CENTRE OF DOCUMENTATION, RESEARCH AND EXPERIMENTATION ON ACCIDENTAL WATER POLLUTION

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SHIP-SOURCE SPILLS

Estuary pollution caused by oil tanker sinking (*MV Moon*, Port of Chittagong, Bangladesh)

During the night of 4th June 2011, a small oil tanker (*MV Moon*), owned by Bangladeshi company Eastern Bunker Service, sank in the Port of Chittagong, causing an oil spill in the estuary of Karnaphuli River. The incident occurred during a loading operation (filling the tanks with 150 to 180 tonnes of fuel oil), and caused the tanker, with a total capacity of 300 tonnes, to sink next to a jetty. The reason for the incident is not clearly established but is believed to be due to overloading of the tanker according to Chittagong Port Authority (CPA).

The 9 crew members were urgently evacuated and Bangladesh Navy divers were mobilised to secure the vessel by mooring it to the jetty. Following a leak of an unknown quantity of oil (later estimated at between 50 and 150 tonnes) through a vent, CPA mobilised 2 oil spill response vessels (*Cleaner 1* and *2*) the following morning, as well as a wreck salvage vessel (*Kandhari 10*). Meanwhile, the port authority gave the tanker owner 48 hours to come up with a refloating and salvage plan, which would be carried out by a local company (Hiramoni Salvage Ltd.) contracted for the job.

A 10 km^2 slick formed on the water and was treated with dispersants, as well as by recovery operations (official estimations reported the collection of 45 tonnes of oil by 6th June). An enquiry into the causes of the incident was commissioned by CPA, and the Bangladesh Department of Environment fined the owner of the *MV Moon* around €11,000.

PIPELINE SPILLS

Spill of production water and oil, following a landslide (Petro-Hunt LLC pipeline, US)

On 2nd April 2011, a landslide near Keene (McKenzie County, North Dakota) caused a 3" pipeline, operated by Petro-Hunt LLC, to rupture. A mixture of 15 m^3 of production water and 0.8 m^3 of oil flowed into a stream that feeds into Lake Sakakawe reservoir (in the Missouri River).

Emergency response initially consisted of containment and recovery operations on the stream, with the laying of makeshift booms (straw) and conditioned sorbents (pads, booms, etc.).

According to the Division of Water Quality of the North Dakota Department of Health, the majority of the oil was recovered, while the production water was rapidly diluted in the environment thanks to the watercourse's high flow due to melting snow. The oil remaining on the banks, trapped in vegetation, was burnt using propane torches.

No environmental impact was observed during the surveys conducted by the State's Game and Fish Department.

This pollution, although ultimately minor, lead to the creation, 6 months later, of a response cooperative gathering together 22 oil operators working near Lake Sakakawea (home to growing oil production on its north bank). This initiative, baptised Sakakawea Area Spill Response, aims to pool the resources required for spill response (lists of specialised companies, experts, personnel training, constitution of spill response equipment stockpiles, etc.)

Gasoline spill from leaking pipeline (Marathon Pipeline LLC, US)

On 13 April 2011, near Stockbridge (Michigan), a farmer informed Wolverine Pipe Line Company of sheen in a rainwater drainage channel running between his property and the oil facility operated by the company in White Oak Township.

The source was initially unknown and the company rapidly contained the oil detected in the channel, mainly using sorbent booms and pads. Following a ground survey and site inspection, the operator's teams located the source of the leak and discovered that a gasket on a 16" pipeline was faulty and letting gasoline escape. After having identified and closed off the faulty pipeline, the response was transferred to the pipeline owner, Marathon Pipeline LLC, in collaboration with the local authorities (Ingham County, in particular the Drain Commissioner and Department of Health) and the State of Michigan (Department of Environmental Quality, MDEQ) gathered together under a Unified Incident Command.

Due to the risks of groundwater contamination, the water quality was monitored by MDEQ, enabling the hypothesis of significant health risks to be rejected. Initially estimated at 480 m^3, the volume spilt was finally estimated by Marathon Pipeline LLC at between 1,100 and 1,750 m^3.

