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Standard Guide for Describing Shoreline and Inland Response Techniques[1]

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1. Scope

1.1 This guide describes methods to clean and remediate stranded oil on marine and lake shorelines, on river banks and other inland water body shorelines, and terrestrial habitats. The primary goal of any countermeasure is to aid recovery while minimizing additional impact.

1.2 This guide describes 22 different tactics that are available for consideration. These options range from natural recovery to active physical or biochemical intervention.

1.3 The tactics listed might not be appropriate under all possible circumstances, and multiple countermeasures could be appropriate on the same shoreline, river bank, lake shore or terrestrial habitat.

1.4 This guide describes technical considerations for selecting appropriate response countermeasures or techniques.

1.5 Selection of specific countermeasures for use during a spill response is guided by properties of the oil, degree of oiling, site accessibility, geomorphology, substrate and vegetation type, mobility of available equipment, hydrologic (coastal and inland) and meteorological conditions, and the presence of sensitive natural and archeological resources. It is advisable to consult with appropriate regulatory authorities since certain response options may require government authorization or approval, or both.

1.6 This guide does not address response to submerged, sunken or buried oil.

1.7 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents: therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate* ~~*safety*~~ *safety, health, and* ~~*health*~~*environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

[1] This guide is under the jurisdiction of ASTM Committee F20 on Hazardous Substances and Oil Spill Response and is the direct responsibility of Subcommittee F20.17 on Shoreline and Inland Countermeasures.

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2. Referenced Documents

2.1 *ASTM Standards:*[2]

F1686 Guide for Surveys to Document and Assess Oiling Conditions
F1687 Guide for Terminology and Indices to Describe Oiling Conditions on Shorelines and Other Terrain
F1872 Guide for Use of Chemical Shoreline Cleaning Agents: Environmental and Operational Considerations
F2205 Guide for Ecological Considerations for the Use of Chemical Dispersants in Oil Spill Response: Tropical Environments
F2532 Guide for Determining Net Environmental Benefit of Dispersant Use

3. Key Terms

3.1 *Shoreline and Inland Habitats*—For the purpose of this guide, marine and estuarine shorelines, river banks, and lake shores will be collectively referred to as shorelines, shores, or shore-zones. Shore types include a range of impermeable (bedrock, ice, and man-made structures), permeable (flats, beaches, and man-made), and coastal wetland (marshes, mangroves,) habitats. Other non-shoreline, inland habitats include wetlands (pond, fen, bog, swamp, tundra, and shrub) and drier terrains (grassland, desert, forests), and will be collectively referred to as either wetlands or terrains, respectively.

3.2 *Mixed Sediment Substrates*—These are described based on the size of the inorganic sediments (Guide F1687). The penetration and retention of oil is largely controlled by sediment size. Only light oils (for example, a diesel) can penetrate sand, whereas all but the more viscous oils can easily penetrate into pebbles and cobbles ("coarse sediment"). Substrates composed of mixed sands, pebbles, and cobbles are sometimes referred to as "gravel." The surface layer often has predominantly coarse sediments with increasing amounts of sand in the subsurface. In mixed-sediment substrates, coarser fractions (pebbles and cobbles) are infilled with the finer sediments (sands and granules) so that these substrates are permeable only for some medium oils and all light oils. Pebble-cobble ("coarse sediment") substrates have open interstitial spaces, so oil typically penetrates them, but can be easily remobilized by wave flushing, tidal pumping, or by river currents.

3.3 *Debris*—Scattered organic or inorganic materials that have washed up onto shorelines, wetlands, or accumulated in rivers and streams, or a combination thereof. These materials are not part of a natural habitat, such as sediments, attached animals (for example, mussels or barnacles), live sea grasses, or aquatic plants. Accumulations of large logs that have washed ashore on sedimentary coasts or mid-channel islands can provide protection against wave action and, in some areas, are considered to be a critical element of the shore zone. Likewise, log jams or beaver dams in rivers and streams can provide critical habitat. A decision to remove oiled logs and other debris may require approval from regulatory agencies.

3.4 *Hot versus Warm Water Washing*—Washing oil from a substrate (solid or otherwise) typically uses ambient (unheated) water pumped from the adjacent water body. The removal of sticky or weathered stranded oil can require an increase in pressure or temperature, or both, to be effective. Conventional water heaters raise water temperatures up to 160°F [70°C]. An operational example is the successful use of warm washing during the *Exxon Valdez* response. Hot water washing involves heating water to temperatures greater than 160°F [70°C]. Hot water heaters are occasionally combined with high-pressure spray systems, require more energy than warm-water heaters, and are only applicable for removal of small amounts of oil ("spot washing") on man-made structures.

