CENTRE OF DOCUMENTATION, RESEARCH AND EXPERIMENTATION ON ACCIDENTAL WATER POLLUTION

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SHIP-SOURCE SPILLS

Collision between tank barge *E2MS 303* and a towboat: light crude oil spill on the Mississippi (United States)

On 22nd February 2014, the collision of the oil barge *E2MS 303* with the towboat *Lindsay Ann Erickson*, near Vacherie (84 km upstream of New Orleans, Louisiana) caused a spill of 119 m^3 of light crude oil into the Mississippi. The US Coast Guard (USCG) was notified and worked jointly with the response contractor (Environmental Safety & Health Consulting Services -ES&H) commissioned by the barge's owner, to implement emergency operations to remove the oil from the barge (completed the following morning) and to contain the slicks around the leak[1].

To ensure safety within the response area and prevent secondary contamination, a 105 km stretch downstream of the incident (including the port of New Orleans) was temporarily closed to all water traffic the day after the collision. Operations to recover oil on the water and clean up oiled structures were carried out all day, while aerial surveys were conducted from the US Coast Guard helicopter *Dauphin MH-65* from the Air Station New Orleans. Meanwhile, the Center for Toxicology and Environmental Health measured the concentration of volatile organic compounds in the air, which did not exceed health limits.

Diesel spill in the Nushagak River, due to a tug hitting a rock (United States)

On 14th May 2014, the *Devon* hit a rock in the Nushagak River (Alaska), damaging one of its diesel tanks, with a total capacity of 28 m^3. Initial estimations by the tug owner (Sam Barging Inc.) indicated the loss of 7.5 m^3 of fuel. This estimation was later increased to between 19 and 20 m^3 following an assessment of the tanks by the US Coast Guard. The diesel remaining in the tanks was transferred to an internal storage capacity within the barge, which travelled to Dillingham Harbor for repairs.
The spill response was implemented by the US Coast Guard, in cooperation with State agencies (Alaska State Troopers, Alaska Department of Fish and Game). Containment booms were set up around the vessel, while the National Oceanic and Atmospheric Administration (NOAA) was called upon to model the weathering of the substance according to conditions in the Nushagak River. The results indicated that the diesel would dissipate (evaporation and dissolution) within 72 to 96 hours.
However 3 to 4 days after the incident, fishermen reported fuel smells and the presence of sheen coming from coarse sediment on Kanakanak Beach, some 32 km downstream of the spill. Following these observations, at ebb tide on 19th May, flushing operations were implemented on stones and the oily effluent was recovered using sorbents in an area contained by booms.
The US Coast Guard continued to carry out aerial and on-land surveys, although no new accumulations or incidences of sheen were detected. No ecological impact was identified.

PIPELINE SPILLS

Crude oil leak at a natural difficult access site (Mid-Valley Pipeline, United States)

On 17th March 2015, around 32 km north of Cincinatti (Ohio, United States), a breach approximately 13 cm long was detected in a 20" pipeline. This crack resulted in a leak of crude oil, which spilt into a watercourse that runs through a wetland area within Glen Oak Nature Preserve (an integral part of Great Parks of Hamilton County, the local network of protected natural areas).

The pipeline, which transports crude oil between Hebron (Kentucky) and Lima (Ohio), is owned by Mid-Valley Pipeline Co., a subsidiary of Sunoco Logistics Partners LP and whose network of pipelines supplies various refineries in the North-American Midwest.

A Unified Command (UC) was set up to coordinate the spill response, led by the federal Environmental Protection Agency and comprising representatives of the local authorities (Great Parks of Hamilton County, Colerain Township), State authorities (Ohio EPA) and representatives of the industrial firm.

Emergency operations aimed to control the leak by closing and depressuring the leaking section of pipeline.

[1] The spill response was coordinated by a Unified Command, placed under the auspices of the US Coast Guard, comprising representatives of the State authorities (Louisiana Oil Spill Coordinator's Office, Louisiana Department of Environmental Quality, Governor's Office of Homeland Security and Emergency Preparedness), local authorities (Saint John the Baptist Parish and Saint James Parish) and specialised contractors (ES&H, Forefront Emergency Management).


Left: deploying Elastec oleophilic drum skimmers; Right: Vacuum trucks (source: Ohio EPA).

Meanwhile, containment booms were deployed to stop the oil from spreading: the main priorities were to protect the Great Miami River, downstream, and to contain and recover floating oil by pumping (using vacuum trucks) and skimming (using oleophilic skimmers in particular).

On the banks, the oil which had infiltrated locally into the sediment was remobilised by scraping/tilling the sediment, using lightweight tools (such as rakes) and concentrated using hoses by pushing it towards containment areas for subsequent recovery.

We note the difficulty in accessing the contaminated sites and the low load bearing capacity of the ground, which required temporary roads to be built for heavy-duty machinery to access and be stationed as close as possible to the clean-up sites.

According to the Great Parks Stewardship Manager, around 70 m^3 of oil was collected during clean-up operations, which constitutes a significant proportion of the quantity spilt, estimated at around 80 m^3 by the US EPA (following initial estimations of around 30 m^3).

Remobilisation of infiltrated crude oil by scraping/tilling sediment (Source: wvxu.org)

Repair clamp (in red) on ruptured section of the line, pending replacement of the section (source: wvxu.org)

Although no details are provided in our information sources, the surveys carried out by the wildlife services resulted in reports of impacts on the surrounding fauna (salamanders, frogs and crayfish), including a few dead specimens near the oiled sites. Certain specimens were collected, cleaned and released.

