

The Importance of Interdisciplinary Planning and Execution of Remediation Projects for Contaminated Sites

**A Presentation to the
Canadian Association for the Club of Rome
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Construction Projects

- Construction has become integral to human society
- Building new infrastructure allows us to move and trade items more easily, facilitating life as we know it
- Human ingenuity has allowed us to build complex societies



Degrading Infrastructure

- ▶ Like anything in nature, infrastructure degrades with time
 - ▶ Rain erodes rock structures similar to water eroding rock
 - ▶ Freeze-thaw cycles degrade roads, bridges, buildings
- ▶ All infrastructure has a lifespan, whether known or unknown at inception



- ▶ Example: a bridge along De la Concorde highway in Montréal collapsed in September 2006

Photo credit: The Canadian Press Images/Montreal Gazette



Degrading Infrastructure (cont.)

- Depending on land use, one of the consequences of infrastructure failure is the release of toxic substances (toxins)
- Toxins can be released into surface water, soil, groundwater, air, and/or bedrock, depending on the chemical properties of the substances
- Historically, releases were not always identified or known to be problems for people, animals, vegetation, or other lifeforms

Contaminated Sites

- Contaminated sites are areas where human infrastructure has degraded and caused releases of toxins into the surroundings
- Persistence of toxins can lead to people, animals, vegetation, or other lifeforms becoming ill, developing conditions that make life more difficult, or dying prematurely



What can we do about contamination?

- ▶ “Livable land” on Earth is limited
 - ▶ Any areas where humans have contaminated the land might be important for sustenance either for people or for other lifeforms
- ▶ Cleaning up contaminated sites has been done through history, but has become more ingrained in our thinking in the 5 decades
- ▶ In Canada, contaminated sites policy frameworks outline how to manage contaminated sites
 - ▶ Phase I: Historical information review
 - ▶ Phase II: Site assessment
 - ▶ Phase III: Remediation
 - ▶ Phase IV: Reclamation

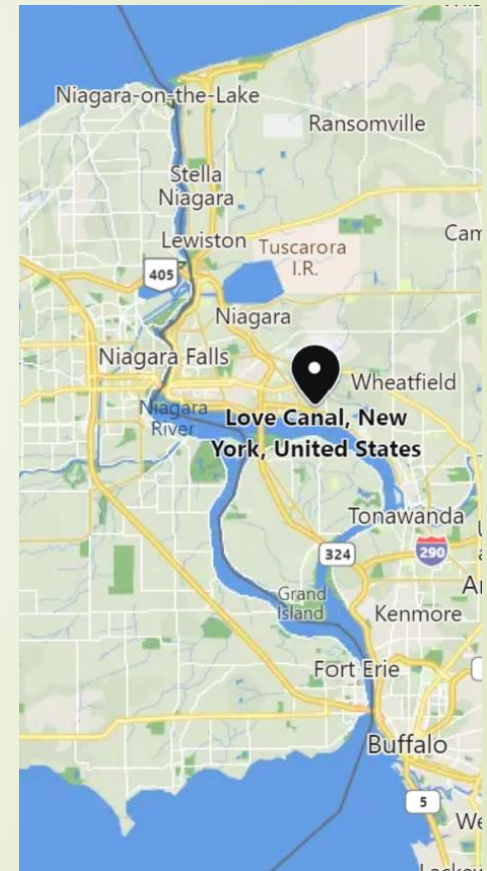
Contaminated Sites – Long Term

- Some contaminated sites are designed to be maintained as such, e.g., municipal landfills
- Landfills are managed by engineering and installing leachate capture systems, air emissions capture systems, liners for the waste cells, final cover to reduce infiltration of water into the contaminated material.
- Construction of new infrastructure on such sites is not typically allowable



What happens if you build on a contaminated site without clean-up?

- ▶ A famous example of construction on a contaminated site without clean-up is Love Canal¹
 - ▶ In 1894, William Love started to build a canal to connect the Niagara River with Lake Ontario, but by 1910 the project had gone bankrupt
 - ▶ Parts of the canal were used as a municipal garbage dump in the 1920s and as a chemical waste dump in the 1940s (with a clay liner and final cap)
 - ▶ In 1953, Hooker Chemical Co, under threat of loss to eminent domain, sold the land to the local school board for \$1, but with a caveat about the waste



¹ United States Environmental Protection Agency, 2020. *The Love Canal Tragedy*. Website: archive.epa.gov. Accessed October 7, 2020.

Building on a contaminated site without clean-up (cont.)

