CENTRE OF DOCUMENTATION, RESEARCH AND EXPERIMENTATION ON ACCIDENTAL WATER POLLUTION

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Light fuel spill with a major impact monitoring programme (British Columbia, Canada)

On 26th July 2013, a tanker truck operated by the Executive Flight Center (EFC) carrying a cargo of jet fuel (to supply helicopters battling wildfires) rolled down a steep embankment and into Lemon Creek (British Columbia), spilling around 33 m^3 of Jet A1, a light kerosene-based fuel.

In the hours following the spill, the high evaporation rate of the fuel meant that health and safety issues for local inhabitants and responders were the main priorities. The Regional District of Central Kootenay (RDCK) and the province's health authority established a safety zone within a 3 km radius, temporarily evacuating over 3,000 local inhabitants. Meanwhile, the concentration of volatile compounds in the air was monitored. This monitoring programme, carried out from 28th July to 9th August, did not record any concentrations in excess of acceptable limits, despite a perceptible smell of fuel which lasted several days (gradually diminishing).

A ban on water consumption was issued by the Interior Health Authority, including two rivers (Slocan and Kootenay, tributaries of the Columbia River) downstream of Lemon Creek. The ban was then extended to recreational activities, as well as to irrigation and livestock. Tanks of potable water were provided at 4 fire halls for local inhabitants. The ban was phased out, progressing from downstream to upstream, starting on 6th August and was fully lifted 3 days later.

In terms of crisis management, a Unified Command (UC) was set up, comprised of representatives of the Province's Ministry of Environment, RDCK, the Interior Health Authority and the responsible party.

The emergency response was implemented by firefighters, together with a Vancouver Hazmat Team. Surveys were carried out on land and by boat to assess the spread of the spill. Containment booms were set up and lined with sorbent booms to contain the oil within the Slocan and Kootenay Rivers. The responsible party rapidly contracted a specialised company to continue to clean up the oiled areas. At the height of operations, the contractor mobilised over 50 responders to conduct operations both on the water (where the product was recovered manually using sorbents and nets/scoop nets, or by pumping with vacuum trucks) and on the shoreline.

Shoreline surveys indicated that the product was rapidly evaporating[1]. Six days after the incident, a specialised consultant (Polaris Applied Science) was contracted to carry out more detailed surveys using the North American Shoreline Cleanup Assessment Technique (SCAT), in order to assess the level of contamination over a 200 km stretch downstream of the incident, and to concentrate clean-up efforts in the most contaminated areas (Lemon Creek and certain sites on the Slocan River showed residual pollution). As recommended by the Ministry of Environment, final clean-up operations were implemented (by flushing to release the oil and recovery using sorbents).

Containment by floating and sorbent booms and recovery by pumping (vacuum truck) (Source: Lemoncreekresponse.ca)

Bearing in mind that this was a very light product, the following quantities were recovered: just over 2 m^3 (2,150 litres) of product pumped by vacuum trucks and around 20 tonnes of oiled solids collected (sorbents, vegetation and debris).

Near the incident site, 1,600 tonnes of contaminated soil was excavated and transferred to a specialised treatment facility.

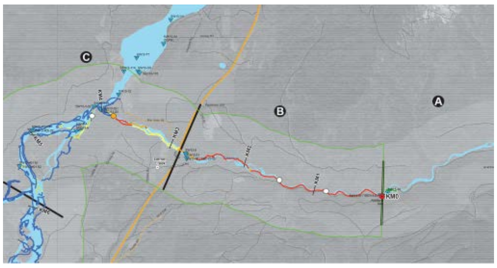
As part of the environmental contamination monitoring programme carried out from the day after the spill until 9th August (implemented by a specialised consultant contracted by EFC), samples of water (surface and groundwater), sediment and soil from the banks were analysed. A similar programme was also implemented, under the supervision of the Ministry of Agriculture, for agricultural land and nearby crops. No concentrations in excess of regulatory levels were detected.

[1] as well as reporting the presence of whitish residues – with a "milky" appearance according to responders – on the banks of the Slocan River, in particular in areas where floating debris accumulates and on vegetation.

Flushing on vegetated streambanks (Source: Lemoncreekresponse.ca)

Acute fish (and benthic invertebrate) mortality was detected in Lemon Creek and the Slocan River soon after the incident: around 260 dead fish were recorded, including juvenile salmonids and cottids. In addition, 14 deceased wildlife specimens, including 11 birds, were collected, whose necropsy indicated that the deaths were not due to the spill (possibly with the exception of 2 passerines - Northern waterthrush and American dipper).

Two weeks after the incident, an impact assessment programme (including water, wildlife and fish) was set up and launched by the environmental consultant contracted by the responsible party. An initial report was submitted to the Ministry of Environment in November 2013. This report indicated the rapid natural dissipation of the substance and the detection (if not quantification)[2] of the immediate toxic impacts. It recommended long term assessment of the chronic effects on a selection of key species, in particular fish and invertebrates.