Crude oil spill from pipeline in wetlands (Rainbow Pipeline, Canada)

On 29 April 2011, wetlands in the Canadian province of Alberta were polluted when a weld on the Rainbow Pipeline gave way. This 44 year old, 20" pipeline is operated by Plains Midstream Canada and transports 30,000 m^3 of crude oil from Zama City to Edmonton each day. The faulty pipe released an estimated volume of around 4,500 m^3 of light crude oil, not far from from the village of Little Buffalo.

This was one of the largest spills in Alberta in the past 30 years and polluted over 8 hectares of land and water bodies around the pipeline, but did not reach any watercourses (its spread was partly limited by beaver dams).

The operator managed to rapidly depressurise the line and isolate the leaking section, and the implementation of the response was supervised by Alberta Environment and Sustainable Resource Development (AESRD) and the Energy Resources Conservation Board (ERCB), in collaboration with Plains Midstream Canada and their contractors.

At the height of the response, over 300 people were mobilised for clean-up operations, which were complicated by the remoteness and characteristics of the sites affected.

The sites were mainly "muskeg", a sort of bogland composed of acidic soil, formed on permafrost in northern regions, whose inaccessibility, low load bearing capacity and high sensitivity to trampling required stabilised paths to be built, by laying over a thousand wooden pallets, to allow heavy machinery (backhoe loaders, vacuum trucks), as well as teams and response equipment, to reach the sites.

On the water, the operations consisted of containing the floating pollutant (by deploying floating and sorbent booms), before recovering the oil from the banks by vacuum pumping, possibly using oleophilic skimmers (in particular drum skimmers). Backpack blowers were used to concentrate the oil and move it towards pumping systems. In some smaller areas, accumulations of floating oil, mixed with varying quantities of plant debris, were recovered manually using scoop nets.

On the banks, several clean-up techniques were implemented: remobilisation of oil trapped in vegetation by low pressure rinsing using fire hoses (before containment and pumping from the water); manual recovery, in small dips in the land, by spreading loose sorbents (mainly peat) and recovering using scoop nets; ground drainage; manual scything of vegetation.

On the day of the incident, 910 m^3 of floating oil was pumped using vacuum trucks and skimmers. According to the authorities, after 3 months of operations the majority of the oil spilt had been recovered.

In addition to the inherent difficulties involved in response on such sites, uncontrolled bush fires meant that the area had to be evacuated and operations suspended for a week, about a fortnight after they had begun (at that point an estimated 40% of the oil spilt had been recovered).

During clean-up operations, bird deterrents - coloured flags, scarecrows etc. - were set up to reduce the risks of birds being oiled.

Meanwhile, a month after the incident, soil removal and remediation began, in particular around the damaged section of pipeline, which was handed over to ERCB for investigation. Polluted soil was excavated from around the spill location and from heavily contaminated ponds that had been temporarily drained.

The excavated soil was placed in primary storage, before being treating by thermal desorption, either on site (mobile units) or in specialised facilities.

Upon recommendation by AESRD, Plains Midstream monitored atmospheric contamination to assess the health risks for human populations: no levels above threshold values were recorded. Oil concentrations were also monitored in surface waters and groundwater (by drilling a network of wells).

This environmental monitoring was still in progress in August 2012.

The enquiry conducted by ERCB into the causes of the incident, together with an investigation by an independent engineering firm, concluded that the breach was caused by high stress on a fillet weld. While the origin of this stress was not clearly determined, it was suggested that it may have been

due to excess pressure in the pipeline or inadequate compaction of the backfill during a previous revision.

Following these assessments, ERCB give its approval in August 2011 for pipeline operations to restart, provided that:

- the pipeline had been inspected at 10 excavated sites along the pipeline (1 of which presented a slight crack on a similar weld)
- weekly aerial surveillance of the pipeline was carried out
- the contingency plan was improved to ensure effective response should another failure occur
- a Community Consultation Plan was submitted to the ERCB by mid-May and included meetings with local stakeholders prior to resumption of operations
- the ERCB was kept informed, through progress reports and monthly meetings, to ensure effective implementation of these conditions of approval.

Before the pipeline could be restarted, the ERCB also demanded that Plains Midstream decreased operating pressure in the pipeline by 25%.

