Spill Response on Rivers, Lakes and Sheltered Marine Waters: An Alternative Approach

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Abstract

Prospective spill response recovery/Control Point locations on many western and northern Canadian rivers are difficult and sometimes impossible to access overland. The river widths and/or isolation of areas of the rivers, the amount of channeling around islands, sand bars and limited access for significant lengths of shoreline makes locating effective Control Points extremely difficult, especially in remote areas.

This document describes an approach that addresses the above problems using a fraction of traditional personnel and response equipment. It may also be utilized in concert with conventional shore based deployments.

While the writer has selected components that work well together to illustrate the concept, users are free to substitute equipment that more particularly suits the conditions and environment in which their system is anticipated to operate. The system can be transported by road, water, rail or air and may be launched from a boat ramp or lowered into the water from a road bridge or rail car. It has a rapid startup to deployment time frame once the location is reached and is able to be operated by a few trained personnel. It is also highly effective for the recovery of a wide range of products while operating in fasterflows and relatively shallow water.

1. Introduction

It has long been recognized that spill response on wide and in some cases isolated rivers and lakes presents significant challenges in terms of logistics, manpower requirements and the quantities of equipment needed.

Waste management issues with regard to collection, temporary storage, transportation and disposal of recovered liquids and solids compound the problems.

To date the usual approach for inland waters has been to identify, assess and document Control Points from which a response may be mounted. A Control Point is generally interpreted to be a pre-assessed location on the bank of a water body where conditions are such that the deployment of spill containment and recovery equipment is likely to result in a high degree of success. For larger releases it is usual for more than one Control Point on a water body to be activated.

Attributes looked for in a good Control Point include:

- River Conditions – water of sufficient depth and uniform flow suitable for response operations and not immediately downstream of features such as riffles or tributaries that could negatively affect the waterborne surface spill approaching the recovery area.

- Road Access – Access of sufficient size and condition to permit its use by heavy vehicles. Overhead wires that could impede higher vehicles approach should not restrict the access.

- Convenient to a Boat Launch – The boat launch, if not at the site, should be in close proximity, have sufficient depths of water at all river levels and be suitable for the launching/recovery of the size, weight and type of vessels to be employed.

- Work Space & Parking – Ample workspace will be required for operations including accommodation of vehicles such as response equipment trailers, vacuum and tank trucks etc. Responder parking will also need to be available at or close to the site.

- Helicopter Pad Location – Optional but not unusual today given the increasing use of helicopter supported responses. This is particularly true in isolated areas.

Ideally, selected Control Point locations should be revisited on a regular basis to ensure their continued viability.

Western and northern Canada has a significant number of wide, isolated rivers, lakes, inshore waters and harbours that could be exposed to a spill from oil production, transportation or processing activities and other sources. The width and/or isolation of areas of these water bodies, the amount of channeling around river islands, shoals, sandbars and the limited access to significant lengths of the shoreline makes locating good Control Points very difficult.

As examples, the Fraser River in the area south of Prince George, BC; the Skeena River downstream of Terrace, BC; the Mackenzie River both around Norman Wells and Inuvik, NT and the North Saskatchewan River around Lloydminster in Alberta and Saskatchewan would all pose significant challenges to responders attempting to negate the effects of a waterborne spill. There are stretches of all of the above waterways where the nearest road is some significant distance away and suitable river accesses for the establishment of Control Points are few and far between.

On the Fraser River immediately south of Prince George, BC one good Control Point was found 7 river kilometres downstream of the potential spill point, the second 38 kilometres from the same point with the third being 62 kilometres downstream. Given the historic river speeds it is acknowledged that the first of these locations would in all probability be passed by the spill's leading edge before a response deployment could be effected. As may be appreciated, this exposes significant distances of shoreline, islands and shoals plus other resources at risk to potential contamination with a concomitant increase in clean-up costs and liabilities.

For the Mackenzie River in the areas of Norman Wells and Inuvik, once the outskirts of the towns are reached there are no roads whatsoever in open water season.This river, too, has a significant number of islands and shoals, not to mention a very large delta (over 16,000 square kilometres/6,000 square miles) in which there are no roads of any kind. With regard to the many shoals, these appear and disappear depending on the water levels and also move year to year.

In the above instances any spill recovery location/Control Point would have to be established and operated with considerable vessel support and helicopters, if available.

There is also the factor of river widths that could amount to a distance of several kilometres. To cover the main flows with deflection and containment boom on a wide river, even if a Control Point was available, would take:

- an army of trained persons
- a mountain of boom and support equipment
- an armada of vessels
- a considerable amount of time

Given that any spill can be expected to be drawn to the faster flows in a river, and that dynamic rivers can vary greatly in terms of depths and flow patterns season to season, it is surprising that few dedicated inland water response vessels are equipped with even the most basic depth sounding equipment to determine the deeper river channels.

