TERMINATION OF SHORELINE CLEANUP – A TECHNICAL PERSPECTIVE[1]

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ABSTRACT

There is always a balance to be struck between the different sensitivities and priorities on a shoreline when trying to decide the degree of cleaning which should be carried out after an oil spill and the methods that should be used. For example, aggressive cleaning techniques like hot water washing and the use of chemicals may be necessary to remove viscous oils or weathered residues from rocks to render them clean enough for recreational use, but they also increase environmental damage. Consequently, priorities need to be set depending on the use and environmental sensitivity of the shore in question. Often, there is no simple answer which will satisfy all parties.

The amount and type of oil and how it weathers, the difficulty of access, the safety of the clean up crews, the extent to which natural cleaning is likely to take place, the environmental impacts of the clean up and the rate of subsequent recovery, as well as the cost-effectiveness of the works are all factors that need to be taken into account in the overall determination of what level of clean up is reasonable in the circumstances. Careful consideration of these factors and whether any remaining oil impinges on aesthetic, environmental or economic concerns provides the basis for deciding whether further clean up is justified and also allows the point to be determined at which clean up should be terminated. Such technical considerations are reviewed and illustrated with examples drawn from recent spills in Chile, France, Taiwan, the UK and the USA.

General Considerations

The decision to bring shoreline cleaning operations to a close depends on a wide range of different considerations and often there are conflicting concerns to be resolved and overcome. The most frequently encountered conflict arises from a demand to remove every last drop of oil from the shoreline. This demand may be driven by a poor understanding of the effects of oil pollution and clean up, and is often inspired by a desire to repair the damage caused by a man-made accident, or it may be politically motivated. Complete removal is neither achievable nor necessary and does not recognise the capacity of the natural environment to recover relatively quickly from perturbations such as storm damage, natural climatic fluctuations and oil spills.

Another common area of conflict identified by Kerambrun and Parker (1998) in their review of issues effecting the decision to terminate clean up operations, is between tourist interests and fisheries and environmental concerns. Those responsible for managing amenity resources for the tourist industry are likely to demand that the clean up is completed as fast as possible, especially if the incident occurs during or in the run up to the tourist season. This usually leads to the use of more aggressive clean up techniques with less consideration of the risk of damage these measures may themselves cause to environmentally sensitive resources and fisheries.

From a technical perspective the issues can be reduced to three simple questions:

- Is the remaining oil likely to damage environmentally sensitive resources?
- Does it interfere with the aesthetic appeal and amenity use of the shoreline?
- Is this oil detrimental to economic resources or disrupting economic activities?

If the answers to these three questions are negative, then there is no technical rationale for continuing the clean up.

One other factor bearing on the decision to stop cleaning is cost. In the figure overleaf, the costs shown in Table 1 are plotted in terms of cost/tonne of oil removed for of each of the three widely recognised stages of shoreline clean-up: Stage 1, bulk oil removal; Stage 2, cleaning of heavily contaminated shorelines and Stage3, final cleaning or "polishing". The figure shows how costs escalate dramatically through the three stages and clearly illustrates the "Law of Diminishing Returns". Early in the clean up operation oil is plentiful and can be removed in quantity with ease. As the work progresses it becomes more and more difficult and requires ever-increasing

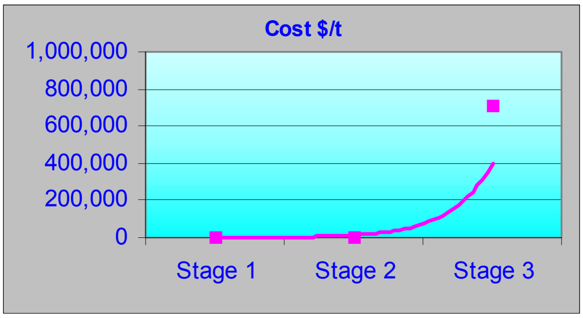
[1] The views expressed in this paper are those of the authors and do not necessarily reflect those of the individual Directors, Members and Associates of ITOPF.

effort, and cost, to remove the diminishing amounts of oil. At some point the costs become disproportionate to the benefits that can be derived from further cleaning.