Map of the results of SCAT observations (e.g. situation on 8th August 2013 in Lemon Creek and its confluence with the Slocan River) (Source: Ministry of Environment, British Columbia).

A mark and recapture programme for the fish populations in Lemon Creek was organised, the results of which are scheduled to be released by summer 2015.

For further information:
http://www.env.gov.bc.ca/eemp/incidents/2013/lemon_creek.htm and http://www.lemoncreekresponse.ca/

Recovery on the water in winter conditions: sinking of the *Stephen L. Colby* (LeClaire, Iowa, US)

On 25th November 2013, the towboat *Stephen L. Colby* struck an unidentified submerged object lying on the bed of the Mississippi River, near LeClaire (Iowa). The vessel sank with 338 m^3 of diesel and 4.5 m^3 of lubricating oil in its tanks, which began to leak within hours of the incident (at a decreasing rate).

The Captain of the Port closed a 14 km section of the river to traffic, as the partially submerged towboat was a navigational hazard. On the water, emergency spill response operations were carried out by the LeClaire fire department, assisted by the US Coast Guard, who deployed booms from the towboat's spill response kit as well as equipment provided by a neighbouring company. In total, 240 m of containment boom and over 200 m of sorbent boom were laid for these containment operations, which constituted the main priority.

Containment immediately downstream of the Stephen L. Colby (Source: USCG)

The response was coordinated by a Unified Command, composed of the federal authorities (US Coast Guard, US Fish and Wildlife Service - USFWS), Iowa state authorities (Environmental Protection Agency - EPA, Department of Natural Resources - DNR) and local authorities. 160 people, 11 workboats and 4 skimmer vessels were mobilised, as well as 900 m of containment boom (together with the same length again of sorbent boom), for containment and recovery operations.

[2] We note that the fish mortalities observed were considered to be an underestimation of the toxic effects caused by this light fuel, due to the large area to be investigated, the strong currents in the river system and the delay (a few days) in the launch of observations.

Recovering diesel-soaked sorbents (red colour) (Source: USCG)

View of booms in the icy waters of the Mississippi (Source: USCG)

Meanwhile, a survey of the vessel showed that there were 3 breaches in the hull. A plan to plug the leaks, remove the remaining fuel and salvage the vessel was drawn up and put into action.

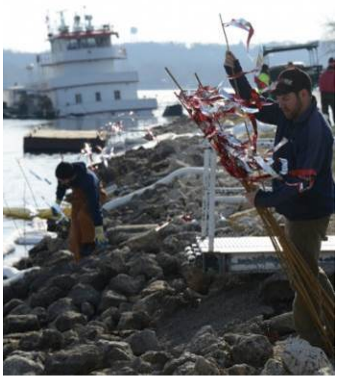
On the water, the cold, ice and snow slowed recovery operations, in particular causing pump and hose failures.

The presence of ice also reduced the efficiency of fuel containment around the wreck and made it difficult to deploy additional lengths of boom.

Finally, as the incident occurred during the migratory season of 2 species of waterfowl, visual bird deterrent devices (coloured tape) were set up on the river banks.

In total, the response lasted around 20 days, including recovery operations on the water, fuel removal and salvage and towing of the towboat. Around 340 m^3 of a mixture of water and diesel was pumped out of the vessel and 150 m^3 recovered on the water.

Response operations also resulted in the recovery of almost 200 m^3 of oiled waste.



Setting up coloured tape as bird deterrent devices (Source: USGC)

Fire and light crude oil spill in a marshland area: derailment of tank cars in Aliceville (Alabama, US)

On the night of 7th November 2013, a 90-car train[3] transporting light crude oil (North Dakota Bakken Shale), an evaporating substance, derailed for an unknown reason in the region of Aliceville (Alabama).

26 cars overturned, 3 of which exploded and caused a fire which spread to the fuel tanks, as well as to the leaking oil. Some of the oil spread across the ground and into the adjacent marsh, while the flames burnt the vegetation cover and trees across a 0.8 ha area. A large cloud of smoke comprising particulates and combustion gases, as well as volatile organic compounds (VOCs), were thus released into the atmosphere.

Aerial view of the derailment site (Source: EPA)

The fire was controlled for the first 3 days by local firefighters (Tuscaloosa Fire Department and Pickensville Fire Department) while the Unified Command was set up, comprising representatives of local to federal agencies[4], as well as the rail company (Genesee & Wyoming/Alabama & Gulf Coast Railway) and its subcontractors[5] tasked with clean-up and air quality monitoring.

Firefighting (Source: EPA)

The intensity of the blaze was such that the content of the damaged tanks was left to burn, while the surrounding area was secured and undamaged cars were moved away. The remaining fires were extinguished by cooling the cars with water and by spraying foam (AFFF)[6] onto the fuel.