According to the Glen Oak Nature Preserve website, "Field work by Sunoco Logistics and its contractors continued throughout all of 2014 in an effort to complete emergency cleanup and begin the remediation and restoration of the nature preserve."

Sunoco Logistics Partners LP announced the repair of the pipeline, which was reopened 7 days after the spill had been reported.

Pipeline breach with major environmental and societal consequences in a Peruvian community

On 30th June 2014, a crude oil spill occurred close to the Kukama Indian community, near Cuninico in Peru, from a leaking pipeline operated by the State-owned company Petroperu, which carries crude oil 845 km from San José de Saramuro in the Amazon basin to the Sechura Bay refinery on the north coast.

An unspecified quantity of oil poured into the Maranon River, a tributary of the Amazon. The Peruvian Minister of Energy and Mines reported in a press release a leak of approximately 320 m^3.

Little information on the management of the spill and its potential impacts has been released. The pipeline is believed to have been repaired and to have gone back into operation on 12th July. Prior to this date, the Kukama community, for whom the river is a resource in various respects (fishing, water, etc.) indicated fish mortalities in the river and impacts on human health (in particular headaches and skin irritation). Criticism over the ageing pipeline and its maintenance frequency, as well as over the protective equipment used by clean-up teams, was apparently broadcast by the media.

ROAD AND RAIL TRANSPORT SPILLS

Spill of Bakken crude oil due to tank car derailment (CSX convoy, United States)

On the afternoon of 30th April 2014, 18 tank cars from a CSX rail convoy transporting Bakken Crude (a very light crude oil extracted from the oil basin of North Dakota) derailed in Lynchburg (Virginia). The accident was immediately followed by a raging fire, and 3 tank cars plunged into the James River,

adjacent to the railway track, releasing an estimated 85 m^3.

Efforts were immediately made to control the spread of the fire and extinguish the blaze. Over 350 local inhabitants were preventively evacuated until the evening. In terms of spill response, the efforts focused on containing the oil leaking from the overturned cars on the banks of the James River, with a view to protecting Chesapeake Bay, ultimately unaffected.

We note that this incident, resulting from the transport of Bakken Crude by tank cars, is one of several recent incidents in North America, followed by explosions, fires and spills, including the derailment of a train in Aliceville (Alabama) in November 2013 and the Lac-Mégantic tragedy (Quebec) in July 2013 (see LTEI n°21).

SPILLS FROM VARIOUS FACILITIES

Storage tank detachment due to bank erosion (Cache La Poudre River, United States)

On 17th June 2014, on the premises of a Noble Energy Inc. facility situated on the bank of the Cache La Poudre River (Colorado, United States), a crude oil storage tank dropped from its foundation as the banks of the watercourse had become undercut by erosion.

As the tank dropped it damaged a valve, releasing 30 m^3 of its contents.

The leak was discovered on 20th June: the majority of the oil had been carried away by the watercourse, contaminating vegetation along a 400-metre stretch of banks downstream, where clean-up operations were then organised. This area is highly sensitive in terms of ecology and tourism, with the Cache La Poudre River being classified as a Wild and Scenic River.

View of the spill site (Source: http://niobrarachalk.com)

Accumulations of oil were recovered by pumping using vacuum trucks or by sorbents by Noble Energy and its contractors (Custom Environmental Services, Eagle Environmental Services) under the supervision of the federal authorities (US EPA) and the authorities for the state of Colorado (Department of Natural Resources, Oil & Gas Conservation Commission).

On 23rd June, surveys were conducted: they did not report any impact on wildlife or on drinking water intakes.

• Main oil spills in France

Crude oil spill in wetlands (*Pipeline de l'Île-de-France*, Saint-Vigor-d'Ymonville)

On 26th May 2014, a leak of crude oil was detected from the *Pipeline de l'Île-de-France* (PLIF), which runs from the Compagnie Industrielle Maritime (C.I.M.) oil storage facility in Le Havre to Grandpuits refinery (Seine-et-Marne) and transports refined products from Le Havre to the Gargenville storage facility.

The leak occurred due to a breach (87 cm long by a maximum of 9 cm wide), along the top of the 50 cm pipeline, whose maximum flow rate is around 1,800 m^3/hour. An inspection of the ruptured section detected traces of impact and deformation which occurred after the laying of the pipeline, probably by a heavy-duty vehicle (such as an excavator or caterpillar-tracked vehicle), and resulted in corrosion cracks. The pipeline had been inspected in 2013.

An estimated 500 tonnes of *Oural* crude oil was released into the ditches and wetlands of the alluvial plain of the Seine estuary, in Le Hode (Saint-Vigor-d'Ymonville). Although the contaminated sector belonged to a vast area of grasslands and marshes within the Seine estuary, it was not part of the Natura 2000 site or the Seine estuary nature reserve.

The pressure in the pipeline caused the vegetation in the area around the leak point to be sprayed with oil, and the fluid crude oil flowed into the neighbouring drainage channels.

Polluted ditch close to the leak (note the path made of backfill built to access the site) (Source: Cedre)

The high water level at the time of the incident limited oil infiltration into the soil and alluvial groundwater.