TABLE 1 Clean-up costs for a spill in the Far East

(from Moller et al., 1987)

Clean-up period	Oil quantity collected (t)	Unit cost ($/t)
Stage 1	2,270	748
Stage 2	200	4,069
Stage 3	20	712,835



The application of these tests to determine whether further clean up is justified is entirely consistent with the concept of "reasonableness" as it applies to the two international Conventions that govern compensation for clean up and damages following tanker spills. The Civil Liability Convention (CLC) 1992 and the Fund Convention (FC) 1992 require that response measures should be "reasonable". Although not precisely defined, the term is widely accepted as meaning that decisions should be made on the basis of a technical appraisal of the circumstances at the time the decision was made. The objective of any measures taken should be to minimise pollution damage and such measures should seek to enhance natural recovery. Where damage does result from the oil or from reasonable clean up measures, the Conventions provide for environmental restoration, subject to the costs of the measures being reasonable and not being disproportionate to the results achieved or that could reasonably be expected. The measures should also be appropriate and offer a reasonable prospect of success.

The dilemmas presented by the decision whether or not clean up should stop obviously have to be faced in every incident and as a result the issues have been widely debated in the past. The topic was addressed as one of the "Issue Papers" presented to the 1997 International Oil Spill Conference, (Baker, 1997). The paper sought to provide guidelines for what is meant by "clean", introduced the concept of Net Environmental Benefit Analysis (NEBA) as a device to assist in reaching a decision and concluded that given the range of interested parties involved in reaching this decision, it could only be achieved through building consensus. The central tenet of NEBA (IPIECA, 2000) and it use in determining "how clean is clean", is to consider the benefits of physical intervention to mitigate the effects of pollution on the environment and socio-economic resources, and balance these against processes that bring about natural cleaning such as the action of the sea, tides and the weather.

Factors in the termination of clean up operations

Table 2 summarises the main factors discussed by Kerambrun and Parker (1998) that influence the answers to the three questions posed above as well as the question of cost. In the section that follows examples are drawn from recent incidents to illustrate how far these factors were taken into account in the termination of clean up operations.

TABLE 2 Summary of factors in termination

?	Use or function of the affected shoreline
?	Shoreline type
?	Oil type
?	Environmental sensitivity / seasonality
?	Determination of whether intervention will do "more harm than good"
?	Comparison of benefits of intervention with natural cleaning
?	Feasibility at reasonable cost

WESTCHESTER

In the United States the system now universally used to manage spill response, the Incident Command System, (ICS), has at its core a very formalised approach to consensus building. The ICS provides all interested parties with the opportunity to participate in decision making at appropriate levels within the organisation but it can also lead to overly large and cumbersome management bodies. A recent example of how this system enabled co-operation between interested parties was found in the setting of pragmatic end points for shoreline clean up during the WESTCHESTER incident on the Mississippi River in November 2000. The incident involved a spill of some 1,800 tonnes of a high pour point Nigerian crude that stranded along 10 miles of riverbank. Following initial surveys to determine the levels of oiling and the different types of habitats involved, the end points described below were set by the Shoreline Clean up Assessment Team (SCAT) which included representation of the State and Federal governments as well as the shipowner and clean up contractors. The approach taken was to evaluate the techniques and equipment available for cleaning each of the different habitats affected and to review the success of cleaning test sites to determine a realistic level of cleanliness. This allowed contractors to aim for known end points from the start of the clean up operation.

