In-Situ Burning in Inland Regions

David E. Fritz
Crisis Management Coordinator
BP America
USA

Abstract

In-situ burning is used in the United States to remove oil from inland oil spills, usually when physical recovery is not feasible. Studies have found that habitats may recover from the effects of burning in less than a year under optimal conditions, but recovery can take much longer. Inland in-situ burning can be a useful response tool, and more guidance is needed for responders. More data is also needed on the environmental impacts of burning. This paper will review a number of U.S. inland oil spill in-situ burns and give key considerations for its use.

Keywords*:* in-situ burning, inland, freshwater, wetland

Introduction

Spilled oil has burned accidentally many times. Spill responders have been attracted to the large amounts of oil quickly removed from the environment during burns and have looked at the possibility of burning spilled oil in-situ under safe and relatively controlled conditions. In-situ burning of oil spilled in inland regions has a much different history than burning oil spilled on the oceans. Marine in-situ burning has been studied extensively by researchers over the last twenty years, but there have been few burns at actual spills. The situation is completely opposite for inland spills. Little research exists, but many burns have been conducted.

Most people's knowledge of inland in-situ burning consists solely of the wetland and marsh burns during the 1990's in Maine (Eufemia, 1994), Texas (Gonzalez & Lugo, 1994), and Louisiana (Hess *et al.,* 1997), but many other places in North America use burning quite frequently. Most inland burns are small (less than 3 cubic meters or 20 barrels of oil), occur in rural areas, and are often associated with pipeline breaks. Burning is most often used when physical recovery is not feasible, usually because of poor access to the spill site. In these cases, burning results in a relatively quick and efficient cleanup with much less environmental damage than if traditional recovery methods had been used.

Considerations & Factors

Experience has shown that a successful burn must take into consideration a number of factors (API, 1999; May & Wolfe, 1997). When oil is spilled, as much as possible is usually recovered mechanically, and in-situ burning is used as an alternative treatment to remove the oil that cannot be recovered. Safety is the primary consideration when planning a burn. Keeping the fire contained and under control is paramount, and soil and plant moisture levels are important parameters to take into account. Responders have created fire breaks and wet the area surrounding the spilled oil to limit the potential for spreading. Often the excessive moisture from rain or water naturally present makes the ground too soft for recovery equipment, but this same moisture in turn can improve the safety of the burn by limiting the spreading of the fire and lessening the environmental damage.

Plants subjected to in-situ burns can be very tolerant of the effects of the heat (API, 1999; Mendelssohn *et al.*, 1996; Mendelssohn *et al.*, 2001). Fire is part of the natural life-cycle for some ecosystems (such as wetlands and prairies), but burning spilled oil may produce a hotter, more intense burn than the plants can safely tolerate. Protecting the roots from excessive heat levels is critical to prevent plant mortality, and the moisture level is again the most important consideration. High soil moisture levels protect the roots from heat effects and improve the chances for recovery. Recovery of burned vegetation can also be strongly affected by the time of year. Winter is the best time to burn because plants are dormant, and the late summer is the worst time to burn because plants are least able to withstand the stress.

Weather conditions are also a major consideration in deciding if a burn is feasible. Particulates in the smoke are the primary health consideration, and the plume must avoid nearby populated areas. Steady, low winds are desired that will allow the smoke plume to loft and disperse downwind in the desired direction. If storms are threatening or weather shifts are forecasted, burns should be delayed or canceled because shifting, unpredictable winds can threaten the safety of the burn. An in-situ burn is sometimes conducted because rainfall may cause the oil to migrate and increase the area impacted by the spill, but the burn needs to be completed before the storm's onset. Weather conditions are usually not ideal and compromises may be needed, but the potential of the fire spreading beyond the oiled area must always be considered.

The local fire department is often required to be consulted, and it often needs to be in agreement with the burn plan. Fire department equipment and personnel often attend the burn to ensure its safety. Natural resource specialists may also need to be consulted to determine if sensitive wildlife or habitat resources are at risk from the burn. In some areas, air quality officials must be consulted to ensure that public health issues regarding the smoke are taken into account. Burning oil produces large amounts of black smoke, and the downwind consequences should be evaluated.

In-situ burning usually leaves a residual that often requires treatment or removal. This residue may not be recoverable in a marsh or wetland. However, for spills in open fields, it is common to till the area, fertilizer it, and then reseed it with appropriate plants. The resulting biodegradation from the plants and soil microbes removes much of the remaining oil.

