



Oceanic Consultants

OIL SPILL RESPONSE MANUAL

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## Oil Spill Response

This Oil Spill Response manual will

1. Describe in general terms the behavior of oil when it has been spilled on water or land
2. Describe the most common types of oil spill equipment / tools / products, such as booms, skimmers, pumps, dispersants, absorbents, storage facilities, vessels, etc.
3. Recommend response tactics - marine to the most common types oil pollution into the marine environment
4. Recommend response tactics - land to the most common types oil pollution on land
5. Recommend remediation processes to the most common types of oil pollution on land, including waste oil pit cleaning
6. Recommended wildlife rehabilitation procedures
7. Describe disposal or use of recovered oil

### **Behavior of Oil**

This section of the Response Handbook has been divided into two chapters:

[Behavior of oil which has been spilled at sea](#)

[Behavior of oil which has been spilled on land](#)

#### **Behavior of oil which has been spilled at sea:**

This chapter is the most fundamental part of the Response Handbook, when it comes to marine oil spills.

Most of the oil which spills into water is crude oil. The spills are either due to natural leaking from the underground, as is the case off the coast of California, or due to human action in connection with exploration, production, or transportation of crude oil.

The behavior depends of the origin of the crude oil, as well as the environment which it is spilled into, e.i. water- and air temperature, wind and wave conditions. But in **very general terms**, the following will happen within hours:

1. **Spreading:** The oil spreads rapidly over a large area and breaks up in windrows, which are long and narrow slicks with the same orientation as the wind.
2. **Evaporation:** The spreading causes the lighter fractions of the oil to disappear rapidly, leaving back in the water only the heavier parts.

3. **Emulsification:** Wave action mixes water into the oil, forming a heavy and sticky water-in-oil emulsion, sometimes called chocolate mousse.

So, if you arrive at the spill site 10 to 20 hours after the spill, expecting to find something like the motor oil from your car, you may get a big surprise. And as if the heavy, sticky emulsion wasn't bad enough, you may in addition find it mixed with all types of floating debris, such as kelp, seaweed, wood, cans, rope, plastic, and more.

The described behavior of the spilled oil sets the demands for a successful oil spill response:

- A. Minimal response time
- B. Efficient and fast concentration of the widely spread oil
- C. Skimmers and pumps which can handle high viscosity emulsion and debris
- D. Appropriate temporary storage capability

(Options: Dispersant spraying may be used in the very early stages after the spill, provided permission has been granted by the authorities. In-situ burning may be an option to skimming).

It is relevant to mention that in some cases very light oil has been spilled in large amounts without significant visual impact. This is due to the fact that nearly all of the oil has evaporated, and that the ocean has handled the rest by natural dispersion. Only in blow-out situations or if such light oil has been trapped in a harbor or in a bay, a fast response may be able to recover significant amounts of the oil.

### **Behavior of oil which has been spilled on land.**

Where the very light oils seem to cause the least problems at sea, it is the opposite situation on land:

Light oil tends to penetrate the top soil rapidly, thus seeping into the deeper ground bringing the groundwater at risk. Heavier oil only very slowly contaminates the soil, as its higher viscosity makes penetration difficult.

Depending on the viscosity, the spilled oil will more or less fast flow to the lower part of the landscape. Apart from this, spreading will not take place, so the evaporation of the lighter fractions of the oil will be limited. Further, there will be no emulsification with water. Therefore the spilled oil will not physically change very much, unless it is left on the ground for a longer period of time.

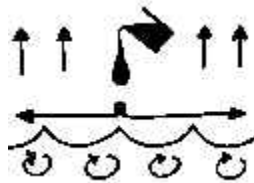
But the oil will mix with gravel, soil, and the present vegetation, which may result in difficulties during clean-up.

The described behavior of the spilled oil sets the demands for a successful oil spill response:

- A. Minimal response time, especially for spills involving light oil
- B. Efficient and fast limitation of further spreading (dikes and ditches)
- C. Skimmers or pumps which can handle debris and soil contaminated oil
- D. Appropriate temporary storage capability

(Options: Certain biologically degradable detergents may successfully be used for fast flushing of the oil to the collection and recovery area. In-situ burning may - in a few special situations - be an option to recovery, pending permission).

Apart from the above mentioned differences from marine spills, it is important to note, that land oil spills very often involve so called product oils. These are oils which have been refined, and their performances (as for instance diesel-, hydraulic-, transmission-, or lubrication oils) have been improved by additives, of which some are extremely toxic and harmful to the environment.



Oil's Behavior on Water



Recovered weathered and extremely viscous crude oil



Land spill at tank farm



Land spill from pipeline

## **Oil Spill Equipment and Products**

Oil spills happen to behave differently from case to case. Even during one spill response operation, the conditions change from area to area and also over time. Therefore you cannot count on – for instance in a marine spill - one specific type of boom, or one type of skimmer, for the collection and recovery of the oil. Mainly for marine spills, but also for land spills, you must have at your disposal a selection of equipment and products which combined will meet the demands for a well prepared contingency.

Therefore this chapter of the Response Handbook will describe the most common types of oil spill equipment , -tools , and -products, such as the most relevant types of booms, skimmers, pumps, dispersants, absorbents, storage facilities, vessels, etc.

The displayed equipment photos and sketches do not express oil-spill-web's preferences, but they have been selected because they best describe the principle or function in question.

[Booms](#)

[Skimmers](#)

[Pumps](#)

[Storage](#)

[Dispersants and Spray Systems](#)

[Response Vessels](#)

[Absorbents](#)

[Other Spill Response Equipment](#)

## Booms

[Booms In General](#)  
[Boom/Water Speed](#)  
[Boom Configurations](#)

### Booms In General

Booms (or Oil Containment Booms) are floating devices which may have one or more of the following functions in connection with oil spill response on water:

1. Deflecting oil to prevent that the oil slick hits sensitive areas
2. Containment of oil (for instance for later recovery by a skimmer)
3. Containment and concentration of oil (for instant recovery by a skimmer)

Booms are manufactured in many sizes, materials, and designs in order to meet the various combat environments and the requirements from the market. But they all follow the same basic principle, having a flotation member at the top, a skirt below, a tension member, and a ballast member at the bottom.

The flotation member may be

- A. an inflatable chamber
- B. a self inflatable air chamber (springs inside the chamber automatically force the air into the chamber as the boom is deployed)
- C. an air chamber which automatically fills with air, which is permanently encapsulated within a two-layer light weight boom design.
- D. foam filled buoyancy chamber
- E. buoyancy chamber made of absorbent material (absorbent boom)

The skirt may consist of one or two layers of the boom fabric. Some special designs have water permeable skirts.