According to Plains Midstream, following the completion of clean-up in December 2011, spring 2012 saw regrowth of vegetation as well as the return of wildlife to the site. We note that habitat restoration measures were implemented by spreading clean woody debris in situ to replace the oiled debris removed during clean-up. In terms of wildlife, according to Alberta Environment, this spill only caused limited impacts, with the death of 10 birds and 6 euthanised oiled beavers.

Finally, this spill resulted in the closure of Little Buffalo School for one week, as, according to the press, some of the pupils from the Lubicon Cree community complained of nausea, headaches and burning eyes. Representatives of the tribe also expressed their frustration with the delay in informing them of the incident and its developments, for which the Province's Ministry of the Environment later apologised.

Plains Midstream is currently planning to build a new pipeline connecting the Enbridge Terminal (Edmonton) to the Plains Midstream Nipisi Terminal (northwest Alberta), running parallel to the existing pipeline for over 250 km, to transport condensate and butane.

This oil spill was not the only one that quarter in Alberta, as on 26 June around 160 m^3 of saltwater (containing around 5% light crude oil) was released in and around Judy Creek (near Swan Hills, in the north of the Province) following the rupture (for an undetermined reason, under enquiry) of a 1.5 km pipeline between a well and a processing facilty operated by Pengrowth Energy Corporation. The fire that broke out was brought under control within a few hours and the spill, which proved to be minor, was contained and pumped from the stream (by deploying booms, sorbents and vacuum trucks).

For further information: http://www.plainsmidstream.com/content/rainbow-pipeline-incident

ROAD AND RAIL TRANSPORT SPILLS

Pollution of an estuary caused by overturned tanker truck (Awakino River, New Zealand)

On 22 June 2011, in New Zealand, a tanker truck belonging to Transpacific overturned on a highway close to Awakino River (North Island), releasing its entire load of 24 m^3 of a mixture of waste automotive (95%) and ship bunker (5%) oil. The majority (20 m^3) of the oil flowed into the river, where the floating pollution rapidly stretched over some 12 km to the mouth of the river (sensitive area as popular for fishing) in the Tasman Sea. The circumstances surrounding the incident, which occurred at a remote site just before sunset, caused a delay in the implementation of the response, allowing the oil to spread during the night and, with the ebb tide, towards inshore waters where no recovery actions could usefully be implemented, as the pollution rapidly dispersed.

In the river, the initial response was coordinated by Waikato Regional Council's (WRC) Ready Response Team (RRT), including setting up an Incident Command Centre (ICC) in Hamilton.

In terms of organisation, control of the incident changed from a Tier 4 event under the Resource Management Act to Tier 2 under the Maritime Transport Act. This decision, made the night following the incident, allowed access to additional resources, in particular in terms of wildlife care and spill response (Maritime New Zealand and Regional Council Marine Oil Spill Teams).

Laying sorbents at the incident site (source: Waikato Regional Council)

Two RRT teams conducted a survey of the incident site the morning after the spill and noted that almost all the contents of the tanker had already reached Awakino River, making it difficult to implement control measures at the source. The teams (i) recommended a certain number of clean-up techniques (excavation, pumping, laying sorbents) around the overturned tanker (resulting in the recovery of 3 m^3 of oil) and (ii) laid sorbent booms along the banks to contain any further leaching.

In the river, the remaining pollution appeared in the form of floating sheen and oiled vegetation on the banks within 3 km. Recovery operations on the water were initiated two days after the spill at the estuary outlet by deploying booms (floating and shore-sealing) and by pumping using vacuum trucks positioned on the slipways. They were carried out sporadically, due to the remobilisation by the tides of oil trapped in vegetation on the banks. Vacuum trucks took turns to conduct pumping on site, with in situ release of settled water.

The day after the spill, it was decided that the containment systems on the banks would be reinforced, with a view to remobilising accumulations of oil by (i) mechanical mixing (using propellers) in calm, shallow waters and (ii) low pressure rinsing of the oiled vegetation (using fire hoses from boats).

Two days after the incident, the majority of operations were gradually completed, with only the maintenance of 2 booms to contain residual floating oil (relative to the observation of sheen from banks that were not significantly oiled). After 6 days (28 June), WRC announced that 6 m^3 of oil had been recovered, while the rest was considered lost at sea.

