

Post-Disaster Food Assessment and Salvaging Best Practices

Literature Review and Jurisdictional Scan

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Post-Disaster Food Assessment and Salvaging Best Practices: Literature Review and Jurisdictional Scan

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Executive Summary

Alberta Health (AH) retained Millennium EMS Solutions Ltd. (MEMS) to conduct a literature review and jurisdictional search on food safety for packaged foods and best practices after a natural or man-made disaster. The findings from the report will be used to supplement food products safety guides that will cover packaged food, beverage, and alcohol.

Natural (e.g., wildfires, floods) and man-made (e.g., chemical releases, power outages) events can negatively affect food safety through packaging directly (e.g., heat damage by fire) or indirectly (e.g., food spoilage due to power outage during a fire). During and after such events, food products in affected areas may become unsafe for consumption.

Due to the magnitude of food products impacted, the variety of packaging, and the conditions they have undergone during an event, it would take a herculean effort to assess and quantify the health risk of food products after an event. However, even in the absence of scientific certainty of risk, reasonable preventive measures should still be taken to protect human health by applying a precautionary risk management approach. For example, assessing the food packaging to infer about the food safety and dispose accordingly

A review of post-disaster food safety best practices from Canada, the United States of America (USA), and Australia were evaluated to determine whether these practices were based on scientifically defensible evidence or a precautionary risk management approach. These practices can be grouped into three main categories: food products spoilage, food products contamination, and impacts related to physical damage. Similar guidance and advice were noted across the different jurisdictions and between private homes and permitted food establishments. Based on guidance from AH, physically damaged foods (e.g., dents, cracks, ruptures, crushing, or other alterations to the integrity of the packaging) were out of scope for the current review as they should be disposed of as they could be reasonable assumed to be contaminated with harmful contaminants of potential concern (COPCs) from a disaster.

Of the best practices reviewed, the following were based on scientifically defensible evidence:

- The disposal of perishable food products held within the “Danger Zone” temperatures (4°C to 60°C) for longer than 2 hours after a power outage due to short bacteria generation time, the amount of time to double in number. This means that bacteria, and their toxic by-products, present on food products can increase significantly in numbers within 2 hours, depending on the growth conditions present and bacteria species.
- The disposal of food products packaged in highly permeable materials, such as paper, cloth or fiber, if they have contacted flood water or fire-related chemicals (including

smoke, soot, ash, and fire-fighting chemicals). Flood water or fire-related chemicals can reasonably be expected to penetrate through the materials. Scientific studies confirmed that there is significant health risk from the ingestion of common contaminants like *E. coli* (flood water) or chemical toxins (fire). Scientific studies quantifying the concentrations of common contaminants in food products affected by floods or fires were not found.

- If food products have not been in direct contact with flood water, heat, or fire-related chemicals, are packaged in uncompromised and commercially sealed metal cans, and have undergone proper cleaning and sanitization methods, retention of such food products is defensible because the modern-day, uncompromised metal can is hermetically sealed and thermally processed to achieve sterility.

Other best practices appeared to be based on the precautionary risk management approach to reduce the risk of consuming harmful COPCs from an event. It was inconclusive from the literature review whether the levels of various COPCs in food products are sufficient to produce a negative health effect. A best practice based on the precautionary risk management approach is:

- The disposal of food products stored in less permeable packaging materials (*e.g.*, less permeable plastics and glass bottles with any type of closure) if they have contacted flood water or heat of fire, if they were affected by flood water or if they were in contact with smoke, ash, soot, or other fire-related chemicals.

Reviewed best practices based on the precautionary risk management approach adopted a zero-risk tolerance policy (“if in doubt, throw it out”). These precautionary measures may need to be re-assessed as more scientific and technological information becomes available and if the chosen level of risk tolerance to food products safety during natural and man-made events is greater than zero.

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Abbreviations

AEP – Alberta Environment and Parks
AGLC – Alberta Gaming, Liquor and Cannabis Commission
AH – Alberta Health
AHS – Alberta Health Services
BCGOV – Government of British Columbia
BCIHA – British Columbia Interior Health Authority
CCME – Canadian Council of Ministers of the Environment
CDC – Centers for Disease Control and Prevention
CFIA – Canadian Food Inspection Agency
COPCs – Contaminants of Potential Concern
kPA - kilopascal
MDH – Minnesota Department of Health
MEMS – Millennium EMS Solutions Ltd.
MPH – Manitoba Public Health
NLM – National Library of Medicine
NSDA – Nova Scotia Department of Agriculture
OPHD – Ontario Public Health Division
PAH– Polycyclic Aromatic Hydrocarbon
RMWB – Regional Municipality of Wood Buffalo
TOXLINE – Toxicology Literature Online
UFIFAS – University of Florida Institute of Food and Agricultural Science Extension
USA – United States of America
USDA – United States Department of Agriculture
USFDA – United States Food and Drug Administration
WHO – World Health Organization

1 Introduction

The Horse River Wildfire in 2016 disrupted the lives of many Albertans within the Regional Municipality of Wood Buffalo (RMWB). It caused enormous destruction to public and private properties with major impacts to the natural environment and to the physical and mental health of residents. Since the fire occurred near and in metropolitan centres, packaged food, beverage, and alcohol (collectively referred to as “food products” in this report) in the area were affected due to exposure to indeterminate factors, such as duration and extent of exposure to chemicals, heat, ash, soot, water, and smoke. In addition to safety implications, the sensory profile of a food item (e.g., smell) may be affected, making it unpalatable.

In Alberta, a significant portion of the food industry, including food establishments, such as grocery stores, restaurants, and some food processing facilities, is governed by the *Food Regulation*, pursuant to the *Public Health Act*. Alberta Health (AH) is responsible for the administration of these legislations while Alberta Health Services (AHS) oversees the inspection programs assessing and monitoring compliance. Even though the *Food Regulation* does not apply to food handling in private dwellings where food products are handled for consumption by residents and guests, AHS does offer food products safety and handling advice to Albertans. In the aftermath of the Wildfire, AHS provided direction to all AHS-permitted food establishments in the RMWB to discard food products based on uncertainties of risks and hazards, a practice that was in line with other North America jurisdictions after similar situations. These food establishments were advised by AHS and the Medical Officer of Health offices to keep hermetically sealed canned goods with no visible damage and ordered to discard the following:

- open foods and all perishable foods;
- all foods with packaging consisting of paper, cardboard boxes, plastic and cellophane;
- single service items/utensils which also includes individually plastic-wrapped items; and
- bottles and jars of food with screw-top lids or crown/crimp cap.

Alberta licensed liquor stores and licensees are regulated under the *Gaming and Liquor Act* and *Gaming and Liquor Regulation*. The Act empowers the Alberta Gaming, Liquor and Cannabis Commission (AGLC) to control the manufacturing, sale, distribution, and consumption of liquor. It does not, however, address the handling of liquor products after a disaster nor does the AGLC have the experience or expertise in food products safety. Moreover, the *Food Regulation* does not apply to food handling by businesses that exclusively sell liquor or liquor-related products licensed under the *Gaming and Liquor Act*, thereby limiting AHS' ability to order the destruction of liquor products for safety reasons. After the wildfire, AGLC communicated to licensees that its staff will pick up damaged products to oversee their destruction and that the licensees should

work with their insurance companies to file claims. AHS provided advice and recommendations on re-opening, but compliance was voluntary.

The Government of Alberta took a predominantly risk management approach, using control options, to minimize Albertans' health risks. Yet, without an updated scientific understanding of the impact of man-made or natural events on packaged food products, this approach may place undue burden on disaster-stricken communities. Ordering the destruction and disposal of food products under this approach can exacerbate food scarcity and insecurity and may delay re-entry if food establishments need to restock supplies prior to residents return to their communities.

2 Objectives and Scope of Work

AH retained Millennium EMS Solutions Ltd. (MEMS) to provide a literature review and jurisdictional search of best practices for packaged food safety following natural and man-made disasters. The jurisdictional review will be used to improve advice and messaging of packaged food safety after a disaster.

Food safety may be negatively impacted by natural events such as wildfires, floods, landslides, tornadoes, and hurricanes; or man-made events such as industrial accidents, chemical/industrial releases or power outages resulting from human error. These impacts may be a direct result (e.g., fire) or an indirect result (e.g., by power outage during a fire) of the event. During and after such events, food products in affected areas may become contaminated with microbiological or chemical agents and interventions may be necessary to prevent human consumption.

The scope of this work is to provide an overview of food safety after a disaster, primarily packaged foods and its vulnerabilities, and current jurisdictional best practices in post-disaster food safety. The objectives of the work were to:

- explore jurisdictional best practices related to food safety after natural or man-made disasters and associated primary evidence; and
- identify gaps and limitations in current best practices and the associated science.