A tension member is any longitudinal part of the boom (boom fabric, ballast chain or wire), and combined they take up the forces of wind, waves, current, and the forces when the boom is dragged through the water in a sweep.

The ballast member may be made of steel or lead, or even water.

A typical boom for off-shore use have a heavy steel chain which can function as both a ballast member and a tension member.

Smaller and more simple multi-purpose booms may have a steel wire which can function as both a ballast member and a tension member.

Booms, which have been specially designed to be able to seal the beach/water interface, so-called beach booms, have one or two water filled ballast chambers at the bottom of the boom.

Sections of booms may be interconnected using standardized connectors, thus creating any practical length necessary.

A tow bar at the end of a boom can transfer the drag forces from a vessel to the boom, or it may be the transmitter of forces from an anchor line, as is the case for a deflection boom in a river or at the water intake of a desalination plant.

### Boom/Water Speed

(of a boom when used in a sweep formation OR of the water when the boom is used stationary, for instance in a river):

The ability of containment booms to collect floating oil is subject to limitations described by fundamental physical laws (the speed of the boom moving through the water, or the speed of the water passing under the boom skirt)

The maximum sweeping speed (the speed of the water passing perpendicular to the boom) using a conventional inflatable or foam filled containment boom is **0.7 knots**, if you don't want to loose oil, escaping under the boom. The maximum speed perpendicular to the boom is 0.7 knots, no matter how much draught the boom has.

There are, however, minimal variations, dependent on for instance the specific gravity of the oil.

Certain boom sweep formations and boom designs, such as the NOFI Vee Sweep and Oil Stop, Inc.'s Fast Sweep System - having a fine meshed net to make a water permeable bottom between the lower parts of the skirts at the apex of the "V-shaped" boom sweep formation - can create a strainer bag effect where the water escapes easier than the oil through the net. These specially designed boom sweep apex formations may reach an effective sweep speed of approx. 1.5 knots before a significant amount of oil is lost under the boom.

Another way to increase the effective sweep speed is the patented LORI circulation system, where the collected oil via a side sweep on a vessel is forced away from the critical zone at the apex of the boom and via a side door in the hull into to an internal recovery area inside the vessel. Any oil which is not recovered immediately by the skimmer inside the hull is then forced back to the collection area via another side door in the hull. The LORI system may likewise reach about 1.5 knots effective sweep speed without significant losses.

## Boom Configurations for the Containment, Concentration, and Recovery of Oil:

Booms, moored and used for *deflection* of spilled oil, for instance in a river, must be placed in an angle to the current which ensures that the speed component of water - projected into a direction perpendicular to any section of the boom - does not exceed 0.7 knots.

All *static containment* of spilled oil must obey the same rule which is that the velocity of the component of water which flows perpendicular to the boom configuration must be less than 0.7 knots.

*Dynamic containment* and *concentration* of oil may be performed using several types of boom configurations:

### **"U" Configuration**

**Concentrating capability: Poor**

**Maneuverability: Poor**

This is the most commonly used, and unfortunately also **the most inefficient way** of sweeping oil for recovery by a skimmer. The "U" sweep will "concentrate" the oil in a large area inside its huge apex, and therefore it will only build up a thin layer of oil, thus making efficient skimming difficult. The U-shape will normally require two vessels towing the boom, and one vessel operating the skimmer. A three vessel operation is extremely difficult to maintain for the masters of the vessels.

### **"U+V" Configuration**

**Concentrating capability: Good**

**Maneuverability: Poor.**

This adds a "V" shaped pocket to the apex of the "U", thus enabling an efficient concentration of the oil, which will support a high recovery efficiency of the skimmer. But still very difficult to navigate.

### **"J" Configuration**

**Concentrating capability: Poor to Medium**

**Maneuverability: Medium**

In this concept, the vessel towing the shorter end of the "J" sweep will also operate the skimming unit. This facilitates navigation, but the oil is still not concentrated very well and therefore only in a thin layer, thus making efficient skimming difficult.

**"V" Configuration or V-Sweep**  
**Concentrating capability: Medium**  
**Maneuverability: Good**

A large scale V-shaped sweep is not possible. It will eventually end up as a U. But for smaller sweeps, mounted at one side of the recovery vessel, this is an **extremely efficient** way of tracing the "windrows". The limited sweeping width limits the overall concentrating capability, but the efficient concentration of the oil which is caught by the sweep, supports a high recovery efficiency of the skimmer. The use of a bottom net design - incorporated into the V-apex of the sweep - may result in increased recovery speed and efficiency.

**"J+V" Configuration**  
**Concentrating capability: Good**  
**Maneuverability: Medium**

In this concept, a "V" pocket has been attached to the apex of the "J", and the vessel next to the "V" will also operate the skimming unit. Two vessels facilitate navigation when compared to three vessels, as needed for a "U", and the efficient concentration of the oil entering the V part of the sweep supports a high recovery efficiency of the skimmer

**Side Fitted Single Vessel Sweep**  
**Concentrating capability: Poor to medium**  
**Maneuverability: Good**

This configuration is very common, and is recommended due to an excellent maneuverability. The vessel is equipped with a side fitted outrigger arm (jib) which holds the boom in either a U shape (poor oil concentration ability), see sketch to the right, or a V shaped formation, see V Sweep sketch above. The V shape has the ability to concentrate the oil and therefore build up a thick oil layer for high skimming efficiency. The sweeping width is, however, limited.

**Side Fitted Single Vessel Double Sweep**  
**Concentrating capability: Medium to good**  
**Maneuverability: Good**

Two side fitted sweeps are used, one jib arm on each side of the hull hold the sweeps. The sweeping width will be increased, and still the maneuverability of this configuration is good.

**"U" Configuration with an open apex, followed by a Side Fitted Single Vessel Sweep**  
**Concentrating capability: Very good**  
**Maneuverability: Medium**

Compared to the "U" with two towing vessels and one recovery vessel operating a skimmer at the apex of the boom, this concept combines the advantage of a large sweeping width, with the efficiency of an independent recovery vessel mounted with a single or double side fitted sweep. The oil which is concentrated by the large "U" will be guided into a narrow stripe behind the U-sweep, and may immediately be contained and recovered by the Side Fitted Single Vessel Sweep following right after the U.

### Skimming Booms:

Please see the skimmer section.

### **Skimmers:**

#### Skimmers in General: Skimmer Principles and their Performance

#### Skimmers in General:

An oil skimmer is a device which can be used to recover floating oil from (or near) the surface of water.