3.5 *Waste Generation*—Each spill response technique, generates different volumes and types of waste depending on the amount and type of spilled oil and the substrate materials. The types of waste generated during spill response include: oily water or liquids, oiled sediments, or oiled debris. Recovered oil and oil-water mixtures are usually temporarily stored prior to recycling, treatment or disposal, or a combination thereof. Operational waste is generated by cleanup or treatment activities and can include personal protective equipment, sorbents, and packaging. Waste management can be an issue during response, particularly in remote areas where disposal options are limited and travel distances to approved sites are long. Estimates of the types and volumes of potential waste should be included in the countermeasure selection process. (**1**)[3]

3.6 *Response Techniques*—For the purpose of this guide, the term, "response techniques," will be used to generically refer to response countermeasures, clean-up techniques, tactics, or methods, or a combination thereof.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The boldface numbers in parentheses refer to the list of references at the end of this standard.

4. Significance and Use

4.1 Once the extent and type of oiling has been defined and documented using proper procedures (see Guides F1686 and F1687), decisions are made on the appropriate course of action for site cleaning and restoration. In some cases, natural recovery (accompanied by monitoring) can be the preferred approach whereas in other cases, active response may be preferred and appropriate. This guide summarizes the principal response techniques available for shoreline, wetland, and terrain habitats.

4.2 This guide is intended to minimize the potential for added impact to the environment from use of response techniques in an overly-aggressive manner or in unsuitable conditions or habitats.

4.3 In Section 5, typical considerations, which can limit the applicability of a given technique are addressed in *Constraints*. An example that is applicable to all techniques other ~~the~~than natural recovery, is special permission will likely be needed for any response operations at sites with known culturally or historically important resources. Also, in Section 5, a synopsis of main trade-offs from use of a particular technique is provided in *Environmental Effects*.

5. Onshore Response Techniques

5.1 This section lists and describes those techniques that can be considered for use in an onshore (shoreline, wetland, or terrestrial) oil spill response. Some of these options may require special consideration and authorization prior to work. Also, some of these techniques have greater personnel and equipment requirements or can generate more waste relative to others. Tradeoffs need to be considered when selecting an appropriate option(s), particularly in remote areas. In most cases, government agencies will be involved in the decision-making process. Government approval may be required for some techniques, and these are typically considered on a case-by-case basis. Contingency plans should provide for use of a range of techniques. The response techniques described in this guide are consistent with Environment ~~Canada,~~ and Climate Change Canada (ECCC), US NOAA, and American Petroleum Institute terminology. (**2**, **3**, **4**, **5**)

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A description of each response technique is discussed in separate sections below.

5.2 *Natural Recovery:*

5.2.1 *Objective*—Stranded oil is not removed either to minimize environmental impacts from treatment, because no effective response technique is available, or because predicted impacts from use of a technique are judged to be unacceptable. In some circumstances, safety concerns can preclude cleanup activities. Oil is left to degrade naturally.

5.2.2 *Description*—Site conditions can be monitored for changes and recovery progress. Prevention of oil remobilization or migration of oil offsite may need active response.

5.2.3 *Applicable Habitat Types*—Can be used on all shoreline, wetland, or terrestrial habitat types.

5.2.4 *When to Use*—When natural oil removal rates are acceptable in terms of the resources at risk, when the degree of oiling is light, or when cleanup actions are likely to result in more harm than allowing oil to degrade by natural forces.

5.2.5 *Constraints*—May be inappropriate for sites used by high numbers of mobile animals (for example, birds, mammals, and crabs) or endangered or threatened species.

5.2.6 *Environmental Effects*—No effects beyond that of the oil alone.

5.2.7 *Waste Generation*—None.

5.3 *Barriers/Berms:*

5.3.1 *Objective*—To either physically prevent oil from entering into a sensitive area, restrict water movement, or to divert oil towards a collection area, or a combination thereof. **(6)**

5.3.2 *Description*—A physical barrier is placed across an area in front of encroaching oil to prevent it from entering a sensitive area. Barriers can be earthen berms, trenches, shore-sealing booms, sheet piling, or filter fences. When passage of water is desired, underflow or overflow dams are used. Sheet piles can be driven into substrates and used to restrict oil leaching from land onto shorelines towards adjacent water bodies.

