping the boom upright and the draft taught.

3.4.2 | Open Water | Containment | Sea Sentry II Oil Boom

Operation/Inflation:

1. During towing operation, be cognizant of the temperature of the boom. During colder morning operation, if the boom is inflated to 1.5 psig, as the boom warms the air may expand increasing the psig and exceeding the 1.5 psig maximum causing severe damage.
2. Monsun valves have an open and closed position. When the valve seat (plate) is pressed down and turned to the right, the valve is locked in open position (as is done during retrieval). When turned to the left, the valve is closed. Inflation is still possible with the valve in closed position.
3. All air chambers have two valves. Prior to inflation, make sure the opposite valve is closed. The boom is designed to be inflated to a maximum of 1.5 psig. Once inflated, be sure to seal the Monsun valve with the outter cap.

Operation/Retrieval:

1. A rope or tag line may be used to connect to the tow bridle to recover the 550 feet /168 metres of boom. Be sure to open both Monsun valves and recover onto the boom reel being sure to avoid over pressure and severe damage.
2. If the system is retrieved to a boom reel, it must be wound up firmly. A vessel or a vehicle may assist in maintaining tension in the system while it is being retrieved.

Operation/Towing Configuration:

1. When towing begins, constant communication between the vessel operators/captains should be maintained. This will aid in a successful collection of oil as they match speed and achieve maximum efficiency.
2. It is worth noting that at towing speeds upwards of 0.8 knots entrainment is encountered and conventional booms may start to fail.
3. Even if the speed through the water and oil type varies, no adjustments of the system are required.

3.4.1 | Open Water | Containment | Sea Sentry II Oil Boom

Tip: When starting operation, tow boom slowly, and be sure to communicate between vessels.

Operation/Towing Speed:

- The maximum towing speed is determined in two ways
  1. The maximum oil collecting speed is 0.8 knots through water because significant loss of oil occurs. Operation at higher speed is not recommended. Note that in current exposed areas, a GPS reading will give wrong speed-reading against water.
  2. When towing directly against short period waves, the speed should be limited to slower towing speeds to avoid splash-over in the stern.
- Normally higher speeds may be used when towing with the waves or at 90 degrees to the wave direction, compared to directly into the waves.

3.4.3 | Open Water | Recovery | Arctic Brush Bucket System

Watch Your Step

Monitor Your Surroundings

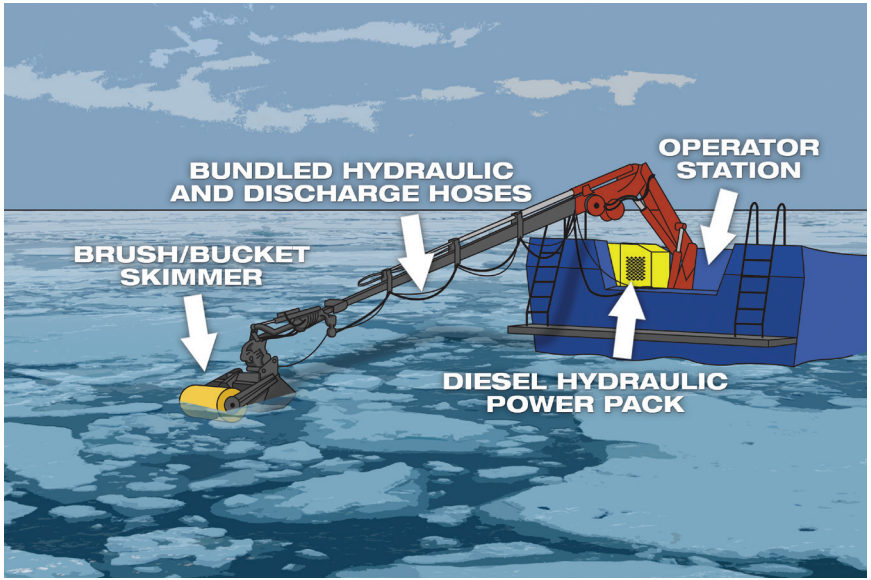


Diagram 3.4.3a Arctic Brush Bucket System Tactical Illustration

3.4.3 | Open Water | Recovery | Arctic Brush Bucket System

Tips: - Note that during recovery operations one responder with a radio should be positioned with a full view of the skimmer and the ice edge or containment boom. Constant communication with the wheelhouse should be maintained for optimal maneuvering and positioning for oil recovery.

- Check for the proper operation of the of the operating components of the system including the crane, brush/drum skimmer, feed screw, bucket locking pins, hydraulic tilt cylinder and pump prior to deployment.

- The skimmer should be deployed in the thickest oil (black oil), trapped against the ice edge or contained in a boom.

Purpose: To recover medium to heavy oil on water or land in all seasons, but specifically designed for cold climate conditions where broken ice is present.

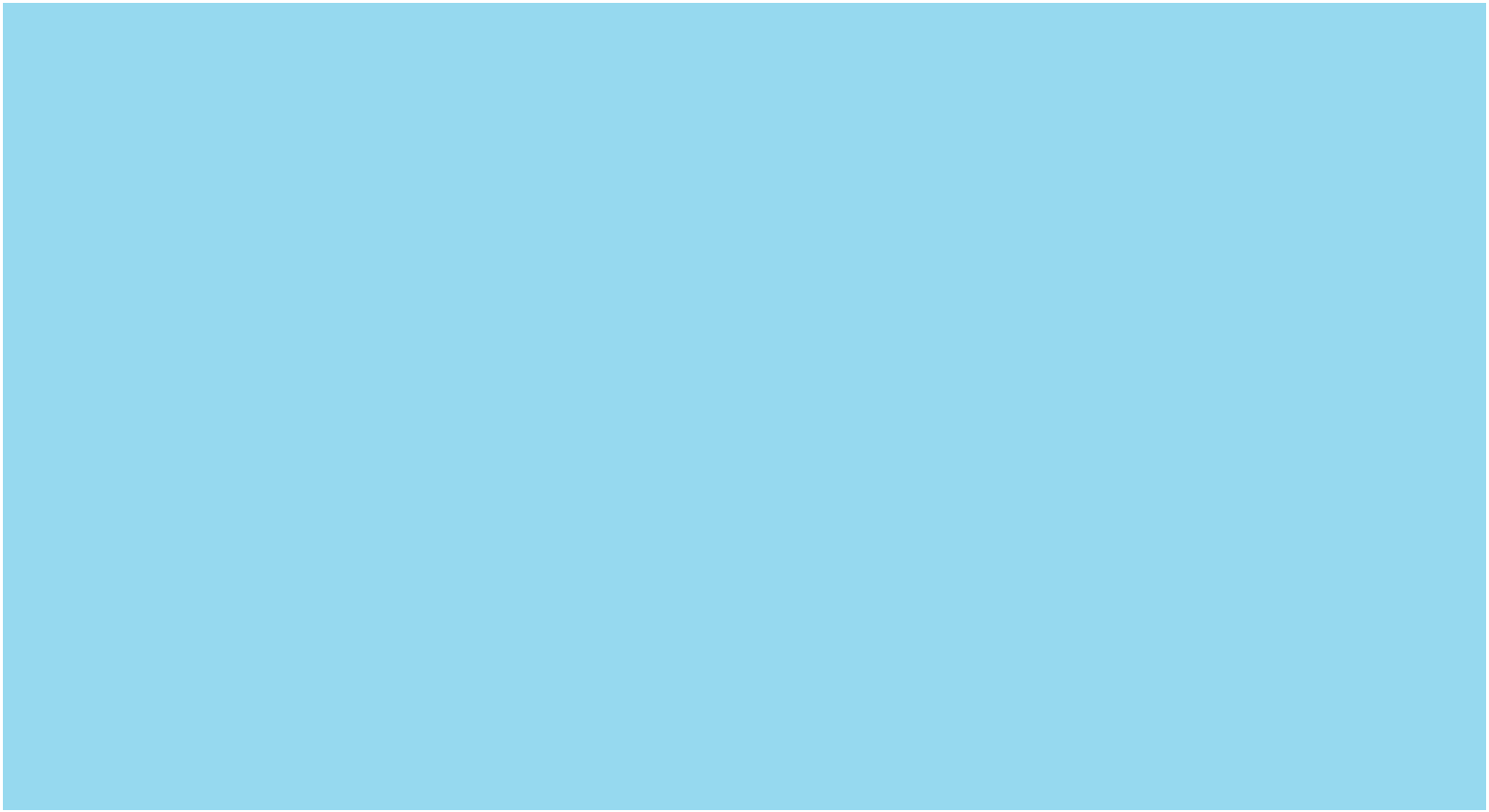
Application: To recover oil that is contained against the edge of ice or in the apex of a containment boom or pooled on land.

Environmental Considerations: Consider environmental sensitivities such as vegetation, rare plant and animal species, sensitive soils and shorelines, critical habitat, and fisheries regulations before deploying the equipment.

Equipment Required: For water recovery, a vessel with a platform or tank barge; for land, a flat-bed truck; water source, hot water generator for injection pump, and 5/8 inch / 15.9 mm hose for deck tank water source or by drawing suction from lake.