The following were determined to be out of scope based on guidance from AH:

- food products before processing (e.g., livestock, unharvested/ unprocessed grains, residential/commercial fruits, and vegetables);
- packaged foods that have not yet arrived at licensed food vendors or liquor stores (e.g., in transport);
- evaluation of the different types of facilities that serve and/or sell packaged food items;

- different types of storage spaces for commercially packaged food products (e.g., commercial freezers and fridges);
- physically damaged food products (e.g., dents, cracks, ruptures, crushing, or other alterations to the integrity of the packaging);
- impacts of a disaster on food nutritional value; and
- non-commercial packaging (e.g., home-canned foods and re-sealable plastic containers), previously opened packages, and food products packaged in non-commercial settings (e.g., home baked cookies in cellophane packaging).

3 Definition

The following definitions are provided to clarify their use in this document.

Food Products – includes food, beverages, and alcohol.

Food Safety – steps in handling, cooking, and storage of food products to prevent foodborne illnesses (United States Department of Agriculture [USDA], 2015).

Food Spoilage – the process of decay in food products due to chemical, biological, or physical changes in the food that render it unacceptable for consumption. Aspects of food spoilage include changing the taste, odour, texture (e.g., dried), and suitability for consumption (e.g., mouldy bread) (Clemson University, 2012).

Food Contamination – the introduction of any biological or chemical agent, foreign matter or other substances to food which may compromise its suitability for consumption.

4 Food Safety Management Approaches

Risk assessments are commonly used to characterize the nature, probability, and magnitude of risk to human health from chemical contaminants and other stressors present in the environment. These assessments are an objective, scientific evaluation of health risk based on the hazardous properties of a substance, and the nature and duration of exposure to the substance. A similar framework can be applied to assess food safety. The basic steps in a risk assessment are:

- Problem formulation – identification of contaminants of potential concern (COPCs), potentially operative exposure pathways and potential receptors;
- Exposure assessment – estimation of the exposure dose for human receptors for each COPC and each operative exposure pathway;

- Toxicity assessment – determination of the relationship between the dose of a chemical to which a person is exposed over a specified duration and the potential for associated adverse health effects; and
- Risk characterization – evaluation of potential risks to human receptors based on the exposure and toxicity assessments; and assessment of the associated uncertainties.

Sometimes scientific data may be inconclusive or insufficient to confidently quantify risk or determine a cause-and-effect relationship but a reasonable amount of risk can be presumed and preventive measures should still be taken to protect public health (Health Canada, 2000). In such circumstances, the risk management of human health using a precautionary approach to decision making may be necessary to facilitate timely and appropriate preventative actions (Health Canada, 2000). This type of approach is inherently subjective because it is based on the regulator's and/or society's chosen level of risk tolerance.

The application of precaution to manage health risk is characterized by three basic tenets: the need for a decision, a risk of serious or irreversible harm, and a lack of full scientific certainty (Government of Canada, 2003). The Government of Canada (2003) considers the application of precaution to be a legitimate and distinctive decision-making approach and states the following for the use of a precautionary approach:

- decisions can be guided by society's chosen level of protection against risk;
- precautionary measures should be subject to reconsideration based on the evolution of science, technology, and society's chosen level of protection; and
- precautionary measures should be non-discriminatory and consistent with measures taken in similar circumstances.

5 Methodology for the Literature Review

The literature review consisted of two distinct stages: (1) a problem formulation stage in which distinct key questions were identified for defining the scope of the literature search and (2) a literature search based on key words.

5.1 Problem Formulation

Problem formulation included the identification of key questions relating to best practices for public health protection and interventions/actions for food products safety following man-made or natural disasters. The key questions were derived from discussions with AH and consisted of the following:

Key Question #1: How can packaged food products be affected directly or indirectly by man-made and natural events?

This key question addressed the following:

- overview of types of food packaging and sealing methods;
- factors that increase the porosity or permeability of food product packaging;
- contaminants of concern for food products during natural and man-made events;
- physical, chemical, or biological impacts to food products; and
- contamination of food products in sealed packaging and potential impacts to human health if consumed.

Key Question #2: What are the best practices and/or interventions and actions associated with food products safety affected directly or indirectly by man-made and natural events for licensed food vendors, liquor stores, private residences, and government enforcement?

This key question addressed the following:

- the effects of natural and man-made events on food products safety;
- the effects of natural and man-made events on different types of packaging and sealing;
- best practices for inspecting food products to evaluate whether they are safe for consumption after man-made and natural events;
- best practices to clean and store food products containers after they have been evaluated to be safe; and
- the scientific basis for decisions to dispose or retain food products based on their packaging and sealing.

5.2 Literature Search

The literature search consisted of four separate steps:

- Step 1 – Planning and searching;
- Step 2 – Narrowing search results;
- Step 3 – Document screening; and
- Step 4 – Data analysis.

The literature search was conducted using three databases: Google standard search engine and Google Scholar; Toxicology Literature Online (TOXLINE); and PubMed literature search system at the National Library of Medicine (NLM).

Search terms were developed based on the two key questions and in consultation with AH. Details of the literature search, including search terms, eligibility criteria, and literature identified for review are provided in Appendix A. Jurisdictional best practices were reviewed for Alberta, other Canadian jurisdictions, and jurisdictions in the USA and Australia.

5.3 Expert Inquiries

Relevant jurisdictions and experts were contacted to supplement information from the literature searches when minimal information was available on-line.

On October 12, 2017, the USDA was contacted via “Ask Karen” (<https://askkaren.gov/>) to inquire about the scientific basis for the 2-hour period of storage for perishable foods at temperatures of 4°C or greater prior to disposal. A response was received the same day and cited common acceptable practices but did not provide a scientific basis.

The Environmental Public Health Department of AHS was contacted on January 12, 2018, by phone to inquire about the process permitted food establishments must follow prior to re-opening after man made or natural events. The response is detailed in Section 7.3.

6 Food Product Packaging Overview

Under the *Food and Drug Act*, a package is any material in which food products are wholly or partially contained, placed, or packed (Government of Canada, 2017). Packages come in many forms, and include, but are not limited to, cardboard boxes, metal cans, folding boxes (e.g., pizza boxes and other boxes that require assembly), set-up boxes (i.e., boxes that are already put together and do not require assembly), glass containers, and plastic containers (Saint-Pierre, 2002). Food products packaging is required to meet certain specifications, such as the requirements to be nontoxic and not affect food products quality or integrity (Potter and Hotchkiss, 2012). Packaging serves multiple functions, including displaying goods and attracting customers, protecting contents from spoilage and contamination, and prolonging the shelf life of food (Allahvaisi, 2012). Selection of the most suitable type of package for food products depend on a variety of factors, including but not limited to, the level of protection required, economic considerations, and food characteristics.

Primary packaging (packaging that is in contact with food) may be composed of individual constituents (e.g., cardboard, plastic, metal, or glass), or a combination of such materials. Secondary packaging does not come into direct contact with food, as is the case with primary packaging, and is not subject to the same regulations as primary packaging. An example of secondary packing is a cardboard box containing wrapped granola bars.

The following sections provide a review of primary packaging and sealing materials and describes vulnerabilities that may result in food impacts during natural and man-made events.

6.1 Cardboard and Paper Packaging

Cardboard and other paper-based packaging materials are inherently porous. Although their permeabilities vary with the degree of mechanical processing (*i.e.*, compression of wood fibres), the fibrous structure of cardboard and paper renders them inherently permeable (Rasi, 2013). Cardboard and paper products are also vulnerable to mechanical destruction and water damage (Rasi, 2013).

6.2 Plastic Packaging

Food-grade plastics (polymers) in Canada and the US are defined by Health Canada and the United States Food and Drug Administration (USFDA), respectively. Food-grade polymers are categorized, as shown in Table 1. It should be noted that the codes for food-grade plastics defined by Health Canada and the USFDA differ from those defined by the Society for Plastics Industry Inc. coding system used in the recycling and sorting of plastics.

Table 1. Polymer Types and Categories for Food-Grade Applications

Polymer Type	Polymer Group	Code
Polyethylenes	1	PE
Polypropylenes	2	PP
Poly(ethylene-vinyl acetates)	3	EVA
Polystyrenes	4	PS
Polyvinyl chlorides	5	PVC
Ionomers	6	I
Polyethylene terephthalates	7	PET
Polyvinyl acetates	8	PVAC
Polycarbonates	9	PC
Polyamides	10	PA

Polymer Type	Polymer Group	Code
Polyvinyl alcohols	11	PVOH
Polyvinylidene chlorides	12	PDVC
Other	13	O

Government of Canada, 2014

Generally speaking, plastics are permeable to small molecules like gases, water vapour, organic vapours, and liquids (Siracusa, 2012). Food-grade plastics tend to have low permeability characteristics compared to plastics used for packaging items other than food (e.g., toy packaging) (Shin and Selke, 2014). Some plastics used for food packaging, such as fresh produce and meats, require a certain amount of air flow to prevent trapping excess moisture and discourage the growth of mould and bacteria (Shin and Selke, 2014). The shelf-life extension of some foods, such as fresh, ready-to-eat cut fruits and vegetables, may use plastics with better barrier characteristics to slow food degradation due to carbon dioxide, oxygen, and water vapour (Siracusa, 2012). However, even the least permeable plastic packaging has appreciable degree of permeability (Shin and Selke, 2014). Environmental factors, such as temperature and humidity, may further increase the permeability of plastic packaging (reviewed in Siracusa, 2012; Bhunia *et al.*, 2013). In comparison to metal and glass, plastic is more permeable.