Straw barriers lined with sorbents, set up by the local fire brigade (SDIS 76[2]) within an hour of discovering the spill, followed by the building of earthen dams, efficiently restricted the spread of the oil through drainage channels. 820 m of ditches were contaminated, approximately 1.8 ha of grasslands were heavily oiled (soil and vegetation), and airborne particles were dispersed by the wind over an area of 4.6 ha of grasslands, resulting in small spots (around 1 mm in diameter) on the grasses (without affecting the soil).

Clean-up and restoration operations were carried out from May to November.

They consisted in pumping floating oil using vacuum trucks, as well as skimmers in certain areas. Contaminated soil (ditches, grasslands and ponds) was removed, with the excavation of a 5 to 60 cm deep layer according to areas. As earth with the same characteristics was available within the vicinity of the site, the grasslands and ditches were able to be refilled to their initial levels. Grasses contaminated by airborne oil particles were scythed.



*Skimming (oleophilic disc skimmer) accumulations of crude oil in a drainage channel (FOST responders) (**left**); Removing contaminated soil: ditch excavation (**middle**); Scraping the surface of grasslands (**right**) (Source: Cedre)*

In total, 2,100 m^3 were purged from the pipeline and 2,400 m^3 of a mixture of oil, water and sediment were collected from the ditches and settled before being treated at the refinery.

Groundwater monitoring did not indicate any contamination of the upper layer of alluvium and, following operations, the total hydrocarbon and PAH concentrations in the surface waters were lower than the guideline values in the French order of 2007 on the quality of raw water for human consumption. The reconstruction of habitats, removed within an area of just under 2 hectares, continued to be monitored until summer 2015.

If this monitoring programme confirms initial observations, the impact will have been local, temporary and low, mainly affecting the flora and fauna in ditches, ponds and grasslands. This impact can be put into perspective given (i) the limited area concerned in relation to all the grasslands within the estuary and (ii) the site's situation, outside of areas of remarkable habitats.

• Main spills of other substances worldwide

Chemical spill in a river: uncertainties and economic consequences (Freedom Industries, United States)

On 9th January 2014, on the premises of a Freedom Industries chemical storage facility in Charleston (Kanawha county, West Virginia), a 3 cm crack appeared in the bottom of a stainless steel storage tank (with a total capacity of 150 m^3) caused a leak of around 38 m^3 of chemicals into a retention basin. The spill involved a mixture of substances, composed of 85 % 4-Methylcyclohexanemethanol (MCHM, classified as an alcohol and used in the coal washing process), glycol ethers (7 %) and water[3].

Between 19 and 27 m^3 of MCHM leaked from the cracked retention tank and spread across the ground, before finally flowing into the nearby Elk River, less than 2 km upstream of the water intake at the Charleston water treatment plant (West Virginia American Water -WVAW). The West Virginia Department of Environmental Protection (WVDEP) was notified, at 8 am, of odours[4] detected by local

[2] Seine-Maritime fire department

[3] This fact was not known until 12 days after the spill. Initially, the spill was believed only to be composed of MCHM.

[4] A liquorice-like odour.

residents, and identified the source of the contamination late morning. Freedom Industries announced that they had discovered the leak shortly beforehand and had already recovered part of the substance on the ground and in the retention tank by pumping.

The immediate priority was to estimate the health risk: the material safety datasheet (MSDS) for MCHM contains relatively little detailed information, but indicates a high boiling point (almost 200°C, therefore in theory eliminating the risk of significant atmospheric contamination) and a high dissolution potential in water.

The water treatment plant, notified as to the incident by midday by WVDEP (which Freedom Industries had failed to do), initially believed it would be able to filter the water, but announced in the afternoon that its activated carbon filters had become saturated, and were no longer able to filter the pollutant. Uncertainty over the contamination of the water network led the authorities to shut down the water treatment plant and to preventively issue a "Do Not Use" order for tap water. This plant supplies almost 9 counties, i.e. 300,000 people, to whom bottled water was distributed as an emergency measure (followed by water from tanker trucks) by the National Guard and the Federal Emergency Management Agency (FEMA).

The same day, the West Virginia Department of Health requested support from the Center for Disease Control and Prevention (CDC) to analyse the data obtained from water analysis and to assess and define a threshold level for safe consumption. A limit of 1 ppm of MCHM was determined by the federal agency. A state of emergency was declared the day after the incident by the State Governor, followed by a federal disaster declaration.

The spill response was organised through the US EPA, the West Virginia Department of Environmental Protection and the US Coast Guard, which was providing support, as well as the industrial firm and the specialised companies it had contracted. Although little detail is provided in our information sources, it appears that attempts were made to recover the chemical (by vacuum pumping and the use of sorbents), which we can reasonably assume remained fairly limited given the soluble nature of the chemical.

For want of any other known treatment option, WVAW rinsed out the pipes for several days, frequently renewing its activated carbon filtration systems. The results of contamination monitoring in the Elk River by National Guard personnel (on an hourly basis during the first 2 days following the spill) indicated, according to WVDEP, a drop from 2 to 1.7 ppm during the night following the incident, then to below the 1 ppm limit 24 hours later. The measurements, which highlighted the substance's rapid dilution in the environment, were prolonged as a safety measure until 13th January, when the decision was made to restart the drinking water treatment and distribution network. No fish mortalities or other impacts on the aquatic environment were detected by the state agencies.

While the incident did not ultimately have a significant impact on the environment or on human health, the incident management was marked by major communication difficulties, in particular relating to the low availability of toxicity data on the chemical involved (penalising the authorities' capacity to fulfil public expectations in terms of risk assessment).