As mentioned earlier, the matter of liquid and solid waste storage and disposal from one of these isolated sites away from any road would prove to be a significant logistical challenge.

The question arises; "Is there a better way to effect containment and recovery of floating contaminants where:

- the river is excessively wide, and/or
- Control Points are few and far between or non-existent, and/or
- the river banks in the area of interest are not accessible by road?"

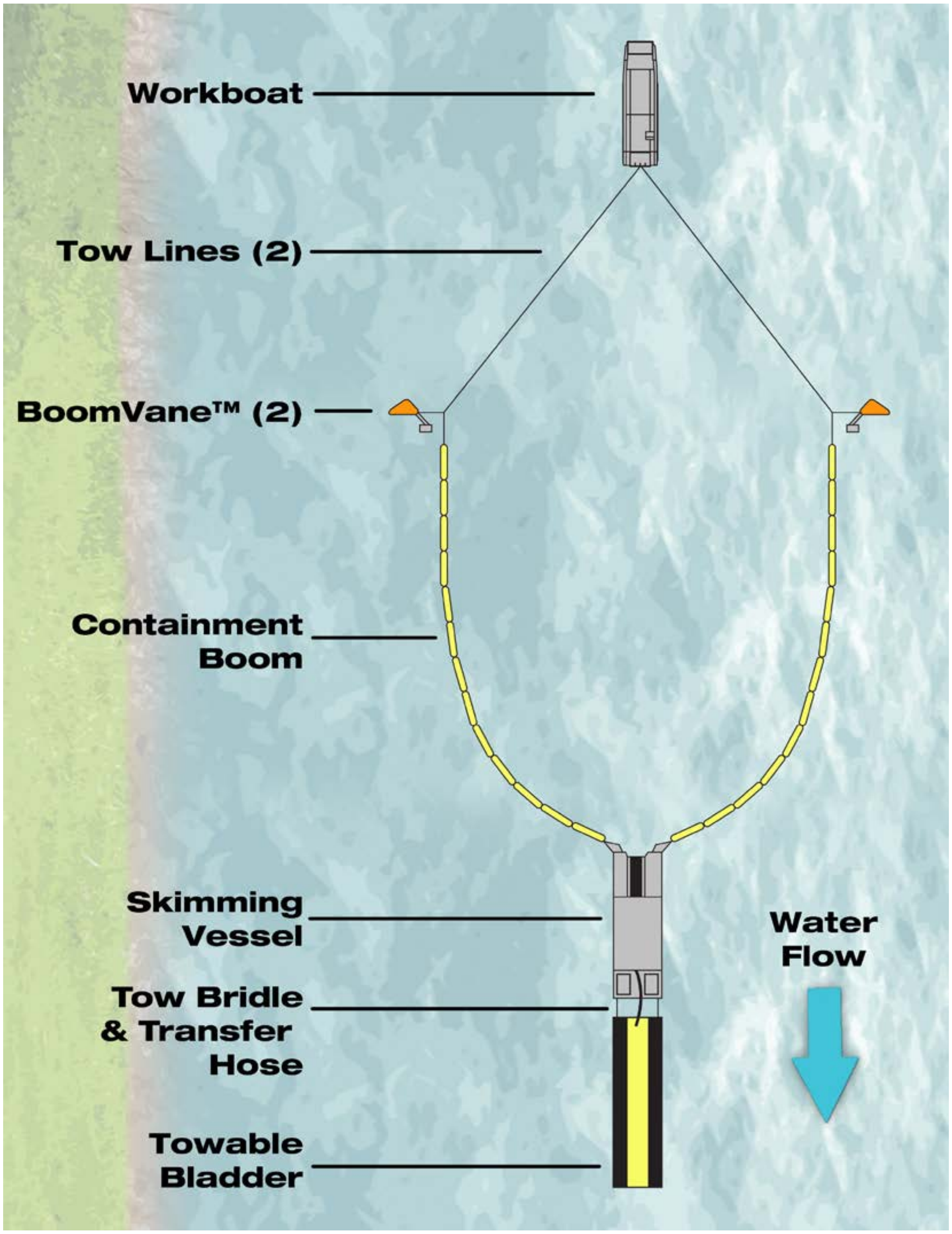
Considering the attributes of a potential solution it would be desirable to have the following:

- Mobile; system ideally transportable by road, water, rail and air
- Fast, both to reach the site once launched and in speed of deployment
- Operable by a few trained personnel
- Effective for a wide range of products
- Effective in relatively shallow water
- Effective in faster water flows
- Have the potential for recovering and storing large volumes of recovered products
- Largely independent of Control Point(s) or shore facilities

In searching for a potential solution it was thought that rather than start anew, the answer might be found in utilizing, as far as possible, response tools currently in existence as components in any new approach. After a considerable amount of research and mixing and matching of products, components were selected that met the targeted aims for the system as a whole. Note that while the system components described in this document are those selected by the writer, there are any number of alternatives a prospective end user could substitute to meet its goals and particular conditions.