TABLE 3 **WESTCHESTER - Techniques and end-points (from RPI, 2001)**

Riprap (riverbank rock armour)
High volume cold water flushing (deluge) was used to remove all pooled oil from crevices between stones. The end point to be achieved was set as no more than 30% coat (black oil that can be scraped off with a fingernail) and no black/brown oil to be mobilised during clean up or natural flushing which could act as a secondary source.
Sand flats
These were fine-grained sand flats exposed at low water where the oil stranded 1-3 cm thick but with no penetration of the water saturated sediments. The oil was collected manually and by vacuum trucks. Heavily oiled vegetation was cut to allow access to the oil. The end point was set as the removal of all free oil (black/brown oil) with no more than a 5% stain on the sand.
Mud flats
The majority of these areas were formed between an outer line of riprap and the main riverbank or

levee. The oil penetrated the riprap and became trapped on the mud flats behind. Low pressure flushing, vacuum trucks, manual removal and the passive use of sorbents were among the techniques used to clean these areas. The endpoint was no visible free oil.
Riverine vegetation and marsh
Low pressure flushing was used to release free oil. Some oiled fringing vegetation was cut and sorbents were used in a passive mode. The endpoint was the removal of all visible free oil and for soil or sand, less than a 5% stain judged visually.

None of these endpoints were particularly challenging. The technique selected for treating the bulk of the shoreline, the rock armour that lined the riverbank, was unable to remove all the oil from the rock face. The high pour point of the oil rendered it effectively solid as temperatures dropped and caused it to adhere firmly to the rocks. However, the main concern was to minimise the risk of wildlife becoming oiled particularly waterfowl and aquatic mammals and so the primary objective was to remove as much free oil as quickly as possible to avoid it moving to adjacent more sensitive parts of the Mississippi Delta. In addition, the adoption of these end points was tempered by i) the recognition that the river bank was of relatively low amenity value and ii) a reliance on natural cleaning based on the knowledge that most, if not all, of the affected area would be flooded when snow melted upstream and the river levels rose in the spring. The river water would then be laden with sediment that was expected to assist in the effective removal of residual oil stains.

AMORGOS

The bulk carrier AMORGOS suffered engine failure and grounded off the southern tip of Taiwan in January 2001. Shortly afterwards, the vessel began to break up and an estimated 1,000 tonnes of IFO180 was lost, stranding along approximately 5km of shoreline within the Kenting National Park. The park is valued for its aesthetic, ecological and cultural resources and this section of the shoreline comprises fossilised coral rock exposed to rough seas and strong winds. The shore is backed by dense vegetation and steep, rugged cliffs 50 - 100 metres high.

Access to the polluted shoreline presented one of the more difficult challenges to be overcome. However, after a period of some eight weeks the removal of bulk oil had been completed by manually lifting it from the water's edge and pumping it up the cliff face.

A range of secondary cleaning techniques was evaluated for the difficult task of removing residual oil from the heavily pitted rock formation taking into account the most sensitive areas in the immediate subtidal zone where coral was abundant. Close to the surf zone and in areas exposed to regular strong wave action natural cleaning was evident within just a few weeks. For many less exposed areas, however, it was clear that little improvement would be likely without secondary cleaning. The presence of rich corals in shallow waters next to the shore precluded the use of chemical cleaning agents. Eventually, agreement was reached with the national authorities to use hot water pressure washing but because of the environmental impacts that would inevitably result, cleaning was kept to a minimum. One area of high amenity value, visible from a designated viewpoint was extensively cleaned. Elsewhere, cleaning was restricted to the upper shore and sheltered areas where waves were unlikely to promote self-cleaning. The oil washed off in the cleaning process was collected using locally made sorbents.

This is a very high energy shoreline and might have been expected to self-clean in time resulting in minimal damage but this was a shoreline of high national import and a compromise had to be found. The balance to be struck was between the clean up operations doing more harm than good by risking damage to the corals, and the government's initial demand for all traces of oil to be removed. Preliminary results of surveys undertaken to monitor the health of the adjacent corals found these to be unaffected by the oil and have helped to vindicate the levels of clean up agreed.

JOSE FUCHS

In May 2000, the tanker JOSE FUCHS spilled an estimated 100 - 200 tonnes of an Argentinean crude over a distance of 80 miles in amongst the islands of an archipelago in southern Chile. The weather conditions were extremely poor it being winter in the Southern Hemisphere and the islands affected were in a remote area important for fishing but with an extremely low population density. Again access to the work sites presented a challenge and surveys were conducted from a small seaplane while all the clean up teams had to be deployed from the water and accommodated on boats.