This led to growing concern from the population (fuelled by the media), forcing, according to the state government, 600 people to seek medical care during the fortnight following the spill. Furthermore, a preliminary study by the Marshall University Center for Business and Economic Research estimated the economic impact relating to the shutdown of water production and socio-economic activities dependent on the water supply (restaurants, hotels, health services, etc.) at $61 million (€56 million).

According to a representative of Kanawha-Charleston Health Department, this incident was "a case study in what not to do in terms of risk communication".

For further information:
http://emergency.cdc.gov/chemical/MCHM/westvirginia2014/
http://ehp.niehs.nih.gov/122-a214/

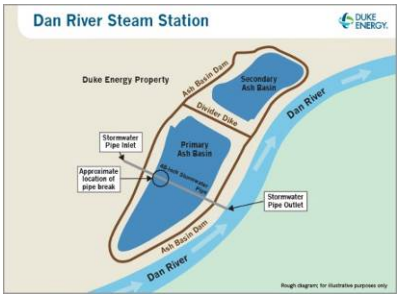
Major ash release from a retired Duke Energy power plant (Dan River, North Carolina)

On 2nd February 2014 in Eden (North Carolina, US), an incident at a retired Duke Energy steam station was reported to the North Carolina Department of Public Safety Emergency Response Center (ERC): Duke Energy reported the rupture of an ageing storm water pipe (Ø=1.20 m) under a coal ash storage basin[5]. Around 39,000 tonnes of coal ash slurry flowed through this breach in the pipe and into the nearby Dan River, tinting the water grey.

[5] North American alternative to the spoil tips found in Europe.

The ERC personnel immediately began to monitor the pollution, which stretched as far as Kerr Lake, 130 km downstream (on the border between North Carolina and Virginia).

The following day, the North Carolina Department of Environment and Natural Resources (NC DENR) requested assistance from the US Environmental Protection Agency, which took on the coordination of the Unified Command set up to manage the incident, and included representatives of Duke Energy (and its contractors) and the various relevant administrative bodies (at State level – NC DENR, Virginia Department of Environmental Quality, federal level – US Fish and Wildlife Service, local level, etc.).



Location of the breach in the pipe in relation to the Dan River (source: Duke Energy)

The substance released contained carbonated residues, silicates and heavy metals. From 4th February, environmental quality monitoring (surface waters and sediment) was implemented on the Dan River, at the release point as well as at sensitive sites downstream (Danville and South Boston water treatment plants). In this respect, a company was rapidly contracted thanks to an existing framework agreement with the EPA[6] (as part of the federal Superfund programme for the restoration of industrial sites liable to contain unmanaged pollutants; the retired steam station was designated as a Superfund site).

Left: Grey waters of the Dan River caused by coal ash slurry (Source: NC DENR);
Right: Definitive sealing of the outfall of the leaking pipe (source: Duke Energy).

On 6th February, Duke Energy announced that the leaking stormwater pipe had been sealed.

Grouting operations (by concrete injection) were also carried out the same month on another stormwater pipe (passing under the second storage basin), identified as a potential release hazard.

From February to July, alongside the monitoring of environmental contamination, clean-up operations were carried out by the company under the supervision of the US EPA. They mainly consisted in dredging deposits and accumulations of ash in specific areas identified along the banks and in the river bed, using pumps and dredgers.

In July 2014 (5 months after the spill), the US EPA announced that around 2,500 tonnes of ash (and contaminated sediment) had been dredged up, mainly from a sand bar at the confluence between the Dan River and one of its tributaries (Town Creek) and at the Schoolfield Dam (Virginia), and 500 tonnes from other pockets in the river.

Pumping of ash deposits on the banks (source: Duke Energy)

The results of the sampling programme indicated that there had been no impact on drinking water since the incident. The quality of the surface water, initially cloudy due to particles in suspension, returned to normal a few days after the incident.

Restoration work on the industrial facility, already in progress at the time of the incident, was accelerated in order to close the ash basins. Long term impact monitoring, run from September 2014 to July 2015, indicated the good ecological status of the river.

For further information:
Duke Energy page: http://www.duke-energy.com/power-plants/coal-fired/dan-river.asp
Relevant pages by NC DENR (http://portal.ncdenr.org/web/guest/dan-river-spill) and US EPA (http://www2.epa.gov/dukeenergy-coalash)

[6] Superfund Technical Assessment & Response Team Contracts (START)

• Statistics

Summary of spills in major watercourses and waterways in the Seine basin (France)

In 2014, the French "Water Police", which comes under the Ile-de-France Regional and Interdepartmental Directorate for the Environment and Energy (DRIEE), produced a summary of events reported during the period 2003-2013, liable to influence water quality within its area of competence. Created in 2010, the DRIEE exerts police powers for the water and aquatic environments in the major watercourses and waterways within the Seine basin, and on smaller watercourses within Paris and the inner ring of surrounding departments (*Paris proche couronne*, PPC), representing 2,422 km of waterways across 16 departments and 5 regions.

This report is based on the information recorded by the DRIEE Water Police service in a specific database, covering the major rivers since 1983 and small watercourses within the PPC area since 2010. More widely, this data collection effort is part of the contribution of French investigation control networks to the implementation of surface water surveillance, as prescribed by the European Water Framework Directive (WFD)[7].

For each event, the date, location, any environmental impacts, the causes, response actions by partners and where relevant any legal proceedings are recorded.