The Skimmer is only one out of several links in the recovery chain, which for instance at sea may consist of the recovery vessel, tug boats, containment booms, skimmers, transfer pumps, and temporary storage. No chain is stronger than the weakest link, and where this is in the recovery chain, depend very much on weather and sea conditions, size of oil spill and type of oil, presence of debris, seamanship, vessel capability, boom configuration/performance, skimmer type, type and capacity of transfer pump, and finally the storage capability.

In the aftermath of the Exxon Valdez incident and the OPA 90, high skimmer/pump capacity has been of higher priority. It is, however, from a practical standpoint necessary to mention, that VERY rarely the skimmer's name plate recovery rate sets the limitation for a successful response operation (the *type* of skimmer and transfer pump being used is more important). Even the best sweep configurations can rarely concentrate more oil than what a 50-100 cbm/hour skimmer can recover simultaneously. Skimmers with 200 or even 400 cbm/hour capacity must be considered more political than relevant. If the very seldom situation should occur where real high capacity is required, it is much more likely that the best efficiency and match with the other links in the recovery chain is obtained by throwing in several smaller sweeps and skimmers.

Several dozens of skimmers have been designed and manufactured over the years, and many have also found their way to a permanent position on the market for equipment which especially is suitable for sheltered and quiescent

water. But for open sea response, only a few types and brands form the backbone of the World's preparedness as a whole.

This is due to the circumstances in this special field: When oil spills at sea happen, and response operations are initiated, very few equipment designers will ever be involved. The parties behind a response operation do not wish to let in curious persons, not directly involved in the clean-up. Therefore most of the design work have been based on theoretic studies or second or third hand knowledge to the realities of an oil spill. Several ingenious designs have been created, but most of them will only work under calm, laboratory like conditions on a spill with nice, liquid oil without debris.

It is important to realize how oil behaves when spilt on water. It is important to know how weather and especially wave action influence the movements and thereby the performance of a skimmer. Low inertia mass and small dimensions are musts if a skimmer shall maintain its operating position relative to the sea surface.

An evaluation and comparison of the different skimmer principles is possible. But what actually is more relevant is to compare the overall performance of the combined skimmer and transfer pump. Therefore the following presentation should be read with the "PUMP" section in mind.

A skimmer may be

- free floating
- side mounted on a vessel
- built into a vessel
- built into the apex of a containment boom
- held by a crane
- held by hand

Skimmer designs are based on the following principles (in alphabetic order):

- adhesion/oleophilic
- air conveying
- belt
- filter
- inclined plane/hydrodynamic
- mechanical feeder
- vortex
- weir
- and combinations of these principles

NOTE: How buoyancy is provided to the different principles will not be discussed, but will appear from the various photos and illustrations (*coming soon!*).

Skimmers may be static or dynamic. However, these terms have caused some confusion over the years. Therefore it is specified for this presentation that a *static skimmer* is a recovery device which is not being moved through the water and no water and oil is moving past it. A *dynamic skimmer* is a unit which is moved through the water, for instance in conjunction with a boom sweep and a vessel. Or it may be fixed in a river where the water and oil is moving by. Most skimmers are meant to be dynamic.

## Skimmer Principles and their Performance

[Adhesion/Oleophilic Skimmers](#)

[Air Conveying Skimmers](#)

[Belt Skimmers](#)

[Filter Skimmers](#)

[Inclined Plane Skimmers](#)

[Mechanical Feeder Skimmers](#)

[Vortex Skimmers](#)

[Weir Skimmers](#)

### Adhesion/Oleophilic Skimmers

This principle uses the oil's ability to stick to certain materials. Polypropylene, PVC and aluminum are – among others - good adhesion materials. The aim is to let the floating oil stick to a moving surface and then – once out of the water - scrape or squeeze it off into a sump or a pump. This may be a rotating disc, drum, or brush. Or it may be an endless band, mop rope or bristles. Bristles and teathed discs combine adhesion and mechanical feeding.

*Viscosity range:* Pure adhesion will work up to a maximum of 10,000 cSt, although optimum is 100-1000 cSt and above 5,000 cSt, efficiency is very low.

*Water content:* Is low at low disc-, band-, drum-, mop-, and bristle speed and at low viscosity. Higher speed and viscosity will increase the water content significantly.

*Debris:* Adhesion skimmers are not very debris sensitive as long as the debris does not restrict the flow of oil to the skimmer. Smaller debris may nevertheless clog the suction- or pump inlet. Big debris will not be dragged into the skimmer.

*Operating conditions:* Disc, band, and drum skimmers: Relatively calm water, as the wave action may push the oil away from the adhesion surfaces. Mop ropes and bristles are less wave sensitive. Mops and bristles have demonstrated good performance in water with broken ice. Small disc and mop skimmers (5-15 cbm/h) are the most commonly used skimmers World wide, for in-shore, harbor, and lake spills. Mop skimmers are used in many static applications, for instance in API separators.

### Air Conveying Skimmers

Vacuum trucks or smaller vacuum units are often used as skimmers with or without a skimmer head mounted at the end of the suction hose. But only for very light oil is vacuum the effective player. With a maximum of 0.8-0.9 bar(12 PSI) of suction, the vacuum will be inefficient on higher viscosities due to friction losses in the suction hose (Please see the "Pump" section of the Response Handbook). But how can it be that they are used anyway?

The secret behind the vacuum unit's ability to recover oil is the high speed movement of the air at the end of- and inside the suction hose. You could talk about an *air conveyor belt*. The high speed air merely lifts off the oil from the surface of the water and transports it to the reception tank. With viscous oil this is only possible if a lot of air is dragged into the hose "parallel" with the oil. Vacuum (and no air flow) will not do it.

Air conveying has been refined in portable units with small reception tanks, but with powerful air conveying capability.

*Viscosity range:* Air conveying will handle even solid oil, provided it is in lumps small enough to enter the intake. Range: up to about 1 million cSt.

*Water content:* Low in calm water conditions, but high in waves.

*Debris:* As long as the size is small enough to enter the inlet, there is no problem, but bigger debris will clog the intake and seize operation until cleared away.

*Operating conditions:* Preferably calm water. Autonomous self floating units will due to weight and size get out of phase with waves, thus losing efficiency. If only the intake head is floating, the wave performance may be somewhat better.

### Belt Skimmers

As belts are used in several ways, covering "adhesion," "mechanical feeder", "inclined plane", and "filter", and combinations thereof, it is relevant to describe the belt type as a separate principle, although it is not one.