- ▶ The board built a school and sold off some of the land for residential development, both on and adjacent to the filled canal
- ▶ Development of the land resulted in multiple piercings of the cap and liner, and weathering released liquid waste from the barrels in which it had been buried
- ▶ In the late 1970s, after some heavy precipitation and infiltration, groundwater pushed the waste to the surface and even carried chemicals through the bedrock to the Niagara Gorge
- ▶ Over 200 chemicals were involved, many of them known carcinogens

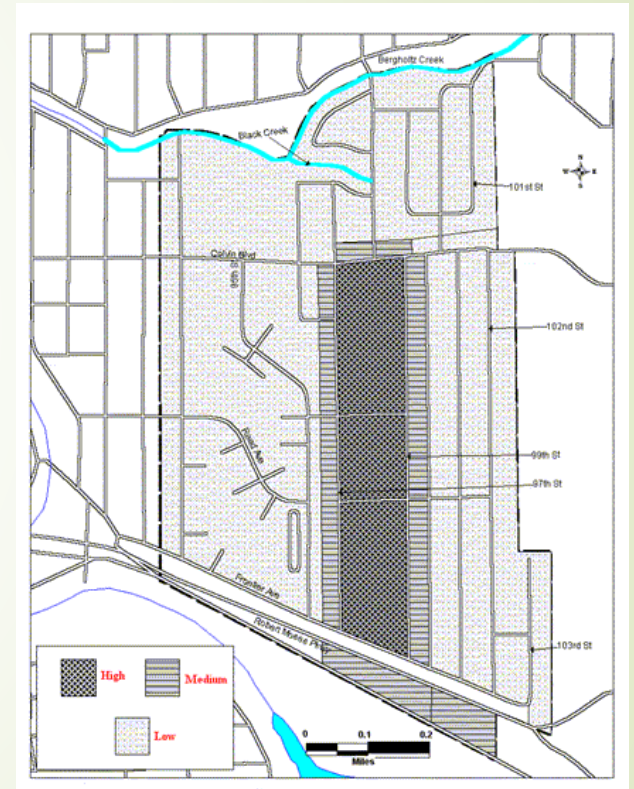


Image from

https://www.health.ny.gov/environmental/investigations/love_canal/401news.htm

Building on a contaminated site without clean-up (cont.)

- Consequently, gardens died, people got sick, people experienced birth defects
- The United States federal government eventually purchased the uninhabitable homes, though it took a great deal of lobbying and two rounds of effort
- Remediation under the Superfund program took over 20 years

Love Canal Cancer Incidence

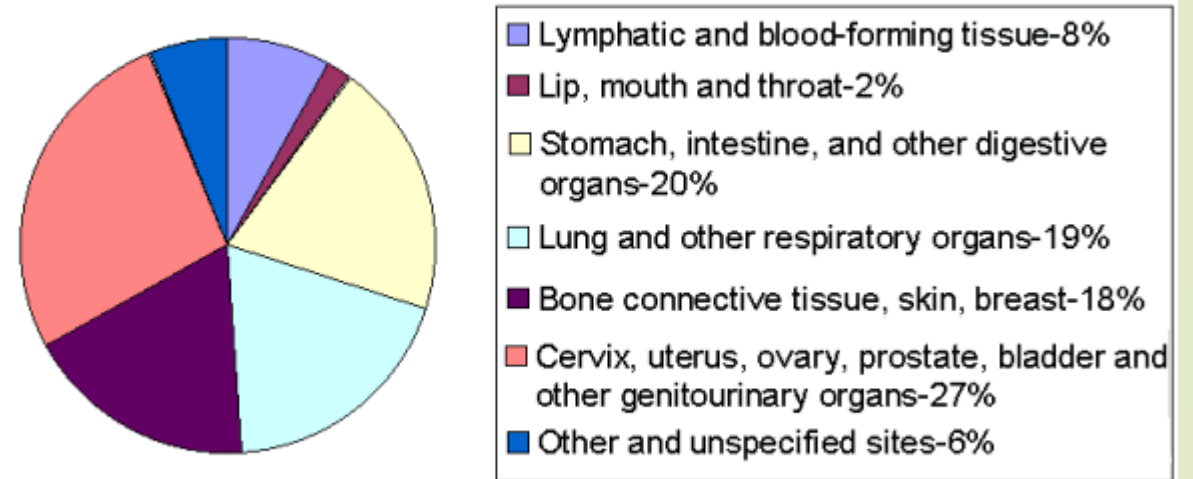


Image from

https://www.health.ny.gov/environmental/investigations/love_canal/cancinci

Contaminated Sites – Long Term

- ▶ Unlike landfills, many contaminated sites can undergo remediation or reclamation so the land can either be returned to its natural state or can be used for other processes or human infrastructure
 - ▶ For example, if a gas station is sold and the ground is remediated, the land can be reused
- ▶ Land use will depend on how well the site is remediated, which in turn might depend on intended land use
- ▶ Some transportation infrastructure projects (e.g., new roads) might involve land acquisition where some sites are contaminated
- ▶ Prior to construction of the new infrastructure, remediation needs to be completed so the integrity of the new build is sufficient and no adverse health effects will occur



Who is involved in clean-up?