The shorelines involved were mainly rock, cobble and shingle but were sheltered and so in contrast to the situation in Taiwan, natural cleaning was expected too proceed relatively slowly. However, given the remote location and recalling the three criteria used to provide technical justification for continued clean up, a reasonable level of cleaning was recommended. This was aimed at minimising damage to the environment and avoiding levels of pollution that would interfere with fishing activities but which fell short of achieving an aesthetically pleasing outcome. Clean up teams were tasked to remove free oil, clean heavily contaminated shorelines and collect oiled flotsam and jetsam. However, consensus on the appropriate end points was not easily reached in this case.

ERIKA

Oil from the tanker ERIKA also reached remote areas along the shorelines of the Brittany coast. In some places the oil was thrown high up on cliff face as a result of the stormy weather that precipitated and followed the tanker's break-up. In order to justify the cleaning of such shorelines they should have a high amenity value and be clearly visible from close enough to readily distinguish the oil. Alternatively the need to clean them may be for environmental reasons, for example, because of potential contamination of seasonally breeding bird colonies. With current climbing technology and in some places, the assistance of cranes and helicopters, it proved feasible to gain access to many difficult areas, and they were cleaned.

Initially the focus was on the highly visible areas and those where access was easiest, but as time passed, pressure mounted to clean every last drop of oil, even in the most inaccessible, difficult and dangerous areas, with little regard to whether it was reasonable or not. This included locations where it was impossible for the public to reach or even see the oil, either from the cliff top or the sea. By the time the cleaning was carried out, residues at these sites were stable and therefore unlikely to contaminate other areas. However, political, media and public pressures demanded levels of clean up which could not be technically justified.

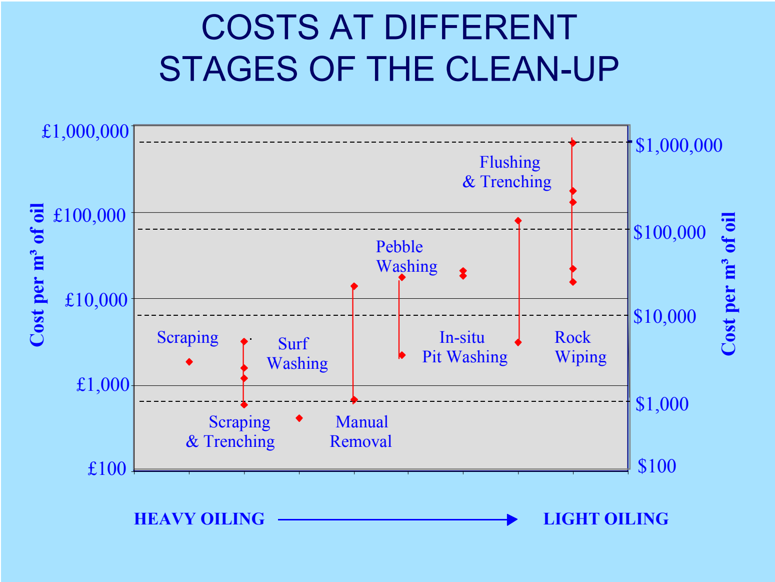
SEA EMPRESS

The tanker SEA EMPRESS ran aground at the entrance of Milford Haven in February 1996 and spilled 72,000 tonnes of Forties crude along some 200km of the Welsh coast. This coastline is noted for its outstanding natural beauty and diverse coastal habitats but as well as its environmental sensitivity, a high proportion of the affected coastline is also important for tourism, leisure and recreation. The nature of the affected coastline led to tensions due to the inherent conflict between the demands of the tourist interests and those concerned with the many environmental resources. These frustrations were reflected in the report of investigations conducted on behalf of the UK government which stated that the selection of clean up techniques and levels of final clean up pursued were probably unduly influenced by amenity concerns, (SEEEC, 1998).