5.3.3 *Applicable Habitat Types*—On most terrain slopes and at the mouths of creeks, streams, or rivers. For tidal habitats, where a berm can be built above the high-water line to prevent oil from over-washing a low shoreline and entering a sensitive back-beach habitat, such as a lagoon.

5.3.4 *When to Use*—When sensitive habitats are threatened and other barrier options are not feasible.

5.3.5 *Constraints*—Disturbance to bird nesting areas, beaver dams, wetlands, or other sensitive areas should be minimized. Placement of dams, filter fences and sheet pile barriers can cause physical disruption, especially in wetlands and tundra habitats.

5.3.6 *Environmental Effects*—Can disrupt or increase localized oiling of substrates and vegetation. Trenching can enhance oil penetration into substrates and increase the degree of substrate oiling.

5.3.7 *Waste Generation*—Oiled barrier substrates and filter fence materials need to be disposed of as oily wastes. Sheet piles can be removed, cleaned and re-used. Water used for cleaning needs to be collected and treated or disposed. Disposal must be in accordance with all applicable regulations.

5.4 *Manual Oil Removal/Cleaning:*

5.4.1 *Objective*—Physically remove oil and oily debris with hand tools and manual labor.

5.4.2 *Description*—Surface oil and oily debris are removed by manual means (for example, gloved hands, rakes, forks, shovels, sieves, and sorbents) and placed in containers for removal and subsequent disposal. No mechanized equipment is used except during transfer and transport of waste.

5.4.3 *Applicable Habitat Types*—Can be used for all habitat types.

5.4.4 *When to Use*—Generally used on areas where small amounts of oil can be easily removed by non-mechanical means. Most appropriate for light to moderate oiling conditions. Manual removal is applicable to viscous oils and weathered oil patches and tar balls.

5.4.5 *Constraints*—Foot traffic over sensitive areas (for example, wetlands, shellfish beds, bird nesting areas, dunes) should be limited or restricted. There can be time periods when access is not appropriate (for example, bird nesting, seal pupping, and periods when land habitats are inundated).

5.4.6 *Environmental Effects*—Minimal, if surface disturbance by responders and oily waste management activities are limited.

5.4.7 *Waste Generation*—Can generate significant amounts of oily substrate and debris, which requires proper disposal or

treatment. Decontamination of tools can yield oily waste water which also requires proper treatment. Worker personal protective equipment can be disposed of daily or decontaminated and re-used. Oily waste water resulting from decontamination must be treated properly. Disposal must be in accordance with applicable regulations.

5.5 *Mechanical Oil Removal:*

5.5.1 *Objective*—To physically remove oil and oily debris using mechanical equipment. (**7**)

5.5.2 *Description*—Surface oil, oiled substrate, and oily debris are removed using mechanical equipment (such as front-end loaders, back-hoes, graders, bulldozers, elevating scrapers, dredges, and beach cleaning machines). This technique necessitates that response resources be provided for temporary storage, transportation, treatment, and disposal of recovered oil, oily debris, and oily waste.

5.5.3 *Applicable Habitat Types*—Locations where surface substrates are amenable to and accessible by mechanical equipment.

5.5.4 *When to Use*—When large quantities of oiled materials are to be removed. Care should be taken to remove substrates only to the depth of oil penetration. This technique should be used sparingly where removal of large volumes of substrate can lead to erosion. Buried oil recovery can include the temporary removal of clean overburden, removal of oiled substrates, and subsequent replacement of clean overburden. Vehicle traffic should be controlled to minimize further oil penetration.

5.5.5 *Constraints*—Special restrictions should be established for sites where traffic and equipment operations could be damaging. It could be useful to check soils in advance for vehicular load tolerances. Heavy equipment use should be restricted in sensitive habitats during breeding or nesting seasons and in areas containing endangered or threatened species. Noise generated by mechanical equipment can be locally disruptive during certain seasons.

5.5.6 *Environmental Effects*—Can be detrimental if excessive substrate volumes are removed without replacement. Organisms in removed substrates might be impacted.

5.5.7 *Waste Generation*—Can generate significant amounts of oiled substrate and oily debris, which requires treatment or disposal, or both. Mechanical equipment can be decontaminated, which yields oily waste water. Oily wastewater from decontamination must be properly collected and treated. Disposal must be in accordance with applicable regulations. The potential impacts from the high volume of oily waste, debris, and substrates should be considered when selecting this technique.

5.6 *Sorbents:*

5.6.1 *Objective*—Physically remove surface oil from substrates by application of oil-attracting (oleophilic) materials.