6.3 Glass Packaging

Glass packaging presents a near-perfect barrier since it is inert and impermeable to gases, vapours and liquids (Rahman, 1999). However, the same is not true for closures used to seal glass bottles and jars. Typical commercial closure types for glass packaging include threaded screw-top caps and lids, non-threaded caps and lids, snap lids, crimped/crown lids, pull-top lids, and stoppers. Glass closures vary in material, composition, and treatment and may be complemented by a ring or a liner to aid sealing.

Food in glass jars that are sealed with metal “pop-top” screw-top lids are packaged hot, creating a vacuum as it cools. Uncompromised metal lids are depressed and, when opened, make an audible “pop” sound as air enters the container (Government of Canada, 2015b). Food products stored in such a manner, in uncompromised packaging, will be hermetically sealed (*i.e.*, air tight) until opened. However, hermetic seals in such containers may deteriorate over time due to aging of the ring or liner. Similarly, other types of threaded screw-top caps and lids, non-threaded caps and lids, snap lids, and crimped/crown lids rely on a ring or liner for closure may become

compromised without signs of damage. Glass bottles sealed with screw-top caps have also been demonstrated to show permeability through low levels of oxygen ingress (Lopes *et al.*, 2006).

Stoppers used as closures for glass containers may be natural, agglomerated, or synthetic and are used primarily to close wine bottles with a friction-hold seal (Robertson, 2016). Natural cork stoppers are mainly derived from the bark of the evergreen oak tree species, *Quercus suber* that grows primarily in the warm climates of southwestern Europe and northwestern Africa. Agglomerated stoppers refer to those composed of cork granules and various synthetic materials (Silva *et al.*, 2005; Robertson, 2016). Synthetic corks are generally composed of a combination of low- and high-density polyethylene and polypropylene (Robertson, 2016). Natural cork has a high-density, honeycomb-like cell structure that is highly elastic, compressible, and has low permeability to air and water (Robertson, 2016). Air pressure in the cells of natural cork stoppers reportedly ranges from 600 to 900 kilopascals (kPa) immediately after bottling, inhibiting air at atmospheric pressures (101 kPa) from entering the bottle (Robertson, 2016). However, for all three cork types (natural, agglomerated, and synthetic), the high pressures introduced during the bottling process equilibrate with the atmosphere over time. The time period over which this happens depends on the stopper material, but ranges from months to years. After this period of time, atmospheric oxygen enters the bottle, either through the cork cells, through imperfections in the cork (in the case of natural stoppers), or through the stopper-glass interface (Lopes *et al.*, 2006, 2007; Faria *et al.*, 2011; Fonseca *et al.*, 2013).

6.4 Metal Packaging

The modern-day, uncompromised metal can is impermeable to gases, vapours, liquids and light (Ooraikul and Stiles, 2013). For the commercial distribution of canned goods, distributors must demonstrate that products are hermetically sealed and thermally processed to achieve sterility (Government of Canada, 2014a). Canned goods (*e.g.*, canned vegetables, canned meats) are generally either heated prior to canning or packaged using a pressure canner to achieve the thermal requirements (Government of Canada, 2013). Metal cans used for food packaging have no separate sealing material. Instead, a sealing or gasket compound is applied to the “can end”, which is in turn folded into the can structure in a double seam (Government of Canada, 2012b). The sealing compound creates a hermetic seal for the can (Government of Canada, 2012b). Similarly, beverage cans (*e.g.*, pull-tab containers) also achieve a hermetic seal through double seaming (United States Patent and Trademark Office, 1991; Ardagh Group, 2017). Unless physically compromised, hermetically sealed food and beverage cans are likely to maintain their integrity until the best before date. A metal can may be compromised if it is visibly damaged (*i.e.*, leaking, bulging, or swollen), if the can spurts liquid or foam when opened, or if the food inside is discoloured, mouldy, or exhibits an unpleasant odour (British Columbia Centre for Disease Control, 2017).

Steel and aluminium may be used for metal container and closure construction for food and drink products. Steel (low-carbon steel) is initially produced as a blackplate and then converted into tinplate or tin-free steel for container and closure manufacture (Coles and Kirwan, 2011). Tin plating in sufficient thickness provides good corrosion/rust resisting properties to steel, making it suitable for direct contact with acidic and brine-containing foods. Regardless, an organic coating is applied to most containers (tinplate and aluminium) on the inside surface to provide an inert barrier between the metal and food product. This barrier acts to prevent chemical reactions between the metal and food product (Coles *et al.*, 2003). Thus, the inside of metal food packaging materials is not expected to corrode/rust during increased moisture conditions (*e.g.*, during floods). Studies addressing potential rusting of the inside of metal food packaging materials were not found.

The design of metal cans also allows them to be resistant to thermal processing during sterilization. Food and drink sterilization temperature generally range from 115 to 135°C and pasteurization temperature range from 90 to 105°C (Coles and Kirwan, 2011). Metal cans experiencing higher temperatures than this may become compromised. Fires may burn at temperatures up to approximately 1000°C (Fire Science and Technology Inc., 2006). Studies on the potential impact of food packaging during fires were not found.

Aluminium foil is not commonly used as a primary packaging material; however, it can be used in foil laminates (Lamberti and Escher, 2007). Aluminium foil can also supplement other packaging types, such as plastics with insufficient barrier properties, since it is impermeable to oxygen and gases, volatile aromatic compounds, and moisture (Lamberti and Escher, 2007). Depending on treatments (such as heating) and food properties (such as acidity), aluminium from the foil can leach into foods when it is used as a primary packaging material (Liukkonen-Lilja and Piepponen, 2009; Kurunthachalam, 2013; Klotz *et al.*, 2017). Studies suggested that the amount of leached aluminium ingested from primary packaging materials under various treatment conditions (*e.g.*, heat, acidity) appears to be inappreciable and represent a small fraction of the total dietary intake (Krewski *et al.*, 2007).

7 Results of the Literature Search and Review

The current review identified three main categories of impacts to food products caused by man-made and natural disasters: food product spoilage; food product contamination (from fires and floods), and physical damage (*e.g.*, dents, cracks, ruptures, crushing or other alterations to the packaging). The physical damage of food products, during events such as tornadoes or landslides, may affect their integrity and safety for consumption. Based on guidance from AH,

food products affected by physical damage are not within the scope of the current review (Section 2).

A detailed summary of the literature search and review for food products safety decisions following natural and man-made events is provided in Appendix B. A summary of the jurisdictions and documents reviewed are provided in Table 2 below. Current best practices for discarding or keeping food products were generally similar across the different jurisdictions and for private homes and permitted food establishments. The following section summarizes the results of the jurisdictional review and examines whether the disposal or retention of food products is supported by available scientific information.

Table 2. Documents Reviewed

Jurisdiction	Reference	Document Title
Alberta	Government of Alberta, 2011a	Flood Water Precautions
	Government of Alberta, 2011b	Reopening Your Food Establishment After Flooding
	Government of Alberta, 2013b	Reopening Your Building After a Wildfire
	Government of Alberta, 2016b	Reopening Your Food Establishment After a Wildfire
	Government of Alberta, 2016c	Returning to Your Home
	Government of Alberta, 2016d	After a Fire – Food Safety for Homeowners
Other Canadian Provinces	British Columbia Interior Health Authority, 2017a	After a Fire – Returning Home
	British Columbia Interior Health Authority, 2017b	Water and Food Quality (Information for Evacuees Returning after a Fire)
	British Columbia Interior Health Authority, 2017c	Returning Home after a Wildfire
	Government of British Columbia, 2017	Guideline of Emergency Action Plan for Food Establishments: Fire
	Manitoba Public Health, 2015a	Guideline of Emergency Action Plan for Food Establishments: Flood
	Manitoba Public Health, 2015b	Food Safety After a Power Outage
	Nova Scotia Department of Agriculture, 2013	Food Safety After a Flood
	Nova Scotia Department of Agriculture, 2015	Food Safety After a Fire
	Ontario Public Health Division, 2011a	Food Safety After a Flood
	Ontario Public Health Division, 2011b	Food Safety in an Emergency
	Canadian Food Inspection Agency, 2012	Guide to Wildfire Recovery
Canadian Red Cross, 2016	Keep Food and Water Safe After a Disaster or Emergency	
International	Centers for Disease Control and Prevention, 2017	Food Safety in Natural Disasters