Operation:

After mobilizing, positioning, and mounting the skimmer on the receiving vessel, lock the securing pins and wire in place. Conduct power pack prestart checks. Check crane functions. Transfer the skimmer storage cradle and connect it to the crane arm and pin into place. Connect hot water generator (if used) to the water supply and connect to the skimmer. Test all skimmer and pump functions. If oil is thick, the skimmer can be used in a weir configuration. For most recovery operations, the brush wheel skimmer will be adequate.



Inland Spill Response Tactics Guide

Cold Weather & Ice Tactics

4

4 | Ice Tactics

Responding to a product release in winter conditions requires a different approach than traditional inland spill response tactics. Seasonal safety concerns such as cold weather and slipping hazards on ice must be considered. The tactics used in response scenarios that deal with ice also require a variety of specialized equipment.

Unlike a non-ice covered watercourse, releases below ice require responders to conduct an ice assessment to ensure that the load capacity of the ice will support operations. Detecting and tracking a product release may also require responders to break through the ice to determine the product's trajectory.

Multiple methods of containment and recovery are available to responders based on the permissible load of the ice cover and available equipment.

4.1.1 | Ice Tactics | Ice Assessment

Use appropriate life safety measures when working on ice: survival suits, PFDs and harnesses.

Before beginning any recovery and containment work on ice, an ice assessment must be completed to ensure the work can be performed safely.

A quick estimate of ice bearing capacity can be calculated as follows:

$$L = 40 \times (t)2$$

Where

L is the bearing capacity of the ice in pounds.

t is the thickness of the ice in inches.

A more comprehensive means of estimating ice bearing capacity follows.

4.1.1 | Ice Tactics | Ice Assessment

Tip: - Use local knowledge, including known danger areas and historical data.

Purpose: To calculate ice thickness to determine the maximum weight allowance of responders and equipment on ice.

Application: Completed when product is released on or below ice on a watercourse.

Environmental Considerations: Avoid disturbing the stream bed with auger. Do not refuel mechanical equipment on ice unless secondary containment has been established. Minimize tracking of soil onto ice surface..

Equipment Required: Ice auger, survival suits/PFD, ice depth measuring device, ice cleats and safety line.

Operation:

1. Two responders with ice rescue package must be present before ice assessment team begins.
2. Observe ice conditions before stepping onto watercourse (extent of ice conditions, abnormal surfaces, large breaks or cracks, flowing water at edges of watercourse).

Color of ice is an important indicator of ice strength:

- Clear Blue Ice = Strongest
- White Opaque Ice = Half as strong as blue ice
- Grey Ice = Indicates presence of water and is unsafe

4.1.1 | Ice Tactics | Ice Assessment

Tip: - Calculate the load capacity in multiple areas, as the ice thickness may change significantly throughout the work area.

If safe to do so, one responder attached to safety line will proceed out onto ice while other responder will remain on shore manning safety line.

Choose a location where recovery and containment work will be completed and use ice auger to drill a hole through ice. Use an ice depth measuring device to determine ice thickness.

Test multiple locations on ice to determine a safe working zone for recovery and containment.

Calculations:

Total effective ice thickness = (Clear + ½ White) x Temp x Crack

Where:

Clear = clear ice thickness

White = white ice thickness

Temp = safety multiplier for temperature effects (Table 3.4.1a)

Crack = safety multiplier for cracks in the ice (Table 3.4.1b)

If water lies between layers of ice, use the thickness of the top layer of ice only.

4.1.1 | Ice Tactics | Ice Assessment

Table 4.1.1a Safety Multiplier for Temperature Effects

Sudden Temp. Drop	Temp. Safety Multiplier
None	1.0
41°F / 5°C or less	0.7
41°F / 5°C to 50°F / 10°C	0.5
50°F / 10°C or more	0.4
OR	
If the air temperature has exceeded 0ºC in 6 of the preceding 24 hours	0.8
If the air temperature has stayed above 32°F / 0°C for 24 hours or more	Unsafe conditions, discontinue on-ice work

Table 4.1.1b Safety Multiplier for Cracks in the Ice

Type of Crack	Crack Safety Multiplier
None	1.0
Dry cracks less than 2cm (3/4”) wide	1.0
Refrozen cracks	1.0
Non-intersecting dry cracks wider than 2cm (3/4”)	0.8
Intersecting dry cracks wider than 2cm (3/4”)	0.58
Non-intersecting wet cracks	0.7
Intersecting wet cracks	0.5

4.1.1 | Ice Tactics | Ice Assessment

Examples of Total Effective Ice Thickness

1. The location has 60 inches / 1.53 metres of clear, blue ice and 10 inches / 0.25 metres of white ice. There are no cracks of significance and the temperature has been consistent and below freezing.

    Total Effective Ice Thickness = (60 + 10/2) x 1.0 x 1.0 = 65 inches / 1.65 metres

2. The location has 40 inches / 1.02 metres of clear, blue ice and 20 inches / 0.51 metres of white ice. The temperature has peaked above 32°F / 0ºC a few times in the past day.

Non-intersecting wet cracks are present.

Total Effective Ice Thickness = (40 + 20/2) x 0.8 x 0.7 = 28 inches / 0.71 metres

4.1.1 | Ice Tactics | Ice Assessment

Table 4.1.1c Weight Bearing Capacity for Continuous Travel

Total Effective Ice Thickness (in / cm)		Permissible Load
Lake	**River**	
2.0 / 5.1	2.4 / 6.1	One person on foot
3.1 / 7.9	3.5 / 8.9	Group, in single file
7.1 / 18.0	8.3 / 21.1	Passenger car 4,400 lbs / 2,000 kg
7.9 / 20.1	9.1 / 23.1	Light Truck 5,500 lbs / 2,500 kg
10.2 / 25.9	11.8 / 29.9	Medium Truck 7,700 lbs / 3,500 kg
13.8 / 35.1	16.1 / 40.9	Heavy Truck 15,000 - 17,5000 lbs / 6,800 – 8,000 kg
15.0 / 38.1	17.3 / 43.9	20,000 lbs / 9,000 kg
24.8 / 62.9	28.7 / 72.9	50,700 lbs / 23,000 kg
31.5 / 80.0	36.2 / 91.9	99,200 lbs / 45,000 kg
39.4 / 100.1	45.3 / 115.1	150,000 lbs / 68,000 kg
49.2 / 124.9	56.7 / 144.0	240,350 lbs / 109,000 kg

4.1.1 | Ice Tactics | Ice Assessment

Table 4.1.1d Weight Bearing Capacity for Stationary Loads and Working on Ice

Total Effective Ice Thickness (in / cm)		Permissible Load
Lake	**River**	
7.9 / 20.1	9.1 / 23.1	2,200 lbs / 1,000 kg
11.8 / 29.9	13.8 / 35.1	4,400 lbs / 2,000 kg
17.7 / 44.9	20.5 / 52.1	8,800 lbs / 4,000 kg
23.6 / 29.9	27.2 / 69.1	17,650 lbs / 8,000 kg
43.3 / 109.9	50.0 / 127.0	50,700 lbs / 23,000 kg
59.1 / 150.1	68.1 / 172.9	99,200 lbs / 45,000 kg
70.9 / 108.1	81.5 / 207.0	150,000 lbs / 68,000 kg
90.6 / 230.1	104.3 / 264.9	240,350 lbs / 109,000 kg

Note: When multiple stationary loads are on the ice, separate them 200 times the minimum total effective ice thickness required for the larger of the two loads

4.1.2 | Ice Tactics | Oil Detection Under Ice

Detecting the location of the oil beneath ice is a challenge. This section offers guidance on ways to detect the location and expected spread of oil that is trapped beneath the ice, so that proper planning for collection and recovery can proceed.

Detecting oil under ice is essential to determining where diversionary boards and ice slots need to be cut. The lack of wind under ice reduces water current and is beneficial to recovery, as oil will travel slower on a watercourse. Technologies such as infrared, ultraviolet, laser-fluorosensors and satellite remote sensing exist, though they may not be readily available to responders. The following tactics use equipment readily accessible to responders.

Use appropriate life safety measures when working on ice: survival suits, PFDs and harnesses.

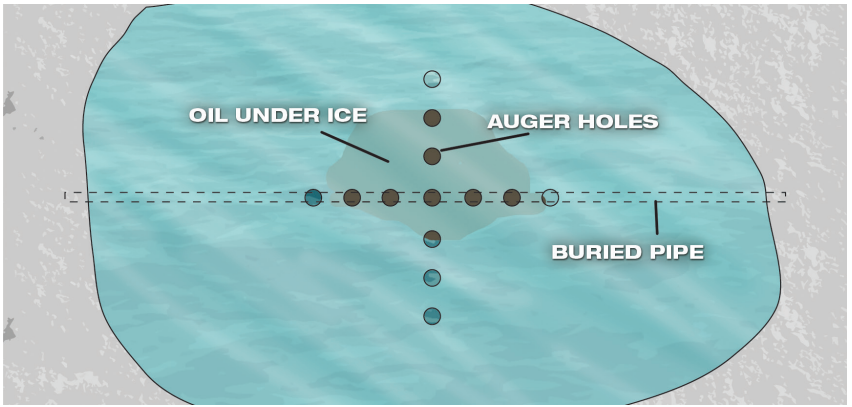


Diagram 4.1.2a Oil Detection Under Ice

4.1.2 | Ice Tactics | Oil Detection Under Ice

Tips: - Ice retards the movement of oil in a current. Oil trapped under the ice will be relatively immobile until the current reaches approximately 0.2–0.4 metres/ second (about 3/4 of a knot).