The flammability of the crude oil made the initial response very complicated, as illustrated for instance by the re-ignition of a fire when attempting to move one of the tanks.

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[3] Ralliant Amory (Mississippi) in Walnut Hill (Florida)

[4] Including US EPA, ADEM (Alabama Department of Environmental Management), ALEMA (Alabama Emergency Management Agency), Pickens County EMA (Emergency Management), FBI, NTSB (National Transportation Safety Board), FRA (Federal Road Administration), and DoT (Department of Transportation)

[5] USES, B&P, RJ Corman, CTEH and Enviro Science

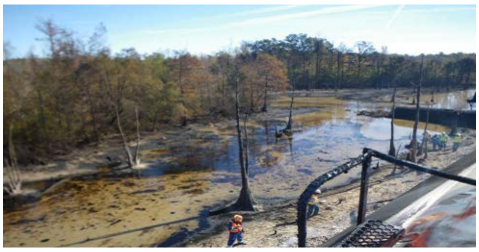
[6] Aqueous Film Forming Foam

Air quality measurements and the identification of risks for both responders and local populations were fundamental prerequisites for subsequent operations (tank removal, clean-up, etc.).

The concentrations of particulates, VOCs (benzene, toluene, xylene) and other compounds (NO_2, SO_2, H_2S, CO) were monitored by a company contracted by the operator, as well as by EPA, in a number of areas: within the 1-mile evacuation zone around the derailment site, within the work area and within the community, i.e. where the closest homes were situated.

The spill response first aimed to prevent the oil from spreading in this relatively remote marshy environment, which forms the upper bed of a watercourse which feeds into the Tombigbee River.

Containment booms and sorbents (booms, mops, rolls attached vertically to piles in a barrier configuration) were deployed around and near to the cars. Downstream, site surveys were carried out and, locally, protective systems were put in place.



Site overview. Note the burnt vegetation next to the railway track (Source: US EPA).

Containment and recovery on a marshy site: laying containment booms next to the damaged tanks (Source: US EPA)

The contained oil was recovered by pumping, with or without skimmers, and manually using various sorbents (oleophilic/hydrophobic sorbent pads, booms, mops, etc., including Opflex products). Around 350 people were mobilised in the field at the height of firefighting and spill response operations.

In total, 790 m^3 of crude oil was recovered from the 26 derailed tanks, which were reported to be transporting a total of 2,830 m^3. The quantity spilt was therefore calculated to be approximately 2,040 m^3, however the burnt and unburnt proportions could not be estimated. According to our sources[7], between 40 and 75 m^3 of oil was recovered on the water and 5,000 to 8,000 tonnes of soil was excavated near to the incident location.

Sorbent mops on ropes, and viscous, sticky, weathered oil on the banks (left); containment booms lined with sorbent mops (middle); sorbent rolls taut between piles (right) (Source: US EPA)

We note that, 6 days after the incident, the sensitivity[8], difficult access and remoteness of the polluted areas caused the On-Scene Commander (OSC) to ask the Regional Response Team Region IV[9] to assess the feasibility of in situ burning of the floating oil. Various factors were considered conducive to the implementation of this technique: favourable weather conditions (heavy rain forecast), site preparation completed (no longer any fire/explosion risk), sufficient distance from the nearest residential areas. An ISB Plan was drawn up by RRT, although difficulties were encountered in obtaining prior approval from fire fighting officials and property owners. In the end, due to operational considerations (changes in weather forecast and inadequate containment), this option was abandoned.

In organisational terms, the response required:

- Safety (flammability/explosivity) and health (atmospheric concentrations of VOCs, gases and particulates, due to the fire) conditions to be controlled, due to the light nature of the oil spilt,

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[7] Variable estimation according to information sources (public agencies) identified, in particular presentations given at the Regional Response Team Region IV Meeting (February 2014) and the 2014 Alabama Association of Emergency Managers' Workshop (December 2014).

[8] Vegetated soft substrates with a low load-bearing capacity, but also presence downstream of threatened or endangered species (unspecified in our information sources).

[9] RRT IV, composed of regional representations of federal agencies

in particular during the first hours/days.

- An ICS[10] to be set up, upon the decision of the OSC due to the wide range of operations implemented (fire fighting, spill response, oil/tank removal, etc.) and, therefore, of structures/responders involved.
- Particularly close health and safety monitoring was implemented in the field during operations, which involved close proximity between heavy vehicles (e.g. for preparing access routes, lifting/evacuating tanks, etc.) and operators working on foot (e.g. laying booms, recovering sorbents, etc.), as well as long working days (with an additional 2 hours of commuting a day for responders) and environment-related risks (presence of poisonous snakes, wild boars, etc.).