Jurisdiction	Reference	Document Title
	International Food Safety Authorities Network, 2005	Food Safety Issues to Consider After a Flood
	Michigan State University, 2018	Food Safety after a Fire
	Minnesota Department of Health, 2010	The Disaster Handbook
	University of Florida, 1998	Tornado Food Safety
	United States Department of Agriculture, 1996	A Consumer's Guide to Food Safety
	United States Department of Agriculture, 2007	Keeping Food Safe During an Emergency
	United States Department of Agriculture, 2013	USDA Offers Food Safety Tips for Areas Affected by Flooding
	United States Department of Agriculture, 2017b	Food and Water Safety During Power Outages and Floods
	United States Food and Drug Administration, 2015	Food Safety for Consumers Returning Home After a Hurricane and/or Flooding
	United States Food and Drug Administration, 2017a	Environmental Health in Emergencies and Disasters
	World Health Organization, 2002	Ensuring Food Safety in the Aftermath of Natural Disasters
	World Health Organization, 2006	Flood Water Precautions

7.1 Summaries of Best Practices

7.1.1 Power Outage

Power outages can be caused by equipment failure, storms, flooding, fire, to name a few. Best practices for food product safety during a power outage are focused on perishable, refrigerated or frozen food products. Perishable food products include, but are not limited to, raw or cooked meat, poultry, seafood, luncheon meats, casserole, stews, soups, dairy, mayonnaise or dressing, cooked pasta, potatoes, rice, and salads made from any of the ingredients listed above (USDA, 2007; Nova Scotia Department of Agriculture [NSDA], 2013). Refrigerated food products not directly affected by other contaminants (*e.g.*, contaminants from a fire, flood or other disasters) should be transferred to a freezer, when possible (NSDA, 2013). Fridge and freezer doors should be kept tightly closed, as much as possible, to maintain cold temperatures (University of Florida, 1998; USDA, 2007; Minnesota Department of Health [MDH], 2010; USFDA, 2015; Centers for Disease Control and Prevention [CDC], 2017). In instances where perishable food products requiring refrigeration are left within the “Danger Zone” (4°C to 60°C) for longer than 2 hours, or if they feel warm or have unusual odour or colour, they should be discarded (Government of

Canada, 2012a, 2014b, 2015a; USDA 2013a, 2017b; USFDA, 2017c, 2017d; US Department of Health and Human Services, 2017). Frozen dinners, desserts, and ice cream should not be refrozen once thawed (NSDA, 2013). Partially frozen food (excluding the desserts listed above) can be refrozen if it has not been fully thawed and if the item still contains visible ice crystals (Government of British Columbia [BCGOV], 2017).

If a power outage occurs during a wildfire, flood, or other event, the different jurisdictions recommended the following:

- Discard all food items from a refrigerator or freezer if seals are not airtight and the potential exists for contamination (e.g., fumes, smoke, water, etc.) to penetrate the refrigerator or freezer (Ontario Public Health Division [OPHD], 2011a, 2011b; NSDA, 2013; BCGOV, 2017; British Columbia Interior Health Authority [BCIHA], 2017a, 2017b, 2017c, 2017d).
- If the seal integrity can be guaranteed, items from refrigerators and freezers may still have to be disposed if the temperature of perishable food items have exceeded 4°C for more than 2 hours (BCGOV, 2017). If, however, the integrity of the seal cannot be determined, then all refrigerated and frozen items should be disposed, regardless of their temperatures (University of Florida Institute of Food and Agricultural Science Extension [UFIFAS], 1998; MDH, 2010; Canadian Food Inspection Agency [CFIA], 2012; NSDA, 2013; USFDA, 2015).

7.1.2 Flood Water and Fire

Based on the literature review, best practices for inspecting, discarding, cleaning, and retaining affected food items were found to be similar for floods and fires. Most jurisdictions recommended that unpackaged food products and food products packaged in permeable packaging be discarded if they have come into direct contact with flood water, fire or fire-related chemicals (including smoke, soot, ash, and fire-fighting chemicals [e.g., fire-retardants]). Only food products in commercially sealed, unopened, undamaged, and waterproof metal cans can be retained after proper cleaning and sanitization. A summary of best practices for food product safety after flood or fire is as follows:

- Inspect all food products thoroughly and discard any items that have come in direct contact with flood water, heat, and fire-related chemicals (World Health Organization [WHO], 2002; USDA, 2007, 2013b; Government of Alberta, 2011a, 2011b, 2013, 2016a, 2016b, 2016c; OPHD, 2011b; CFIA, 2012; Manitoba Public Health [MPH], 2015a, 2015b; NSDA, 2015; USFDA, 2015, 2017a; BCIHA, 2017a; CDC, 2017).
- Discard any opened goods, cartons or boxes showing residue (smoke or otherwise) on its exterior and any food products that have visible water or heat damage. Discard food

products stored in permeable containers and containers with closures that are not air-tight, including screw-caps, snap lids, crimped or crown caps, and corks (WHO, 2002; USDA, 2007, 2013b; Government of Alberta, 2011a, 2011b, 2013b, 2016a, 2016b, 2016c; OPHD, 2011b; CFIA, 2012; MPH, 2015a, b; NSDA, 2015; USFDA, 2015, 2017a; BCIHA, 2017a; CDC, 2017).

- Discard all food products wrapped in soft packaging (paper, plastic, cloth, or fiber) (UFIFAS, 1998; Government of Alberta, 2011a, 2011b, 2016a, 2016c; MPH, 2015a, 2015b; NSDA, 2015).
- Discard all home-jarred and home-canned items (Government of Alberta, 2011a, 2011b; CFIA, 2012; BCIHA, 2017a).
- All fresh or cooked fruits and vegetables should be discarded (UFIFAS, 1998; WHO, 2006; NSDA, 2013; MPH, 2015a, 2015b).
- Discard all food items that are past expiration date or showing signs of spoilage (BCIHA 2017a).
- Discard all commercially canned goods (food and beverages) that exhibit any signs of damage, including bulging, swelling, leaking, punctures, dents/holes, fractures, rusting, or items with damaged labels (USDA, 2007, 2013b; OPHD, 2011b; CFIA, 2012; Government of Alberta, 2013b, 2016a, 2016b, 2016c; NSDA, 2015; USFDA, 2015, 2017a).
- Discard all beverage containers with screw caps, corks, or other closure types, including commercially bottled beverages, since these closures are permeable to flood water and fire-related contaminants (UFIFAS, 1998; USDA, 2007, 2013b; OPHD, 2011b; Government of Alberta, 2013b, 2016c; MPH, 2015b; NSDA, 2015; USFDA, 2015, 2017a).
- Discard non-food items that may facilitate the accidental ingestion of contaminants if they have or may have come into contact with flood water or fire-related chemicals, including single service items such as utensils wrapped in plastic, stir sticks, and straws. Porous items that may come in contact with a person's mouth, including baby bottle nipples and pacifiers, wooden bowls and cutting boards, plastic, paper or foam storage containers, and utensils, should be discarded (MDH, 2010; OPHD, 2011b; MPH, 2015a; NSDA, 2015; BCGOV, 2017; CDC, 2017).
- Only food products packaged commercially in hermetically sealed, unopened, undamaged, air-tight, and waterproof cans that have not been in direct contact with flood water, heat, or fire-related chemicals may be retained after cleaning and sanitization (Government of Alberta, 2011a, 2011b, 2013; OPHD, 2011b; CFIA, 2012).
- Cleaning procedures should be completed before the affected cans are opened. Affected items should be thoroughly washed with soap and water. They should then be rinsed with clean potable water, sanitized by immersing for 15 minutes in 5 ml (1 tsp) bleach per 750 ml (3 cups) water or 2 minutes in hot water (above 77°C), rinsed with clean potable water

to remove the bleach, if used, and air dried (USDA, 2007, 2013b; OPHD, 2011b; CFIA, 2012; NSDA, 2015; USFDA, 2015, 2017a). As an additional precautionary measure, cleaned and sanitized cans may be held for 3 weeks before use and inspected for signs of blowing or leaking; if present, such cans should be discarded (MPH, 2015b).

7.2 Rationales for Best Practices

The rationales for best practices for food product safety following natural and man-made disasters can be grouped into three main categories: food spoilage (e.g., natural decay or biological food spoilage), food contamination (e.g., the introduction of biological or chemical agents from flood water or fire), and physical alteration (e.g., chemical alteration due to heat or mechanical damage of food packaging). Rationales for the best practices reviewed in Section 7.1 are provided below.

7.2.1 Food Spoilage

Food spoilage during natural and man-made disasters may be due to natural decay, which affects the taste, odour, and texture of food (e.g., due to moisture loss or browning), or microbes (e.g., bacteria, moulds or yeast). Microbial food spoilage may be caused by non-pathogenic or pathogenic microorganisms. Ingestion of food products containing pathogenic microorganisms and their toxins may affect human health (Wagner, 2008). In contrast, food products that have undergone natural decay or contain non-pathogenic microorganisms may not cause illness but they can make food products undesirable to consume.

