



Case Study of a Persistent Landfill Fire and Community Health Impacts

Questions for Consideration: Suggested Answers

Risk Assessment, Management, and Communication

Initial approach

Question 1: What information would you need to begin approaching this problem?

Assess

- Learn more about the fire, its location and characteristics.
- Determine whether air quality measurements are being done and if so, assess air quality measurements for contaminants of concern,
- Find out if there are any obvious health impacts (e.g., through hospital visits/admissions) due to smoke exposure.
- Consult other public health professionals who have expertise in this area or who have managed similar scenarios.

Plan

- Consider short-term options to mitigate risk to the population (i.e., acute risk – particulate and acrid gases; chronic disease risks – dioxins, etc.) and long-term options (e.g., landfill management plan, new infrastructure).
- Create key messages to communicate to the public about reducing exposure.

Implement

- Short term: Health advisories regarding minimizing exposure as appropriate.
- Long term: Advocacy role for long-term solutions/investment in a modernized landfill and development of a comprehensive landfill management plan.

Evaluate

- Since compliance with public health advice is not monitored, formal evaluation of the effectiveness of public health measures in preventing health consequences is difficult. However, process evaluation of environmental and health surveillance systems, waste management plans, etc., could be conducted.

Question 2: What further information would you want to know?

The following is a list of possible questions that could be discussed in conducting risk assessment. (Note: Some of the proposed questions below contain specific information pertinent to the community under study):

Landfill

- When was the landfill built?
- How deep is the landfill?
- What type of refuse does this landfill contain?
- Is the waste segregated at all?
- What potential contaminants may be released?
- Are landfill management/mitigation practices used?

Community surrounding the landfill

- Who are the populations exposed (e.g., firefighters, landfill workers, neighbors)?
- Who are the vulnerable populations to consider?
- How far are the closest homes, schools, daycares, hospitals, residential care facilities in relation to the landfill?
- How far is the more densely populated community located from the landfill?
- What is the current capacity of the local fire service (e.g., number of firefighters, technical expertise, specialized equipment)?

Socio-political environment

- Who are the stakeholders (e.g., landfill operators, members of the fire service, public health, municipal council members, federal/territorial government agencies, community residents)?
- Who funds landfill/solid waste disposal plans, and who is responsible for the costs of landfill fires (e.g., municipal government, a private company that operates the landfill, Aboriginal Affairs and Northern Development Canada (AANDC), Health Canada, First Nations Inuit Health, a combination of several of these, or another entity)?
- What are the regulatory mechanisms for landfill sites in this health authority? Does this landfill site meet specifications required for leachate collection systems, gas-monitoring systems, composite liners, etc.?
- What jurisdictions are involved?
- Are there equity issues?

Physical environment

- What is the topography of the region?
- What are the weather and wind patterns or inversions?
- What is/are the drinking water source(s) for the community?
- Is there a potential for surface or ground water contamination?
- Is there any environmental testing conducted (e.g., air quality) and what is the frequency?
- Have any mitigation strategies been tried to date?

Health Environment

- What, if any, health impacts have resulted from this fire?
- What, if any, public health advisories have been issued?

Potential health hazards

Question 3: What are the potential health hazards resulting from landfill fires?

- Burn/explosion hazards, primarily as an occupational risk to firefighters but may also impact civilians.
- Smoke exposure, which can result in both acute and chronic effects.
- Fine particulate matter of less than 2.5 micrometres in diameter (PM_{2.5}) can aggravate respiratory conditions such as asthma and bronchitis, and has been associated with cardiac arrhythmia, myocardial infarction, and acute heart failure. People with pre-existing pulmonary or heart conditions, seniors, and children are at highest risk from exposure to PM_{2.5}.
- At low levels of carbon monoxide exposure, humans may experience a variety of neurological symptoms including headache, fatigue, nausea, and vomiting.
- Dioxins released into the air settle on vegetation and bio-accumulate within the food chain. Exposure to dioxins has been linked to suppression of the immune system, disruption of hormonal systems, liver damage, skin rashes, reproductive and developmental disorders, as well as certain kinds of cancer.
- Other airborne compounds that can affect health include ozone, nitrogen oxides, sulphur oxides, associated metals, volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs).
- Potential water contamination.
- Anxiety/stress – Many residents in the area are suffering from anxiety as a result of the landfill fire.

(Federal Emergency Management Agency, 2002¹; U.S. Environmental Protection Agency, 2014²; Nunavut Department of Health, 2014³)

Question 4: This scenario involves both a surface fire and an underground fire. What are the differences between surface and underground landfill fires, and what are some hazards associated with them?