Of the 900 cases registered throughout the decade, we note that:

- three quarters of cases were classed as "accidental" (i.e. between 60 and 70 cases per year on average), the rest were caused by controlled operational discharge (or malfunctions/failures) from wastewater treatment plants.
- three quarters of the cases were in Ile-de-France (in particular the departments of Essone, Seine-et-Marne and Val-de-Marne), which can be partly explained by better reporting of incidents in these administrative divisions (e.g. action cards from the Essone fire brigade (SDIS 91) are systematically sent to the DRIEE and discharge operations from sanitation networks are organised by the General Councils for the departments in Ile-de-France, in particular Val-de-Marne).
- half of the events recorded occurred in the Seine River, followed by the Marne (16 %) and the Oise (12 %) rivers.
- the causes, identified in 59 % of cases, are most often related to transport by road (accidents) and by river (unloading of oil products and illegal discharge).
- the products reported in half of the cases were oil (unspecified type) and in 25% of cases were urban wastewaters (the rest included a variety of products).
- The DRIEE has established its own severity scale, detailed in the document, which led it to classify around fifty events as "severe"; meanwhile, an analysis according to the type of consequences (fish mortality, impact on fauna, habitats, drinking water production) is put forward.

Despite certain clear limitations – related to gaps and the heterogeneity in the reporting of pollution incidents in inland waters – this overview provides an initial summary for the area covered by the DRIEE and, for want of more details at this stage, constitutes a very interesting initiative illustrating how bottom-up information flow (via a network of field players) and information banking (ideally as standardised and exhaustive information as possible) in a database could be beneficial in the development of a base of information on past spills in French continental waters.

For further information:
Article by Cedre in this issue in its Bulletin n°23 (May 2007, in French): http://wwz.cedre.fr/content/download/654/5564/file/bull23.pdf
DRIEE document, 2014 (in French): http://www.driee.ile-de-france.developpement-durable.gouv.fr/IMG/pdf/Evenements-2003-2013_cle7c83d4.pdf

[7] Which requires Member States to implement monitoring programmes intended to establish an overview for each river basin district and to define a programme of measures (actions) to achieve/maintain their good ecological status.

• Recovery

New modular skimmer: Lamor MiniMax 25 (LMM 25)

The Finnish company Lamor, world leader in brush skimmers, is offering a new skimmer with a modular design, on two accounts, known as MM 25.

Firstly, the basic module can be fitted with brushes, discs or an oleophilic drum. These modules are hydraulically operated and easily interchangeable.

Secondly, up to 4 basic modules can be joined together, with a single pumping unit, to provide higher recovery rates (25 m^3/h for a single module, 100 m^3/h for a quadruple system).

The basic module weighs around 20 kg, is compact (lxwxh = 85 cm x 85 cm x 46 cm) and can therefore be easily deployed. It can also be easily assembled and disassembled without any specialised tools.

According to the manufacturer, this oleophilic skimmer has been fully tested at Ohmsett testing facilities, confirming its efficiency both on light and highly viscous oil.

It can be connected to a vacuum system or a suction pump and, with a draught of less than 13 cm, is suitable for use at coastal and port sites, as well as in inland waters (rivers, lakes, etc.).

Photo and diagrams of the LMM 25 (Source: lamor.com)

For further information:
http://www.lamor.com/en/2013/07/maximize-your-efficiency-with-the-new-modular-lamor-minimax-25-skimmer/

IOSC 2014: Demonstration of response equipment for use in watercourses

The 2014 edition of the International Oil Spill Conference (IOSC), held from 5th to 7th May in Savannah (Georgia, United States), was the opportunity to run a response equipment demonstration on the Savannah River. This year the main emphasis was on (i) aerial surveillance and remote sensing equipment and (ii) real-time transmission of collected data (displayed at this event on screens placed in front of the conference centre), with:

- the deployment of compact/unmanned aerial surveillance equipment, fitted with cameras and various sensors, including:
  - an aerostat (QualiTech)
  - two Unmanned Aerial Vehicles (UAVs) by Prioria Robotics (Hex-Flyer, a small six-propeller helicopter and Maveric, a hand-launched glider).
- on the river, the mobilisation of several vessels including:
  - a Clean Gulf Associates vessel (fitted with the Securus system) for remote sensing of slicks from vessels.
  - the new Elastec/American Marine Rapid River Response System (R3S), designed for dynamic recovery of oil slicks in shallow waters and strong currents (estuaries, rivers, etc.). This system is composed of a 9-metre Kvichak MARCO recovery vessel, positioned at the apex of a V-shaped containment arrangement comprising 2 legs of lightweight solid-core boom (Optimax). The 2 legs of boom are held open by 2 BoomVanes (small model, less than 1 m draught) towed by a small workboat operating at low speed (approx. 1 knot). The oil recovered by the vessel is stored in a floating tank (towable bladder with a capacity of approximately 4 m^3). This system can be completed with a compact aerostat for remotely sensing surface slicks, such as that developed by the Norwegian firm Maritime Robotics and marketed by Elastec under the name of OceanEye™ (equipped with visible and infrared cameras).[8]

[8] See LTEI 19

This R3S system is highly reminiscent of the Rapid Deployment Skimmer System by SUPSALV (U.S. Navy Supervisor of Salvage and Diving) based on a similar design although of a suitable size to work in more open waters and which required 2 workboats to tow the floating booms in a pair trawling configuration.