- Even if the current is moving oil, the uneven surface of the base of ice will trap oil in ridges and pockets. Locating and recovering these pockets of oil must be considered for continuing recovery operations.

- Knowing the location of the release will improve chances of detecting oil. Use pipeline markers to identify line location.

- Limit the number of auger holes used during detection. Too many holes can weaken the ice and potentially increase the spread of oil.

Purpose: To determine location and trajectory of oil to contain and recover product.

Application: When oil is under ice and its trajectory must be determined.

Environmental Considerations: Avoid disturbing the stream bed with auger. Do not refuel mechanical equipment on ice unless secondary containment has been established. Minimize tracking of soil onto ice surface.

Equipment Required: Ice auger, survival suits/PFD, ice depth measuring device, ice cleats and safety line, current/flow meter, shovels, underwater flashlight.

Operation:

1. Ensure an ice assessment has been performed before beginning any operations.
2. Remove snow from surface of ice.
3. Begin making auger holes in a cross pattern to delineate surface area of spill.
4. Measure ice depth on auger holes as load capacity may change.
5. An underwater flashlight can be inserted into auger holes to provide greater visibility.
6. Using a current meter (rated for cold-water use), determine if current is capable of moving oil.
7. If current is moving oil downstream, continue to auger ice downstream until a recovery point is determined.
8. If current is not strong enough to move oil, consider using the ice slotting tactic. Shown in 4.1.4.
9. When oil is detected, the outline should be marked with spray paint or flagging.

4.1.3 | Ice Tactics | Trench on Ice Sheet

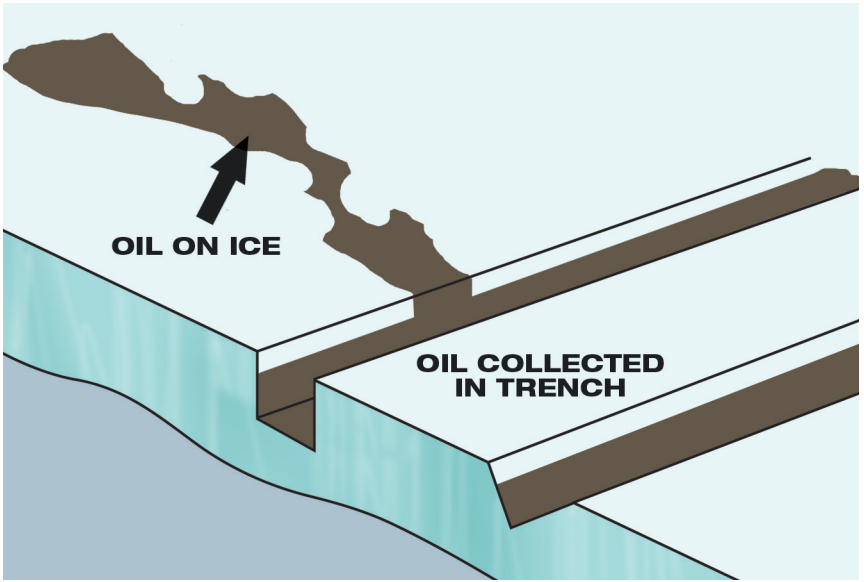


Diagram 4.1.3a Trench on Ice Sheet

4.1.3 | Ice Tactics | Trench on Ice Sheet

Ensure ice assessment has been completed.

Tips: - A chain saw can be used to cut a V-shape trench as an alternative.

- An ice auger may be used to create a bell hole for product recovery.

Purpose: To limit the spread of oil and collect oil that is loose on an ice sheet surface.

Application: When oil is on top of ice, ice thickness is suitable and an ice berm is not sufficient.

Environmental Considerations: Ice must not be breached entirely to prevent oil from entering surface water. Ensure mechanical equipment is free of petroleum lubricants. Do not refuel mechanical equipment on ice unless secondary containment has been provided.

Equipment Required: Ditch Witch, a backhoe (Caution: do not break through or fracture the ice.), ice scrapers, picks and shovels, chain saws, ice augers, squeegees and brushes.

Optional Equipment: Commercial ice resurfacer.

Recovery Equipment Options: Sorbents, pump, hoses, hose strainer, temporary liquid storage capacity, vacuum truck.

Operation:

1. Ensure an ice assessment has been performed before accessing the ice sheet.
2. When using mechanical equipment, do not break through or fracture the ice.
3. Use squeegees and ice scrapers to direct oil into trench.

4.1.4 | Ice Tactics | Trench on Ice Sheet

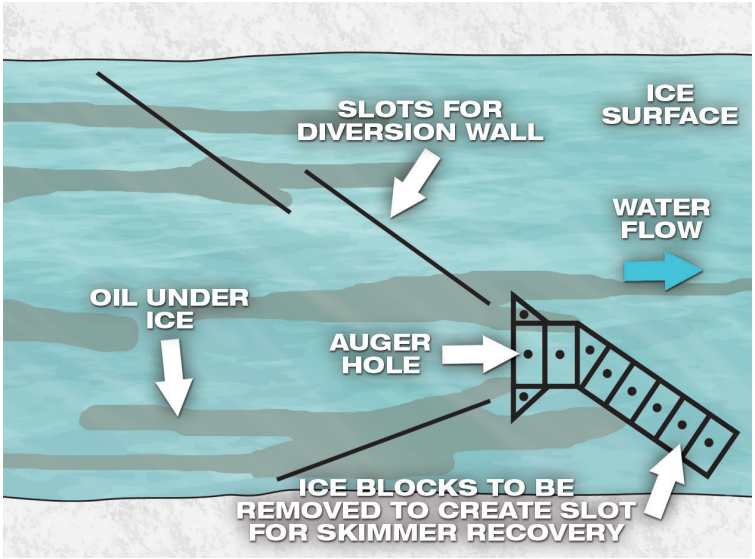


Diagram 4.1.4a Ice Slotting on Rivers

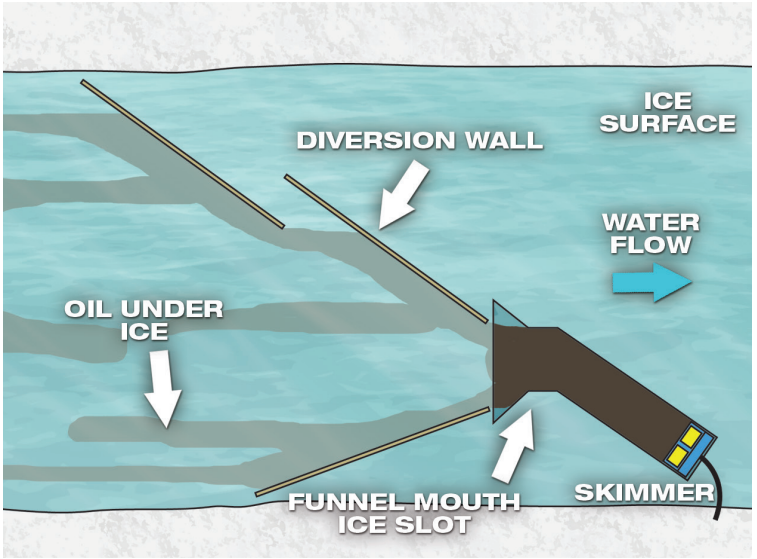


Diagram 4.1.4b Ice Slotting on Rivers

4.1.3 | Ice Tactics | Trench on Ice Sheet

Tip: - If ice slotting on still water, a current can be created to move oil toward recovery area. A suction hose with foot valve and screen, pump, discharge hose and reducer will be required. Ensure fish intake screen is present on pump intake.

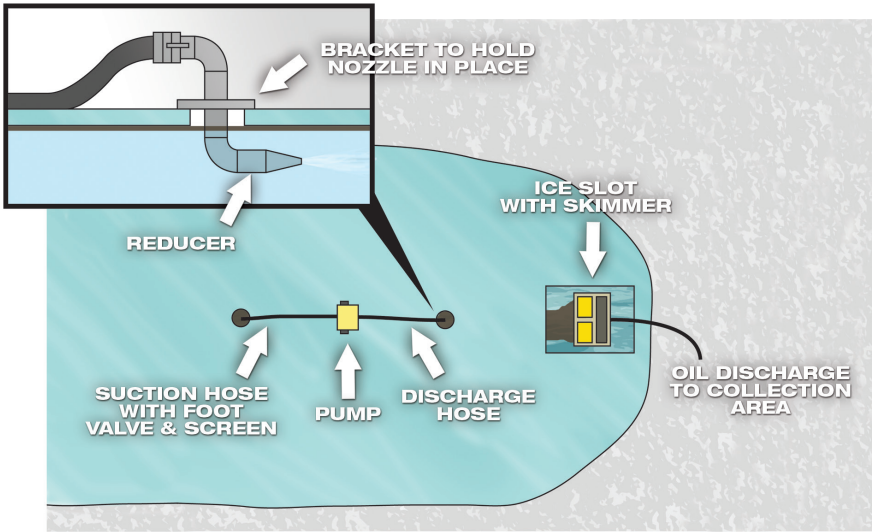


Diagram 4.1.4c Ice Slotting

4.1.4 | Ice Tactics | Ice Slotting

When spilled during winter freezeover, oil may be carried by currents beneath the ice. Sections of ice must be removed in order for the product to rise to the surface, allowing for containment and recovery.