The *filterbelt* combines filtration with adhesion and mechanical feeding . The belt is moved through the water/oil, and a pump behind the belt may increase the flow to and through the belt. The filter effect separates oil and debris, letting the water pass through the filterbelt. The adhesion effect lifts the oil and oily debris out of the water, conveyed by the belt's movement. At the top of the belt the oil is scraped off into a sump or a pump, while the biggest debris is guided to a separate storage.

The *non-adhesion belt* is used to convey the floating oil below the water surface and feed it into a collection and recovery tank, where the oil again will float up to the surface. The belt's movement will offers almost zero relative velocity to the

oil, thus facilitating separation and re-floating. As the layer builds up, a built in weir skimmer recovers the oil, and a pump will transfer it to a reception tank. This principle combines mechanical feeding and inclined plane, and is called the submerged belt or *Dynamic Inclined Plane*, DIP.

The *conveying belt* is used to lift - by means of cups or scrapers - the oil (and in some cases also some water) out of the water and dump it into a sump or a pump. This principle is actually mechanical feeding. When cups are mounted on the belt, some water will be recovered together with the oil. However, this may be decanted from the recovery sump prior to transferring the oil.

*Viscosity range:* The above water belt type skimmers may recover even very viscous oil. The expected maximum is 50-100,000 cSt. The cup belts may have a problem getting high viscosity oil out of the cups. The submerged belt skimmers will only recover what the pump or skimmer in the reception tank will handle.

*Water content:* The conveying belt with cups will always recover a lot of water with the oil. The other types will have a low water content in calm water, however, increasing with increased wave action, belt speed, and viscosity.

*Debris:* The belt skimmers are very good at handling debris. Normally it is the transfer pump which sets the limitation.

*Operating conditions:* From calm sheltered water and near shore up to 8 m/sec wind speed, 1.5 m significant wave height. Higher waves will push the oil away from or under the skimmer. Belt skimmers have been used with good results for many years, although they - due to price and size - have only been distributed moderately.

#### Filter Skimmers:

The *filter belt* has already been mentioned above under belt skimmers. Filter skimming also takes place in the *net-drum skimmer*, which consists of a horizontally oriented drum made of stretch metal, which rotates around a circular tube with a built in hopper. The diameter of the net-drum varies from maximum at the opening or inlet, to minimum at the horizontal tube and hopper, thus creating a concentrating capability by rotation. The hopper is well above the water surface, so the concentrated oil will be scraped into the hopper with no or minimum water content. Inside the hopper an Archimedes' screw feeds the recovered oil into the transfer pump. The net-drum combines filter and mechanical feeding, and to some extent adhesion.

*Net bags*, or so called oil trawls, which can be attached to the apex of a sweep, in order to recover tar balls and high gravity oil and bitumen (floating in or under the water surface), must in principle be considered as a filter skimmer. The forward movement of the sweep will force both oil and water into the oil trawl.

The water will escape through the masks, which, however, will hold back the oil, due to the oil's higher viscosity and inner tension (shear rate).

*Viscosity range:* Net drums and net bags will recover oil well over 100,000 cSt.

*Water content:* The net drum will increase the water content with increasing RPM of the drum and with the increase of viscosity. But in general both the net drum and the net bag will - under moderate working conditions - recover very little water.

*Debris:* Once debris, which is too big for the feeding screw and the transfer pump to handle, gets into the net drum, it is very difficult to remove, and it may seize the operation for a long time. But smaller debris is no problem. The net bag will recover whatever debris can get into the bag.

*Operating conditions:* The net drum and the net bag are not very sensitive to wave action as long as oil is constantly moved to the unit. The expected maximum significant wave height is about 2m for the net drum, while the net bag will work as long as the containment booms can hold the oil. The filter or net principle is not as widely distributed World wide as it deserves.

#### Inclined Plane Skimmers:

The belt combination was mentioned above, under belt skimmers. The inclined plane skimmer (without belt) works in a similar way. But here it is solely the forward movement of the skimmer through oil and water which forces the oil under the plane and into the collection and recovery area, where the oil will re-float. As the layer builds up, a built in weir skimmer recovers the oil, and a pump will transfer it to a reception tank.

*Viscosity range:* It should not be expected that the inclined plane skimmers will be efficient above 20,000 cSt, as oil of higher viscosity will tend to be pushed in front of the skimmer, and will also have difficulties in following the flow to the surface of the collection chamber. This principle will further be limited to recover what the pump or skimmer in the reception tank will take.

*Water content:* For moderate weather and moderate viscosity (less than 10,000 cSt) the build up of a thick oil layer in the collection chamber will result in a low water content with the recovered oil. Higher speed, bigger waves and high viscosity will increase water percentage significantly.

*Debris:* Larger debris may enter the collection chamber, but may not be handled by the built in weir skimmer or transfer pump. This situation will require personnel ready to manually remove debris.

*Operating conditions:* The principle of re-floating submerged oil limits how much bumping the skimmer can take before the oil is lost under the skimmer. A

significant wave height of about 1.5 m will be the upper limit for a reasonable performance. The principle is intended for higher speed than the normal 0.5 to 1 knots. But the higher speed, the smaller waves can it take. The principle is not widely spread outside the USA.

#### Mechanical Feeder Skimmers:

This principle is always used in combination with one or more of the other skimmer principles. One exception could be the conveyor belt cup skimmer, which is best described as a mechanical feeder.

Combination examples:

*A disc skimmer with teeth* at the perimeter of the discs combines adhesion with the teeth's ability to feed.

Rotating (or endless ropes of) *bristles or brushes*, mounted on a weir skimmer, combine adhesion to the bristles, and feeding capability provided by the stiffness of the bristles, with the simplicity and low inertia mass of the weir skimmer.

The *net drum skimmer*, combines filtration and adhesion with the feeding and concentrating geometry of the stretch metal drum.

The *filterbelt* combines filtration with adhesion and mechanical feeding.

Common for the addition of mechanical feeding to the various skimmer principles is that it results in significantly increased performance regarding high viscosity, debris capability, and to some extent, low water content. However, this puts further stress on the importance of the transfer pump's performance. But there is no doubt that "above water" feeding combinations are good choices in difficult oil spill operations with weathered and debris laden water-in-oil emulsion.

#### Vortex Skimmers:

This principle creates a vortex in the central zone of the skimmer, by rotating and evacuating water through the bottom of the recovery chamber, using a large diameter propeller pump or paddle wheel. Thereby water and oil is "dragged" towards the skimmer, and simultaneously a centrifuge function is created, which tends to allow for the build up of an increased oil layer in the center of the vortex. The oil is sucked by a pump or recovered via a simple weir at the center. A different way of creating the vortex is to let a forward movement force oil and water tangentially into a circular chamber. The water escapes through the bottom, and the oil is sucked away from the increased oil layer at the center of the vortex.