In terms of impact on wildlife, joint assessments by biologists from Massey University and the Department of Conservation concluded that there were no deaths linked to the spill, with only minor effects observed and a dozen birds lightly oiled. From the day after the spill, this observation caused the number of environmental experts mobilised within the National Oiled Wildlife Response Team to be reduced; 2 days later, wildlife operations were suspended as no signs of stress were observed in the few lightly oiled birds found. No significant impact was either visible or expected outside of the estuary.

Monthly monitoring of the contamination of both sediment and bank vegetation was initiated in July and showed a decrease in total hydrocarbon contents in these 2 compartments, with a return to the initial values of less than 40 and 70 ppm within a few weeks and a few months respectively, meaning

that monitoring could be stopped.

In December 2011, following investigation by the authorities, it was established that the incident was caused by careless driving and exceeding speed limits.

Almost the entire cost (90%) of the response by the authorities was covered by the polluter, whose collaboration was appreciated by the authorities throughout the management of the incident. The response organisation was lifted in February 2012.

• Main oil spills in France

Tanker truck accident and fuel oil spill in Canon Canal (Gard, France)

On 31 January 2011, a tanker truck transporting 27 m^3 of heating oil and 5 m^3 of diesel overturned on the D15 highway, as it left Fourques (Gard).

The damaged truck released an estimated 10 m^3 of oil, which flowed along the road's surface and into a drain that feeds into the Canon Canal, a man-made canal with vegetated banks that joins the Little Rhone. Arles fire brigade was the first on site: the road was closed to traffic and rescue operations mobilised around thirty firemen under the supervision of the chief officer of the north Bouches du Rhône group. After having secured the area, inflatable plugs were inserted into the breach in the tanker to stop the leak.

Containment using sorbents on Canon Canal (source: SDIS13)

Joined by back-up staff from response units specialised in technological risks, the firemen contained the oil on the ground (using straw) and on the water.

Operations on the water aimed to deploy sorbent booms and pads in the canal, both up and downstream of the spill area. Contained oil was recovered by a private contractor equipped with an ADR/ATEX sewer cleaning truck together with pumping and transport equipment suitable for hazardous substances. On land, the oil remaining in a second tank was removed before uprighting the truck and finalising rescue and response operations.

The road was reopened the following day.

• Main spills of other substances worldwide

Sulphuric acid spill from barge *Waldhof* (Rhine, Germany)

On 13 January 2011, the 105-metre tanker barge *Waldhof*, travelling from the Badische Anilin und Soda-Fabrik (BASF) plant (Ludwigshafen, Germany) to Antwerp (Belgium) with a cargo of 2,378 tonnes of 96% sulphuric acid, capsized on the Middle Rhine near Saint Goarshausen (Rhineland-Palatinate, Germany), not far from the Loreley rock, at around 5 am.

The overturned barge drifted for about ten minutes before hitting the left bank of the Rhine, then becoming lodged against the right bank, lying on its port side with its bow pointing upstream. Rapidly, the wreck's movements were controlled using a tug and pusher tug, but 2 of the 4 crew members were still missing at the end of rescue operations. Initially, no pollution was observed.

Salvage operations were conducted by the Dutch firm Mammoet Maritime, contracted by BASF, in coordination with the Bingen Waterways and Shipping Office and the Central Commission for the Navigation of the Rhine (CCNR).

Steel cables were passed under the wreck and held by 2 sheerlegs (*Amsterdam* and *Grizzly*), stabilising the *Waldhof*. The contents of the 7 tanks could then be analysed by piercing several holes in the hull. This examination resulted in the conclusion that (i) part of the cargo (estimated at around 900 tonnes) had leaked out, due to the barge's position and (ii) hydrogen had formed, due to corrosive action of the acid on the wreck's structure. Potentially flammable when mixed with air, this release of gas immediately required the explosion risk to be taken into consideration during operations.