For further information:
http://www.elastec.com/

Overview of the R3S system from the OceanEye *(Source: Elastec)*

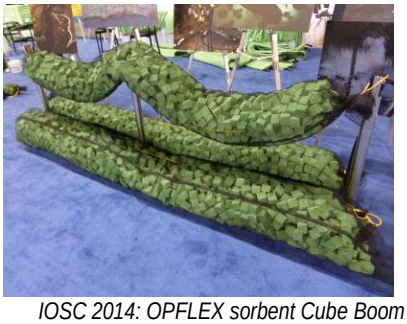
• Sorbents

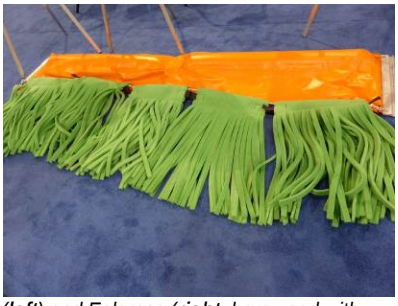
Reuseable hydrophobic sorbent OPFLEX

The American firm OPFLEX Environmental Technologies manufactures and markets a range of sorbents designed for oil spill response on water. The material used is foam derived from a copolymer of ethylene/methyl acrylate (EMA). It is apolar and therefore oleophilic and hydrophobic.

Its open-cell cavity structure (comparable to that of a sponge for instance) is said to have a good oil sorption capacity and means that these foam products can be reused 5 to 6 times after extracting the oil by squeezing/wringing, thus reducing the quantity of waste to be disposed of. OPFLEX exists in various shapes and sizes: pads, belts, eelgrass...

We note in particular the existence of forms providing a large surface area for contact between the sorbent and the environment: the Cube Boom, composed of cubes (5 cm edge) contained within a mesh tube and the Eelgrass form, designed to collect oil at the surface or in the water column.





*IOSC 2014: OPFLEX sorbent Cube Boom (**left**) and Eelgrass (**right**, here used with sections of fence boom) (Source: Cedre)*

According to the manufacturer, this material's tensile strength and elasticity mean that it can be used in currents and rough water: rivers, estuaries or even coastal waters.

OPFLEX Environmental Technologies has a strong presence on the spill response market (for instance during the 2014 International Oil Spill Conference) and conducts tests at the OHMSETT facilities to evaluate (i) the performance of its products in various configurations (e.g. forms, lengths, thicknesses, etc.) and (ii) their implementation using the equipment proposed by the manufacturer (deployment by towing from reels, wringing system, etc.). The tests, following which further developments are planned according to OPFLEX Environmental Technologies, have apparently included both dynamic (e.g. towing through floating slicks) and static (shoreline protection) collection methods.

For further information:
http://www.opflex.com/index.php/opflex-foam

Multilayer adsorbent film: ROC Barrier and ROC Oil Cling Pads

The Canadian firm Murrenhil Corporation markets a small disposable adsorbent boom, composed of a multilayer oleophilic and hydrophobic polyethylene film: the ROC (Rapid Oil Containment) Barrier™. This thin barrier (around 0.13 mm thick) exists in various lengths (1000, 2000 and XL1000 – 300, 600 and 2x300 metres long respectively) and is, in all cases, a light (approx. 4 to 7 kg), compact system, contained in a plastic canister (20x20x50 cm) from which it can be deployed by hand by a single operator.

The adsorbent film placed on the water surface incorporates the floating oil within its multilayer structure through the perforations in the film laminate's surface. The oil adsorbed can be extracted once the film has been removed from the water.

These barriers are first line emergency supplies, designed to be easily stored (on board workboats for instance) and deployed in response to small spills in relatively calm waters (harbours, sheltered watercourses, etc.). The adsorption principle of the ROC Barrier™ means that it is primarily intended to be used on light pollutants (diesel, petrol, jet fuel...). The firm also markets this product in the form of compact pads (35 cm x 35 cm) known as ROC Oil Cling Pads.

For further information:
http://murrenhil.com/

(Source: Murrenhill Corp.)

• Containment

Grintec lightweight self-inflatable boom BC650

The Spanish firm Sorbcontrol markets a range of oil spill equipment under the brand name Grintec: containment booms, reels, skimmers, power packs, sorbents, temporary storage tanks, etc.
The manufacturer recently added a self-inflatable containment boom to its range, Grintec Ràpid BC650, which exists in 2 versions: L (light), designed to be used in sheltered waters (harbours, relatively calm watercourses, etc. and HD (heavy duty), for use in more open waters (coastal waters, etc.). They have the same dimensions (25 m long, total height of 1.10 m with a draught of 0.65 m) but different tensile strengths, due to the density of the fabric.
The boom structure contains no metal components, making it is as compact as a conventional inflatable boom, enabling it to be stored on standard reels (also on offer from Sorbcontrol), and relatively light (6.5 and 9.5 kg/m according to the model).
The BC650 has 2 skirts, between which flexible inlet pipes are placed which, when the boom is deployed from the reel, let air in, rapidly inflating the 5 chambers in each section of boom (the chambers are opened by a system of flexible hoops).

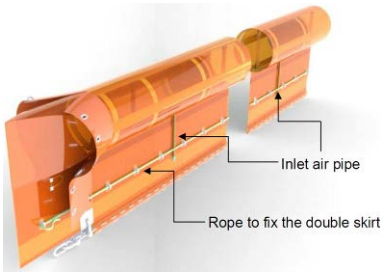


Diagram of the BC650 (Source: Sorbcontrol)

The boom can be deployed from a permanent reel (placed on the bank, quay, deck of a boat), but also by helicopter using a special reel (like the Quick Response Oil Boom by CoastSaver AS in Norway).
For further information:
http://www.sorbcontrol.com/en/product/self-inflatable-booms/

• Conferences

International Oil Spill Conference 2014

The 2014 International Oil Spill Conference (IOSC) was held in Savannah (Georgia, US) from 5th to 7th May. Over 2,500 participants attended this triennial event consisting of many conferences, a trade exhibition with around 175 stands run by equipment manufacturers, service providers, etc., as well as a spill response equipment demonstration on the Savannah River.