Recovery of Burned Habitats

Despite the frequent use of in-situ burning in some inland areas of the U.S., little monitoring of the effects on the environment has occurred. Studies have been conducted on a large Texas spill (Hyde *et al*., 1999; Tunnel *et al*., 1995) and a Louisiana spill (Pahl *et al*., 1997). They showed that plant regrowth can occur quite rapidly but that full plant diversity may take years to occur. Another study looking at the recovery of four sites subjected to in-situ burning showed that recovery may be quick or may be long depending upon the conditions of the spill and burn (API, 2002). The study showed that some of the delay in recovery may not be due to the burn but due to the response actions taken before and after the burn and to the effects of the oil on the environment before the burn was initiated. A study to collect existing monitoring data from inland in-situ burns found little data, and the data that was found consisted mostly of soil Total Petroleum Hydrocarbon (TPH) levels (API, 1999).

The lack of data on the effects of inland burns may be because most burns tend to be small and occur on habitats that have been heavily altered by human activities, primarily farming. As a result, any damage is perceived to be minimal and short-term. Regions of the U.S. where grasslands and wetlands are commonly burned to control the habitat tend to view in-situ burning of oil spills as a similar practice and believe that the long-term environmental consequences are similar if the burn is conducted properly.

Case Studies

Figure 1 shows ignition of diesel spilled three months earlier in January, 2000 from a Utah pipeline in a brackish marsh north of the Great Salt Lake. About 16,000 liters (4200 gallons) of diesel covered about 15 hectares (38 acres) of marsh and mud flats. Because of delays in getting permission to burn, the initial burn using a helitorch occurred in February, one month after the spill. Ice covered areas did not burn, however, and an additional burn was conducted in April with ignition by a flare and a propane torch. Despite the delay in removing the oil, Figure 2 shows that recovery of the vegetation was almost complete after 1.5 years.

Figure 3 shows a burn in February, 2000 during a pipeline spill at Louisiana Point near Sabine Pass where substantial moisture was present to protect the plants. An unknown amount of condensate was released and impacted about 5 hectares (13 acres) of salt marsh. The burn was conducted two days after the release was discovered, but the condensate was in the marsh for 3 – 5 days before ignition. As shown in Figure 4, about 55 hectares (135 acres) of marsh actually burned because a firebreak created by running an airboat over the marsh grass was only partially effective. Subsequent studies show that plant regrowth over most of the site was rapid because the condensate was removed before it could kill the plants (API, 2002).

Figure 5 shows another large burn on a salt marsh at Mosquito Bay, Louisiana in April, 2001. About 160,000 liters (42,000 gallons) of condensate were spilled from a pipeline break, and about 127,000 liters (33,500 gallons) of it were removed in two burns six and seven days after the spill. Road flares were used to ignite the oil. Firebreaks created by airboats again failed, and 40 hectares (98 acres) burned even though only 5 hectares (12 acres) were oiled. Studies showed that damage occurred to the marsh before the oil was burned due to the toxicity of the oil. A year later, much of the burned area had recovered, but some areas that had received heavy oiling with penetration into the sediments had not yet recovered (API,2002).

Figure 7 shows a burn in July, 2002 during a pipeline spill in northern Minnesota near the Mississippi River town of Cohasset. Note the large amounts of black smoke that are produced by the burning oil. About 954,000 liters (252,000 gallons) of Canadian crude oil were released to a peat bog and were burned the next day to prevent the oil from migrating to the river. Figure 8 shows that the moisture present, assisted by fire retardant spread by plane, was adequate to stop the burn at the edge of the oiling. No firebreaks were created. In this spill, only about half of the oil burned, and the remaining oil was mechanically removed with the top layer of peat.

Figure 9 shows a small shallow pond with a maximum depth of about half a meter that was created by the removal of the peat (Lee, 2003).

Another spill on the same crude pipeline in July, 2000 on Ruffy Brook near Leonard, Minnesota resulted in about 8,000 liters (2100 gallons) of Bow River crude oil (API gravity of 21) released to about 1.2 hectares (3 acres) of ponded wetland. The burn occurred on the same day as the spill and resulted in a tar-like residue (Figure 10) about 1 cm thick. The residue was picked up in sheets within three days after the burn. A survey one year later showed substantial regrowth of the wetland grasses (API, 2002).