Surface Fires

This type of fire contains recently buried or un-compacted refuse, situated on or close to the landfill surface in the aerobic decomposition layer. These events generally burn at relatively low temperatures and can be intensified by landfill gas (methane), which may cause the fire to spread. They are characterized by the emission of dense white smoke and the products of incomplete combustion. However, if surface fires burn materials such as tires or plastics, the temperature can be quite high. Higher temperature fires can cause the breakdown of volatile compounds, which emit dense black smoke.¹

Underground Fires

This type of fire occurs much deeper than surface fires and involves waste that is months or even years old. The most common cause of underground landfill fires are due to hot spots created by an increase in oxygen content, which results in increased bacterial activity and aerobic decomposition, leading to increased temperatures. These “hot spots” can come into contact with pockets of methane gas and result in a fire. Underground fires are more difficult to extinguish than surface fires, and are more dangerous due to the potential for cave-ins. Underground fires produce flammable and toxic gases and can damage leachate containment liners and landfill gas collection systems.¹

Question 5: Exposure to smoke from the landfill fire is a major health concern. However, many of the homes in this community are of poor quality, making them less effective as clean air shelters. What might you propose to accommodate vulnerable people living in these conditions?

Community clean air shelters should be provided to vulnerable residents. These shelters are buildings or areas of a building with filtration that is capable of reducing smoke exposure. It would be prudent to perform an inventory of potential clean air shelters in the community such as HVAC-equipped (heating, ventilation, and air conditioning) shopping malls, libraries, or community centres, and to determine whether it is feasible to use these spaces in the short-term (hours) and/or long-term (days to weeks) for the duration of the smoke event. HVAC engineers can advise on how to achieve the best smoke reduction with the existing systems. (Elliott, 2014⁴; Barn, 2014⁵)

Question 6: What are some potential challenges with community clean air shelters?

- Residents may need to travel longer distances to reach community clean air shelters, and may be exposed to smoke in transit.
- Mobility may be limited for families with small children or elderly residents or who may not be able to walk or drive to a community clean air shelter.
- Community members who are accessing community clean air shelters instead of remaining at home may experience additional stresses, especially if extended stays are required.
- The benefits of potentially more effective but intermittent filtration at community clean air shelters should be weighed against less effective but more consistent filtration in home clean air shelters for extended periods of time.

(Barn, 2014⁵; Elliott, 2014⁴)

Risk Communication

Question 7: Recent air samples indicate that the some of the levels of dioxins over 24 hours is 0.2 pg/m³ (picograms per cubic metre), which exceeds the Ontario health standard for 24 hour average exposure of 0.1 pg/m³. Long-term exposure to high levels of dioxins is known to increase cancer risk; however, the current levels of dioxins are well below the health standard for cancer.

Question 7a: As the medical health officer, how would you communicate the risk to the citizens of this community?

Pregnant women and women who may become pregnant while the landfill fire is still burning should limit their exposure to the landfill fire smoke because dioxins above the standard may lead to decreased fertility in male offspring. Although dioxin concentrations have exceeded the relevant health standard, this is a chronic risk based on long-term exposure. Therefore while there is potential for adverse health effects, the risk remains low. With respect to cancer risk, since current levels of dioxins are well below the relevant health standards for cancer, it is not a concern at this time.

Question 7b: What advice would you give to the community?

The most effective way to minimize exposure to landfill smoke is to stay inside during smoky periods with doors and windows closed and with air exchangers on recirculation mode. Other sources of dioxin include backyard burning, tobacco smoking, and consuming animal fat. Therefore reducing exposure from those sources will also reduce long-term exposure to dioxins. (Nunavut Department of Health, 20143; Health Canada, 20056)

Question 8: Air quality data shows that most air pollution concentrations, such as fine particulate matter, have been low and do not pose a threat to public health. Usually prevailing winds do not blow the smoke towards town. However, wind predictions suggest that winds will move smoke towards town later in the day.

Question 8a: As the medical health officer, how would you communicate the risk to the citizens of this community?

Although the 24-hour average for particulate matter concentrations has been below health standards, spikes may occur due to the shift in wind patterns. If this happens, smoke from the landfill could have an impact on vulnerable groups including seniors, children, pregnant women and people with health problems such as heart disease, lung disease, or asthma.

Question 8b: What advice would you give to the community?

Vulnerable people should stay indoors during high smoke events when wind blows the smoke towards town, and keep doors and windows closed with air exchangers (if available) on recirculation mode during these periods. Limiting sources of indoor air pollution from combustion activities such as cooking with gas and smoking is also advised.

If you feel that smoke is resulting in symptoms such as difficulty breathing, you should seek medical attention as soon as possible. (Nunavut Department of Health, 2014³; Health Canada, 2005⁶)

Question 9: There was significant community outrage over this fire. What are some of the factors influencing outrage in this scenario?

According to Sandman (2012),⁷ some of the factors are:

- Lack of voluntariness
- Lack of controllability
- Fairness (rural/remote community)
- Lack of understanding
- Uncertainty
- Delayed effects
- Effects on children
- Effects on future generations
- Lack of trust (politicians, government officials at various levels)
- Negative media attention
- Human vs. natural cause

Question 10: What strategies can you employ to increase community responsiveness to your risk communication approach?

According to Sandman (2012),⁷ some strategies include:

- Be open and available
- Show compassion and courtesy
- Share values and personalize concerns
 - e.g., “I have children of childbearing age who also live in this community, and I am not worried that this event will negatively impact their offspring.”

