WABAMUN: A MAJOR INLAND SPILL

by

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ABSTRACT

On August 3, 2005, forty-three cars of a westbound Canadian National Railways freight train derailed on the shore of Lake Wabamun, just west of Alberta's capital city of Edmonton, spilling about 750 m^3 of Bunker C and 75 m^3 of a pole-treating agent on the lakeshore. The spilled materials quickly flowed into the lake, forming a slick that spread rapidly along the north shore of the lake, oiling more than 12 km of shoreline. This paper will describe the response to this spill over the subsequent three months. Some issues, such as the fate of Bunker C in a temperate lake and the problems of dealing with heavily oiled reed beds will be discussed. As with most spills, the Net Environmental Benefit of various response options was evaluated in order to choose the optimum strategy for this situation.

1) INTRODUCTION

Historically, oil-spill response has been considered a maritime issue and most of the available material refers to the marine situation. While there are similarities between the salt and freshwater situation, there are some major differences in terms of water use and the dynamics of the oil in and on the water. As the number of marine spills continues to decline, as shown in figure 1, inland oil spills into the freshwater environment will become of greater concern. The largest two spills this century in Canada have been in a freshwater environment, one from a pipeline failure into the Pine River and the other the spill described in this paper.

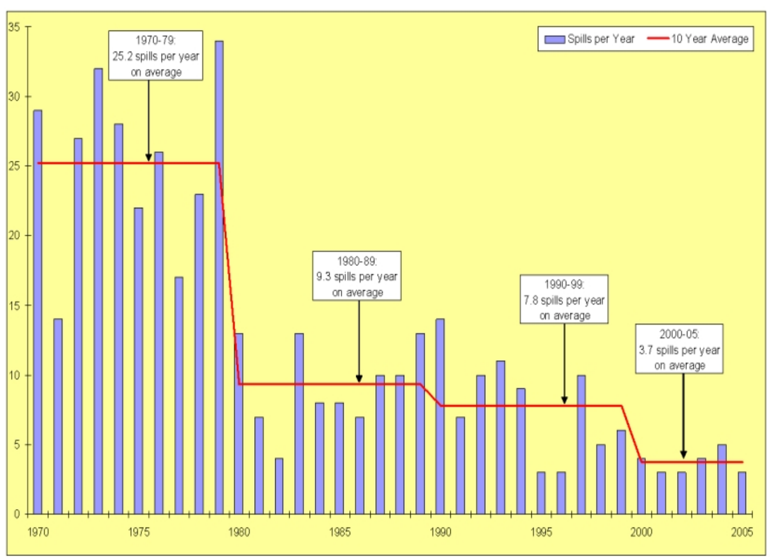

Figure 1 Oil-Spill Statistics from ITOPF (2006)

2) DESCRIPTION OF INCIDENT

On August 3, 2005, forty-three cars of a westbound Canadian National Railways freight train derailed on the shore of Lake Wabamun, which is 60 km west of Alberta's capital city of Edmonton, spilling about 750 m^3 of Bunker C and 75 m^3 of a pole-treating agent on the lakeshore (see figure 2 for map). The lake is 19.7 km long and 6.6 km wide (area 82 km^2), with a mean depth of 6.3 m (maximum depth of 11 m at the western end). Most of the year, it is hydrographically isolated. The area was settled in the early part of the last century as the result of coal mining being commenced in the area. Major strip mining of coal began in 1948, with the establishment of a major coal-fired electricity generating plant. Due to its proximity to Edmonton, Alberta, the lake has recently become a popular resort area and summer cottages occupy most of the shoreline.

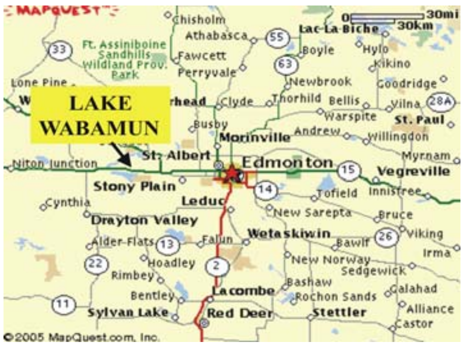

Figure 2 Wabamun Location Map

Figure 3 Whitewood Sands Spill Site

The derailment occurred on the north shore of the lake, in a subdivision known as Whitewood Sands as shown in figure 3. This is a residential area and the derailed cars were thrown onto the lawns of the residents. No houses were hit and there were no casualties.