5.6.2 *Description*—The term, sorbent, applies to both absorbent and adsorbent materials. The material is placed on an oiled surface to sorb oil that is refloated or mobilized by tidal, wave, or river current action. Sorbents can be used manually to wipe oil directly from a substrate. Sorbent types include boom, pads, rolls, sweeps, snares, and granules. Removal efficiency is dependent on the capacity of a sorbent material, degree of oiling, wave, tidal or water current energy available to free oil from a substrate, and the oil type and its degree of weathering. Recovery of sorbent material is preferred.

5.6.3 *Applicable Habitat Types*—Can be used on any habitat type.

5.6.4 *When to Use*—When the oil is floating on water (for example a pond or wetland), or has stranded on a shoreline or spilled to land. The oil should readily adhere to the sorbent. Sorbents are often used as a secondary treatment method after bulk oil has been removed or in sensitive habitats where access is restricted. Sorbents are typically not appropriate on or near high energy or steep shorelines. Some sorbents can break apart in high energy conditions. Steep shorelines make recovery of used sorbents difficult.

5.6.5 *Constraints*—Recovery of sorbent material is recommended. Loose granular sorbents should be selected to be readily recoverable or biodegradable. Deploying and retrieving sorbents should be conducted to avoid adversely affecting local wildlife. Sorbents should not be placed in a manner that could endanger or trap wildlife. Sorbents can be slow-acting on viscous oils.

5.6.6 *Environmental Effects*—Deployment and retrieval can cause physical disturbance to habitats. Improperly deployed or tended sorbents can harm or smother sensitive organisms. Some sorbents, when left in place too long, can break apart and present an ingestion hazard to wildlife.

5.6.7 *Waste Generation*—Can generate large volumes of oiled substrate and oily debris, which requires proper treatment and or disposal. Generation of large amounts of lightly oiled sorbents should be avoided; sorbent types and application should be monitored to maximize performance. Some sorbent types can be de-oiled and reused. Equipment used for retrieval of loose sorbent in terrestrial habitats can be decontaminated and reused, but yields oily wastewater which requires proper treatment or disposal, or both. Disposal must be in accordance with applicable regulations.

5.7 *Vacuums:*

5.7.1 *Objective*—To physically remove mobile oil which is pooled.

5.7.2 *Description*—A vacuum unit with a suction head is used to recover mobile oil. The size of equipment can range from small portable units used to fill 55-gal [202 liter] drums to large truck-mounted devices which can lift large cobbles. Oil removal rates can be extremely slow with this technique. Water spray systems can be used to flush mobile oil toward a suction head.

5.7.3 *Applicable Habitat Types*—Vacuums can be used on any accessible habitat. Vacuums can be mounted on barges, onshore on trucks, or deployed as individual units from boats or onshore at low tide.

5.7.4 *When to Use*—When liquid oil is pooled, concentrated in trenches, or trapped amongst accessible vegetation.

5.7.5 *Constraints*—Special restrictions should be established for areas where foot traffic and equipment operation could be damaging, such as soft substrates. Wetland operations need to be closely monitored. A site-specific list of procedures and restrictions is recommended to prevent damage to vegetation.

5.7.6 *Environmental Effects*—Effects can be minimal if foot and vehicular traffic are controlled and minimal areas of substrate are affected.

5.7.7 *Waste Generation*—Recovered oil and oil-water mixtures are usually stored temporarily prior to recycling, treatment or disposal. Large amounts of water are often collected with vacuums, which then requires separation and treatment. Oil recycling and disposal must be in accordance with applicable regulations.

5.8 *Debris Removal:*

5.8.1 *Objective*—Physically remove unoiled debris in the path of spilled oil prior to stranding. (7)

5.8.2 *Description*—Manual or mechanical removal of unoiled debris (for example, wood, seaweed, trash, wreckage). Removal includes the cutting and removal of large ~~oiled~~unoiled logs. Refer to “debris” in 3.3.

5.8.3 *Applicable Habitat Types*—Can be used on any habitat type with safe access.

5.8.4 *When to Use*—When debris becomes oiled, it becomes a potential source for re-oiling habitats and biota, an aesthetic problem, and can be a safety hazard for responders. Pre-cleaning of an area before stranding of spilled oil can limit these issues during a response. In some cases, removal is only temporary and natural debris, such as rack on a shoreline, can and should be replaced once there is not further threat of oiling.

