Canadian Brownfields Case Study

Lac-Megantic Rail Disaster Remedation

Source: Connect2Edmonton.ca

The Lac-Megantic downtown core experienced a derailment of crude oil carrying tankers on a heavy rail line running through the city along the lakeshore.

PROJECT SUMMARY

Lac-Megantic's downtown core experienced a six million litre oil spill from tankers during a derailment episode. 67 people died in the initial explosions. Initial contamination migration prevention efforts were complicated by the bankruptcy of the railway company responsible for the derailment. Soil excavation and water pumping occurred to treat more than 270,000 m^3 of soil and 3,000,000 litres of water. Ex-situ aerated biopile remediation successfully returned some soils to the site; however, due to the instability of the fill used on site, significant soil shifting is expected for many years to come. Due to the lack of demand for land in the local market, it has currently been too expensive to build the deeply anchored foundations needed for redevelopment. Open space and a memorial park are currently planned for the site.

At 1:00 am on July 6, 2013[1], in Lac-Mégantic, Quebec a freight rail train carrying eight million litres of crude oil derailed[2]. The ensuing explosion, described as 30 meters in height[3], and subsequent fire wrought havoc on the surrounding area. Most of downtown Lac-Megantic, which was adjacent to the derailment site, was destroyed[4]. Some homes in close proximity to the disaster site were also lost in the catastrophe[5]. In total, eleven hectares of land were scorched by fires caused by ignited oil spilt during the derailment[6].

The resulting oil spill caused significant contamination to the natural environment. Approximately six million litres of oil spilt from 63 out of 72 tankers derailed during the accident[7]. Although much of the spilt oil was burned during the fire, some migrated into surrounding soils, a groundwater aquifer, and onto the adjacent

QUICK FACTS

Location
Lac-Megantic, Quebec

Project type
Petroleum hydrocarbon disaster remedation

Site size
12 hectares (29.6 acres)

Land uses
Open space, recreation, public market

Keywords/special features
Disaster, oil spill, biopile, soil washing, water decontamination, ex-situ remedation

Website
https://englobecorp.com/canada/en/projets/remediation-of-contaminated-soil-following-the-train-derailment-at-lac-megantic

Project address
4999-5271 Rue Frontenac
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Brownfield Project Award(s)
2018 Brownie Award Finalist: Sustainable Remediation and Technological Innovation
2016 Brownie Award: Best Overall Project

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waterbodies[8]. Overland oil migration also caused infiltration of oil into the municipal stormwater system through stormwater outlets[9]. Consequently, the Chaudière River, Lake Megantic[10], and municipal water treatment facilities were contaminated with petroleum products[11].

Site Characteristics

Although the oil spill affected a large area, this case study will focus on the 120,000m^2 area of destruction surrounding the derailment site. The area impacted by the train derailment was determined through satellite photography analysis[12]. Before the disaster, the site area was a primarily commercial district with some open space, residential, and a bisecting heavy rail line[13]. The commercial district constituted most of Lac-Megantic's downtown core[14]. Activities on the site included commercial retail, the town library, bars, and a pharmacy[15]. 28 buildings were destroyed during the disaster[16], and an additional 22 buildings were removed during the remediation process on and around the site[17].

Source: CanadianManufacturing.com

Destruction of buildings occurred due to fire, explosions, and demolition during the emergency remedation phase.

Cleanup

Cleanup of the Lac-Megantic site is signified by two phases. The first phase consisted of efforts to prevent the migration of spilt oil into the nearby Chaudière River and Lake Megantic[18]. This work lasted approximately 1 month before the second phase of soil and groundwater remediation occurred[19]. A large portion of the remediation was thereby completed by December 20, 2013[20].

Many geotechnical activities were performed during the first month after the disaster to prevent migration of contaminants off-site. As mentioned, after the oil spill, contaminants were migrating into the stormwater and municipal sewer system through manholes and stormwater inlets[21]. To prevent further oil migration inlet points were sealed[22]. Additionally, vents were installed in order to evacuate petroleum vapours from the now sealed storm/sewer system[23]. This was likely done to mitigate any risk from explosions caused by petroleum vapours trapped in sewer/stormwater pipes, which could have been catastrophic. Further, air quality monitoring equipment was implemented on the site[24]. In addition to detecting the risk of explosion from pooling petroleum vapours emitted from soil contaminants and from sewer/stormwater vents, careful air quality monitoring helped maintain a safe work space for workers involved in the remediation efforts.

Contaminant migration efforts also included the creation of ponds or trenches to collect oil at key sites. For example, in order to prevent contaminant migration into nearby water bodies, temporary holding ponds were constructed at stormwater outlets[25]. Temporary ponds also allowed oil to collect in key sites within the municipal water treatment system to prevent further damage to treatment facilities[26]. Approximately one kilometre of other trenches were constructed to assist with oil recovery efforts[27].