3) EARLY RESPONSE

The local volunteer fire department responded in a few minutes and evacuated local residents. There was no fire and the spilled material quickly flowed into the lake. There was a large amount of a single product (750m^3), which at the time was not identified as a dangerous good, so the fire department turned the response of the spill to the spiller. Canadian National Railways (CNR) called upon their response contractor to respond to the spill. They responded by deploying mainly sorbent booms, which were ineffective in containing the heavy Bunker C oil. Some containment boom was deployed, but there was an inadequate quantity of this type of boom available. By mid-morning of August 3rd, the oil slick had spread some 12 km along the north shore of the lake, driven by a strong northwesterly wind. The wind then changed to the west or southwest and the oil on the water was driven onto the beaches of the cottages on the northern part of the lake downwind from the spill site.

Eventually, the size of the spill was recognized and a response organization with experience and equipment suitable for a larger response effort was contracted and the spill response proceeded as would have been expected. The on-water response lasted for about a month. The response to the oiling of the shoreline was quite conventional, starting with a well-run SCAT process, followed by cleanup of the individual shore segments based on their geomorphology and degree of oiling.

Most of the oil-spill cleanup was completed by the end of October, 2005. At this time, the lake was beginning to be covered with ice. There will continue to be monitoring during the winter and for several years in the future. Some cleanup is anticipated in the spring of 2006.

4) LESSONS LEARNED

As with any spill situation, there are a number of lessons learned which could be applied to the next spill situation. The limited amount of response equipment available during the early stages of the spill created great angst among the residents of the area, and was the focus of public concern.

a) Lesson One—The difference between large and small spills

In most regions of Canada, there are commercial environmental response organizations that routinely respond to small spill situations with volumes of less than one or two cubic metres. Most carriers of hazardous materials have such firms under contract to respond to spills, which occur during their operations. Such spills are generally handled in a few days to a week or two. The experience of Wabamun showed that while these firms can do an excellent job for small spills, their methods of operation, training and skill sets cannot be readily applied to larger spills involving tens to hundreds of cubic metres and a month or more of concentrated response effort. The large oil-spill response organizations have the mandate, training, equipment and experience to handle large spills, which involve sustained effort over a long period of time. Ten organizations experienced in small spills are not nearly as effective in response as one organization experienced and dedicated to large spill response.

Thus, for a transportation organization to have a response strategy for all possible situations, the company must have agreements with both local response contractors for small spills and a group capable of handling the infrequent larger spill situations.

b) Lesson Two—Regulatory response or response assistance

In any spill situation of this size, laws and regulations are broken. This results in the imposition of fines or charges by various regulatory agencies. In the case of Wabamun, there were enforcement officers from both provincial and federal agencies monitoring the situation and taking the appropriate action according to their mandate. This is a traditional role of government.

The residents of the community, however, expected more from their government. They wanted guidance and assistance in responding to the spill and in mitigating the damage. During the early stages of the spill, no such support was available and this was a very great concern of the local residents. After a few days, there were experts in spill response available from both levels of government.

The lesson learned is that governments are expected not only to enforce the law, but to provide assistance in response, in the same way as a fire department puts out a fire and subsequently investigates its cause. It is desirable if these two functions are performed by different groups within a government agency.

c) Lesson Three—The need for contingency plans

Contingency plans should form the basis for a response activity. It was found that the plans by the railway for the Wabamun area were generic and did not focus on any response scenario for the area. They had not been tested recently and there had been little or no contact with the other response groups in the area, including local responders, or government agencies. This resulted in considerable confusion in the early stages of the response and limited the effectiveness of the response. In the early stages of the response, there was no central command structure such as ICS and as the number of people in the response increased, there was little or no organization structure to handle these increased numbers. In most regions of Canada, Environment Canada has established a regional response structure known as REET (Regional Environmental Emergency Team), which coordinates all governmental groups into one advisory organization. It is typical that the REET organization meet outside of an emergency situation so that the members can become familiar with other members of the government team. Since no REET organization existed in Alberta, this group was not available in the early stages to coordinate government actions.

d) Lesson Four—The Transportation of Dangerous Goods (TDG) and labels have some shortcomings

The Transportation of Dangerous Goods Act (TDG) 1992 was developed to provide information for responders in the event of a release of the material during the course of its transportation. The two materials involved in the Wabamun situation were Bunker C and Lubricating Oil known as a Pole Treating agent. Neither were identified as requiring labels under the TDG Act, and so no identification was present. It was later found that the Bunker C should have been classified as UN3256 since it was being transported at a temperature that is greater than or equal to its flash point when it was spilled. The rapid cooling on release meant that there was little danger since the liquid temperature was quickly lowered below the flash point of 60.5º C. However, the high temperature of the Bunker C resulted in it being more mobile than would be observed had the material been at ambient temperature (25ºC).

5) DATA GAPS

The Wabamun incident revealed several data gaps with regard to the spill of a high-density viscous oil into a fresh water environment.

a) Dynamics of near neutral density oil

Bunker C is well known to have a serious environmental impact, mostly due to smothering. Its density being near that of freshwater, means it has a tendency to sink with only a limited amount of weathering or picking up of debris.