Ensure ice assessment has been completed.

Wear chain saw chaps when operating free-hand chain saws.

Mark open holes with pylons, wire flags or other safety markers.

Purpose: To free trapped product for recovery in an ice-covered watercourse and to prevent its further spread

Application: When product needs to be contained and recovered on an ice-covered watercourse.

Environmental Considerations: Ensure mechanical equipment is free of petroleum lubricants. Do not refuel mechanical equipment on ice unless secondary containment has been provided.

Equipment Required: Chain saws, chain saw slotting guides, ice auger, Ditch Witch, backhoe, pry bars/tamper bars (approximately 5 feet / 1.5 metre), rope, chalkline, aerosol paint (not white), crane, ice hooks, A-frame hoist, T-bar, shovels, ice cleats and safety line Mechanical snow removal equipment (for site snow clearing once site has been approved for operations), snow fence and stakes, vegetable oil for lubrication (optional), chalk line, aerosol paints (not white), wire flags (not white), chain block lifter(s) with tripping line, ladle, slot cleaning basket (for ice debris) (optional), plywood sheets, propane torch with propane bottle(s), toboggan or sled for equipment transport or snowmobile with towed sled (optional), tent for recovery area (optional).

Recovery Equipment Options: Sorbents, pump, hoses, skimmer, temporary liquid storage capacity and vacuum truck.

4.1.4 | Ice Tactics | Ice Slotting

Tips: - If blocks are cut at a 15 to 20 degree angle, they may be easier to remove than if cut vertically.

- A wider slot at the upstream end will aid oil collection.

- When using a crane or excavator to remove blocks, they may shift unexpectedly on the extraction chain. Ensure that personnel stand a safe distance from this operation. An ice hook can be attached to slide the block away.

- When manually extracting blocks with pry bars or tamper bars, place at least two responders on either side of the block and force bar underneath the block, which will allow it to rise out of water. An ice hook can be attached to slide block away.

Operation:

- Ensure an ice assessment has been performed before beginning any operations.
- Use a J-slot template (upstream portion of J-slot cut with the current and base of J-slot at an angle suitable to current toward recovery location). The angle is determined from the stream speed/slot angle table. The length should be sufficient to permit the maximum amount of oil to surface and provide surface storage capacity that the skimmer recovery rate can handle, bearing in mind the water flow will carry the oil to the downstream (skimmer) slot end. The width will be that of the skimmer, which is usually in the 24 to 36 inches / 60 to 90 cm width range. Mark cutting lines using chalkline. Overspray chalkline with aerosol paint. A rope acting as a guide and chain saw can also be used to score the cutting lines. (Refer to pages 94 and 95.).
- Auger holes can be drilled in the center of each block prior to cutting through ice to allow a T-bar to grasp the block from underneath, allowing an A-frame hoist or crane to lift blocks out.
- Free-hand chain saws or chain saws mounted inside slotting guides can be used to cut blocks of ice.
- A skimmer or vacuum truck hose can be placed at the base of the J-slot to recover product.

4.1.4 | Ice Tactics | Ice Slotting

Tips: - Calculating the approximate weight of the blocks will determine what size blocks will be cut and if mechanical lifting aids will be required.

a) Lake ice (clear) weighs 56 lbs per cubic foot / 900 kg per cubic metre.

b) To calculate volume, multiply depth by length by width.

c) Weight in kg equals 900 multiplied by the volume in cubic metres or weight in pounds equals 56 multiplied by the volume in cubic feet.

For example, an ice block measuring 1 m x 1 m x 1 m would weigh ~2,000 lbs / 900 kg.

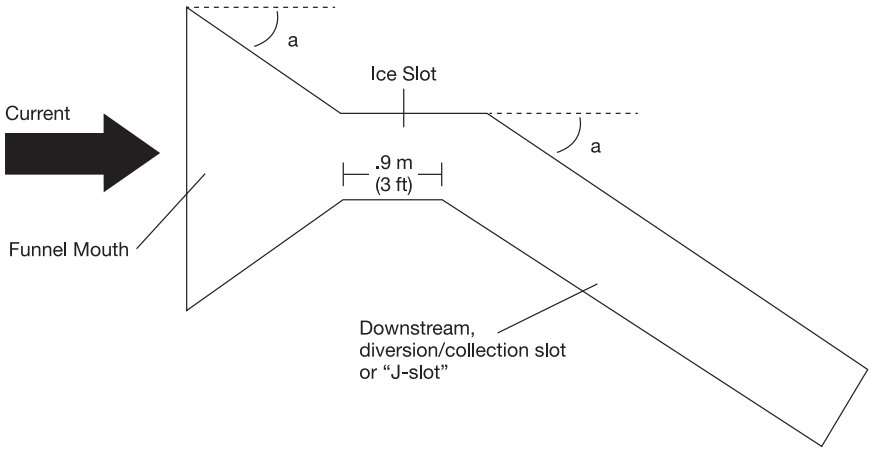


Diagram 4.1.4d J-Slot Template

4.1.3 | Ice Tactics | Ice Slotting

Table 4.1.4a J-slot Angle as a Function of Current

Maximum Current, Knots	Maximum Angle (a), Degrees, Relative to the Direction of Flow
0.8	75
0.9	60
1.1	45
1.5	30
2.9	15

4.1.5 | Ice Tactics | Through Ice-Deflector/Diversion Wall

Tips: - A saw sleigh or slotting guide should be used, as manually-sawed lines are unlikely to be straight and vertical.

- Overlapping auger holes or trenching tools can be used to create the slot.

- It is usually impossible to recover the plywood sheet post-response. Therefore, it is normally acceptable to cut it off at the ice sheet surface to prevent it being a hazard to winter river users.

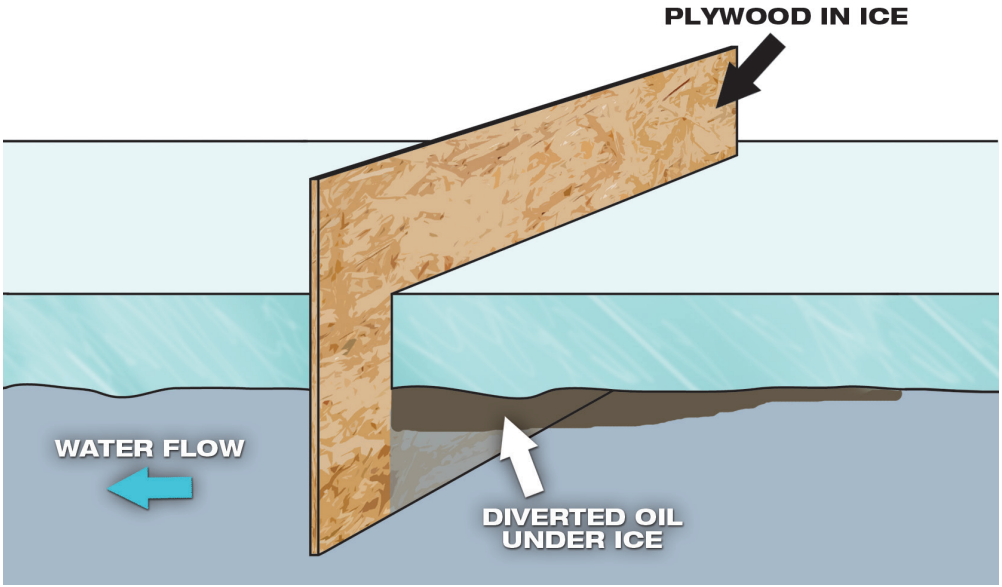


Diagram 4.1.5a Through Ice-deflector/Diversion Wall

4.1.5 | Ice Tactics | Through Ice-deflector/Diversion Wall

The deflection walls are made by installing a barrier (plywood or melamine boards) vertically through the ice.

Purpose: To deflect or divert an under-ice spill towards a desired direction such as into an ice slot for recovery.

Application: In wider and faster moving watercourses under ice.

Environmental Considerations: Avoid disturbing the stream bed with ice auger or diversion wall, or by pushing ice blocks under the ice sheet.

Equipment Required: 4 x 8 feet / 1.2 x 2.4 metres 1/2 or 3/4 inch / 12.7 or 19 mm thick plywood sheet(s), chain saw with chain/bar of sufficient length to cut completely through the ice sheet; saw sleigh that holds the saw vertically while cutting.

Optional but Recommended: Wooden wedges, if required, sledge hammer/post driver.