Forty-five thematic sessions were run, comprising over 180 presentations mainly relating to spills in marine or inshore waters (with emphasis on Arctic topics and chemical dispersion - in particular subsea injection). Nevertheless, a few presentations focused on subjects applicable to inland waters. We therefore draw your attention to:

- a presentation by Cedre, during a session on "Cutting Edge Techniques and Research", outlining the results of the European Hoverspill project[9] (devoted to designing a hovercraft for

[9] The Hoverspill Consortium, 2014. Hoverspill: a new amphibious vehicle for responding in difficult-to-access sites. International Oil Spill Conference Proceedings 2014: 649-659 (doi:http://dx.doi.org/10.7901/2169-3358-2014.1.649).

response on difficult access sites; see LTEI n°20), alongside a project partner (Turbylec) who detailed the development of the associated oil/water separation system[10].

- a session on **Response to Non-Floating Heavy Oils** comprising presentations often devoted to response planning in the context of a specifically North American organisation, relating to the transport of crude oil extracted from Canadian tar sands.
    - One presentation on response preparedness[11] addressed the apparent need to identify locations most at risk at local and regional level, with regard to current transport routes (road, rail, pipeline, etc.) or storage locations for these products. Thereafter, the recommended actions consisted in the revision of contingency plans in terms of the definition of the most suitable equipment and techniques for recovering submerged oil, as well as training for personnel specifically relating to the issues and challenges raised by dilbit. The speaker also suggested the prior identification of potential deposition areas where sunken oil could collect (for instance, through mapping), based on existing environmental information and feedback from past incidents – including that of the spill in the Kalamazoo River in 2010 (see LTEI 15, 19 and 21).
    - an interesting case, presented by US EPA[12], relating to the question of response to a dilbit spill in Kalamazoo River in July 2010 (see LTEI n°15, 19 and 21). This major spill, one of the largest ever to occur in North America, indeed required, in addition to the "classic" initial floating oil recovery operations, the implementation of detection and recovery techniques for sunken deposits (following evaporation of the light fraction of the dilbit, then the submersion of the heavy fraction under the combined effect of mixing with sediment and turbulence) over a 3-year period. This feedback highlighted the complexity of clean-up operations. This complexity required a methodological approach which, according to the speaker, could constitute a foundation of basic recommendations in terms of response preparedness for sunken products in freshwaters. This approach included:
        - geomorphological analysis of the river bed in order to identify candidate sites of bitumen deposition, based on the currents and topography.
        - field assessments (poling) using sorbents to determine whether or not submerged oil is present. These results – as well as the sheen observed at the surface – were recorded in a regularly updated GIS, enabling the entire area concerned to be monitored.
        - the development of forensic oil chemistry methods to associate with certainty the oil detected in the sediment with the spill (an important point given that the catchment basins of watercourses often contain various sources of chronic oil pollution). In this respect, the speaker indicated that markers able to distinguish the dilbit from residual background hydrocarbons have been identified (to be discussed in a future paper) for sheen and globules, however this was more problematic for sediment contamination.
        - the use of a numerical sediment transport model (developed by a consultant for Enbridge), to predict the fate (remobilisation, secondary sedimentation, etc.) of submerged deposits (for instance, during erosion phases caused by spring tides). We note that the US EPA has since conducted a number of experiments, in controlled environments, in order to specify the potential differences in behaviour between fine particles and aggregates of oil and fine particles (in the case of this incident, the models were used based on the hypothesis that these 2 categories showed similar behaviour).
        - the definition of site clean-up priorities and techniques based on a NEBA (Net

[10] Maj G., 2014. Turbylec: Development and experimental validation of an innovative centrifugal oil-water separator. International Oil Spill Conference Proceedings 2014: Pages 634-648 (doi:http://dx.doi.org/10.7901/2169-3358-2014.1.634).
[11] Booth & Macon, 2014. Action, not Alarm: Preparing for Oil Sands Response at the Local Level. International Oil Spill Conference Proceedings, pp. 417-425.
[12] Dollhopf, Fitzpatrick, Kimble, Capone, Graan, Zelt & Johnson, 2014. Response to Heavy, Non-Floating Oil Spilled in a Great Lakes River Environment: A Multiple-Lines-Of-Evidence Approach for Submerged Oil Assessment and Recovery. International Oil Spill Conference Proceedings pp. 434-448.

Environmental Benefit Analysis) approach.

- A session entirely devoted to the benefits and prospects relating to **Shoreline Cleanup Assessment Techniques** (SCAT) with a presentation[13] on its application in inland waters. Emphasis was placed on the need to define appropriate clean-up endpoint criteria, determined when establishing the technical recommendations, based on the analysis of several real cases, according to the characteristics (e.g. hydrodynamics, lateral spreading, geomorphology, etc.) and sensitivities (ecological, uses, etc.) specific to these types of environments. Over and above these organisational aspects (in particular the involvement of SCAT teams in the unified command and the link between the unified command and on-site command centres), recommendations were made on the importance of gaining greater insight into and feedback on the impact of treatments considered to be "aggressive" (e.g. sediment removal), as well as on the long term benefits of "non-response", in various examples of spills. Certain currently used criteria were discussed, such as the "no sheen" endpoint typically applied by the EPA which, in certain cases, means using certain types (or durations) of operations which may increase site recovery times.