Pathogenic bacteria and other microorganisms are commonly present at low (undetectable) levels in perishable food products. Pathogenic bacteria may cause serious illness and even death, especially in children and older adults (USDA, 2016). Some pathogenic bacteria produce heat-stable toxins; thus, cooking may kill the bacteria but their toxins remain intact. The full list of pathogenic microorganisms and their associated natural toxins is extensive and includes many gram-negative (e.g., *Salmonella spp.*, *Vibrio vulnificus*, *Shigella spp.*, and the *E. coli* group) and gram-positive (e.g., *Staphylococcus aureus*, *Streptococcus spp.*, and *Mycobacterium bovis*) bacteria (USFDA, 2012). For example, foodborne illness due to *E. coli* is typically associated with uncooked beef, unpasteurized milk, contaminated produce, and contaminated water. *E. coli* generally has an incubation period (the time between consumption and onset of symptoms) of 2 to 10 days after ingestion. Symptoms include abdominal cramps, vomiting, and watery diarrhoea (USDA, 2013a; New South Wales Government, 2015; USFDA, 2017b). Foodborne illness due to *Salmonella sp.* is typically associated with raw eggs, poultry, seafood, unpasteurized milk, cheese, and contaminated fruits and vegetables. The incubation period for the onset of symptoms

due to *Salmonella* is 12 to 72 hours after ingestion. Symptoms include diarrhoea, fever, and abdominal cramps (USDA, 2013a; USFDA, 2017b).

The recommendation to dispose a perishable food product if it is stored for over 2 hours in the “Danger Zone” (4°C to 60°C) appears to be based on a precautionary approach to protect human health. Bacteria grows most rapidly within the “Danger Zone” and can double its population every 20 minutes (USDA, 2017b). For example, a single bacterium can give rise to 64 bacteria after 2 hours if its doubling rate is 20 minutes. The ingestion of even a small number of pathogenic bacteria can result in serious health effects (USDA 2016). The doubling time for bacteria will vary depending on its species and environment, which is constituted of the available nutrients, temperature, moisture, pH and many other factors (Maier and Pepper, 2015). The refrigeration of perishable food products at temperatures below the “Danger Zone” (4°C to 60°C) slows the growth of microorganisms (USDA, 2016). Refreezing or consuming partially frozen food (Section 7.1.1) can put a person at risk because the food product may have been held in the “Danger Zone” for some time even though the temperature may be below the “Danger Zone” at the time of checking. A large food item (e.g., a big slab of meat), whose core and outer temperatures may differ significantly, may be unsafe for consumption, even if it is still partially frozen. The assessment of large food items was not in any of the best practices reviewed.

The following is noted to further inform decisions on food disposal in the event of a power outage:

- a full freezer can keep food frozen for approximately 48 hours, while a half full freezer will keep food frozen for approximately 24 hours (CFIA, 2012); and
- an unopened refrigerator will keep food cold (below 4°C) for approximately 4 to 6 hours (CFIA, 2012).

7.2.2 Food Products Contamination

7.2.2.1 Potential Contamination From Flood Water

Analysis of flood water following natural disasters has been documented throughout the world (Cabrera *et al.*, 1999; Kondo *et al.*, 2002; Pardue *et al.*, 2005; Casteel *et al.*, 2006; Presley *et al.*, 2006; Chaturongkasumrit *et al.*, 2013; Callahan *et al.*, 2016; Shah *et al.*, 2016). The chemical and biological composition of flood water may vary from region to region depending on local fauna and livestock, as well as municipal waste management facilities and local industry. Some microbiological and chemical contaminants that are common to flood water from different regions and are known to pose risks to human health (Pardue *et al.*, 2005; Presley *et al.*, 2006; Government of Alberta, 2013a) are discussed further below.

In 2005, following hurricane Katrina, researches from Louisiana State University sampled flood water and identified faecal coliform, lead, arsenic and, in some areas, chromium concentrations

that exceeded US drinking water standards (Pardue *et al.*, 2005). Additionally, researchers from Texas Tech University assessed pathogens and toxicants following hurricane Katrina and found elevated levels of arsenic, lead, and several semi-volatile organic compounds in sediment/soils that exceeded the environmental standards for the protection of human health. Elevated numbers of *Aeromonas ssp.*, pathogenic *Vibrio spp.*, and coliform bacteria were also present in the flood water samples (Presley *et al.*, 2006). In 1999, following hurricane Floyd, researchers from the University of North Carolina identified multiple samples with faecal coliform, *E. coli* and coliphages, indicating the presence of human and animal faeces in the flood water (Casteel *et al.*, 2006).

Locally, the Government of Alberta conducted surface water quality monitoring following the 2013 flood event in Southern Alberta (Government of Alberta, 2013a). The study assessed surface water quality and not flood water, but it can be used to inform the types of contaminants that may be present in flood water that originated from these surface water bodies. Results from the monitoring program indicated that three sites located on the Bow River downstream of Calgary, two sites along the Oldman River, and one site along the South Saskatchewan River had elevated levels of faecal coliform bacteria and *E. coli* above the Canadian Council of Ministers of the Environment (CCME) guidelines for irrigation water use and contact recreation. Faecal material of human origin was also detected. Metals (including arsenic, iron, and mercury) and organic parameters (including polycyclic aromatic hydrocarbons [PAHs] and petroleum hydrocarbons) were detected in surface water but did not exceed any human health guidelines. Pesticides were detected but were within historical ranges observed prior to the flood.

Researchers from the University of Maryland investigated the *California Leafy Green Products Handler Marketing Agreement* requirement of a 9 metre setback applied to any leafy green produce that is to be harvested in areas subject to flooding (Callahan *et al.*, 2016). The study simulated a 9 metre setback from an area that was artificially flooded with *E. coli*-contaminated water. *E. coli* was detected at a distance of 9 m within 1 day of the study. After 14 days, *E. coli* was not detected within the setback distance; however, *E. coli* was detected after 63 days in soil within the flood zone, suggesting biological contaminants may persist for some time after a flood.

Current evidence supports the disposal of all permeable packaging materials that have been immersed or impacted by flood water. This includes all packaging materials with any type of closure, except for commercially sealed, watertight metal cans. Although the literature search did not identify any studies that specifically evaluated the penetration of flood water/water into different types of packaging materials or the levels of flood-related contaminants present in different types of packaged food products, it is reasonable to assume that flood water would easily penetrate into highly permeable packaging materials such as paper, cloth, or fibre.

Therefore, the ingestion of food products packaged in such materials would result in significant health risk from common flood water contaminants like *E. coli*.

The likelihood of human health risk from food products packaged in less permeable materials (such as certain plastics or glass containers sealed with different closures) is less clear. In this instance, the use of the precautionary approach and disposal of these food products may be appropriate due to the following:

- there is a lack of scientific information demonstrating low or no risk to human health from the ingestion of these food products;
- even the least permeable plastic packaging has measurable permeability (Shin and Selke 2014);
- environmental factors, such as temperature and humidity, may cause plastic packaging to become more permeable (reviewed in Siracusa, 2012; Bhunia *et al.*, 2013); and
- all closures used to seal glass bottles and glass jars have some permeability (summarized in Section 6.3).

Jurisdictional best practices consistently allow for the retention of unopened, undamaged, and waterproof metal cans after proper cleaning and sanitization (described in Section 7.1.2). Based on the impermeable nature of commercially sealed metal cans (discussed in Section 6.4), the cleaning and sanitization of such cans is expected to be a reasonable risk-protective measure from flood water contaminants. However, commercially sealed cans should be discarded if they exhibit any bulging, swelling, leaking, punctures, dents/holes, fractures, rusting, or damaged labels (USDA, 2007, 2013b; OPHD, 2011b; CFIA, 2012; NSDA, 2015; USFDA, 2015, 2017a).

7.2.2.2 *Potential Contamination From Fires*

Fire smoke emissions consist of a complex mix of gases, including carbon monoxide, carbon dioxide, nitrogen oxides, volatile organic compounds (*e.g.*, acrolein, formaldehyde, methane), and suspended particulate matter (Gouv. du Québec, 2014). Depending on the chemical composition of the materials burned, such as building materials, vehicles, tires, industrial infrastructure, and petrochemical substances, a variety of toxic chemicals may be present in fire ash and soot. For example, the combustion of pressure treated wood products can result in elevated levels of arsenic, copper, zinc, and chromium in ash and soot (Government of Alberta, 2016a).