Operation:

- Ensure an ice assessment has been performed before accessing the ice sheet.
- Determine position and angle for deflector wall(s). Mark outline on the ice. Two parallel saw cuts, approximately 3/4 inch / 19 mm apart, will make it easier to drive the plywood sheet down into the ice.
- Place the plywood sheet over the cut ice. Place a wood block on the top edge to reduce damage to the plywood sheet itself. Sledge hammer the plywood sheet vertically downward until it reaches the required depth beneath the ice sheet. Approximately 8 - 12 inches / 20 - 30 cm is normally sufficient, depending on the expected volume of oil and the water depth beneath the ice. If ice thickness is greater than about 36 - 40 inches / 91 - 101cm, the plywood will need to be installed vertically to reach sufficiently far below the ice sheet base. Do not rest the plywood base against the river bed, as this can seriously affect the water flow/direction in smaller rivers. The displaced ice will normally break off and be carried downstream by the water flow.
- Secure the plywood sheet in place at the required depth with wooden wedge(s) between it and the ice cut on the ice surface, if necessary. Install re-bar to support and adjust barrier in ice.

Line 3 Replacement Project: Addendum to Assessment of Accidental Releases: Technical Report
Attachment 1

Inland Spill Response Tactics Guide

Equipment for Material Recovery or Alternative Removal

5

5 | Ground Tackle and Anchors

Released oil will be recovered to the greatest extent possible. Recovery will involve use of equipment and temporary storage as determined by plans and the scope of the incident.

Oil spill response operations can generate large volumes of waste in a short period of time. Plans for characterization, treatment, handling, disposal and temporary storage of wastes during initial stages of an oil spill response are important considerations and should be discussed with Environment Department personnel who will coordinate with the appropriate regulatory agencies. As with containment and recovery equipment, there are many temporary storage options that can be made to meet operational requirements.

The boom tactics described in Section 3 assume that boom and skimmers can be held in place in moving water. The anchors most commonly used in water are categorized as drag embedment anchors. They rely on the flukes of the anchor biting into the bottom sediment to generate holding power.

A proper anchor setup should include, at a minimum, 10 feet / 3 metres of the appropriate rated chain attached directly to the anchor. An anchor line will be attached to the anchor chain and the entire length of the anchor line, including the chain, shall be at least six times longer than the water depth. A long anchor line reduces uplift at the anchor. Uplift can make the anchor lose its grip.

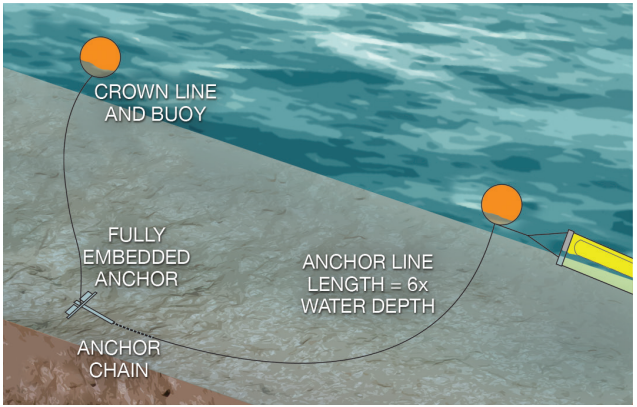


Diagram 5.1a Typical Anchoring System

A typical anchoring system is shown in Diagram 5.1a. It includes an anchor buoy and a second buoy and line called a “crown line” because it is attached to the crown of the anchor. The crown line gives responders a more accurate view of where the anchor is relative to what they are trying to hold in place. It is also used to retrieve and reposition the anchor.

Information on the holding capacity of anchors and the strength of commonly used tension members is included in section 6.6.

Among the most commonly found drag embedment anchors is the Danforth-style anchor. It is capable of resisting a horizontal pull of 7 to 14 times its own weight when properly set. Another drag embedment anchor in use in Canada and the United States is called the Sarca anchor. It does not require a trip line or crown line. It can resist a horizontal pull of up to 20 times its own weight. By comparison, a rock or a cement block is categorized as a “deadweight anchor” and will resist only a fraction of its own weight when pulled horizontally.

When installing drag embedment anchors, it is critical to remember that they may drag many metres across the bottom before they embed themselves in the soil and develop holding capacity. Whenever possible, they should be installed and “set” before booms or other equipment are tied off to them. This can be achieved from a power boat.

5.1.1 | Ground Tackle and Anchors | Drag Embedment (In-water) Anchors

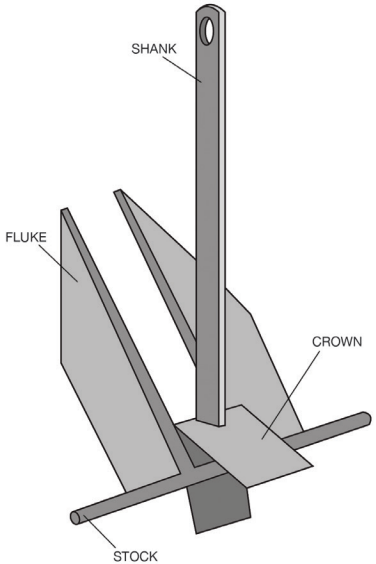


Diagram 5.1.1a Danforth Anchor

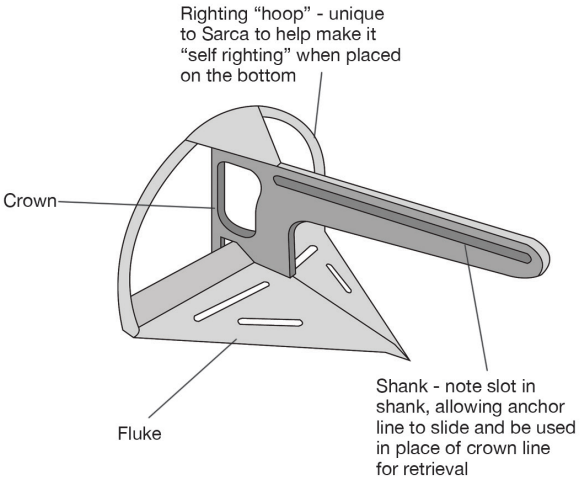


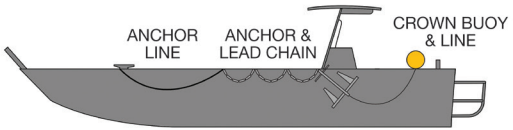
Diagram 5.1.1b Sarca Anchor

5.1.2 | Ground Tackle and Anchors | Anchor Deployment from Boat

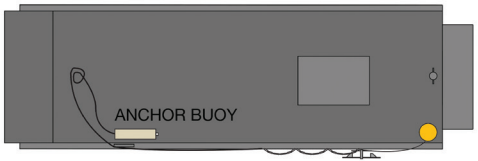
If a boat is used to deploy anchors, experience has shown that it is advisable to assemble ground tackle system (anchor, anchor line, buoy, crown line and crown buoy) entirely before commencing installation. Smaller mooring systems, where anchors, buoys and other components are easily moved by hand, are not difficult to install. Keep in mind, though that it is wise to hold onto the anchor/mooring line and buoy, so that the boat can pull on the mooring line to "set" the anchor.

For larger systems, it may be safer to rig the anchor system for deployment on the outside of the boat using sacrificial lines that can be cut to allow the heavier components to fall. Even tension members should be rigged on the outside of the boat so that running lines do not present a safety hazard to personnel on the boat. The sequence of diagrams below illustrates how a larger mooring system might be installed from a boat.

Caution: Installing anchors, particularly in moving water, requires skill and experience. It should only be attempted by skilled boat handlers under competent supervision.

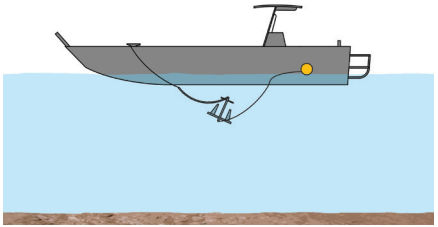


1. Assemble the entire set of ground tackle on the boat before starting.
   - a. Crown buoy and line (if used)
   - b. Anchor
   - c. Anchor lead chain
   - d. Anchor line
   - e. Anchor buoy

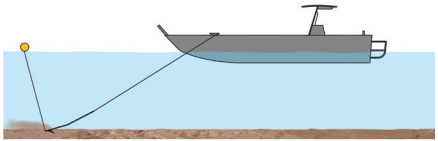


2. Tie off the anchor line near the anchor buoy to the towing point of the boat.
3. Once near the desired location of the anchor, overboard the crown line and buoy.

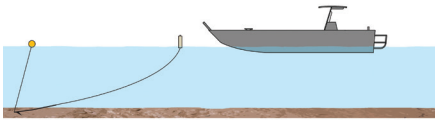
5.1.2 | Ground Tackle and Anchors | Anchor Deployment from Boat



4. Drop the anchor and chain several metres from the desired anchor location and away from the direction of pull.



5. Use the boat's power to pull gently against the anchor line until the anchor stops dragging. Gradually increase power to completely set (embed) the anchor.



6. Release the anchor line and overboard the mooring buoy.

Tip: - A proper line will be at least six times longer than the water depth.

5.1.3 | Ground Tackle and Anchors | Shoreline Anchors

Anchor points can also be established on the shoreline. Trees, for instance, when properly protected from chafing damage, can be used as anchors. Any tree with a caliper (trunk diameter) of greater than 6 inches / 15 cm is a candidate for use as a tie-off or anchor point.

Spade, Rake and T-Post anchors are examples of shallow water or shoreline anchors that can be installed by response personnel without boats. They are generally pushed or pounded into the bottom sediment.