5.8.5 *Constraints*—Consultation with appropriate regulatory authorities should take place prior to removal of debris because of its potential wildlife habitat value. Foot traffic over sensitive areas (for example, wetlands, tundra, bird nesting sites, dunes, areas containing endangered plant species) should be restricted. There may be temporary periods when shoreline access is restricted (for example, bird nesting, influx of large numbers of migratory birds, or seal pupping).

5.8.6 *Environmental Effects*—Removal could affect future habitat use, lower erosion protection, and reduce sources of food from foraging for some species.

5.8.7 *Waste Generation*—An advantage of collecting debris prior to oiling is that waste disposal requirements would likely be less restrictive than if the debris is oiled. Oiled debris is likely to be handled as hazardous waste. Disposal of oiled debris must be in accordance with applicable regulations.

5.9 *Mixing:*

5.9.1 *Objective*—Physically rework oiled sediments in situ to break up oil deposits, increase surface area, and mix deeper subsurface oil layers to expose them to natural removal processes and enhance their rate of natural weathering and degradation. **(8)**

5.9.2 *Description*—Oiled substrate is mixed either in the absence of water above the water line ("dry" mixing) or underwater ("wet" mixing) using mechanical equipment or manual tools. In both cases, the intent is to agitate sediment in situ, without sediment removal. This differentiates mixing from sediment relocation (5.10) where sediments are purposely moved from one location to another. Refloated oil from reworked areas can be contained and recovered. "Wet" mixing typically takes place within a boomed area in shallow water (<1 m depth), and can involve the use of high-pressure water jets to agitate underwater sediments. Landfarming, which uses both mixing and bioremediation (5.21) is a common practice and may require regulatory approval.

5.9.3 *Applicable Habitat Types*—Any habitat which can support mechanical equipment or foot traffic, or both.

5.9.4 *When to Use*—On sand to coarse-sediment substrates with surface or subsurface oil, where sediment removal is not feasible due to erosion or waste disposal issues, and in remote areas with small amounts of oil. Can be used in later phases of a cleanup program, after bulk oil removal has been completed, to accelerate weathering of oil residues.

5.9.5 *Constraints*—Might not be applicable on shorelines located immediately adjacent to sensitive habitats (for example, those with shellfish beds, fish-spawning areas, bird nesting or concentration areas) because of the potential for continued release of oil.

5.9.6 *Environmental Effects*—Mixing of oil into substrate could expose biota which occur beyond the original layer of oil. Repeated reworking could delay re-establishment of biota. Oil released into water, either by "wet" mixing or by rising water levels after "dry" mixing and that cannot be contained at the surface, can flow to adjacent areas. Studies show rates of biodegradation of oil are greatly accelerated when it is released into surface water from mixing. Field experiments show released oil rapidly spreads into a water column, is positively or neutrally buoyant, and is unlikely to sink in quantities which could cause widespread effects.

5.9.7 *Waste Generation*—Equipment used for mixing sediment, whether dry or wet, can be decontaminated and reused. Decontamination yields oily wastewater which requires proper treatment or disposal, or both. Disposal must be in accordance with applicable regulations.

5.10 *Sediment Relocation:*

5.10.1 *Objective*—Physically relocate oiled sediments to enhance natural weathering and cleaning rates by wave or river current activity. **(8)**

5.10.2 *Description*—Oiled sediments are removed from one location and relocated to another which has a greater potential for weathering processes or exposure to wave or current action.

5.10.3 *Applicable Habitat Types*—This technique is generally used on sand, coarse-sediment, or cobble shorelines or river bars where sediment removal, potential erosion, or low natural sediment replenishment, or a combination thereof, are of concern. Sediment relocation can also be used at remote sites with small amounts of oil.

5.10.4 *When to Use*—Appropriate for sites where oil is stranded above the normal waterline or in the upper intertidal zone, swash zone, or river bank. Sediment relocation can be used where remoteness or other logistical limitations make oiled sediment removal impractical or undesirable due to waste management issues. Can be used in later phases of a cleanup program to accelerate the weathering of oil residues after bulk oil removal has been completed.

5.10.5 *Constraints*—This technique is not usually applicable on shorelines located immediately adjacent to shellfish habitats or fish spawning areas during bird migration due to the potential of introducing oil into these sensitive habitats.

5.10.6 *Environmental Effects*—Oil released onto surface water can be transported to immediately adjacent areas. Field experiments show the released oil rapidly spreads into the water column, is positively or neutrally buoyant, and is unlikely to sink in quantities which could cause widespread adverse effects. Studies show rates of natural biodegradation of oil, released into water from sediment relocation, are greatly accelerated. Oil recovery efforts (booming and collection) at the site of relocation can limit