This incident highlighted the need to revise regulations on the rail transport of hazardous substances, a process initiated prior to this incident by the US Department of Transportation (DoT) and its agencies FRA and PHMSA[11]. Four recommendations focused on improving the safety of DOT-111 tank cars, involved in the incident (as well as the Lac-Mégantic tragedy in Canada, see below). Those built after October 2011 must be altered to meet new safety requirements (older cars are not required to be retrofitted).

These actions were in line with the Operation Classification (also dubbed "Bakken Blitz") launched in January 2013 by PHMSA and FRA, aimed at ensuring the proper classification, by charterers and carriers, of the unconventional oil from Bakken oil field (Bakken shale). These actions have since led to (i) new operational obligations for certain trains transporting large volumes of flammable liquids (Class 3), (ii) improvements in tank car standards, (iii) the revision of general requirements for appropriate classification and characterisation of gases and liquids extracted from the subsoil.

Rail tragedy and spill into the Chaudière River in Lac-Mégantic (Quebec, Canada)

On 6th July, in the municipality of Nantes in Quebec, a fire broke out on the engine of a freight train awaiting a crew change. The train slid into motion again for an unknown reason[12], and hurtled down the sloping railway track towards downtown Lac-Mégantic, where its 72 tank cars, each carrying over 100 m^3 of a light crude (Bakken Crude), become detached and derailed. A series of explosions then followed and a giant blaze raged for 40 hours. This was above all a human tragedy, with the death of 47 local inhabitants and the devastation of dozens of shops, restaurants, homes, etc. within a 2 km radius of the downtown area. However it also caused the contamination of the Chaudière River (which flows from Lake Mégantic into the Saint Lawrence River) via the sewer system, requiring water intakes at various facilities downstream to be shut down and the Mégantic dam to be closed. Alternative water intakes were subsequently set up.

Pumping operations in the Chaudière River began on the day of the incident and a fortnight later were reported to have resulted in the recovery of 43 m^3 (just under half of the total quantity spilt into the river according to estimations by the Ministry of sustainable development, environment and the fight against climate change - MDDELCC). To monitor the concentrations of pollutants in the air, the ministry also deployed its mobile laboratory known as the Trace Atmospheric Gas Analyser (TAGA).

Bank clean-up, initiated just over a fortnight after the incident, included an initial manual recovery phase for accumulations of oil on substrates and oiled vegetation (scything). At the height of these operations (22nd July-17th August 2013), over 100 responders were mobilised. The second phase lasted around 3 months (10th August to 28th October) and aimed to remobilise residual pollution trapped in/on sediment, followed by recovery on the water using sorbents. These operations were carried out (i) by flooding the banks (deluge system, using pierced pipes on fine sediment or fire hoses on coarse sediment, set up on the upper section of the bank) and (ii) in the river bed, by manual agitation using tools (rakes, shovels, etc.) or by injecting a mixture of water and air.

10 Incident Command Structure, the recommended organisation in the US for major crisis management.

11 Respectively Federal Railroad Administration and Pipeline and Hazardous Materials Safety Administration

12 The enquiry by the Transportation Safety Board of Canada (TSB) later pointed to a combination of factors, namely a mechanical problem with the locomotive causing it to catch fire, fire extinguishing efforts causing the locomotive's engine to shut down in accordance with rail instructions, deactivating the air brakes, together with an insufficient amount of hand brake force. The convoy was therefore not secured and hurtled down the slope.

Final clean-up of banks: flooding with a deluge system (left); containment and recovery of released oil using sorbents (source: MDDELCC)

This phase suffered interruptions due to adverse climate conditions (risks of accidents and hypothermia). It mobilised between 150 and 200 responders and resulted in the recovery of over 60 tonnes of oiled waste (including 35 tonnes of sorbents) following clean-up operations on a total of approximately 40 km of banks.

Meanwhile, various visual reconnaissance surveys and a major sampling programme were carried out to determine the level and extent of environmental contamination. The main focus was on water and sediment, but samples were also taken from populations of fish and benthic organisms.

In early 2014, a "Chaudière River Expert Committee" was commissioned by MDDELCC, based on the results of this sampling programme, to (i) draw up an overview of the contamination of the river, (ii) assess the potential impacts, and (iii) develop a management plan for the residual contamination and support the ministry in implementing the plan in 2014-2015 (the Expert Committee's report on residual contamination outlining observations, recommendations and actions put forward is now available on the MDDELCC website).

For further information:
http://www.mddelcc.gouv.qc.ca/lac-megantic/
http://www.mddelcc.gouv.qc.ca/lac-megantic/Rapport-chaudiere.pdf
ftp://documents.mddelcc.gouv.qc.ca/Tragedie-Lac-Megantic-Rapports-interpretations/CIMA/QR0090A-ENV-CAR-Revue%20litterature-01%5B1%5D.pdf
http://www.tsb.gc.ca/fra/enquetes-investigations/rail/2013/r13d0054/r13d0054.asp

• Review of significant spills having occurred worldwide in 2013

This analysis is based on an inventory of incidents in 2013 recorded by Cedre having led to a spill of over an estimated 10 tonnes, for which sufficient information was available. We remind readers that, for a certain number of incidents, the volumes spilt are not known or divulged by our information sources, although they clearly exceed the 10-tonne mark; these missing data and inaccuracies indubitably penalise the accuracy of the results presented below.