There is a significant amount of observational evidence that the Bunker C submerged and was in contact with the lake sediments. During the two months of the spill response, it was noted that globules of oil would surface and form sheen together with a small patch of dark oil. This process seemed to be related to changes in temperature of the surface water of the lake, but the dynamics of the process are not well understood. (Vandermeulen and Jotcham, 1986; Brown *et al,* 1992 ; Brown *et al*, 1998; Hollebone, 2005)

b) Flowing of hot product

The Bunker C was released from the tanker cars at a temperature well above ambient, and flowed more rapidly than would be expected from the physical properties of Bunker C with its viscosity of more than a million cSt. at 20º C. However, Bunker C has a viscosity of less than a thousand cSt at 50º C and would flow quite readily at these temperatures. The cooling process upon release and the dynamics of flow are not well understood.

c) Interaction of oil and fine sediments

There is some information from the literature on the interaction of light oils, which do not form a surface film, with sediments. However, in the case of Bunker C, which quickly forms a surface film; this interaction has not been studied to any degree. The binding mechanism of the sediment to the surface film has not been studied and hence, the interactions between the lake sediment and the submerged oil cannot be determined. (Lee *et al* , 1996)

d) Cutting of reed beds

Much of the near offshore environment in Lake Wabamun consists of large reed beds *(Scirpus sp),* which are a habitat for the Western Grebe (*Aechmophorus occidentalis*). Some of the reed beds became collection points for the surface oil and the stems were coated both below and above the water line due to wave action. It was recognized that any disturbance of the root system had the potential to destroy these beds and all access was made by water using shallow draft vessels. The reed beds became a continuing source of surface oil contamination after the major amount of free oil had been removed from the water surface. In order to eliminate this continuous source of oil contamination, it was decided to cut the reeds. However, this was made on the basis of need, rather than based on any scientific studies of the consequences of cutting the reed bed and the possible consequence on the nesting of the western grebe, which builds its nests on old growth reeds. Since some reed beds were not cut, this may not be an issue.

6) TECHNOLOGY GAPS

During the response there were several technology gaps identified and while some on-site solutions were developed, these were far from optimal. The development of both new detection techniques and response methodologies are needed to handle this situation.

In view of the controversy around the total response, there was a reluctance to use this spill to conduct experiments on technologies for which the probability of success could not be determined.

a) Detection of oil in water

Since the density of the Bunker C is very close to that of fresh water, and small blobs of the oil continually rose to the surface, it was believed that there was a considerable amount of oil suspended in the water column. This belief was further enforced when the TransAlta power plant was restarted and tar balls and oil particles were collected in the inlet canal using a fine-mesh screen. While both acoustic and laser fluorosensor techniques were considered for the detection of oil in the water, there was insufficient data on either technique to recommend the use of these methodologies.

For the acoustic system, there were only two references and both were for relatively concentrated plumes in a salt-water situation. The density of oil particles in Lake Wabamun was thought to be small, and the limits of sensitivity of acoustic sensing are not well known. (Hay *et al*, 1984)

There are two possible configurations of fluorosensing equipment that could have been tried: a towed system and a remote-sensing system using an aircraft. However, since the fluorescing component of the oil is the lighter ends, it was unclear as to the sensitivity of these systems for the heavy Bunker C. (Brown *et al*, 2002)

As a result of this experience, research should be undertaken on the understanding of how these technologies could be used when a heavy oil is spilled into a freshwater environment.

b) Detection of oil on bottom

It was clear that some of the Bunker C had settled to the bottom, but its exact location was difficult to determine. Sorbent pads on long poles were used to probe the bottom, but these were ineffective since the Bunker C had formed a skin and did not adhere to the sorbent. This was not a surprise, since the Bunker C on the water surface was not readily sorbed. Video cameras were tried but the dispersed nature of the oil meant that this was not successful except in some shallow water situations.

Research should be undertaken in the development of suitable technologies for the detection of oil on the bottom of water bodies.

c) Collection of oil particles

Various forms of netting were tried to collect oil from the water column and in the inlet channels of the power plant. Previous studies on the use of nets to collect bitumen had showed that the oil would adhere to the net filaments and a net size of ten millimetres or so was an effective collection medium. In the Wabamun situation, such nets were ineffective and very fine netting or geotextile were more effective in the collection process, but inhibited water flow. The lack of flow through the materials result in very large forces due to water pressure gradients and complicated the use of such materials in the collection of the oil in the water column. (Morris *et al*, 1986; Brown *et al*,1989; Thomas *et al*, 1983; Zhang *et al*, 1999)

Research is needed to understand the critical parameters, both of the oil and the catching material, to optimize the oil collection and an increase of the permeability of the collecting material.