*Viscosity range:* Up to a maximum of about 5000 cSt this principle may work as intended. But increased viscosity will disable the circulating water's ability to bring the oil along.

*Water content:* Relatively low, provided absolutely calm conditions.

*Debris:* The vortex may be severely disturbed by the presence of debris. The vortex inducing propeller pump or paddle wheel will very soon be jammed up with debris.

*Operating conditions:* Absolutely calm and clean conditions. More like a laboratory situation... But for such condition the paddle wheel vortex principle may be the only skimmer which will have any effect in static mode. The principle was popular in the earlier years of oil spill response history.

#### Weir Skimmers:

This is the most simple of all the principles. Actually, all it does is the same as when the cook skims the fat off the soup, using a table spoon. The weir lip may be adjusted vertically up/down hydraulically, or the entire skimmer may be air ballasted up/down by dragging water out of - or into - one of the floats. A few have manual adjustment. However, the most common adjustment is by means of a self adjusting weir lip, which floats higher or lower depending on the pumping rate.

Weir skimmers may be free floating skimmers, mounted on a crane, hand held, or built into combination skimmers as described above. A special combination is the weir boom, where a weir, a hopper, and a transfer pump is integrated in the apex section of a boom. There are also designs with two or more weirs built into the boom.

Combinations where the weir skimmer is the basis for attachments of different cassettes with disc sections, bristles, or other feeders are also available, offering a versatile concept.

A weir skimmer may have an internal transfer pump mounted in or under the weir hopper. Or transfer of recovered oil may be handled by an external suction pump or a vacuum unit.

*Viscosity range:* As a free floating dynamic weir skimmer, preferably placed in the apex of a V sweep, efficient skimming will seize at about 30-40,000 cSt, dependent on the design of the weir lip. Additional mechanical feeding may expand the viscosity range up to 50-100,000 cSt. Free floating lumps of almost solid oil may also be recovered, provided they can pass the weir lip and enter the intake of an appropriate transfer pump.

*Water content:* Weir skimmers will – especially at open sea - recover more water than most other skimmers, but over a longer term their simplicity and reliability still make them recover more oil than other skimmers.

*Debris:* Big debris may obstruct the oil's flow to the weir or may clog the transfer pump or suction intake. Depending on the type of transfer pump, medium and smaller size debris will not affect the skimmer.

*Operating conditions:* Due to small size and weight, when compared to recovery capacity, this principle will allow skimming in up to 12 m/sec wind speed and a significant wave height of 2 to 2.5m. In general you can say that an open sea weir skimmer will work as long as the containment boom can hold the oil. Weir skimmers are the most widely distributed skimmers for open sea and near shore skimming, and over the last few years they have become quite common in land spill clean-up operations and in waste oil pit-cleaning, as it is convenient that responders may push or shovel oil sludge directly into the hopper.

**Pumps:** Coming soon

**Storage:** Coming soon

**Dispersants and Spray Systems:** Coming soon, but in the meantime get the information as provided by ITOPF:

<http://www.itopf.com/dispersa.html>

**Response Vessels:** Coming soon

**Absorbents:** Coming soon

**Other Spill Response Equipment:** Coming soon

### **Response Tactics - Marine Oil Spills**

(please note the Behavior of Oil Section)

[General Remarks](#)

[Oil Spills at Sea](#)

[Oil Spills in Lakes and Shallow Water](#)

[Oil Spills in Rivers](#)

[Oil Spills on the Shoreline](#)

### **General Remarks:**

[Maintenance and Training](#)

[Health and Safety](#)

It is very difficult to generalize on marine oil spill situations. Each spill has its own set of characteristics: Location, close to shore or far off shore, degree of environmental sensitivity, shallow or deep water, waves, current, wind speed and direction, temperature, size of spill, type of oil, time after spill, debris, etc.

There are several factors which influence how successful the clean-up operation will be, and they are all incorporated in an appropriate contingency plan:

Availability and capability of properly maintained equipment and products (ships, skimmer systems, booms, pumps, storage, dispersants, absorbents, etc.).

Availability of manpower, well trained/not trained

What to protect first of all.

Communication

Information

Surveillance

Command

Strategy/Planning

Regarding the equipment and personnel involved in an oil spill combat operation, the most important factors for success are:

### **Maintenance and Training**

Equipment for combating oil pollution should be treated as emergency equipment. These tools should be maintained and kept in a state of readiness in the same way as fire-fighters treat their gear. **It is too late to inspect and repair oil spill combat equipment when the "alarm bell" of an environmental emergency rings!**

Training and exercising again and again is the only way to be sure to realize the full return on an investment in oil spill combat equipment.

### **Health and Safety:**

Oil spill responders are dealing with several hazardous situations:

Working at sea: Risk of drowning

Working with cranes

Working with pumps and skimmers with debris cutting knives

Working with heavy weight containment booms

Working in atmospheres containing toxic vapors

Working with various chemicals

Working in or close to explosive atmospheres

It is extremely important that an appropriate **Health- and Safety Plan (HSP)** has been prepared and that all involved personnel has received proper HSP education.

**All safety instructions in the response equipment operating manuals must be obeyed!**

*Please note that for the sake of simplicity, the following oil pollution combating scenarios mainly use containment booms and free floating skimmers. We know*

*that other techniques are available. They will gradually be integrated into this section, for instance by assistance from the manufacturers or the users.*

### **Oil Spills at Sea (Mechanical Recovery):**

Sweep configurations

Oil Recovery

Debris

(Please note that for the sake of simplicity, the following oil pollution combating scenarios mainly use containment booms and free floating skimmers. We know that other techniques are available. They will gradually be integrated into this section, for instance by assistance from the manufacturers or the users)

Oil spill response at open sea is a challenging task, and is normally only initiated if the oil pollution threatens a shoreline or important marine life. Our knowledge about the sea currents and the weather makes it possible to predict the most probable route which the spilt oil will follow. PC software is available for trajectory analysis. Surveillance is done by satellites or from aircrafts. Once it has been decided by the responsible authority to launch a response operation, the basic pattern should follow the instructions in the contingency plan for the area. The following describe some – but not all – of the tactics considerations which one should be aware of in the practical oil spill response at sea:

#### **Sweep configurations:**

A free-floating skimmer is in most cases supposed to be within sight of the operator. The closer, the better control and recovery efficiency. Difficult debris can be observed and removed before disturbing the skimmer or the entire sweep. It is therefore recommended to use the skimmer(s) in conjunction with a Side Fitted Single Vessel Sweep (single or double sided) with the skimmer(s) placed in the apex of the sweep boom(s). "V" shaped sweeps are strongly recommended. Please see the boom section of this handbook.