Occupational health concerns

Question 11: As the chief medical health officer, you are asked to work with your occupational health and safety authority to develop advice on occupational exposure groups. Expressed concerns and requests for advice came from office workers and school staff wanting to know if masks should be worn or workplace/school closures should be issued, as well as from the firefighting crew concerned about dioxin exposure.

Question 11a: With whom would you consult and work concerning occupational health issues?

- HVAC engineers to advise on complex ventilation systems (such as would exist in a hospital).
- Regional occupational health and safety personnel.
- Environmental health experts such as the National Collaborating Centre for Environmental Health (NCCEH) or your provincial environmental health specialist
- Health Canada

Question 11b: Who might be in the high- and low-risk occupational exposure groups in this scenario, and what are some issues to consider around their potential risks and exposure routes?

- Low-risk exposure groups would include staff working in buildings such as hospitals, schools, and office buildings. Although this question refers to occupational health, consideration should also be given to others experiencing similar exposures such as children, patients, etc. Inhalation is the exposure route of concern.
- High-risk exposure groups would include the firefighting crew, landfill staff, and any workers in close proximity to the landfill that may be injured on the job or be exposed to significant amounts of smoke, such as construction workers on nearby roads. Inhalation and ingestion are the exposure routes of concern.

Question 11c: What are some things people in each of the lower- and higher-risk occupational groups can do to reduce their exposure to the smoke?

Lower Risk

In general, the same techniques to reduce smoke exposure at home would apply to other settings such as schools and office buildings. Consideration should be given to the location of the building and the air handling efficiency of each building.

Many health care institutions have augmented filtration. A ventilation engineer or a professional of similar capacity can assess a building's vulnerability to smoke infiltration and minimise unwanted effects of any filtration changes. In the absence of adequate in-duct filtration in an institution, clean air shelters using portable HEPA filters can be a reasonable approach. Ongoing examination of any filtration system during a smoke event is important to avoid overloading filters.

It is theoretically possible to set up clean air shelters in building areas with positive pressure and higher filtration efficiency such as operating rooms. However, alterations to HVAC systems may affect airflow and filtration in other areas of the hospital. Therefore these alterations should be individually designed under the guidance of a qualified professional to ensure important HVAC functions, such as infection control, are maintained.

Higher Risk

Personal protective equipment such as particulate filtering facepiece respirators (e.g., N95 masks) can be worn to reduce smoke exposure. Frequent rotation of workers would also reduce exposure. Dirty/contaminated clothing or uniforms should be cleaned outside of homes to avoid bringing contaminants home. (Elliott, 2014⁴; Keefe, 2014⁸)

Future considerations

Question 12: What types of surveillance would you want to have?

Environmental

- Air quality – monitoring specific parameters relevant to the landfill fire, such as particulate matter, carbon monoxide (CO), and dioxins.
- Wind/Weather patterns – continuous air quality monitoring and accurate weather forecasting are required for an accurate air quality health index surveillance system.
- Water quality – important if water sources are potentially affected.

Health Effects

- Monitoring of emergency room visits, hospitalization rates, rapid access clinic visits for conditions related to landfill smoke, e.g., exacerbation of asthma, bronchitis, chronic obstructive pulmonary disease (COPD), heart attacks, and neurological complaints potentially related to chronic carbon monoxide exposure.

Question 13: List important strategies to reduce the risk of future landfill fires.

Reduce waste generation

- Recycling program
- Composting program
- Packaging reductions

Appropriate and effective waste management

- Separating hazardous wastes, non-hazardous wastes, construction and demolition waste, and industrial waste
- Prohibiting all forms of deliberate burning
- Thoroughly inspecting and controlling incoming refuse
- Compacting refuse to prevent hot spots from forming
- Prohibiting smoking onsite
- Maintaining good site security
- Detecting and collecting methane gas

Early fire detection system

- e.g., Carbon monoxide monitors

(Federal Emergency Management Agency, 2002¹)

Scenario shift

Question 14: What is your role, as the medical health officer, in reviewing this proposal?

The MHO needs to assess if this plan would create more public health risks. For example, what are the risks for increased smoke or ash emissions? What about potential leachate contamination of surface or ground water? The extinguishment plan must include mitigation measures to avoid water contamination. Another consideration is the cost of spending a large amount of money when other significant public health issues exist in this region, such as a profound deficiency in safe and affordable housing.

Question 15: What are your recommendations for the future of this landfill?

A comprehensive waste management plan is needed for this community. There are many options for dealing with solid waste apart from landfills. Contingency plans for management of landfill fires, as well as improvement plans for landfill infrastructure, are required if landfills are the only plausible option for this community. Upstream prevention and modernization of the infrastructures are more cost-effective in the long term than passive reaction to toxic fires and associated health effects. Efficient coordination and communication across all levels of government are critical and remain ongoing issues.

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This document was produced by the National Collaborating Centre for Environmental Health at the British Columbia Centre for Disease Control, March 2015.

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Production of this document has been made possible through a financial contribution from the Public Health Agency of Canada through the National Collaborating Centre for Environmental Health.

ISBN: 978-1-926933-81-8

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