Following the Horse River Wildfire in the spring of 2016, Alberta Environment and Parks (AEP) and the RMWB collected and analysed ash samples from burned forested areas and various neighbourhoods in Fort McMurray and surrounding areas (Government of Alberta, 2016a). The analytical results indicated that ash collected in residential areas contained metals (arsenic, hexavalent chromium, and lead), PAHs, and dioxin and furan concentrations above health-based screening values (Government of Alberta, 2016a). The ash samples were generally caustic, with

pH values as high as 12.5 (Government of Alberta, 2016a). Ash and debris from burned structures in homes and buildings contained more toxic substances than forest fire ash due to the presence of synthetic and chemically treated materials (e.g., treated wood used for desks and fences).

During a fire, direct exposure of food products to fire and fire-related chemicals can make them unsafe for consumption. Toxic fumes, smoke, soot, ash, fire-retardant, and other chemicals can permeate through food packaging or penetrate into refrigerators and freezers lacking airtight seals. Current best practice recommends the disposal of all permeable packaging materials that have come into direct contact with fire-related chemicals and heat. This includes all packaging materials with any type of closure, except commercially sealed, undamaged metal cans.

Specific studies on the penetration of fire-related chemicals into different types of packaging materials were not found. Similarly, studies on the levels of fire-related contaminants present in different types of packaged foods were not found. However, fire-related chemicals can reasonably be expected to penetrate into highly permeable packaging materials such as paper, cloth, or fibre. Therefore, food products packaged in these materials will likely be compromised during a fire and should not be ingested.

The likelihood of human health risk is less clear from food products that have not been in direct contact with fire and are packaged in less permeable materials (such as certain plastics or glass containers sealed with different closures). In these instances, the use of the precautionary approach and disposal of these food products may be appropriate because:

- there is a lack of evidence confirming fire-related chemicals do not penetrate into packaged food products during a fire and are not present at sufficient levels to affect human health;
- there is potential risk to human health from the ingestion of COPCs associated with fire-related chemicals, such as PAHs;
- even the least permeable plastic packaging has measurable permeability (Shin and Selke, 2014);
- environmental factors, such as temperature and humidity, may cause plastic packaging to become more permeable (reviewed in Siracusa, 2012; Bhunia *et al.*, 2013); and
- all closures used to seal glass bottles and jars have some permeability (summarized in Section 6.3).

Due to the impermeable nature of commercially sealed metal cans, the proper cleaning and sanitization of metal cans that have not had direct contact with fire is expected to be a reasonable protective measure from smoke, soot, and ash (described in Section 7.1.2). However, commercially sealed cans should be discarded if they exhibit any bulging, swelling, leaking,

punctures, dents/holes, fractures, rusting, or damaged labels (USDA, 2007, 2013b; OPHD, 2011b; CFIA, 2012; NSDA, 2015; USFDA, 2015, 2017a).

7.2.3 Physical Damage to Food Packages and Food Products

During a fire, food exposed to the heat of fire may become chemically (e.g., cooked or partially cooked) or physically (e.g., ruptured cans, fractured glass jars, or melted plastic containers) altered and unsafe to consume.

Natural or man-made disasters can physically damage food packaging. Mechanical damages (such as dents, cracks, ruptures, rusting, or crushing) crack the organic coating on the inside surface of metal cans and internal corrosion (Section 6.4) and allowing the food products to gain access to the underlying metal (Coles *et al.*, 2003).

Food products may also become tainted by physical hazards, such as glass, wood splinters, and other debris (USDA, 1996). Based on guidance from AH, food products tainted by physical hazards were not within the scope of the current review.

7.3 Permitted Food Establishments

Current jurisdictional best practices for the disposal of unpackaged or packaged food products affected by power outages, flood water or fire-related chemicals did not differ between permitted food establishments and private households. The best practices for permitted food establishments are the same as those summarized in Section 7.1.

In Alberta, AHS (2013b) states that after flood incidents: “[i]t is the responsibility of the Manager or operator to conduct a complete self-inspection to ensure that normal operations can be resumed safely and without compromising food safety.” For small fires in food establishments, Government of Alberta (2016e) recommends a local public health inspector be contacted once it is safe to enter the premises. In the same document, a footnote at the end of a table (no table number or table title provided) suggests that “Alberta Gaming and Liquor” (which is now the AGLC) should be contacted for guidance on the disposal of alcoholic beverages after a small fire in food establishments. Other government documents about re-opening food establishments after a flood or wildfire did not mention contacting AGLC for guidance (Government of Alberta, 2013b, 2016c).

Two public health inspectors from the AHS Public Health Department were interviewed on January 12, 2018 and January 25, 2018 and asked about the requirements for a commercial food-handling establishment to re-open following a disaster or emergency, from a food safety perspective. Both inspectors indicated that the information is publicly available on the AHS website and the specific requirements for a commercial establishment handling food to re-open

following an event would be handled on a case-by-case basis. The inspectors were then asked if the requirement to contact a public health inspector prior to re-opening applies to all event types. Both inspectors noted that the operator of the establishment should know that they do need to contact a health inspector prior to re-opening. Their advice is in line with that of “Reopening Your Food Establishment after a Wildfire” (Government of Alberta, 2016c). The alignment of the practicing professionals and the AHS publication provides assurance to the public that the messaging is consistent.

A footnote at the end of a table (no table number or table title provided) in the Government of Alberta (2016e) document, entitled “*What to do if there’s a small fire in your food establishment*”, suggests that “Alberta Gaming and Liquor” (now the AGLC) should be contacted for guidance on the disposal of alcoholic beverages after a small fire in food establishments. Other Albertan documents relating to re-opening food establishments after a flood or fire in the establishment did not mention the AGLC (Government of Alberta, 2013b, 2016c).

Information specific to jurisdictional best practices for the disposal of alcoholic beverages was not found. Based on the information summarized in Section 6.3, the different types of stoppers used to seal alcoholic beverages in glass bottles would be permeable to flood water and fire-related contaminants. Similarly, alcohol packaged in plastic containers would also be permeable to flood water and fire-related contaminants. Therefore, alcoholic beverages in glass and plastic bottles can be handled in the same manner as other permeable materials (*i.e.*, dispose of these bottles if they have been in direct contact with flood water or fire; or if they have been affected by flood water, ash, soot, or smoke). Alcoholic beverages stored in impermeable metal cans (*i.e.*, those sealed with a double seam as discussed in Section 6.4) may be cleaned and sanitized if they have not come into direct contact with fire or flood water and if they do not exhibit any bulging, swelling, leaking, punctures, dents/holes, fractures, or rusting.

8 Conclusions

This review identified four common precautionary recommendations for food product safety across all jurisdictions:

- if there are any signs of damage to the food products, they should be discarded;
- if food products come into direct contact with a contaminant source, they should be discarded;
- if food products are in permeable packaging and are in the vicinity of a contaminant source, they should be discarded; and
- if freezer items were held above 4°C for longer than 2 hours, they should be discarded.

Current best practices for discarding or keeping food products were similar across different jurisdictions and between private homes and permitted food establishments. Based on a review of these best practices, the following were identified to be based on scientifically defensible evidence:

- Dispose of perishable food products that should be refrigerated or frozen after they have been held in the “Danger Zone” (4°C to 60°C) for over 2 hours (as discussed in Section 7.2.1). There are pre-existing microorganisms present in the food that can multiply quickly at that temperature range and can produce toxins that once ingested, can cause illness.
- Dispose of food products packaged in highly permeable materials, such as paper, cloth or fiber, or in damaged packaging are defensible since flood water or fire-related chemicals can penetrate such materials to contaminate the food and there is a significant health risk from the ingestion of common contaminants like *E. coli* (flood water) or chemical toxins (fire).
- Retain food products packaged in uncompromised, commercially sealed metal cans following proper cleaning and sanitization methods is defensible since the modern-day metal can is impermeable to gases, vapours, and liquids (Ooraikul and Stiles, 2013). Additionally, for commercial distribution of canned goods distributors must demonstrate that products are hermetically sealed and thermally processed to achieve sterility (Government of Canada, 2014a).

Other jurisdictional best practices for discarding or keeping food products following man-made and natural disasters had insufficient and inconclusive scientific data. However, there was sufficient information to infer that the COPCs present during these events may potentially pose a risk of serious harm to human health. Whether COPC concentrations were sufficiently elevated in food products to produce a negative health effect could not be determined. A precautionary risk management approach would be appropriate in these instances because as all three tenets for the application of precaution were present: the need for a decision, a risk of serious or irreversible harm, and a lack of full scientific certainty (Government of Canada, 2003).

From the jurisdictional review, it appears that governing and regulatory bodies, third party non-profit groups, university extensions, and international organizations all apply the precautionary approach rooted in zero-risk tolerance (“if in doubt, throw it out”). Under the zero-risk tolerance policy, foods stored in less permeable packaging materials (e.g., less permeable plastic and glass bottles with any type of closure) should be disposed of if one knows or suspects the food products have been in direct contact with flood water, smoke, ash, soot, other fire-related chemicals, or exposed to high heat because:

- there is no evidence to confirm that COPCs from a flood or fire will not pass through the packaging to contaminate the food products;

- there is evidence that even the least permeable plastic packaging has measurable permeability (Shin and Selke, 2014);
- environmental factors, such as temperature and humidity, can make plastic packaging more permeable (Siracusa, 2012; Bhunia *et al.*, 2013); and
- all closures used to seal glass bottles and jars have some permeability even though glass packaging may present a near-perfect barrier due to its inert and impermeable characteristics (Rahman, 1999) (summarized in Section 6.3).