Excellent maneuverability makes these concepts suitable for small and medium size oil spills. They can rapidly attack the "windrows" of oil. Lane by lane.

For larger oil spills, the Side Fitted Single Vessel "V" Sweep configuration may be combined with a large "U" configuration with an open apex. The oil - which is concentrated by the large "U" - will be guided into a narrow stripe behind the U-sweep, and may immediately be contained and recovered by the Side Fitted Single Vessel Sweep following right after the "U".

Very often, the importance of **temporary storage** capacity for the recovered oil is not taken seriously enough. It is important that all links in the "recovery chain" match up. Use for temporary storage:

Tanks onboard the recovery vessel  
Barges or small tankers  
Floating flexible tow able storage bladders (TSB)

### **Oil Recovery:**

The recovery vessel's forward movement will force the floating oil - trapped inside the sweep – to concentrate at the apex of the boom formation. Allow the oil layer to build up before starting the skimmer. An oil layer of at least 2.5 to 5 cm (1-2") is recommended. No type of skimmer will work efficiently in a real life situation without the presence of sufficient amounts of oil. But on the other hand the oil should continuously be pumped away as it enters the skimming zone. Otherwise it may escape under the boom. It is a question of obtaining a balance, and only the actual situation can indicate where this balance is. If you are in doubt, it is always better to start skimming too early than too late. In the first case, you may recover more water than necessary (dependent on type of skimmer), but in the second case you may lose the oil under the boom. If you recover too much water, it is not necessarily a big problem, as long as the type of skimmer pump used does not emulsify oil and water. Recovered water can easily be decanted from the storage tank, to be discharged in front of the sweep. In this way, any oil in the decanted water will be recovered again.

### **Debris**

Debris is a universal problem in almost all oil spill situations. Therefore the skimmer should be able to handle a lot of the debris normally found at a spill site: Seaweed, kelp, plastic bags, aluminum cans, bottles, etc. But the bigger debris such as lumber, trees, big branches etc. must be manhandled. One way is to pull it away from the skimmer at the apex of the boom. But the best way is to deflect the bigger debris before it enters the sweep. Various techniques exist. One is to have personnel located in a MOB boat (rubber dinghy) in front of the sweep, using rakes to pull away the debris. The same may be done from a small vessel, which is preferable in bad weather. The deflection of debris may cause deflection of some oil too. But this is far better than losing all the oil contained in the boom, due to rupture or other complications caused by for instance a big tree floating in the water.

### **Oil Spills in Lakes and Shallow Water:**

The response principle is as for open sea, but you use smaller units.

### **Oil Spills in Rivers:**

Small to medium size rivers

Fast flowing rivers

The combating of oil spills in large and slow rivers will in most cases follow what has been described for lakes and sea.

For small to medium size rivers, there is a large variety of scenarios to consider. But the aim is to keep the recovery equipment fixed to the river bank or structures in the river, while the water with the spilled oil is doing the work. Always try to deflect the oil to the slow side (the inner bank at a curve) of the river, if possible.

Please observe that the speed of the river current may require that the booms are positioned in a very small angle relative to the direction of the current. This is due to the fact that the speed of the water perpendicular to any section of boom must be less than 0.7 knots. For more information please see the boom section under "Oil Spill Equipment".

The skimmer must be placed in a way which ensures the maximum flow of oil to it. In some situations it is possible to form a small circulation area close to the river bank, where the deflected and concentrated oil will rotate in a direction driven by the incoming oil, flowing along the boom. In this way the oil moves away from the critical entrainment zone at the apex, thus better avoiding loss of oil under the boom. Another very efficient way to ensure this, is to dig a small pond right next to the river. The river and the pond must be connected with one or two ditches. Use the boom to guide the oil into the pond. Both solutions work very well with the skimmer placed in the middle of the circulating oil.

It may not always be possible to drive a truck all the way to the river bank, as the ground is too soft or muddy. It may be necessary to man-carry the recovery equipment to the river. So low weight is of essence here! Air lifting by helicopter is another option.

Large debris must be deflected before it enters the boomed area. Rakes used from small boats will be quite useful. In some situations it is even possible to deflect large debris by means of a steel wire stretched across the river in or below the water surface, and placed in a small angle relative to the direction of the current.

### **Fast flowing rivers:**

There exists a limited selection of equipment and techniques for oil spill response in fast flowing rivers. The realistic upper speed limit is 6 knots. The high speed current can make it impossible to get combat equipment dispatched and deployed in operating mode before the spill has passed. Therefore pre-positioned equipment is a must in fast flowing rivers. The oil must be deflected to the slow side of the river (the inner bank at a curve). Booms must be used at very small angles relative to the direction of the current. Skimmers must be used in conjunction with speed reducing sweeps, i. e. sweeps or rigid constructions which lead the deflected oil into a system where the area of the upper oil/water cross section gradually is enlarged, thus reducing the speed. If the area of the cross section gradually is enlarged six times, you may reduce the speed of the top layer with the oil from 6 to 1 knots.

## **Oil Spills on the Shoreline:**

### **Regular Sandy Beaches**

### **Stony or Rocky Beaches**

### **Gravel Beaches Subject to Tidewater**

Unfortunately this kind of clean-up operation is not very unusual. It is threatening to the wild life environment and may result in the most costly recovery method. It should therefore be avoided by recovering as much as possible of the oil in open water. However, there are several ways of acting in the event of an oil spill on the shoreline, but they all depend on the actual situation:

### **Regular Sandy Beaches:**

Small to medium size spill: Use beach cleaning machines or bulldozers on the beach if it will carry the weight of such vehicles. If there is no significant surf, you can wash and push the oil back into the sea, to be recovered by a small shallow water skimmer, operating in an area surrounded by a beach boom. Dig a hole under the skimmer if the water is too shallow. Use a Fastank or a rigid open container for temporary storage.

Larger spills/light to medium viscosity: Fence in the oil by means of a shoreline boom, and operate a shallow water skimmer from the beach. If possible, try to push or wash the oil on the beach back into the water in order to let the skimmer recover it. Severe surf will make this operation difficult, if not impossible.