• Research & development

Towards the development of a nanocellulose sorbent?

The French laboratory LCPO (*Laboratoire de Chimie des Polymères Organiques*)[14] and the Swiss Federal Laboratories for Materials Science and Technology (EMPA)[15] have jointly developed an oleophilic material designed to efficiently absorb oil floating at the water surface and to enable the oil to be readily extracted.

This material is produced from nanofibrillated cellulose (NFC, a cellulosic raw material obtained from wood fibres, straw or recycled paper) which is chemically modified by silylation – a dilution process in water, followed by mechanical treatment (high pressure homogenisation) resulting in the formation of a gel containing fine interconnected fibres. The addition of an alkoxysilane molecule to this gel, followed by freeze-drying, results in the production of an oleophilic, hydrophobic nanocellulose "sponge".

According to an article (published in 2014) by the scientists having developed this concept, the microscale (laboratory) trials conducted indicate a sorption capacity of approximately fifty times the material's weight in oil while preserving its original shape and volume.

According to the authors, this nanocellulose "sponge" could also work with other organic compounds (e.g. methanol, chlorofom). Based on the initial results which were considered to be encouraging, as well as the origin (wood fibres or agricultural by-products) and apparent biodegradability of this product, the concept is to be developed in order to be applicable on real spills (hence the search for an industrial partner by EMPA).

For further information:
http://pubs.acs.org/doi/pdfplus/10.1021/cm5004164

• Fines, legal proceedings

€1.2 million fine for Plains Midstream

In June 2014, the pipeline operator Plains Midstream pleaded guilty to three charges brought against them by the Alberta Government and the Canadian Federal Government, relating to two spills in Alberta's watercourses, following the rupture of the Rainbow Pipeline in April 2011 (spill of 4,500 m^3 of light crude oil in wetlands, see LTEI n°16) and of the Rangeland South Pipeline in June 2012 (spill of approximately 460 m^3 of light crude oil into a river and a lake, see LTEI n°18). At this trial, Plains Midstream agreed to pay a total of $1.3 million (i.e. approximately €1.2 million) in fines:

- In relation to the 2011 incident, Plains Midstream pleaded guilty to the charge of "failing to

[13] Whelan, Clark, Andrew, Michel & Benggio, 2014. Developing Cleanup Endpoints for Inland Oil Spills. International Oil Spill Conference Proceedings pp. 1267-1280.
[14] Joint research unit between the University of Bordeaux and the French National Center for Scientific Research (CNRS).
[15] Swiss institute for applied scientific research (materials and technology), under the Federal Department of Home Affairs.

take all reasonable measures to repair, remedy and confine the effects" of the spill, as required by the Environmental Protection and Enhancement Act (EPEA)[16]. The statement of facts confirmed that the pipeline operator had restarted the leaking pipeline four times after problems were first detected, likely exacerbating the spill. The company was fined $450,000 for this charge.

- In relation to the 2012 incident, Environment Canada and the Alberta Government with regard to federal and provincial laws respectively, each formulated similar accusations, relating to the delay in informing the authorities of this release of a deleterious substance (i) "in water frequented by fish" as required under the federal Fisheries Act and (ii) as soon as the release was detected, as required under the province's Environmental Protection and Enhancement Act. The company was fined $400,000 and $450,000 in relation to these two offences. According to the agreed statement of facts between the Alberta Government and Plains Midstream, the company took three hours to report the spill of light crude oil – during which time the residents around Red Deer River had already been alerted by perceptible oil odours (which generated public criticism towards both the company and the provincial government).

Following this trial, Plains Midstream announced that it had also spent $110 million on clean-up following these two incidents, as well as $4 million on various preventive actions between 2010 and 2013 (including enhanced automated pipeline monitoring).

Verdict issued by Bordeaux criminal court following the spill at Bec d'Ambès (Gironde, France, January 2007)

On 12th January 2007, a storage tank at the oil storage facility operated by SPBA (*Société Pétrolière du Bec d'Ambès*) ruptured, causing a spill of 13,500 m^3 of crude oil, of which approximately 50 m^3 flowed into the Garonne river, also contaminating the Dordogne and the Gironde rivers with the following tides (see LTEI n°8).

Over 7 years on, in October 2014, the prosecutor of Bordeaux criminal court called for fines of €30,000 and €5,000 for SPBA and its former director respectively, following claims by parties for civil damages (environmental protection associations, and the municipality of Macau, Gironde). Over and above the pollution itself, these claims were based on the fact that the management at the time did not decide to empty the tank until 12th January, despite a leak having been detected the evening before (a layer of water was injected at the base of the storage tank pending tank draining operations).

Based on the claim that there was no evidence of any offence, the company's lawyers pleaded for an acquittal. The lawyers of the parties claiming civil damages called for €250,000 in damages. The decision was deferred until 17th November 2014, when Bordeaux criminal court ultimately acquitted SPBA.

[16] Two other charges were dropped in relation to this incident: releasing a substance into the environment that may cause a significant adverse effect and failing to take all reasonable measures to remediate, manage remove or dispose of the substance as soon as they were aware of the spill.