(Purnell, 1999) reviewed the costs of each of the techniques used to clean the shoreline and concluded that some of the techniques selected for final cleaning were probably not the most cost-effective. Three techniques in particular represented poor cost-effectiveness:- i) flushing and trenching shingle and pebble beaches, ii) excavation and pebble washing and iii) rockwiping.

The technique of trenching and flushing low energy shingle and pebble beaches was found to be inefficient because not only was it difficult to release the oil but the manipulation of the pebbles caused further contamination and required the treatment to be carried out more than once. This led to substantial costs in terms of costs/m^3 of oil removed. In analysing the costs of washing some 955 $m^3$of pebbles recovered from various shorelines, it was reported that less than 1m^3 of oil was recovered. A comparison of the costs of excavation and washing with costs for direct landfill showed a 50% premium for washing but more importantly, since less than 40% of the excavated material was returned to the shoreline, the goal of conserving the physical environment was not well served.

Rockwiping, the manual wiping of oiled rock surfaces with sorbents, was found to be highly wasteful of resources. For some beaches more than 90% of the total expenditure (ie. including the initial removal of bulk oil) was incurred using this method of final polishing. In fact, the average cost per cubic metre of oil removed was found to be at least two orders of magnitude greater than the average cost incurred during the initial stages of the clean up clearly illustrating the law of diminishing returns.



In her conclusions, Purnell points to the use of costs as one tool that can be used to decide when clean up operations should be drawn to a close. Monitoring costs in real-time alongside an assessment of the effectiveness of clean up techniques can signal where disproportionate efforts are being expended in relation to expected benefits. A review of areas of expenditure after an incident can certainly highlight where problems occurred and provide an opportunity to consider employing more cost-effective strategies in future incidents.

KATJA

The tanker KATJA was involved in an accident while berthing in the Port of Le Havre in August 1997. A spill of less than 200 tonnes of HFO coated some 11 km of quay wall inside the port and polluted adjacent shorelines outside the port. In discussions of the levels of cleaning that should be sought, differences were noted in the criteria applied inside and outside the port. Outside the port the shorelines provide valuable amenities to the tourist industry which was at the height of its seasonal activity in August and demanded rapid and thorough cleaning. Inside the port two levels of cleaning were set, one for those areas which were purely industrial and another for those which were visible to visiting ferry boats where maintaining the aesthetic appearance was important for protecting the reputation of the port. For the industrial areas the standard was set to ensure that vessels using the berths would not become oiled and so that oily sheens did not contaminate those areas cleaned to a higher standard and took into account existing levels of contamination.

In one area outside the port, a steep bank of rock armour was heavily contaminated throughout the tidal range. A limited trial was conducted to evaluate the effectiveness of an agent to promote bioremediation. After a period of evaluation it was determined that no benefit was gained. With the current knowledge of the requirements for this technique to be employed successfully, by assessing the characteristics of the oil and the existing levels of nutrients in the receiving environment, it is now possible to judge better the likelihood that the technique would be successful, avoiding wasted effort and costs.

CONCLUSIONS

Although increasingly efforts to reduce the number of oil spills are bearing fruit, spills will inevitably continue to occur and as time goes on the cumulative experience and lessons learnt provide a growing knowledge base of the effects of oil and clean up on different habitats and species. As a result of more than 30 years of research and experience there is already a huge body of knowledge which should form the basis for building consensus. In most of the examples discussed some attempt has been made to reach consensus across a range of interest groups and in some of the cases compromises have been made, in others this has not been possible. However, where compromises are made in order to reach consensus, it is important that they are based on a realistic understanding of the technical issues involved and draw upon the lessons from past incidents. The consensus reached should not be driven simply by the loudest voice, whether that is an individual opinion, a political agenda, commercialism or a desire to punish the polluter.

Finally, it has to be recognised that these decisions are in the hands of governments, whether national, regional or municipal, and obviously therefore there will be a political component to any decision reached. It is the task of technical advisers to ensure that every effort is made at whatever level is appropriate, to make the politicians and decisions makers aware of the consequences of ignoring the technical criteria discussed above, both in terms of the risks of aggravating damage to the marine environment and to avoid difficulties with subsequent claims for compensation.

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