Spill sources

In 2013, 34 incidents followed by significant spills were identified in inland waters.

Compared with estimated data for the years 2004 to 2012 (median = 41), this places 2013 among years with a lower number of spills. The total quantity of oil and other hazardous substances spilt was approximately 3,200 tonnes. This estimation[13], one of the lowest recorded since 2004 (Fig. 1), is far lower than the annual medians expressed for the periods 2004-2007 (19,900 tonnes) and 2008-2012 (12,300 tonnes).

[13] Minimum estimation due to a lack of detailed data for several incidents.

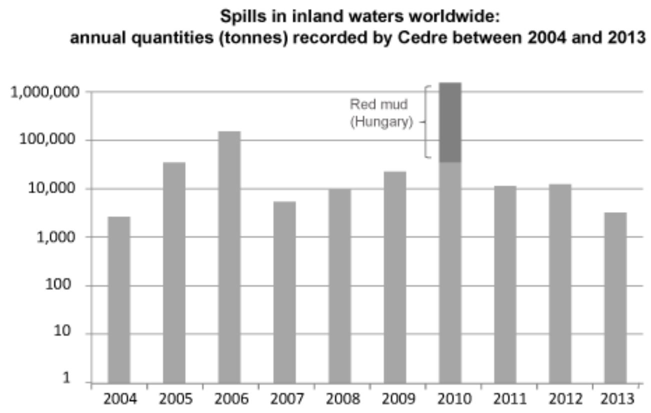

Figure 1

The largest spill identified in 2013 (approximately 900 m^3) was that of the underground Pegasus Pipeline which occurred in Arkansas (US)[14], followed by two spills of approximately 500 m^3, respectively caused by a pipeline in the Komi Republic (Russia) in May[15], and a leak of salt water from a corroded pipeline in Canada in June[16].

With the exception of these cases, the majority of spills in 2013 were minor, and rarely exceeded 100 tonnes.

Pipelines were the most frequent spill source (26 %) in 2013, closely followed by tanks (Fig. 2), involved in 24 % of cases, equally divided between **tanker trucks** (12 %) and **rail tank cars** (12 %).

On-land oil facilities were the source of around 23 % of spills, 14 % of which were from **unspecified oil facilities** (and respectively 6 % and 3 % from wells and storage facilities).

The other sources identified generally represented less than 5% of significant spills for the year.

In terms of quantities, and in line with the observations in previous years, we note the major share (around 70 %) of **pipelines** in the 2013 total (Figure 3). The largest spills from such facilities occurred in the US in March[14], in Russia in May[15], and in Canada in June[16]. Due to the lack of detailed information on the quantities involved in several other cases[17], the share of the total quantity spilt due to pipelines is no doubt underestimated.

Other notable contributors to the total quantity spilt are **tank cars** (with around 10 %, i.e. around 350 tonnes; Fig. 3), followed by **on-land oil facilities** and **tanker trucks**, the only sources to exceed 100 tonnes.

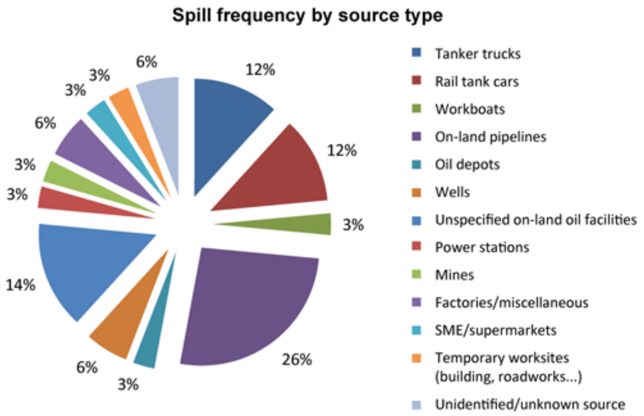

Figure 2

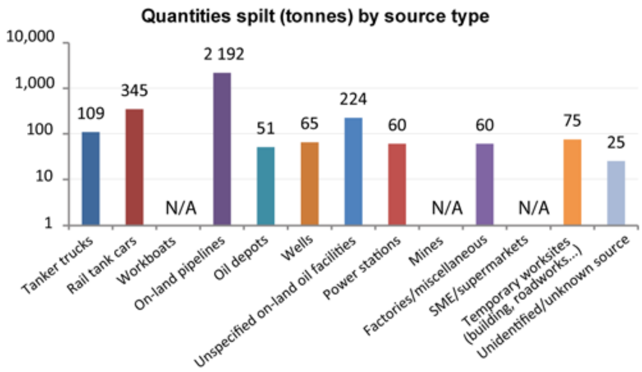

Figure 3

The other structures involved each contributed to less than 3 % of the total quantity spilt (Fig. 3).