A skimmer head or pump with a self adjusting weir lip - mounted on a "Hiab" type hydraulic crane - a so called "Sweeper", is a very useful tool for this type of spill response. The skimmer- or pump head can always be placed in the best recovery position, remotely controlled from the beach, a vessel, or a barge. Fast to operate and safe for personnel. Pump the oil to a land-based storage or to a sea-based facility such as a barge or a tow able storage bladder (TSB).

Larger spills/high viscosity: As just above, but due to the viscosity it may be necessary to dismantle the skimmer pump from the floats and use it for transfer of the spilled oil. Some times the oil emulsion in the water next to the beach will be so high viscous that a skimmer cannot sink into the oil. It will stay on top of it! Therefore a skimmer pump, mounted on a "Hiab" type hydraulic crane, a so called "Sweeper", also here is a useful tool.

### **Stony or Rocky Beaches:**

Small to medium spill/light to high viscosity: Use absorbents for small amounts of oil and when gentle treatment is required. For larger amounts the best way to recover the oil from a rocky coast is to wash the oil back into the sea, using fire hoses or high pressure- or hot water cleaners, and let a small shallow water skimmer recover it there. Work in an area fenced-in by a shoreline boom. Use a Fastank or a rigid open container for temporary storage.

**NOTE! It must always be considered whether it is environmentally feasible to pressure wash a coast line. If there are important living organisms at risk, and the spill is too big for using absorbents, a more gentle treatment with bio-degradable detergents or surface washing agents could be the option. No action at all may in some cases be the best solution. Therefore experts must be consulted before decision on how to clean a sensitive area is taken!**

Large spill/light to medium viscosity: As above for small spills. However, you may want to use larger skimmers and pumps. Operate the skimmer from the shore, from a vessel, or from a barge, and store the oil in a land or sea-based temporary storage facility. A skimmer head or pump with a self adjusting weir lip - mounted on a "Hiab" type hydraulic crane - a so called "Sweeper", is a very useful tool for this type of spill response. The skimmer- or pump head can always be placed in the best recovery position, remotely controlled from the beach, a vessel, or a barge. Fast to operate and safe for personnel. Let nature finalize the cleaning process, or use a bio-degradable detergent or surface washing agent. Use absorbents whenever feasible.

Large spill/high viscosity: As just above, but dismantle the skimmer pump from the floats for transfer of the oil. Or use a skimmer which by means of a feeder can force heavy oil into the transfer pump. Some times the oil emulsion in the water next to the beach will be so high viscous that a skimmer cannot sink into the oil. It will stay on top of it! Therefore a skimmer pump, mounted on a "Hiab" type hydraulic crane, a so called "Sweeper", also here is a useful tool. Let nature finalize the cleaning process, or do the final cleaning using a bio-degradable detergent or surface washing agent.

#### **Gravel Beaches Subject to Tidewater:**

As it was the case after the Exxon Valdez spill in 1989, gravel beaches and tidewater cause special problems for the oil spill responders: When the tide goes down, the oil sinks with the water level deep into the gravel. And at every high tide the oil will be back at the surface. If you try to wash the top layer of gravel at low tide, as described in the paragraphs above, it may seem nice and clean until after the next high tide. Then new oil "from the deep" will cover the beach.

A careful assessment of the pros & contras of cleaning must be performed prior to doing anything to these beaches. In the warmer parts of the World Mother Nature's work may be the fastest and safest for the environment. But natural degradation may take many years under cold conditions. Therefore an expert evaluation could conclude that cleaning is preferable.

The application of fertilizers for speeding up the work of the "local" microorganisms have shown some results. More aggressive organisms may also be added. But the tidewater disturbs the bio-degradation deep in the gravel beach too much.

There are, however, bio-degradable chemicals available, which seem to be able to do the cleaning of the tidewater gravel beaches: They are available as a water dillutable "soap" or as a citrus oil based solvent.

The fastest working "soap" will stop the oil's ability to stick to anything. However, only some of the oil particles will surface and may be recovered by a weir skimmer (adhesion does not work). The rest will remain in the water column as "powder", but due to its enormous surface it will be subject to relatively fast natural degradation. A slower working type of "soap" has the advantage of leaving most of the dispersed oil at the surface, an ability which is enhanced by the application of compressed air. The oil at the surface may be recovered using a weir skimmer with self-adjusting weir.

The soap types (mixed with water) must be sprayed on and into the beach at low tide. In this way they will reach the oil deep in the gravel and reduce or totally stop the oil's ability to stick to the stones. The high tide will wash away the oil particles, some of which may be recovered and others leave the area totally dispersed.

The citrus oil based solvent must likewise be sprayed into the gravel at low tide. But quite differently from the "soaps", all of the oil that has been removed from the gravel will rapidly come to the water surface when the tide goes up. The oil is therefore faster and easier to recover, when compared to the soap washing method.

## **Response Tactics - Land**

This section is still under construction

### **Waste Oil Pit Cleaning**

[What is a waste oil pit?](#)

[What can be done?](#)

[What will work in the rain forest?](#)

[Inverse Emulsification](#)

### **What is a waste oil pit?**

A so-called **pit** is a leftover from oil exploration and oil production on land. Typically the oil companies in earlier years left drilling mud and crude oil, discharged in connection with drilling and testing of the new well, in ponds or pits next to the drilling hole. Over the years the lighter fractions of the oil have evaporated and in many cases additional contamination has taken place due to the dumping of chemicals, refinery waste, and debris. Consequently the pits may contain extremely viscous and debris laden asphalt-like oil, which is very difficult to recover. The soil in the bottoms and sides, as well as the surrounding land may suffer from serious oil pollution. Contaminated water from the pits may in connection with rain overflow into rivers and lakes.

In some cases attempts have been made to cover the problem by soil, or by burning the content of these pits. But such behavior only adds to the problem, as the costs of proper cleaning afterwards increases substantially.

Thousands and thousands of waste oil pits are still distributed throughout the world, threatening the surrounding environment, ground water, people and especially children, as well as animals.

### **What can be done?**

There are only a few ways to do **proper** pit cleaning, and even fewer of them will be able to cope with the very old, extremely viscous and debris laden pits. You have to consider whether the cleaning must be done in-situ or ex-situ. It gives a lot of meaning to do in-situ cleaning, as this minimizes further environmental damage caused by transportation and double handling of the oil, soil, water, debris, etc.. If, however, the pit is located close to a refinery or a municipal waste incineration plant with electric power generation, it may in some special cases be feasible to bring the whole problem to such a facility for treatment.