In addition, with the aim of providing the most flexibility, components were selected with a view to them being of use either individually or in combinations for other spill response related missions. The eventual component selections and their places in the overall system are described in the Figure 1 and text below. For ease of understanding, these are described from the upstream end of the consolidated system deployment to the downstream. There are a number of variations that could be utilized such as the BoomVanes being held by one river bed anchor or affixed to a bridge pier or other permanent structure in a river, but these are not discussed here.

Figure 1 – The Consolidated System



2. Work Boat/Tow Boat (1)

This vessel will lead the response in the river. It should have sufficient deck space to load 2 BoomVanes, the required quantity of boom and support equipment plus additional rolled bladder(s). Ideally, in addition to communications equipment, the tow boat would be equipped with a depth sounder to assist in locating the deeper channels in a wide river where the faster water flows and consequently the highest concentrations of a spill may be expected. Users may wish to consider adding a GPS with course tracking capabilities that also may prove helpful both to responders and response management.

In terms of crew, it is anticipated that 3 persons will be required, particularly during the initial deployment phase.

The loaded work boat/tow boat may be launched at a conventional boat launch or lowered by crane from a river bank, road bridge or rail car.

3. BoomVanes™ (2) and Tow Lines (2)

Deployed from the Tow Boat the tow lines hold the 2 BoomVanes that are configured to operate in opposite directions to hold the boom "V" open in order to direct the contaminant to the skimming vessel.

The reason 2 Shallow Water BoomVanes (0.55m draft) rather than the Standard models (1.1 m draft) were included in the field trials and this explanation is due to the short quantity of boom being utilized (150' per side = 300' x 6" x 6" riverboom) and to maximize the opportunity to pursue and recover a spill in shallower waters. Even if the boom lengths were increased to 250' per side; total 500' it is thought unlikely that a step up to Standard BoomVanes would be required.

4. Boom

Ideally a shallow, fast water boom such as 6" x 6"river boom will be available. The length of each of the two legs of boom would be commensurate with that needed given the circumstances and conditions. Usually the length of each leg will be in the 100' to 250' range allowing for a wide swath.

At field trials, 2 x 150' long legs of 8" draft boom were utilized, and the two Shallow Water BoomVanes had no difficulty in deploying this in 2.2 knots of flow. The resulting capture area between the boom ends was measured to be 120' at the field trial. Adapters are used to connect the boom end connectors to the vessel's two boom guides.

5. Skimming Vessel

A self-propelled 30' shallow draft belt skimming vessel was selected. The twin outboard engines provide for maneuverability and speed (>12 knots). When trailered the vessel is legal for transport by road without restriction. While the vessel used at the field trials was propeller powered, it would be possible to equip the unit with jets although there would be a penalty to speed and maneuverability; however, a decrease in vessel draft would also be realized.

The selected vessel has 3.8 cubic metres (833 Imperial gallons/1,000 U.S. gallons) integral stowage capacity for recovered liquids and a sorbent lifting belt recovery system. A secondary separation system is used to maximize recovery efficiency and take full advantage of onboard storage capacity.

In addition, small debris recovered by the belt system is automatically sorted into a basket while liquid drains into the vessel's integral recovered liquid storage tank. For larger debris, the system could be maneuvered to allow the hazard to pass, unlike fixed conventional Control Point boom deployments. Note that for the next field test of the system, it is planned to fit the BoomVanes with control lines which, if successful, will permit, by moving the BoomVane rudders to the stalled position, the boom deployment to close the "V" thus significantly increasing the ability to avoid larger debris. The deployment would then be quickly re-established when the hazard had passed by reactivating the BoomVane rudders.

A range of recovery belt inserts is available to accommodate the retrieval of a wide range of products as shown below in Table 1. The selected vessel is equipped with an induction pump to facilitate the surface-borne spill contacting the recovery belt.

Table 1 - Skimming Vessel Recovery Rates - Not Derated

Oil Type	Examples	Cu. Metres/Hour	Barrels/Hour
Type 1	Jet “B”, Gasolines etc	**8 cu. metres** per hour	50 bbls. per hour
Type 2	Diesel, Light crude oils, etc	**33 cu. metres** per hour	207 bbls. per hour
Types 3 & 4	Medium & Heavy crude oils, Bunker “C “ etc	**68 cu. metres** per hour	427 bbls. per hour

Standard operating crew is 2 persons.