d) Removal of oil from bottom

Once the oil has settled on the bottom of a water body, it is out of sight and becomes of less concern for responders. In the case of Lake Wabamun, the oil continued to rise to the surface as small globs, reminding the response organization of the presence of oil on the lake bottom. As discussed above, the distribution and location of the submerged oil was difficult to determine. When oil was detected or accidentally found, the questions arose as to how to remove this oil. Diver-guided vacuum systems have proven successful when the oil on the bottom occurs in large patches such as occurred in the Berman and Haven spills. In the case of the Athos spill where the oil was broadly distributed in a water system with poor visibility, various methods of beating the bottom sediment were used to bring the oil to the surface. However an understanding of any of these methods was incomplete and while various techniques were tried at Wabamun, the success of removing the oil from the lake bottom was limited. (Burns, 1995; Weems *et al*, 1997; Helland *et al*, 1997; Michel, 2005)

e) Tar ball formation

Tar balls have been recognized as a product of an oil spill for many decades (Goodman, 2003), but there has been little research of their formation, fate or impact. Some studies were conducted on their formation by Omotoso *et al*, (2002), but this work was discontinued due to a lack of interest, and hence funding. The understanding of the dynamics of tar balls formed from Bunker C in a fresh water environment was lacking at Wabamun. There is needed a detailed, science-based research activity on tar ball formation and long-term fate in both the marine and fresh-water environments.

Research is needed to understand the effectiveness of the various techniques and the development of different innovative methods.

7) THE ENVIRONMENTAL PROTECTION COMMISSION

There was a strong public reaction to the lack of response by both the federal and provincial governments to the spill situation and it was widely perceived that government agencies had failed the needs of the public in this situation.

a) The establishment of the Environmental Protection Commission

The public concern about the response and the lack of action by the Alberta Government resulted in the Alberta Minister of the Environment establishing the Environmental Protection Commission on August 14, 2005 with a mandate to develop an improved infrastructure to respond to environmental emergencies in Alberta. This group was requested to develop recommendations for an improved system of dealing with environmental emergencies anywhere in Alberta in the very short time period of three months. Support staff were seconded from a number of government departments and a series of commission meetings were held to develop the new system. During these meetings, briefs were presented by most of the stakeholders in emergency response and these were used to develop the new mandate.

b) Composition

The commission consisted of seven members and was chaired by Dr. Eric Newell, Chancellor of the University of Alberta. This group consisted of response experts, academic research specialists and a representative from the public. A number of experts were recruited to assist the commission by contributing their knowledge and experience to the development of the final set of recommendations.

c) Developing new ideas

Due to the short time period given for the development of the recommendations, a series of task forces were established for focus on some of the main subject areas. These task forces were composed of commission members, subject matter experts and stakeholders from a broad range of interest groups. The task forces met and developed ideas, which were consolidated by the research staff of the commission. After the work of the task forces had been completed, subject matter groups were established to develop and provide focus for the recommendations.

d) Recommendations

The recommendations of the commission were presented as a commission report to the Alberta Minister of the Environment, and then were released to the public. While there were many recommendations, the main recommended changes were:

i) The development of a new agency

Emergency response in Alberta is currently the responsibility of a number of government departments and agencies, with some overlap in jurisdiction and a lack of interagency coordination. In order to improve this situation, the commission recommended a single agency become responsible for all emergency response and the head of this agency should report directly to a high-level official within the government. Staff for this new agency would be drawn from a number of government departments and agencies.

ii) Research and technical information institute

There was a lack of technical information available to adequately respond to the spill at Wabamun and the commission recommended the establishment of a new Research and Technical Information institute to support the needs of the agency and provide guidance and funding for the initiation of new research in the areas of freshwater spills and risk management.

iii) Government response and training team

In order to provide the government and in particular Alberta Environment with a response guidance and assistance capability, the commission recommended that a full time team of experts be developed within Alberta Environment to provide technical assistance during a response and to provide training to other response groups within the province. This team would be dedicated to response, and not be associated with any enforcement activities. It would provide a recognized competence in the response field and would interact with other industry response organizations.

iv) Central alert and contact group

The response to an emergency situation is a complex process and the commission recommended that the initial contact for any emergency be made to a single group, which would be staffed by individuals trained in handling the initial response. This centre would be modelled after the "911" response centres in common use.

v) ICS response structure

While the Incident Command Structure (ICS) (Gundlach and Jensen, 1997 and Andersen *et al*, 1998) is routinely used for response by industry, such a system is less common in government. It was recommended by the commission that all groups performing a response function develop an easily expandable ICS system within their response structure. This would allow the response to grow according to the incident and would provide a common language and definitions for all responders.

These recommendations, along with many others, were well received by the Alberta Government and are in the process of being implemented.

8) CONCLUSIONS

Each spill is different and, for each situation, new techniques, procedures and needs are identified. The Wabamun spill is another example of how the understanding and implementation continues to evolve.

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