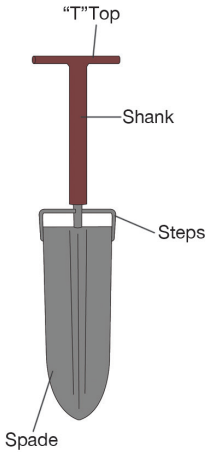


Diagram 5.1.3a Spade Anchor

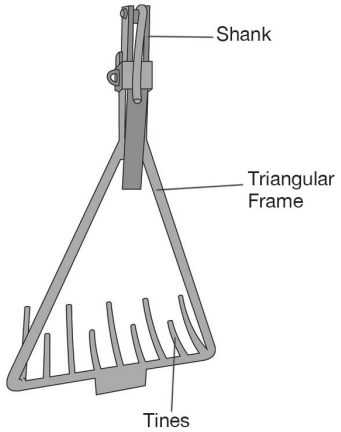


Diagram 5.1.3b Rake Anchor

5.1.3 | Ground Tackle and Anchors | Shoreline Anchors

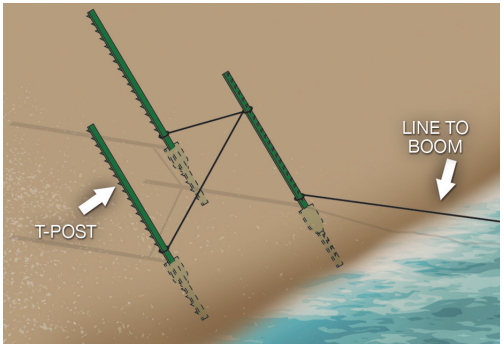


Diagram 5.1.3c T-Post Anchor

T-Post Anchor

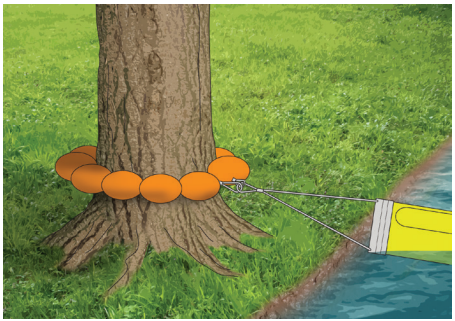
Some points of interest for the T-post anchor set:

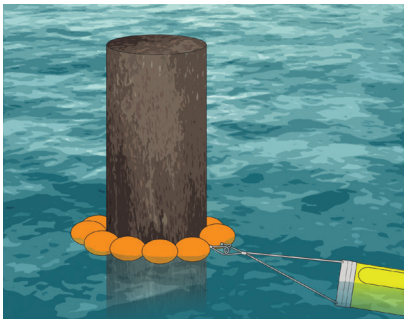
- Tie rope from front top to rear bottom.
- Face T-post nubs forward (toward the boom) on the front post and backward (away from the boom) on the rear posts.
- Overlap rope wraps on the rear post before tying to help prevent them from sliding up the post.
- Pound T-posts in, angled away from the boom pull direction using a post pounder.
- To reinforce this anchor in sand or in loose dirt, use another set of T-posts and a top-to-bottom rope behind the rear posts.

Use a post pounder and wear safety glasses/goggles.

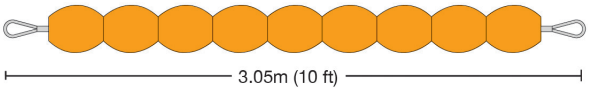
5.1.4 | Ground Tackle and Anchors | Anchors of Opportunity

If there are man-made structures such as road bridges or piers in the vicinity, pilings that support these structures can sometimes be used as midstream anchoring points. Piling bridles depicted below will prevent damage to pilings and allow the bridle to adjust to changes in water level.

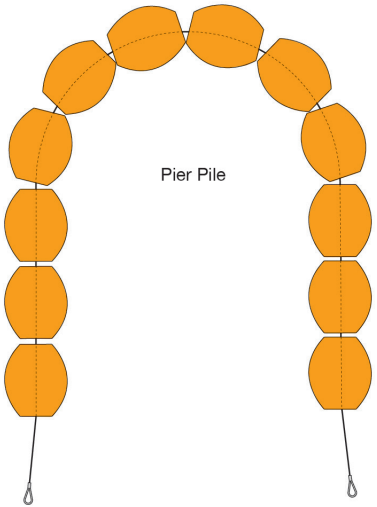




Tip: - Piling bridles can be used to protect trees.



Solid core floats compress under pressure.



5.2 | BoomVane™

A BoomVane™ offers an alternative to ground tackle for deploying boom in moving water and holding it in place by harnessing the power of the current. There are two sizes of BoomVane in regular use in inland waters, the 1 metre standard model and the 0.5 metre shallow version. The BoomVane is designed for both shore-based and vessel operations with containment boom.

BoomVane is constructed as a cascade of vertical wings mounted in a rectangular frame. Powered by the current, BoomVane is held by a single mooring line, and then swings out toward the opposite shore with the oil boom in tow. Its operation is based upon the science of sailing with the art of flying a kite, in the water.

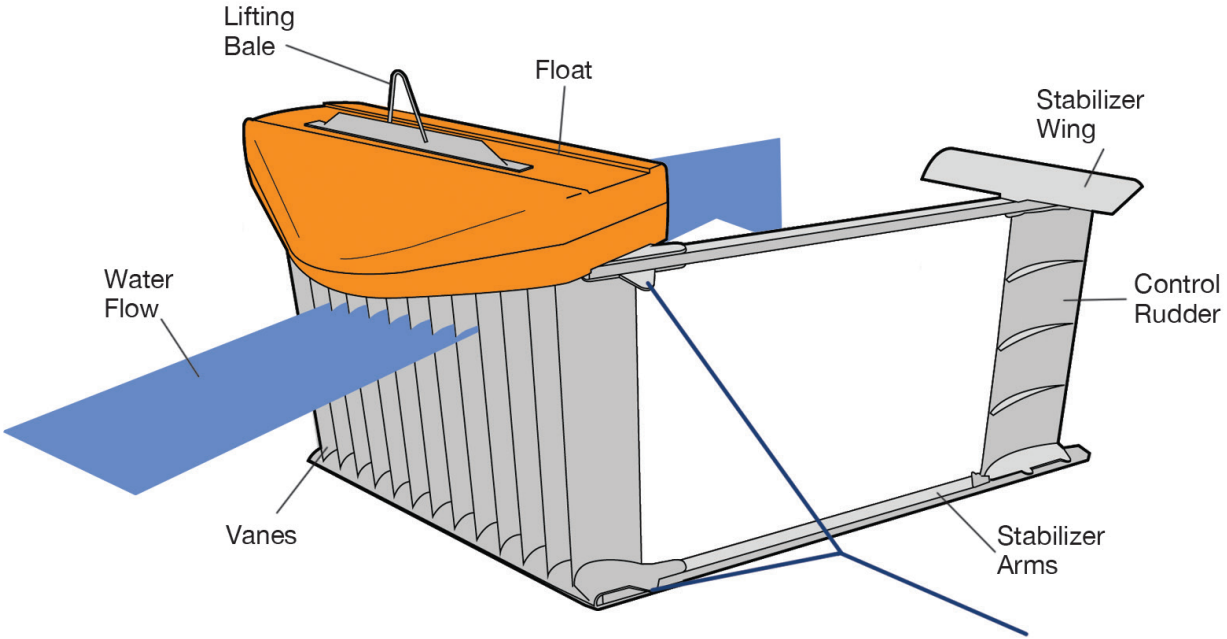


Diagram 5.2a 1.0 Metre Standard Boom Vane

5.3 | NOFI Current Buster®

The NOFI Current Buster® technology contains and controls oil spill with minimum loss at up to 5 knots towing speed. It incorporates a separator combined with a temporary storage unit. The thick layer of oil in the separator provides excellent recovery rates. It is suitable for most types of oil. It can be operated as a single vessel sweep system in combination with BoomVane™ systems and are available in four different sizes depending on application. Tactics for the NOFI Current Buster® 2 and NOFI Current Buster® 4 can be found in section 3.4.1 of this manual.