The less difficult pits, with relatively fresh and light oil waste, may be cleaned according to methods as described in the "Response Tactics – Land Spills" section of this handbook.

Dependent on climate, geography/geology, and lifestyle of local inhabitants, the cleaning must be more or less complete.

In the Amazon Rain Forest, where the locals drink the water from the rivers and have their children and animals close to the contaminated sites, the cleaning requirement will be high, and pit closures using concrete or quicklime stabilization should be ruled out, due to the rain and groundwater's ability to continue washing out oil and heavy metals.

But in the deserts, with sparse population, and if there is no groundwater, it may be safe to recover whatever you can pump and dig out, and then stabilize the remaining oil. Bio-degradation may be an option to stabilization if the required amount of humidity can be obtained.

### **So, what will work in the rain forest, where the pits contain extremely viscous oil, water, and debris?**

Well, there are a couple of complete and environmentally friendly processes for the in-situ cleaning of difficult waste oil pits. The most affordable is based on an **inverse emulsification** of the asphalt-like crude in the old pits, which makes the oil liquid for easy recovery. The most expensive and most foreign currency costly in-situ process is extracting the oil from the pits by an evaporation/condensation process, using heat, generated from the recovered oil. This containerized

process is very efficient cleaning oil, sediments and water, provided a technique for bringing the asphalt-like oil to the processor is available. This technology will not be described in further detail here, but you may want to check [Soil Recovery](#).

### **Inverse Emulsification:**

A **biodegradable dispersant** is mixed with water and thereafter sprayed on the pit. By using compressed air (large bubbles) and pressure water from fire pumps, the dispersant is mixed with the oil, which gradually becomes more and more liquid. Sand and stones sink to the bottom and debris is relatively easy recovered for final cleaning. As the compressed air nozzles are pointing downwards, this process treats the bottom and the water in the pit at the same time as treating the oil. Heavy oil products in the bottom sediments will be washed out, and (dependent on the dispersant) air bubbles from the agitation process enable the oil to float to the surface. Even if the gravity is higher than 1!

(Most dispersants or surfactants will not have this important capability of re-floatation, but some may compensate for this by being extremely fast making the asphalt pumpable and fast separating the oil from the sediments. They may, however, cause difficulties separating water and dispersed oil)

The oil water mixture is easily recovered, using overflow weir skimmers. The agitation and cleaning of the water and the bottom sediments by means of compressed air continues. Once the water meets the country's EPA requirements, it will, upon approval by the authorities, be discharged to the surroundings (in some cases it will in addition be necessary to use simple filtration). With a little remaining water left in the pit, the bottom and sides are now pressure washed with water and dispersant to a depth of 0.5 m, by high pressure cleaners. In this way the remaining oil from bottom and sides will be washed out. The oil is skimmed off the surface and the last bit of water discharged, when clean enough. The sides and bottom sediments are tested to meet the allowed total hydrocarbon content. It may be too costly to clean the sediments completely, using the washing process. Climate permitting, natural or supported biodegradation may take over once the level has reached for instance 2000 PPM of hydrocarbons in the soil and sediments. Biodegradation works extremely fast on oil which has been dispersed.

The debris, which mainly is wood, should be cleaned to a reasonable level and used as fire wood for cooking by the local inhabitants. It is important to underline that only small debris, such as oil wetted leaves and small branches, which cannot be cleaned without excessive efforts, should be incinerated.

The recovered oil may after filtration be re-injected into production, or it may be used for the production of asphalt and/or fuel for thermoelectrically power plants. In any case: The result of using this process should not cause a new waste problem.

The described process requires mainly low-technology machinery, and - apart from skimmers and special pumps – all equipment, such as tank trucks, back hoes, water pumps, and compressors, are readily available in most countries. Contracts may be performed by local contractors based on local labor under supervision of an external response management.

## **Wildlife Rehabilitation**

[The effects of oil](#)

[Sequential Procedures](#)

**It is important to underline that wildlife rehabilitation should be performed only under the guidance of experienced professionals.**

We are pleased that Simple Green has granted us permission to present the below protocol for oiled bird and mammal rehabilitation, which they have received from one of their customers. Further information: [www.simplegreen.com](http://www.simplegreen.com)

### **The effects of oil:**

1. Externally, oil mats the feathers of avians and the fur of mammals and drastically reduces the insulating and waterproofing properties of both. The risk of mortalities from exposure is therefore increased. It follows that resultant flightless or reluctance to remain in cold water leads to predation exposure.
2. It may be impossible for the victim to find uncontaminated food, either because of flightlessness, the inability to remain afloat or endure cold water temperatures. Additionally, oil clogs the nares (nostrils) and mouth, and causes irritation to the eyes.
3. Internally, oil causes ulceration and bleeding in the gastrointestinal tract, and toxins may be absorbed through the skin and the pancreas. Serious liver and kidney damage has been documented. Susceptibility to secondary infections is increased and oil aspiration pneumonia is common.

### **Sequential Procedures:**

1. Once captured, the victims must be examined and a system for the identification of individuals must be established in order that the patient progress can be monitored.
2. Wipe eyes and inside of mouth with gauze pads, then flush thoroughly with water. Intravenous fluids should be administered to severely dehydrated animals and birds; for those less severely dehydrated, the gastrointestinal tract should be flushed by tubing. Small doses of Pepto-Bismal should be given to sooth the irritated gut.

3. Then, place victims in a warm, quiet area and allow them to stabilize for 8-24 hours before the actual washing process is commenced. Nutrients are added to tubing solution and victims are tube-fed every 4-6 hours.
4. Large tubs should be lined with towels and partially filled with 104 deg. F (40 deg. C) water; oiled victims should be thoroughly wetted. Using the small spray bottle provided by Simple Green, spray Simple Green directly onto fur or feathers, taking care to saturate those areas which are especially grimey.
5. Allow several minutes for the emulsification process to get underway, then begin stroking the feathers or fur in the direction of growth. The subject should be removed from the tub when the water gets dirty and the entire washing process repeated. An oiled victim may require three or more tub washings.
6. The animal or bird must be completely rinsed if it is to be rehabilitated. Any detergent residue can impede waterproofing. Rinse until diamond-like beads of water roll freely from the feathers.
7. When dry, access to a small pool should be given. Through preening and grooming, water proofing will be restored.
8. Release can be expected to take place 4-5 days after washing.

## **Disposal or Use**

This section under construction

### **NOTE:**

The material in this manual has been provided by and will express the opinion of the operator of the **oil-spill-web**, [flemingCo environmental](#), or the opinion of an author who contributed to the content. The content can be used for educational purposes only.