Strategies for cleaning up an oil spill are greatly affected by a variety of factors, such as the type of oil, the characteristics of the spill site, and occasionally political considerations. A number of approaches and technologies have been developed for controlling oil spills in marine shorelines and freshwater environments. The most commonly used shoreline cleanup options are briefly described in the following table:

<table>
<thead>
<tr>
<th>Category of Response Options</th>
<th>Example Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural method</td>
<td>Natural attenuation</td>
</tr>
<tr>
<td>Physical method</td>
<td>Booming</td>
</tr>
<tr>
<td></td>
<td>Manual removal (Wiping)</td>
</tr>
<tr>
<td></td>
<td>Washing</td>
</tr>
<tr>
<td></td>
<td>Tilling</td>
</tr>
<tr>
<td></td>
<td>Skimming</td>
</tr>
<tr>
<td></td>
<td>Mechanical removal</td>
</tr>
<tr>
<td></td>
<td>Sediment relocation/Surf-washing</td>
</tr>
<tr>
<td></td>
<td>In-situ burning</td>
</tr>
<tr>
<td>Chemical method</td>
<td>Dispersants</td>
</tr>
<tr>
<td></td>
<td>Solidifiers</td>
</tr>
<tr>
<td></td>
<td>Demulsifiers</td>
</tr>
<tr>
<td></td>
<td>Surface film chemicals</td>
</tr>
</tbody>
</table>

**Natural methods:**
Natural attenuation or natural recovery is basically a no-action option that allows oil to be removed and degraded by natural means. For some spills, it is probably more cost-effective and ecologically sound to leave an oil-contaminated site to recover naturally than to attempt to intervene. Major natural processes that result in the removal of oils include:

**Evaporation:**
Evaporation is the most important natural cleansing process during the early stages of an oil spill, and it results in the removal of lighter-weight components in oil. Depending on the composition of the oil spilled, up to 50 percent of the more toxic, lighter weight components of an oil may evaporate within the first 12 hours following a spill (U.S. EPA, 1999).

**Photooxidation:**
Photooxidation occurs when oxygen under sunlight reacts with oil components. Photooxidation leads to the breakdown of more complex compounds into simpler compounds that tend to be lighter in weight and more soluble in water, allowing them to be removed further through other processes.

**Biodegradation:**
Various types of microorganisms that are capable of oxidizing petroleum hydrocarbons are widespread in nature. Biodegradation is a particularly important mechanism for removing the non-volatile components.
of oil from the environment. This is a relatively slow process and may require months to years for microorganisms to degrade a significant fraction of an oil stranded within the sediments of marine and/or freshwater environments.

**Physical methods:**

Physical containment and recovery of bulk or free oil is the primary response option of choice in the United States for the cleanup of oil spills in marine and freshwater shoreline environments. Commonly used physical methods include:

**Booming and skimming:**
Use of booms to contain and control the movement of floating oil and use of skimmers to recover it. The environmental impact of this method is minimal if traffic of the cleanup work force is controlled.

**Wiping with absorbent materials:**
Use of hydrophobic materials to wipe up oil from the contaminated surface. While the disposal of contaminated waste is an issue, the environmental effect of this method is also limited if traffic of cleanup crew and waste generation is controlled.

**Mechanical removal:**
Collection and removal of oiled surface sediments by using mechanical equipment. This method should be used only when limited amounts of oiled materials have to be removed. It should not be considered for cleanup of sensitive habitats or where beach erosion may result.

**Washing:**
Washing of the oil adhering along the shorelines to the water’s edge for collection. Washing strategies range from low-pressure cold water flushing to high-pressure hot water flushing. This method, especially using high-pressure or hot water, should be avoided for wetlands or other sensitive habitats.

**Sediment relocation and tilling:**
Movement of oiled sediment from one section of the beach to another or tilling and mixing the contaminated sediment to enhance natural cleansing processes by facilitating the dispersion of oil into the water column and promoting the interaction between oil and mineral fines. Tilling may cause oil penetration deep into the shoreline sediments. The potential environmental impacts from the release of oil and oiled sediment into adjacent water bodies should also be considered.

**In-situ burning:**
Oil on the shoreline is burned usually when it is on a combustible substrate such as vegetation, logs, and other debris. This method may cause significant air pollution and destruction of plants and animals.

**Chemical methods:**
Chemical methods, particularly dispersants, have been routinely used in many countries as a response option. For some countries, such as the United Kingdom, where rough coastal conditions may make mechanical response problematic, dispersants are the primary choice (Lessard and Demarco, 2000). However, chemical methods have not been extensively used in the United States due to the disagreement
about their effectiveness and the concerns of their toxicity and long-term environmental effects (U.S. EPA, 1999). Major existing chemical agents include:

**Dispersants:**
Dispersing agents, which contain surfactants, are used to remove floating oil from the water surface to disperse it into the water column before the oil reaches and contaminates the shoreline. This is done to reduce toxicity effects by dilution to benign concentrations and accelerate oil biodegradation rates by increasing its effective surface area.

**Demulsifiers:**
Used to break oil-in-water emulsions and to enhance natural dispersion.

**Solidifiers:**
Chemicals that enhance the polymerization of oil can be used to stabilize the oil, to minimize spreading, and to increase the effectiveness of physical recovery operations.

**Surface film chemicals:**
Film-forming agents can be used to prevent oil from adhering to shoreline substrates and to enhance the removal of oil adhering to surfaces in pressure washing operations.

**Bioremediation as an Oil Spill Cleanup Technology**

Although conventional methods, such as physical removal, are the first response option, they rarely achieve complete cleanup of oil spills. According to the Office of Technology Assessment (OTA, 1990), current mechanical methods typically recover no more than 10-15 percent of the oil after a major spill. Bioremediation has emerged as one of the most promising secondary treatment options for oil removal since its successful application after the 1989 Exxon Valdez spill (Bragg et al., 1994; Prince et. al., 1994). Bioremediation has been defined as “the act of adding materials to contaminated environments to cause an acceleration of the natural biodegradation processes” (OTA, 1991). This technology is based on the premise that a large percentage of oil components are readily biodegradable in nature (Atlas, 1984, 1981; Prince, 1993). The success of oil spill bioremediation depends on our ability to establish and maintain conditions that favor enhanced oil biodegradation rates in the contaminated environment. There are two main approaches to oil spill bioremediation:

**Bioaugmentation,** in which known oil-degrading bacteria are added to supplement the existing microbial population, and

**Biostimulation,** in which the growth of indigenous oil degraders is stimulated by the addition of nutrients or other growth-limiting cosubstrates, and/or by alterations in environmental conditions (e.g. surf-washing, oxygen addition by plant growth, etc.).

Source:
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