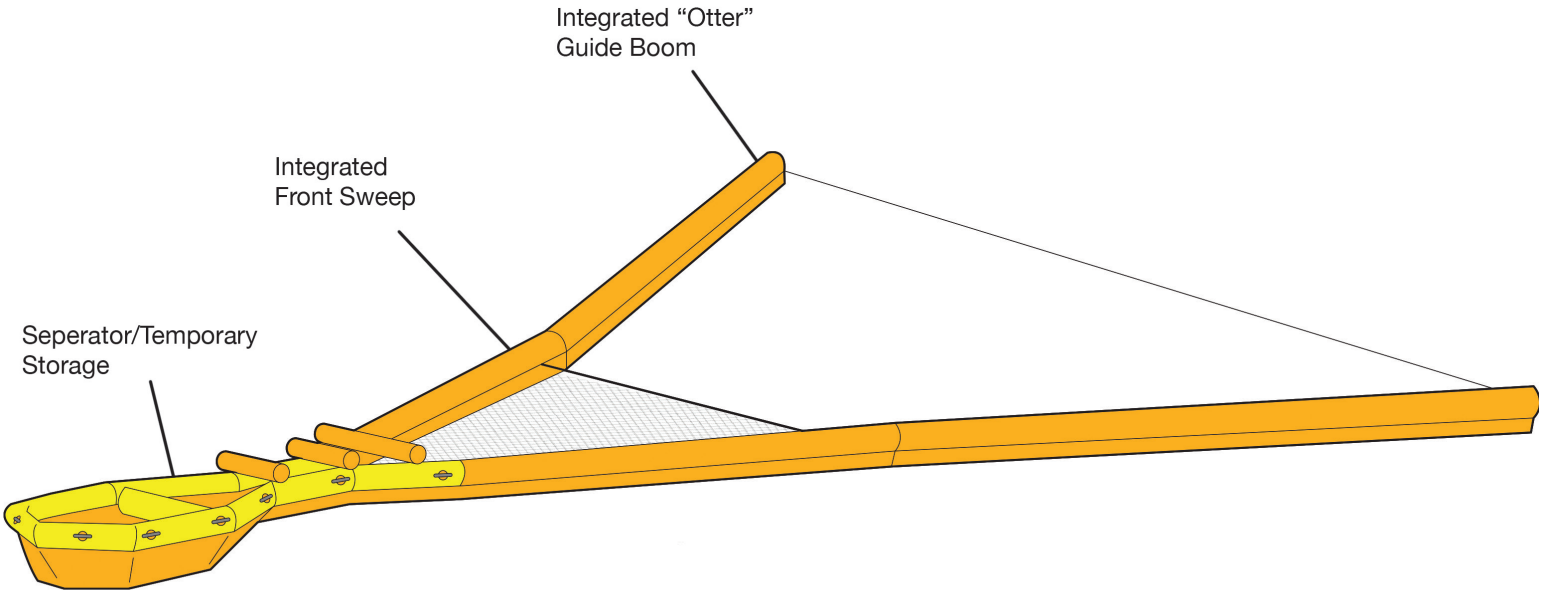


Diagram 5.3a NOFI Current Buster®

5.4 | Skimmers

Selective skimmers rely on oleophilic (oil-attracting) material that can be passed through the oil-water interface. Selective skimmers collect a higher concentration of oil in the recovered fluid stream than non-selective skimmers. Non-selective skimmers are usually weir or suction devices that recover fluid indiscriminately.

The table below is a guide developed by the American Society for Testing and Materials (ASTM) for the selection of oil skimmers relative to incident criteria.

Table 5.4a ASTM Skimmer Selection Guide

Skimmer Type	Oil Type	Mode	Debris Tolerance	Wave Tolerance	Currents
Drum	Wide range of oil viscosities	Stationary	Debris must be managed to allow flow of oil to skimmer	Low sensitivity to waves with height less than diameter of drum	Not generally used in currents
Disc	Low to medium viscosity	Stationary	Debris must be managed to allow flow of oil to skimmer	Low sensitivity to waves with height less than diameter of disc	Not generally used in currents
Brush	Medium to high viscosity	May be operated in stationary mode if current is present	Effective in most forms of small debris	Low sensitivity to waves	May be operated in stationary mode if current is present
Belt	Medium to high viscosity	Stationary or advancing	Relatively insensitive to most types of debris	Low sensitivity to waves	Some units can work in currents greater than one knot
Rope Mop	Wide range of oil viscosities	Stationary	Generally not affected by debris	Good wave-following characteristics in nonbreaking waves	Typically operated in low current environments

5.4.1 | Skimmers | Selective (Oleophilic) Skimmers

5.4.1a | Drum Skimmer

Drum skimmers (smooth and grooved) use an oleophilic drum rotating at low rpm to separate oil from water. Scraper blades remove the recovered oil from the rotating drum and direct it to a trough, from where it can be pumped or sucked into a temporary storage device. Some of the lightest units can easily be carried by one or two people. Drum skimmers are stationary skimmers. They function most effectively in near-zero relative current velocities.

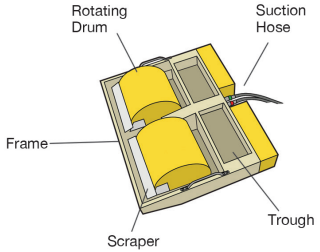


Diagram 5.4.1a Drum Skimmer

5.4.1b | Disc Skimmer

Disc skimmers are similar to drums, except that the oleophilic component of the separation device is a disc or series of discs mounted in parallel. They can be single or multiple banks of discs. Historically, disc skimmers have used smooth or brushed surfaces on the individual discs, and offer only stationary recovery. However, recent design improvements have incorporated grooved discs and unique housings that allow recovery in both stationary and advancing modes at speeds up to 3 knots. Grooved discs have proven to have higher recovery rates than smooth discs.

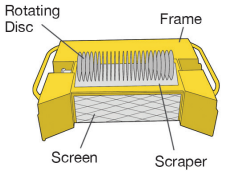


Diagram 5.4.1b Disc Skimmer

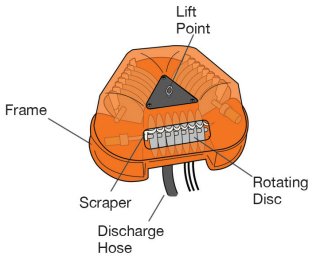


Diagram 5.4.1b Multi-Sided Skimmer

5.4.1 | Skimmers | Selective (Oleophilic) Skimmers

5.4.1c | Brush Skimmer

Brush skimmers use chains or drums equipped with oleophilic bristles to separate oil from water. They are more effective on thicker or more viscous oils. Some brush skimmers rely on currents or forward motion to introduce oil and water to the brushes. Oil is removed from the bristles by combs and scrapers.

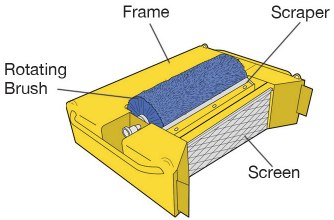


Diagram 5.4.1c Brush Skimmer

5.4.1d | Belt Skimmer

Oleophilic belt skimmers can either be upwardly or downwardly moving belts. For lifting belts, the belts themselves are oleophilic. Oil is removed from the belt by scrapers and squeeze rollers, similar to the wringer rollers found on old washing machines. On submerging belt skimmers, or dynamic inclined planes, oil adheres to the belt and is forced downward. Oil is then separated from the belt using a scraper, and allowed to float up into a collection well that is open at the bottom. Capable of stationary and advancing skimming, belt skimmers are effective in a wide range of viscosities.

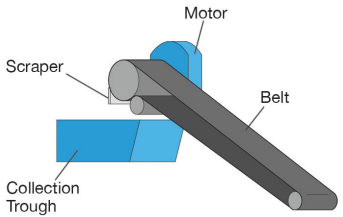


Diagram 5.4.1d Belt Skimmer

5.4.1 | Skimmers | Selective (Oleophilic) Skimmers

5.4.1e | Rope Mop

A rope mop uses a continuous loop of oleophilic filaments attached to a central tension member, laid down on the surface and drawn through the oil. The oiled rope mop is pulled upwards out of the fluid and passed through squeeze rollers to remove the oil. Rope mops are traditionally stationary skimmers.

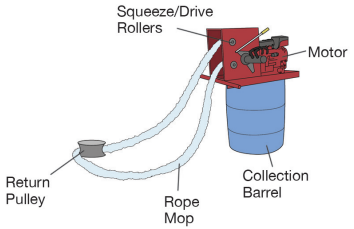


Diagram 5.4.1b Multi-Sided Skimmer

5.4.1f | Arctic Bucket Brush

The arctic bucket brush is an active skimmer ideally suited for the recovery of contained oil in ice conditions. The arctic brush bucket skimmer is fitted to a dedicated crane and can be used either with the oleophilic (oil attracting) brush wheel skimmer that rotates through the oil/water interface or the integral bucket in a weir skimming mode. The bucket can also be used to scoop solid heavy oil sludge or remove other materials such as ice. The skimmer is controlled by a single operator, can be used in a stationary or sweeping mode and is unaffected by ice or debris.

5.4.1f | Arctic Bucket Brush

Some skimmers offer floating skimmer heads with interchangeable skimming mechanisms. This allows users to select the skimming technology that best fits the requirements of spill recovery. (Not shown.)

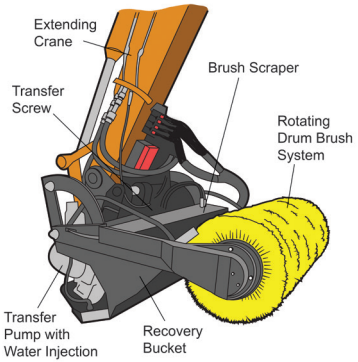


Diagram 5.4.1b Multi-Sided Skimmer

5.4.2 | Skimmers | Non-Selective Skimmers

5.4.2a | Weir Skimmer

Weir skimmers encourage fluid to flow over a shallow lip or weir by continuously pumping from behind the weir. The surface current created by the pumping draws water and oil to the unit. These units are very lightweight and easy to operate, and are suitable for lighter, less viscous oils. However, they are not efficient separators of oil from water. They recover large quantities of water with the oil.