- ▶ Cleaning up contaminated sites is inherently interdisciplinary since clean-up requires understanding geology, hydrogeology, hydrology, agronomy, atmospheric sciences, ecology, chemistry, epidemiology, toxicology, engineering, earth moving, landfill design and maintenance, etc.
- ▶ Clean-up may also involve members of the public, lawyers, doctors, government officials, or other stakeholders
- ▶ The entire process of contaminated sites clean-up needs to involve professionals and personnel from all walks of life, who should be involved in planning, execution, and conclusion



Case Study 1

- An urban contaminated site was selected as an area for redevelopment for a major infrastructure project
- Steps were taken by the municipality, which owned the site, to determine:
 - the volume of material that would need to be removed
 - the volume of material that could be reused
 - when the work could be accomplished
 - engineered design for the remaining and new infrastructure
- Many professionals were involved in the planning and design phase of the project

Case Study 1 (cont.)

- ▶ Prior to construction, wildlife surveys were completed to ensure nesting birds and local wildlife would be minimally impacted by construction
- ▶ Risks were assessed to determine what measures needed to be taken to protect workers health and safety
- ▶ Chemical exposure at the site needed to be considered since hydrogen sulphide and methane gases were present



Image from <https://www.nationaltrust.org.uk/minchinhampton-and-rodborough-commons/features/wildlife-surveys>

Case Study 1 (cont.)

- ▶ During remediation, a few problems arose:
 - ▶ One area was over-excavated—engineers had to be consulted to assess the area anew and provide new drawings
 - ▶ Exposure of the contaminated subsurface resulted in spontaneous combustion—thermal monitoring wells were installed around the construction zone to ensure the fires did not spread subsurface
- ▶ Communication between construction professionals, municipal officials, emergency services, engineers, and government officials was paramount in managing issues that arose during remediation



Image from <https://abc30.com/news/trash-fire-burns-at-merced-county-landfill/347567/>



Case Study 2

- Before construction, a pond on the site needed to be removed to manage contamination underneath it
 - Construction professionals worked with scientists and engineers to do this
 - A pilot test was initiated to determine what type of treatment might be needed for the pond water and how to test the water
 - Pilot test results were used to work with the municipality to determine where the water could be sent offsite for treatment
 - Dewatering the pond involved a coordinated effort by many firms and professionals to manage the contaminated water and contaminated subsurface materials
- Design for the new infrastructure project included construction of a new storm water pond in the same area of the old pond
 - Construction of the new pond involved determining what materials on site to reuse and involved import of new materials



New Construction

- ▶ Materials import for any new construction project needs to include knowledge of the site from which materials are being imported
 - ▶ Materials might have come from a contaminated site, and the companies involved might not know what requirements there are to import clean fill
 - ▶ Contaminated materials might degrade differently than other materials over time and might result in poor health outcomes or might accelerate degradation of new infrastructure
- ▶ Knowing from where your materials come is important regardless of whether you are involved in construction at an uncontaminated site or a previously contaminated one that has been remediated

Case Study 3

- ▶ A new construction project in an area that was not contaminated
 - ▶ Materials imported for new construction were not tested prior to import
 - ▶ Methane gas was being emitted from the imported material (fill) once it was in place
 - ▶ Health professionals and government officials worked with the construction company and consultants to engineer an extraction system for long-term methane management
- ▶ This issue might have been mitigated with testing of the imported material



Image from <https://roquedisposal.com/about-us/our-landfill>



Conclusion

- Construction projects are a challenge under any circumstances
- Contaminated sites increase the complexity of new construction since they can introduce acute or chronic health risks, hazardous work environments, and/or more uncertain subsurface conditions for long-term infrastructure integrity
- Given the complexities of construction at contaminated sites, it is vital to engage professionals from many walks of life at all stages of the project
- It is also important to communicate regularly between all professionals and to engage different professions as new issues arise

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