[14] Spill of nearly 1000 m^3 of Wabasca heavy crude oil in Mayflower (see LTEI n°20).

[15] Leak (unspecified cause) from a Rusvietpetro pipeline of 500 m^3 of oil (unspecified type) which polluted the Kolva, Pechora and Usa rivers, and which required the Usinsk municipal district to implement a response involving "over 100 people".

[16] Leak of 400 to 600 m^3 of salt water from a Penn West Exploration pipeline, causing the pollution of 2 ha of muskegs 20 km from Little Buffalo (Alberta), without however reaching fast-flowing watercourses (or water bodies).

[17] E.g. Rupture of the Trans-Ecuador pipeline following a landslide, in May, and resulting in the release of between 1600 and 1800 m^3 of crude oil. An unspecified quantity affected the Quijos and Coca rivers. The spill reached Peru and also led to the notification of the Brazilian Government.

Types of substances spilt

In 2013, like in previous years, the vast majority of pollutants spilt were **oils** (around 90 %), half of which were of **unknown** or **unspecified** type (Fig.4).

The category of identified oil representing the largest share (around 30 % of the total) was that of **oil derivatives**, here a non-conventional product, due to a spill of around 900 tonnes of diluted heavy oil from the tar sands of the Wabasca region from the Pegasus Pipeline[18].

With the exception of **light refined oil** (7 %) and **crude oil** (9 %), the other oil products identified never made up more than 2 % of the total annual quantity spilt.

In 2013, the share of chemicals was once again far lower than that of oil.

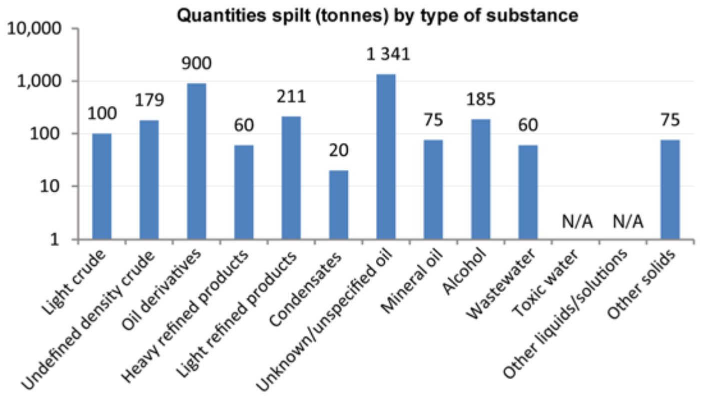

Figure 4

With a total quantity in excess of 100 tonnes (185 tonnes, i.e. 6 % of the annual total), we note the **alcohols** category, due to the derailment of 5 tank cars transporting ethanol in May in the US.

Events

The most frequently reported incidents in 2013 were **structural breaches or ruptures** (70%; Fig. 5):

- Most were due to a **loss of integrity** (38 % of events) of various structures, mostly pipelines, or internal pipes within on-land industrial oil facilities. This category also represents the main proportion (80 %) of the quantity spilt in 2013 (Fig. 6), a third of which was caused by a breach in the Pegasus Pipeline in the US (see LTEI n°20).
- **Overturning incidents (capsizing/derailment)**, involving road or rail tanks, represented 23 % of events. Such incidents also ranked second in terms of their share (14 %) of the total volume of pollutants spilt during the year (Fig. 6).

With the exception of **unspecified events**, involved in 12 % of cases reported, the other categories involved low frequencies (Fig. 5) and none of them represented more than 2 % of the total volume (Fig. 6).