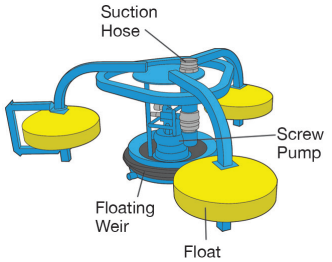


Diagram 5.4.2a Seaskater Weir Skimmer

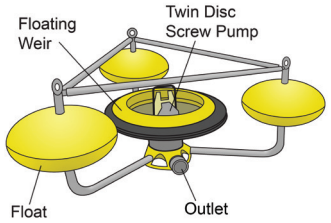


Diagram 5.4.2a Foilex Weir Skimmer

5.4.2b | Circus Skimmer

Oleophilic belt skimmers can either be upwardly or downwardly moving belts. For lifting belts, the belts themselves are oleophilic. Oil is removed from the belt by scrapers and squeeze rollers, similar to the wringer rollers found on old washing machines. On submerging belt skimmers, or dynamic inclined planes, oil adheres to the belt and is forced downward. Oil is then separated from the belt using a scraper, and allowed to float up into a collection well that is open at the bottom. Capable of stationary and advancing skimming, belt skimmers are effective in a wide range of viscosities.

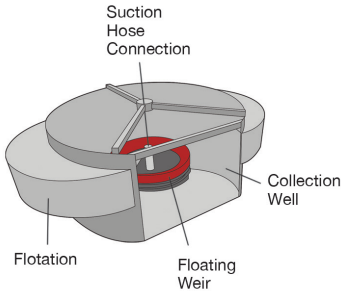


Diagram 5.4.2b Circus Skimmer

5.4.2 | Skimmers | Non-Selective Skimmers

5.4.2c | Broad Suction Skimmer

Broad suction skimmers are another example of non-selective skimmers. Powered by a vacuum or pump, and designed for still water applications, these collectors allow an operator to "sweep" an area of the water surface to remove floating oil. The broad suction collectors can be attached directly to a vacuum tanker.

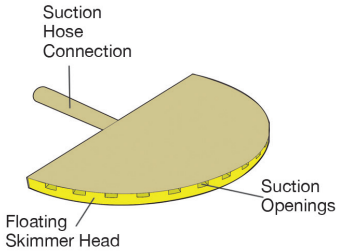


Diagram 5.4.2c Broad Suction Skimmer

5.4.2d | Adjustable, Half-Barrel Weir-Type Skimmer

This half-barrel, weir-type skimmer pivots on a central crossbar, enabling it to be adjusted to capture the approaching waterborne spill while reducing the amount of water intake. The two most common models are the .6 metre wide with one spill recovery pipe and the 1.2 metre wide with two spill recovery pipes. In both cases the pipes are camlocked for hose attachment.

It is essential that this device be manned during operation in order to limit the quantity of water recovered with the oil. Unmanned, this skimmer has been known to recover over 99 percent water, thus should be continuously monitored while in operation. Some units have been equipped with adjusters that will lock the half barrel in a particular position for this purpose. The skimmer works best for recovery of very deep liquid product.

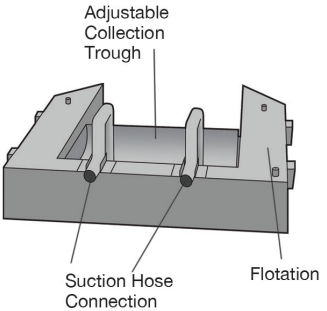


Diagram 5.4.2d Adjustable, Half-Barrel Weir-Type Skimmer

5.5 | Sorbents

Sorbents (both absorbents and adsorbents) are a family of disposable textile or granular products manufactured from oleophilic materials. Hydrocarbon-only sorbents are preferentially wetted by oil and mostly repel water. They are predominately single-use products. When allowed to come in contact with oil on water, they will absorb or adsorb the oil over time. In general, they come in the following forms.

5.5.1 | Skeets, Pads, Pillows, Rolls

Generally smaller in size. Useful for spot cleaning by hand.

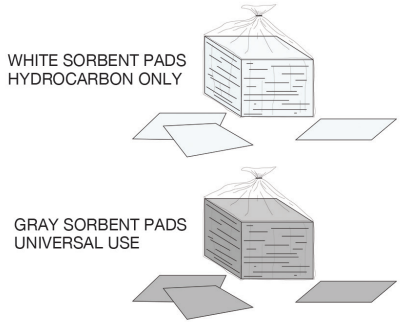


Diagram 5.5.1a Sheets, Pads, Pillows, Rolls

5.5.2 | Sorbent Booms

Sorbent booms are easily deployed in low current environments. Usually sausage–shaped, with a few inches of freeboard (height above water) when floating.

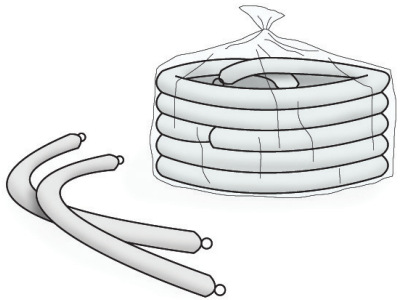


Diagram 5.5.2a Sorbent Booms

5.5.3 | Sorbent Sweeps

Long, narrow sheets of sorbent material with an integral tension member, sorbent sweeps can be used in place of sorbent booms for managing and recovering sheens.

5.5.4 | Pom-Poms/Snares

Oleophilic filaments, both individual and attached to ropes. Particularly useful with more viscous oils. Can be used to wipe down rocks or vegetation or anchored in place to catch oil. Several individual snares may be attached along a length of rope to form viscous oil sweeps or "snare boom".

5.5.5 | Sorbent Socks

A smaller, more compact version of sorbent booms. Useful for building small containment walls around storm drains, sumps, bilges or sewer entries.

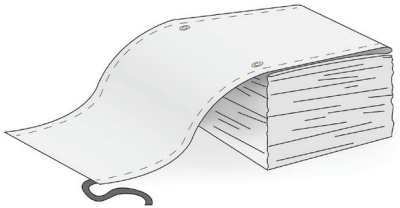


Diagram 5.5.3 Sorbent Sweeps

Diagram 5.5.4a Pom-Poms/Snares

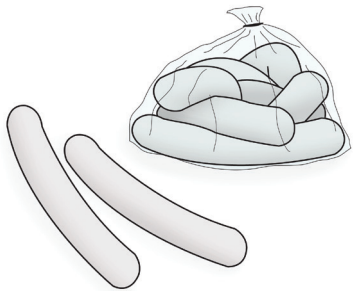


Diagram 5.5.5a Sorbent Socks

5.6 | Temporary Storage Devices

Temporary storage of recovered oil can be critical to the success of a spill response. Temporary storage tanks are usually fabric, for storage and portability. Depending on the type, they may or may not have a rigid frame. Note that open storage devices do not have positive vapor control. Hence, they may not be suitable for storage of highly volatile products.

5.6.1 | Sealed, Vented Storage Devices

A pillow tank is a collapsible storage container that provides temporary as well as long-term liquid storage. Pillow tanks can be used for potable (drinking) water, fruit juices, wastewater, chemicals, oils and more. They are made of urethane, rubber or vinyl fabrics, depending on the usage intended. Capacity ranges from 200 to 5,000 gallons (750 to 19,000 litres).

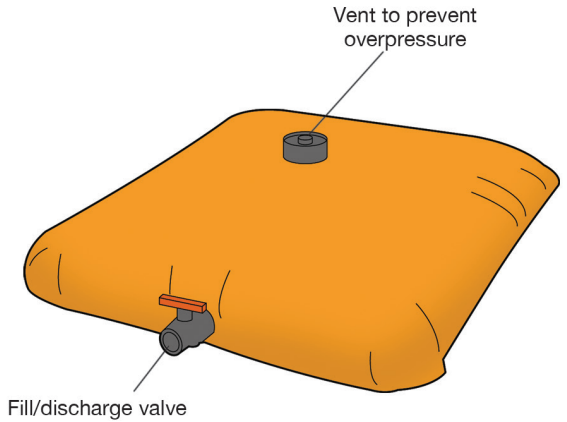


Diagram 5.6.1a Pillow Tank

5.6.2 | Open Storage Devices - Rigid Frames

Rigid frame, fabric storage devices are easy to assemble and can be taken apart and re-sited quickly. Some of them can accommodate uneven ground. Capacities range from 240 gallons / 909 litres to 20,000 gallons / 75,708 litres. The next three diagrams are examples.

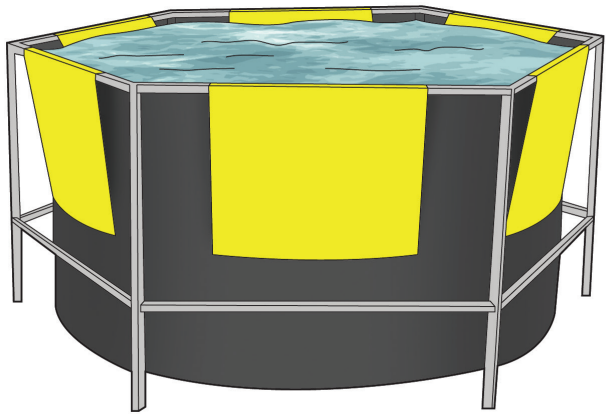


Diagram 5.6.2a Open Storage - Rigid Frame