The precautionary measures outlined above should be subject to reconsideration as more scientific and technological information becomes available.

9 Limitations and Challenges

The following are data gaps based on the literature review and jurisdictional search for post-disaster packaged food safety:

- There is a lack of scientific studies specific to the penetration of flood water and fire-related chemicals into low permeability plastics, different types of glass closures, fridges, and freezers.
- There is a lack of scientific studies quantifying the levels of chemicals present in food products stored in various packaging types after various natural and man-made events.
- There is a lack of information on the doses of contaminants that might be ingested from food products stored in permeable packaging and if these doses would pose a significant risk to human health.
- Large food items may have temperatures that are significantly different between the core and periphery of the food item and additional precautions may be required if any part of these foods have been exposed to temperatures in the “Danger Zone” (4°C to 60°C) for an extended period of time. This was not noted in any of the best practices reviewed. Based on the current zero-risk tolerance approach of the different jurisdictions, such items would be disposed.

10 References

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Appendix A Literature Search Methodology

A.1 Objectives

An on-line staged search method was employed for reviewing best practices for food product safety following natural and man-made events. Literature was identified for the current report through the application of the following four steps:

- Step 1 - Planning and searching
- Step 2 - Narrowing search results
- Step 3 - Document screening
- Step 4 - Data analysis and reporting

A discussion of how each step was applied is diagrammed in Figure A-1 below.

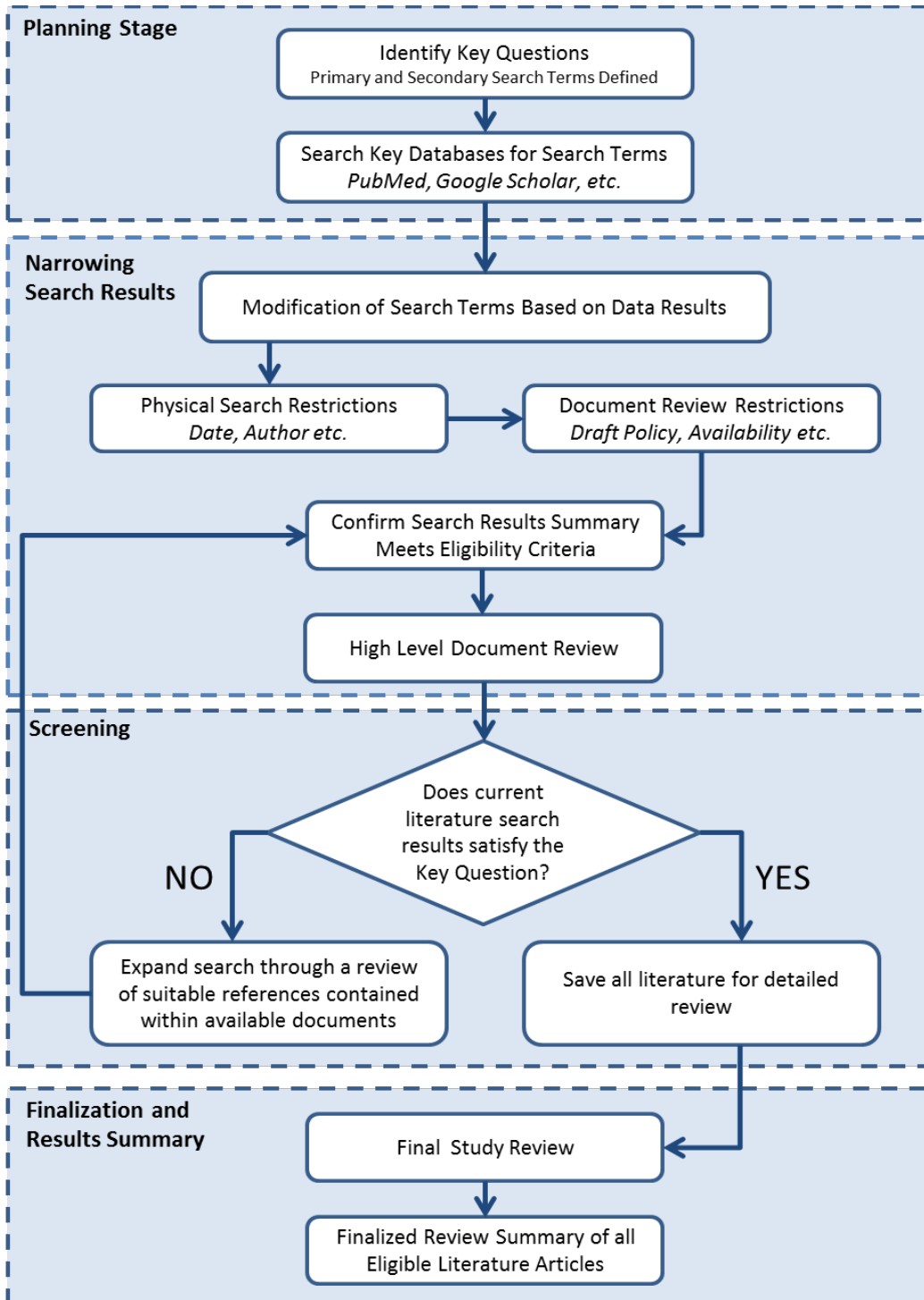


Figure A-1. Literature Search Methodology (4-step process).

A.2 Step 1 – Planning and Searching

Table A-1. Primary and Secondary Search Terms

No	Key Questions	Primary Keywords		Secondary Search Terms
1	How can foods, beverages, and alcohol be affected directly or indirectly by man-made and natural events? Including the following topics:	Types of food/beverage/alcohol packaging	Foods Vegetables Fruits Meat Condiments Fresh foods Frozen foods	
	1a Overview of types of food packaging and sealing methods.	Types of food/beverage/alcohol sealing Food package/package safety	Cereals and grains	Porous
	1b Contaminants of concern for food products during natural and man-made events.	Glass products Metal canned products Plastic bags/wrappings Plastic bottles	Beverage Alcohol (e.g., beer, wine, liquor) Food safety	Aluminium Discard Primary
	1c Changes caused to food products by physical, chemical, or biological contaminants.	Polymers Aluminum bags/wrappings Cardboard bags/wrappings	Contaminated Impacted Tainted	Permeation/permeable Food freshness Food-grade Low
	1d Contamination of food products in sealed packaging and potential impacts to human health if consumed.	Foam bags/wrappings Sealing/closure methods (e.g., corked, flip-top, screw cap)	Affected Physical changes Chemical changes Biological changes	Stopper Oxygen ingress
1e Factors that increase the porosity or permeability of food product packaging	Natural events Natural disasters Man-made events Man-made disasters	Increased porosity Greater porosity Increased permeability Greater permeability		

No	Key Questions	Primary Keywords		Secondary Search Terms
2	What are the best practices and/or interventions and actions associated with food, beverage, and alcohol safety affected directly or indirectly by man-made and natural events for licensed food vendors, liquor stores, private residences, and government enforcement?	Types of food/beverage/alcohol packaging	Foods Vegetables Fruits Meat	Food/water quality
	2a Best practices for inspecting food products to evaluate whether they are safe for consumption after man-made and natural events.	Types of food/beverage/alcohol sealing Food package/package safety	Condiments Fresh foods Frozen foods Cereals and grains	Wildfire Fire Flood Hurricane
	2b The effect of natural and man-made events on food product safety.	Glass products Metal canned products	Beverage Alcohol (e.g., beer, wine, liquor)	Power outage Emergency
	2c The effect of natural and man-made events on different types of packaging and sealing.	Plastic bags/wrappings Plastic bottles Polymers	Food safety Contaminated	WHO Environmental Health Disasters
	2d Best practices to clean and store food, beverage, and alcohol containers after they have been evaluated to be safe.	Aluminum bags/wrappings Cardboard bags/wrappings Foam bags/wrappings Sealing/closure methods (e.g., corked, flip-top, screw cap)	Impacted Tainted Affected Physical changes Chemical changes Biological changes	BC Wildfires Emergency Action Plan USDA After flood Issues
2e The scientific basis for decisions to dispose or retain food products based on their packaging and sealing.	Natural events Natural disasters Man-made events Man-made disasters	Increased porosity Greater porosity Increased permeability Greater permeability	Interior Health Authority Recovery Red Cross	

At this step, key concepts were determined through the evaluation of the key questions, as per Section 5 in the main report, and a list of primary and secondary key search terms were identified for each key concept. Two key questions were identified, and 39 primary search terms were selected and searched to address these questions. Table A-1 shows key questions, primary search terms and secondary search terms related to each key question. Some of the primary keywords were common to each question. Secondary search terms were similar for all questions and selected to meet the objective of identifying selected jurisdictional best practices and guidance.