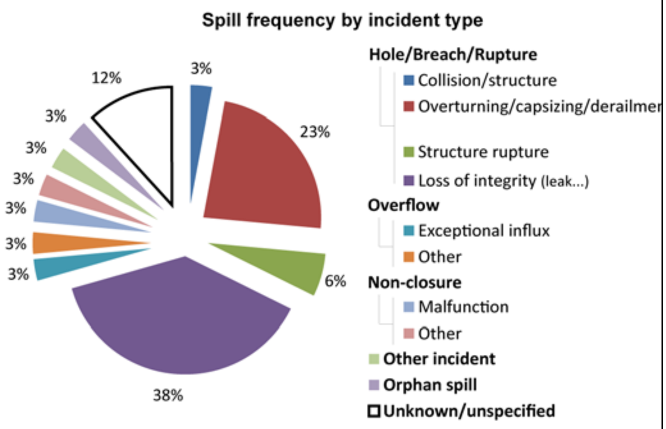

Figure 5

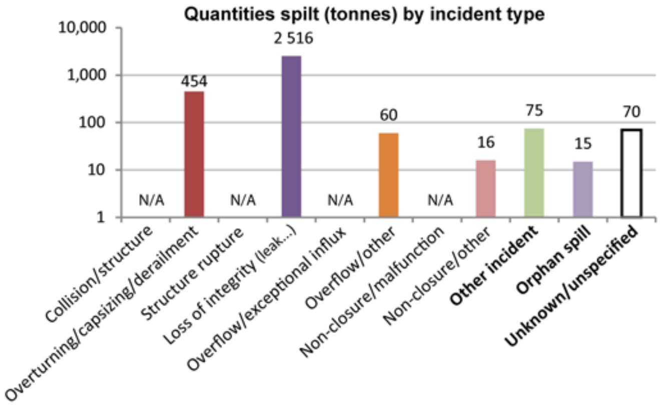

Figure 6

Causes

Analysis of the frequencies of each cause shows that the cause was **unknown or unspecified** in almost a third of cases listed (Fig. 7). These incidents also weighed heavily (25 %) in the total balance in terms of quantities spilt (Fig. 8).

[18] See LTEI n°20

While this lack of information hinders the identification and ranking of incident causes, we note the prevalence of **technical failures** (29 %):

- Over half of these failures were related to the **defectiveness/dilapidation** of facilities[19] (Fig. 7), a cause which represented a 26 % share of the total volume spilt (Fig. 8).
- Despite their relatively low occurrence (3 %), **facility failures (design/inadequacy)** were the number one cause (28 %) in terms of their share of the total volume spilt, mainly due to the spill from the Pegasus Pipeline, to which damage was believed to have been caused due to the transport of Wabasca Heavy Crude rather than a conventional crude oil (see LTEI n°20).

Natural causes were identified as having caused 25 % of the spills listed:

- The most frequent (15 %) of these causes was **flooding/precipitation**, which also represented a 13 % share of the total annual quantity spilt, mainly due to the derailment of a train following flooding which washed away part of a railway track (in Canada, in May, see LTEI n°20), and the submersion of oil facilities in Coloradao (US) in September.
- This was followed by **landslides** (which ruptured pipelines in Ecuador on two occasions, one in April and another in May) and **storms**, whose share is difficult to evaluate due to inaccurate data.

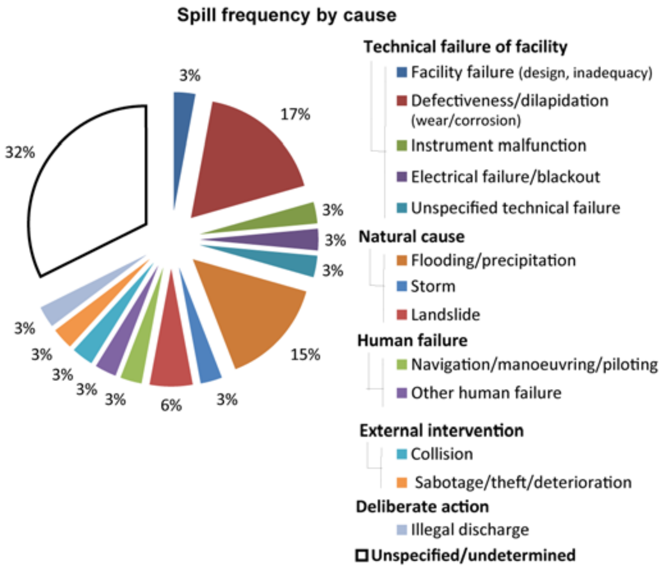

Figure 7

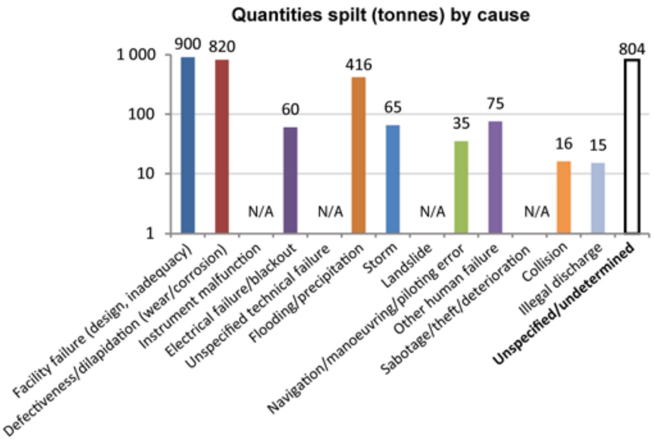

Figure 8

The other causes identified showed relatively low frequencies (3 % at the most) (Fig. 7) and did not weigh heavily in the 2013 balance in terms of quantites spilt (Fig. 8).