The success of the above efforts to prevent contaminant migration is hard to judge. Out of the six million litres of oil spilt, approximately 100,000 litres of petroleum products contaminated the Chaudière River[28]. The initial phase of cleanup was complicated by several factors. Residual heat from the initial fires as well as potential exposure from benzene, a toxic substance contained in crude oil, were reported to hinder cleanup efforts[29]. Such conditions made trenching activities and the demolition of 28 buildings and 55 trees occurring in the first month both dangerous and challenging[30].

An example of aerated biopile soil remedation.

Source: Ash Remediation Management

The second phase of dealing with the Lac-Megantic oil spill began with a characterization of contamination and remediation. To accern the level and location of contaminants, 125 groundwater samples and 1,200 soil samples were taken[31]. Additionally, 116 boreholes and 320 exploration trenches were dug[32]. Results of soil testing estimated the quantity of contaminated soil at 300,000 m^3[33]. Contamination levels in soils ranged from 3,000 mg/kg to 30,000 mg/kg of hydrocarbons[34]. Soil and groundwater testing were complicated by the need to accommodate reconstruction of the damaged heavy rail line[35]. Despite challenges, the result of contaminant characterization was the production of an emergency remediation plan near the end of October 2013[36].

Remediation of contaminated soils and water involved soil excavation and pumping of contaminated water for treatment[37]. Twenty-three excavations were performed in and around the site of the derailment[38]. Approximately 280,000 m^3 of soil contaminated with petroleum hydrocarbons was excavated for treatment[39]. Soils were stored on site, in a nearby municipal industrial lot nearby, and in two nearby municipalities for remediation[40]. Contaminated soils were treated[41] using biopile remediation technologies[42]. Biopile remediation involves using microbes native to local soils, aeration, nutrient supplementation, and moisture control to consume and transform petroleum products[43]. Soils meeting Quebec standards for contamination of less than 300 mg/kg were used to re-fill excavation sites[44]. Alternatively, soil with contamination levels below 700 mg/kg was used during the remediation of a nearby former mining site[45]. In total, approximately 3,000,000 litres of water contaminated with petroleum hydrocarbons[46] was decontaminated using a novel process called Ultrasorption[47]. Ultrasorption is a technique for treating contaminated water using organic compounds that bind to contaminants and de-emulsify the contaminant-water solution. The Ultrasorbtion treatment process is not fixed in one place, and thus able to be moved to different areas containing contamination[48]. Once treated water reduced levels of contamination to provincial standards, the water was returned to nearby rivers[49]. As a result of decontamination efforts, approximately 50,000,000 litres of oil was recovered[50].

Planning and Redevelopment

Although soil remediation at the Lac-Megantic disaster site was slated to be complete by 2018, some issues have prevented redevelopment of the site[51]. An analysis of satellite imagery from 2019 shows that no buildings are currently present on the site where significant excavation and remediation with clean fill was performed[52]. Excavation of contaminated soils reached several meters in depth on the site[53]. The sandy quality of soil used as fill on the site has created unstable soil conditions[54]. In order to redevelop on the site, significantly deeper excavation is required to anchor building foundations and accommodate the currently unstable soil structure[55]. The existing lack of redevelopment on the Lac-Megantic site also reflects the lack of strong market demand for land in the small town. Lacking demand coupled with the extra costs associated with redevelopment on sandy soils would likely preclude profitability of any projects. Currently, it is estimated that soils will continue to shift for years until building on the site becomes viable[56]. Consequently, the town has re-routed the main street to the east and have completed a new downtown visioning process[57]. Plans for the former disaster site include a city-owned public market and a memorial park in honour of the people killed by the derailment[58].

Source: Google Maps Satellite Imagery, 2019

A 2019 photo of the Lac-Megantic derailment site showing the removal of many buildings and lack of redevelopment.

Financing

Because the railway operator MM&A was found to be at fault for the disaster due to safety violations[59], MM&A was liable for the entire cleanup costs associated with the Lac-Megantic disaster[60]. Unfortunately, MM&A's liability insurance was insufficient to cover the cleanup costs[61] expected to exceed $400 million and led them to declare bankruptcy[62]. Later, Canada Pacific Railroad and World Fuel Services (who ordered the oil shipment from MM&A) were ordered by the Quebec government to contribute to the costs of cleanup[63]. During the initial cleanup after the bankruptcy of MM&A Lac-Megantic municipal and Quebec provincial governments contributed financing towards cleanup costs[64]. Later, the federal government of Canada contributed $95 million in financing for cleanup[65].

Lessons Learned

The Lac-Megantic disaster reveals how brownfield redevelopment on unstable soil fill can pose challenges in regions that lack a strong real estate market as it becomes difficult to justify costs associated with anchoring buildings to bedrock. Lac-Megantic might consider expansion of the memorial park opened on the site to help improve land use and bring healing and closure to the community. Lac-Megantic's experience demonstrates how there are also significant safety issues that arise for emergency and remediation workers as a result of evaporating petroleum vapours. Finally, biopile remediation was demonstrated to be an effective remediation technology for petroleum hydrocarbons.

Endnotes

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