Summary and Recommendations

In-situ burning of spilled oil is routine in some of the inland regions of the United States, most often for small remote spills in inaccessible areas. It has proven to be capable of effectively removing oil spilled in remote and inaccessible sites with minimal environmental damage. Although open-water burning of marine oil spills has been extensively researched, burns of oil spilled on land and in wetland habitats have been poorly studied, and only a few burns have been monitored for environmental impacts. Nevertheless, most regulators in the states that do allow inland burns are comfortable with the practice and believe that burning can be a safe and environmentally friendly response technique for situations where physical recovery of spilled oil would cause extensive damage.

Except for a few well-documented burns of spills in wetlands along the U.S. Gulf Coast, in-situ burning for inland spills is not well known in the oil spill response community. Many industry and local government responders seem reluctant to acknowledge their use of this technique as if they are afraid that federal regulators will stop them from using it. Federal regulators know, of course, that in-situ burning is used for inland spills, but they have issued little guidance on how it should be authorized or conducted. Some states interested in establishing an in-situ burn policy are wrestling with the air pollution issues associated with the smoke plume and would appreciate any guidance on how to balance the benefits of a successful burn with the need to protect the health of the public.

More information on the ecological effects of inland burns would be useful, and industry and government responders could help our understanding by better documenting in-situ burns that they conduct. Basic data should be collected, such as: the type and quantity of oil spilled, type of habitat impacted, effectiveness of the burn, amount of oil remaining after the burn, concentration of oil residual in the soil after the burn, and pictures of the impacted area before and after the burn. This information can be easily acquired at a spill at minor costs.

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Figure 1 – The remaining diesel is being ignited by a propane burner three months after this Utah spill (API, 2002).

Figure 2 – Most vegetation fully recovered 1.5 years after the Utah diesel spill and burn (API, 2002).

Figure 3 – The burning condensate at this Louisiana Point marsh will be contained by the muddy surface in the foreground. (API, 2002).

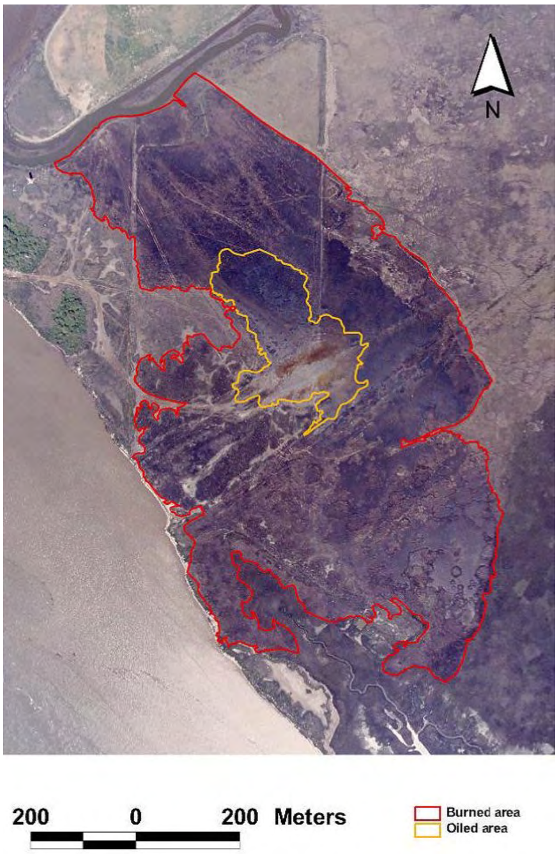

Figure 4 – The Louisiana Point spill site showing oiled (red outline) and burned (yellow outline) areas (API, 2002).

Figure 5 – This large burn at Mosquito Bay, Louisiana also burned an area much larger than the marsh affected by the spilled oil (API, 2002).

Figure 6 – This picture of Mosquito Bay was taken one hour after the first burn ended. The arc around the small bay is the attempted firebreak. The straight line across the upper right traces the pipeline. The spill source is off the page to the right (API, 2002).

Figure 7 – This in-situ burn in a Minnesota peat bog shows the large amounts of smoke that are produced (Lee, 2003).

Figure 8 – The burning oil in the peat bog damaged trees in the foreground, but moisture was adequate to prevent the burn from spreading to the unoiled trees in the background (Lee, 2003).

Figure 9 - The final cleanup after the burn resulted in a shallow pond on the surface of the peat bog (Lee, 2003).

Figure 10 - Tar-like residue resulting from a crude oil burn in a ponded freshwater wetland in Minnesota was picked up in sheets (API, 2002).