• Recovery

Extreme Spill Technology recovery barges

The Canadian firm Extreme Spill Technology (EST) has recently developed a recovery barge concept comprising a vacuum oil separation system. The performance of a 12 m-long model, built for the Canadian Coast Guard, was assessed during tests at OHMSETT in September 2012[20].

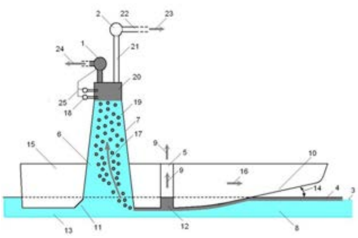

Diagram showing how the EST barge works (Source: EST)

This vessel takes the form of a small shallow-draught catamaran which concentrates the oil between its floats as it moves forward, then submerges it and channels it towards one or more internal tanks (according to the barge dimensions) where gravity separation of the oil occurs (see diagram on left). These tanks are topped with a removable oil recovery vacuum tower housing a system to pump and transfer the collected oil towards an internal (ballasts) or auxiliary storage capacity.

The origin of this prototype dates back to 2005, initiated by Dalhousie University (Halifax), and its development benefited from funding from a Norwegian firm and the National Research Council of

[19] Almost all pipelines
[20] Tests were also carried out in August 2012 in China, upon request by the Chinese Coast Guard and Maritime Safety Administration, with Bunker C fuel oil.

Canada.

This principle is reminiscent of that of the barges developed a few years ago by another Canadian firm, SMAVE Environmental, which were a variation of the Pelican concept (created over 30 years ago by the French company Bagnis and marketed in the 2000s by the Canadian firm Hewitt Environmental).

Tests on a 12 m model in the OHMSETT test tanks (right, view of the removable vacuum tower and the transfer system) (source: EST)

According to the manufacturer, the simplicity of the prototype's structure means that it requires minimal maintenance and is very robust. Unlike other concepts, this model does not include a system creating a surface current to draw the oil into the vessel (water jets), an oil submersion system as the barge moves forward (e.g. partially submerged conveyor belts) or a sweeping arm at the bow. The tests performed at Ohmsett, in various conditions (e.g. with and without agitation, speed of between 1 and 4 knots, etc.), indicate good performances (oil recovery rate often over 60%), limited however by surface agitation.

For further information:
http://www.spilltechnology.com/
http://www.spilltechnology.com/library/EST_R&D_Rev2.pdf

• Sorbents

Ultra-X-Tex sorbent and filter media

UltraTech International Inc. markets a filtrating, oleophilic material, by the name of Ultra-X-Tex, which differs from "classic" polypropylene geotextiles. Composed of recycled synthetic fibres, its interstitial structure has been designed to ensure a large surface area for contact between the fibres and the liquid to be filtered, while allowing the liquid to pass freely. According to the manufacturer, Ultra-X-Tex can absorb the smallest of droplets (e.g. dispersed oil), giving this media a high filter capacity for contaminated water.

In addition to its use for industrial applications (effluent filtration), various forms exist for oil spill response: booms with or without a ballasted skirt (90 to 150 cm high according to models), mats, filter fence reinforced with steel wire (to protect streams for instance) and loose fibres (e.g. for use in filter cartridges to filter waste water after settling).

According to the manufacturer, Ultra-X-Tex can absorb up to 20 times its weight in oil and can be reused after extracting the absorbed oil.

Ultra-Spill Fence ® being used to protect a sensitive shoreline - here at the edge of a marsh in Louisiana, during the Macondo spill, US 2010 (Source: http://www.spillcontainment.com)

For further information:
http://www.fibradsorb.fr/ (French supplier of this product)
http://www.spillcontainment.com/oil-spill

• Past spills

Restoration and environmental monitoring in Kalamazoo River: out-of-court settlement 5 years on

In July 2010, a spill of approximately 3,700 m^3 of dilbit from a faulty underground pipeline contaminated the Kalamazoo River (see LTEI n°15 and n°19). Five years later, in May 2015, the state of Michigan (US) announced that a $75 million financial settlement had been reached with Enbridge Energy, to finalise clean-up and restoration actions following the spill.

This agreement ends any further legal action by the state of Michigan against the Canadian firm. The sum paid out is to be used to fund various operations: to restore and extend (purchase land) wetlands affected in 2010 ($30M); to complete the dismantling of Ceresco Dam (structure built in 1939) in order to restore the run of the river to its natural historical condition ($18M); to create various access sites to the river for recreational purposes ($10M); to restore various watercourses within the catchment basin ($5M). Finally, $12M have been earmarked to reimburse past and future expenses incurred by the state of Michigan for long term environmental monitoring and restoration.

According to Enbridge, this settlement brings the sum total of expenses incurred and fines potentially due with regard to federal law up to $1.2 billion, for one of the largest oil spills ever to occur in US continental waters.

The state of Michigan expressed its satisfaction at having reached an agreement enabling the implementation of long term environmental restoration and monitoring actions which previously lacked funding.