An on-board integral pump is utilized to transfer the recovered liquids to the towed bladder, if being used.

The skimming vessel, like the tow boat, may be launched at a conventional boat launch or lowered by crane from a river bank, road bridge or rail car.

While the above primarily discusses river response due to the need for speed induced by the faster water flows, there is nothing to prevent the system from being utilized effectively in slower flowing water bodies such as lakes, harbours or sheltered marine waters.

6. Bladder with Tow Bridle and Camlocked Transfer Hose

A 3.8 cubic metre (833 Imperial gallons/1,000 U.S. gallons) camlocked bladder with tow bridle was found to be optimal for use with the system. This capacity is identical to that of the skimming vessel’s integral liquid storage tanks. The liquid transfer from vessel to bladder is accomplished through a camlocked hose from the skimming vessel using the onboard pump. A full bladder may be replaced while recovery continues by utilizing the vessel’s integral tanks for temporary liquid storage during the bladder switch. When the change of bladder is completed, the product recovered during the switch may then be transferred to the new bladder. To protect against damage to the towed bladder from shoals or other snags in a waterway, a reusable protective “sled” may be used. Efforts are currently under way to strengthen the underside of all bladders to the point it will negate the need for the sled. Spare bladders may be carried rolled-up on the skimming vessel deck, in the tow boat, supplied by a support vessel or even delivered by a helicopter with long line.

After capping of the camlocked loading port, a full bladder may be anchored in a waterway for later retrieval or towed to a shore point for emptying/reuse by a support vessel.

Should night operations be contemplated or planning indicates that bladders may be anchored in a water body overnight, a strobe light is available for bladder identification. For daylight operations, the bladder’s yellow stripes are highly visible.

7. Conclusion

Mobility permits a centrally located system to be available to cover a wide geographic area and response countermeasures to be initiated closer to the spill source, thus reducing the potential for damage to downstream resources at risk. The approach negates the need for fixed shoreline Control Point availability and allows for operations in wide or shallower water bodies that may otherwise require a significant increase in response manpower and equipment. That having been said there is nothing to prevent the system being deployed bank-to-bank in narrower waterways provided adequate depth of water and a uniform flow is available at the selected location.

The reduced manpower requirements compared to a conventional Control Point deployment likely means quicker mobilization of sufficient personnel, potential savings on training costs and possibly a reduced response equipment inventory.

In comparing the result to the initial aims for this alternative concept in spill recovery the following is suggested:

- Mobile: the above described system is transportable by sea, rail or air (a large cargo aircraft or heavy lift helicopter would be required for air transport).

  Can be road trailered to any suitable waterside launch point and, if required, placed in the water at a boat launch or lowered by crane from a riverbank, road bridge or rail car. Potential users may already have access to a vessel suitable for use as the tow boat.

- Fast: both the tow boat used in the field trials and the skimming vessel can operate at more than 12 knots, thus can initiate response countermeasures closer to the spill source, reducing the potential for downstream shoreline contamination and threats to other resources at risk.

  Approximately 15-30 minutes after reaching the deployment site, the system can be in operation, as opposed to approximately 90 minutes for a conventional boom deployment at a Control Point, if one was available. There is also the advantage of being able to operate in wide rivers or other similar water bodies which would present significant challenges for conventional shore based deployments. This alternative approach permits the response to move downstream with the spill while continuing recovery operations. A distinct advantage over fixed shore based deployments.

- Operable by a few trained personnel

  System designed to be operated by 5 persons.

  Savings in training and labour costs

  Increases the likelihood of a sufficient number of responders being available

- Effective for a wide range of products due to the availability of skimmer belt inserts

- Effective in relatively shallow water

  Shallow BoomVane draws 0.55m

  Propeller powered skimming vessel described draws 0.79m empty, 1.09m full

- Effective in faster water

  Vessels can also operate moving downstream with the river/spill flow

- Less vulnerable than riverbank deployments to river debris

  Smaller debris is recovered by the skimming belt and dropped in a basket that drains into the recovered liquid tank. Debris is then easily bagged for disposal. Fixed Control Points usually require hand removal and bagging of small debris Tow vessel may be able to evade larger debris common in many western and northern Canadian rivers at certain times of the year by maneuvering the system to avoid it. As mentioned earlier, adding the BoomVane control lines may permit the boom "V" deployment to be closed until the hazard has passed then be quickly redeployed. Control Point installations are fixed and very vulnerable to large debris being carried by the river to the point boom installations may be ripped out or damaged

- Storage capacity is increased by the ability to transfer recovered liquids to the towed, reusable, replaceable 3.8 cubic metre camlocked bladders.

8. Acknowledgements

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