Stabilising the barge Waldhof using sheerlegs during salvage operations (source: Mammoet Salvage)

After flushing the tanks with nitrogen to displace the hydrogen, followed by mixing of the acid to ensure a uniform concentration (the ingress of water having caused layers of diluted and concentrated acid to form), around 570 tonnes of the cargo were unloaded to a storage tank on the pontoon. Due to the hull's deformation and risk of rupture, the whole of the cargo was not unloaded and, with the authorities' agreement and under their supervision, the remaining 800 tonnes of acid were released in a controlled manner, at a rate which allowed gradual dilution to minimise the risk of environment impact (continuous monitoring of acidity levels in the waters of the Rhine was conducted around the wreck throughout the process).

The Rhine was partially or completely closed to downstream traffic until the end of unloading operations on 13 February, i.e. for a total of 32 days, creating a backlog of up to 400 vessel. The preliminary enquiry (whose final conclusions have not yet been made known) suggested that the incident was caused by poor stability conditions due to improper load distribution.

For further information:
http://www.cefic.org/Documents/ResponsibleCare/RC%20Conference%202011/RC%20Conference%202011%20-%20Presentations/01_Haselhorst_Crisis%20Communication%20and%20Emergency%20Response.pdf
http://www.ccr-zkr.org/files/actualitesfocus/focus/20120109_cp_en.pdf

Series of chemical spills in China (Zhejiang and Yunnan provinces)

On 4th June 2011, a tanker truck broke down on a motorway 150 km south-west of the city of Hangzhou (Zhejiang province, eastern China). While the truck was being repaired, it was hit by a second truck. One of the workers was killed in the collision and one tank was burst, causing 20 tonnes of phenol (also known as hydroxybenzene, phenic acid, or carbolic acid) to leak onto the road before flowing, swept by heavy rain, into Xin'an River. This river is the main source of drinking water for the city and the authorities closed off water intakes for the 5 water plants. The response consisted of releasing extra water from nearby dams to dilute the phenol (increasing the flow speed in Xin'an River four-fold).

The efficiency of operations was controlled by monitoring of the water quality by the province's environment authorities: two days after the incident, the phenol content was still 900 times higher than safe drinking level.

Meanwhile, the water supply was cut off in Yuhang, another district of Hangzhou, after having discovered about ten molecules of industrial origin, including benzene, in the tap water. The authorities in charge of environmental protection closed the local school for three days, while water was released from reservoirs, and suspended the activity of the chemical plants suspected of causing the pollution.

In March, a tanker truck incident had caused the spill of an undetermined part of its cargo of 32 tonnes of benzene into Zhesang River, near Funing in the province of Yunnan. The emergency services built up embankments to attempt to contain the spill and reduce contamination of a downstream reservoir.

Waterway pollution following animal fat storage tank rupture (Houston Ship Channel, US)

On 4th January 2011, a storage tank ruptured at a food processing company (Jacob Stern & Sons Inc.) based at the Port of Houston (Texas), releasing 946 tonnes of animal fat. Just under 60 tonnes flowed via the storm drain into Houston Ship Channel, one of the country's busiest waterways.

The behaviour of the beef tallow facilitated its recovery, as it rapidly solidified upon contact with the water to form large floating chunks. Clean-up actions on the water were coordinated by the US Coast Guard in collaboration with the Texas General Land Office, the State authority in charge of spill prevention and response. The patties of fat were contained using floating booms (for which 6 boats were mobilised), before being collected manually, using forks and scoop nets, by a company contracted by the polluter.

Clean-up operations were completed two days after the spill, and the channel was reopened to traffic. According to the USCG, the fat did not cause any environmental damage, and the main impact of the incident was the suspension of traffic for around 10 hours in a 1 km section. The enquiry indicated that the spill had been caused by an unspecified human error.

Fish mortality due to an ammonia release during barge loading (Catoosa, US)

On 31 May 2011, during routine safety operations in the CF Industries chemical terminal in the Port of Catoosa (Oklahoma), a hose was dropped into the water during ammonia loading operations on barges operated by Southern Towing of Memphis.

The gas, highly soluble in water, led to an increase in biochemical oxygen demand (BOD) in the water, such that this sudden nitrogen input resulted in an oxygen depletion immediately next to the spill location, followed by fish deaths (in particular catfish).

The response by CF Industries - the ammonia manufacturer - was supervised by the USCG and consisted of oxygenating the water by mechanical mixing using boat propellers. The dead fish were contained using floating booms then recovered manually using scoop nets.

• Main spills of other substances in France

Fire and pollution of coastal inlet with plant protection products (Aber Wrac'h, Finistère)

In the late afternoon on 1st June 2011, a fire devastated an agricultural cooperative's barn near Ploudaniel, Finistère. The fire was caused by burning pallets which, due to strong winds, spread to the 3,300 m^2 barn, used to store and package potatoes. Fire outbreaks were also reported along the side of the dual carriageway. Over 50 firemen from the surrounding fire stations were sent on site to fight the fire, and were soon joined by military police and were given aerial backup by civil protection helicopter *Dragon 29*.

The fire was under control by the evening; the barn, completely destroyed, contained various plant protection products (in particular fungicides, herbicides, insecticides and additives). Given its activities (refrigerating plant and potato store), the site was not subject to French legislation on classified facilities: as it did not have a retention basin, the extinguishing water washed a mixture of plant protection products into a stream next to the plant, a tributary to the Aber Wrac'h. Some 15 km of this coastal inlet were polluted.

Downstream, the presence of water intakes for Kernilis drinking water plant and shellfish farms raised concerns of a health risk; from the following day, daily analysis of the contamination level in the stream was set up, as well as later at several points between the incident site and the drinking water plant.

While no fish mortality was observed in the stream, laboratory analyses revealed concentrations of propamocarb HCl (fungicide) and prosulfocarb (herbicide) respectively 150 and 5 times higher than WFD (Water Framework Directive) limits for good chemical status. Consequently, water pumping was suspended at the Kernilis plant, which was shut down after running for a certain time on its own reserves (3 days after the fire, the plant was connected up to the Plouedern plant).

In addition to monitoring water quality in shellfish farms, on 4 June the local authorities banned professional and leisure fishing, the collection, transport, purification, shipping, distribution and sale of all species of shellfish, crustaceans, gastropods and fish, as well as the pumping of seawater for aquaculture, over a total of 15 km of the Aber Wrac'h.

These restrictions were lifted gradually, by sector and by activity, with the last ban being lifted on 27 June 2011 based on negative results of water and fish and shellfish analyses.

At the agricultural cooperative, while waiting until the sandy rubble (containing traces of products) could be evacuated to a specialised landfill site and with rainfall forecast, on 4th June the manhole was plugged and a temporary retention basin was built.

• Past spills

Reopening of a pond polluted in 2010 following a crude oil spill (Salt Lake City, US)

Following a spill, in June 2010, of 130 m^3 of crude oil from a Chevron pipeline into Red Butte Creek (Utah), Salt Lake City contracted an environmental expert to assess the possibility of demanding that the polluter implement restoration measures in the urban Liberty Park pond, a recreational area which, in practice, was the operating theatre for key containment and recovery operations (as they prevented the pollution from spreading downstream to the Jordan River and the Great Salt Lake).

It was not until spring 2011, almost 1 year after the incident and after Chevron had conducted removal and dredging operations for a total of $2.5 million, that the pond (which had also been deepened and rimmed) was reopened to water fowl, paddleboats and inhabitants of Salt Lake City.

• Response preparedness

ORSEC inland waters exercise in Vosges (France)

On 23 June 2011, a response exercise, planned by the Vosges authorities, was run within the emergency response framework in case of technological or industrial incidents, with application of the French ORSEC (civil protection response organisation) system.

The scenario of this exercise, which involved all the institutional and public stakeholders in charge of response and post-incident monitoring, was based on an HNS spill together with issues of environmental and health impacts.

The aim was to test the inland waters response organisation, in particular in terms of:

- the alert chain
- mobilising containment and response resources and measures
- informing populations and the authorities
- complementary actions between bodies and departments involved in crisis management
- communication relating to the pollution.

The exercise simulated a road accident involving the transport of ammonia, with a 400-litre spill into a river close to the site. An initial field session was organised, followed by a tabletop exercise, with the participation of fire brigade, military police, civil protection, health agency, environment department and water agency staff.

As part of its support role to the public authorities in terms of technical expertise, *Cedre* took part in this exercise upon request by the French National Agency for Water and Aquatic Environments (ONEMA), to which it provided ecotoxicological data and advice on response techniques.