The literature search was performed using three different databases:

- Google standard search engine and Google Scholar;
- Toxicology Literature Online (TOXLINE); and
- PubMed literature search system at the National Library of Medicine (NLM).

Eligibility criteria were determined for the selection of literature as follows:

- food packaging, sealing methods, and permeability properties;
- packaging and food safety guidelines in post-disaster response; and
- exposure routes of contaminants into food.

Boolean operators were used to connect search terms, to define relationships between search terms (primary and secondary), and to narrow or broaden record sets. Examples of search strings are provided in Table A-2 below.

Table A-2. Examples of Search Strings

Boolean Operators	Search Strings
AND	"Cork" AND "Permeability"
OR	"Food Safety" AND "Fire" OR "Natural Disaster" OR "Power Outage", etc.
Double quotes (" ") or brackets ({}), for an exact match.	{Glass products} AND "Sealing Methods" OR "Closures"

In the initial stage of research, combinations of the primary search terms for each section were selected.

A.3 Step 2 – Narrowing Search Results

Search strings were determined by a combination of the primary and secondary search terms. Secondary search terms were similar for all questions and were chosen to identify selected jurisdictional best practices and guidance (Table A-1). Difficulty in obtaining relevant search results necessitated the addition of secondary search terms to the primary search terms. For

example, the primary search term “Cork” yielded 40,000,000 results while the search string “Cork” AND “Permeability” yielded 279,000 results.

The results were categorized for each key question and a high-level review of all documents was conducted. In this step, a total of 73 documents including guidelines, acts, fact sheets, scientific articles, book chapters, and handbooks remained eligible for detailed review.

A.4 Step 3 – Document Screening

All 73 retained documents were screened in this step to identify information relevant to the key questions. An additional search was completed for new relevant references identified within these documents. Bibliographies of publications that met the eligibility criteria were manually searched for the additional citations of possible relevance and obtained if they met the eligibility criteria.

Included in the search results were some websites. A list of websites that met the eligibility criteria is included below.

Government of Canada:

Canadian Food Inspection Agency – Guide - Process Control Technical Information

<http://www.inspection.gc.ca/food/fish-and-seafood/imports/documents/process-control/eng/1412623332610/1412623333845>

Canadian Food Inspection Agency – Guide to Food Safety

<http://www.inspection.gc.ca/food/non-federally-registered/safe-food-production/guide/eng/1352824546303/1352824822033>

Canadian Food Inspection Agency – Food Safety in an Emergency

<http://www.inspection.gc.ca/food/information-for-consumers/fact-sheets-and-infographics/food-handling/emergency/eng/1331578972167/1331579901110>

General Food Safety Tips

<https://www.canada.ca/en/public-health/services/food-safety/general-food-safety-tips.html>

Home Canning Safety

<https://www.canada.ca/en/health-canada/services/general-food-safety-tips/home-canning-safety.html>

Safe Food Storage

<https://www.canada.ca/en/health-canada/services/general-food-safety-tips/safe-food-storage.html>

Safe Internal Cooking Temperatures

<https://www.canada.ca/en/health-canada/services/general-food-safety-tips/safe-internal-cooking-temperatures.html>

Statistics Canada

<http://www.statcan.gc.ca/pub/31f0027m/31f0027m1996002-eng.htm>

Alberta:

Tips for Food Safety

<https://www.albertahealthservices.ca/assets/info/nutrition/if-nfs-tips-food-safety.pdf>

Flood Water Precautions

<https://www.albertahealthservices.ca/Advisories/ne-pha-flood-water.pdf>

Returning Home Safely After a Flood

<https://www.albertahealthservices.ca/assets/news/advisories/ne-pha-flooding-kit.pdf>

Cleaning the House After a Flood

<https://www.albertahealthservices.ca/Advisories/ne-pha-cleaning-house.pdf>

Reopening Your Food Establishment After Flooding

<https://www.albertahealthservices.ca/assets/wf/eph/wf-eh-water-safely-flood-reopening-your-food-establishment-after-flooding.pdf>

Reopening Your Food Establishment After a Wildfire

<https://www.albertahealthservices.ca/assets/wf/eph/wf-eh-reopening-your-food-establishment-after-wildfire.pdf>

Reopening Your Building After a Wildfire

<https://www.albertahealthservices.ca/assets/wf/eph/wf-eh-reopening-your-building-after-wildfire.pdf>

Returning to Your Home

<https://www.albertahealthservices.ca/assets/wf/eph/wf-eh-returning-to-your-home.pdf>

Wildfire Smoke and Your Health

<https://www.albertahealthservices.ca/assets/wf/eph/wf-eh-wildfire-smoke-and-your-health.pdf>

British Columbia:

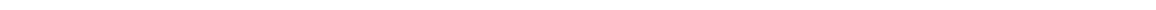
Fire Retardants Recommended Precautions for Water and Food

<https://www.interiorhealth.ca/YourEnvironment/EmergencyPreparedness/Documents/forest%20fire%20-%20Precautions%20for%20Water%20and%20Food.pdf>

Water and Food Quality Information for Evacuees Returning after a Fire

<https://www.interiorhealth.ca/YourEnvironment/EmergencyPreparedness/Documents/Food%20and%20Water%20Information%20for%20Evacuees%20Returning%20after%20a%20Fire.pdf>

Returning Home After a Wildfire



<https://www2.gov.bc.ca/gov/content/safety/emergency-preparedness-response-recovery/emergency-response-and-recovery/returning-home>

Manitoba:

Guideline on Emergency Action Plans for Food Establishments: Fire

<https://www.gov.mb.ca/health/publichealth/environmentalhealth/protection/docs/fire.pdf>

Guideline on Emergency Action Plans for Food Establishments: Flood

<https://www.gov.mb.ca/health/publichealth/environmentalhealth/protection/docs/flood.pdf>

Guideline on Emergency Action Plans for Food Establishments: Interruption of Electrical Services (Power Outage)

https://www.gov.mb.ca/health/publichealth/environmentalhealth/protection/docs/interruption_electrical_service.pdf

Packaging and Food Safety

https://www.gov.mb.ca/agriculture/food-safety/at-the-food-processor/packaging.html#packaging_types

Nova Scotia:

Food Safety After a Power Outage

<https://novascotia.ca/agri/documents/food-safety/factsheet-powerout.pdf>

Food Safety After a Flood

<https://novascotia.ca/agri/documents/food-safety/factsheet-flood.pdf>

Ontario:

Food Safety After a Flood

http://www.healthunit.org/emergency/_resources/fs_flood_foodsafety.pdf

Food Safety After a Fire

http://healthunit.org/emergency/_resources/fs_fire_foodsafety.pdf

United States of America:

Food Safety for Consumers Returning Home After a Hurricane and/or Flooding

<https://www.fda.gov/Food/ResourcesForYou/Consumers/ucm076993.htm>

Food Safety Issues to Consider after a Flood

http://msue.anr.msu.edu/news/food_safety_issues_to_consider_after_a_flood

Refrigerated Food and Power Outages: When to Save and When to Throw Out

https://www.foodsafety.gov/keep/charts/refridg_food.html

Keeping Food Safe During an Emergency

https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/emergency-preparedness/keeping-food-safe-during-an-emergency/CT_Index

USDA Offers Food Safety Tips for Areas Affected by Flooding

<https://www.fsis.usda.gov/wps/portal/fsis/newsroom/news-releases-statements-transcripts/news-release-archives-by-year/archive/2017/nr-050117-01>

Fires and Flood Safety

https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/emergency-preparedness/fires-and-food-safety/ct_index

Centre for Disease Control and Prevention – Keep Food and Water Safer After a Disaster or Emergency

<https://www.cdc.gov/disasters/foodwater/facts.html>

US FDA – Food and Water Safety During Power Outages and Floods

<https://www.fda.gov/downloads/Food/RecallsOutbreaksEmergencies/ucm076962.pdf>

Minnesota Department of Health – Food Safety After a Fire

<http://www.health.state.mn.us/divs/eh/food/fs/fsafterfire.pdf>

The University of Wisconsin-Madison – Food Safety after a Flood

https://foodsafety.wisc.edu/assets/pdf_Files/Keeping%20Food%20Safe%20after%20a%20Flood.pdf

A.5 Step 4 – Data Analysis and Reporting

Once the four steps were completed, 73 studies were identified for inclusion in the review. Of these, two additional results were rejected after closer review since they did not meet the eligibility criteria.

Table A-3 lists the final number of eligible publications identified after completion of the four stages of literature search. In total, 67 eligible results were identified, reviewed, and used for reporting.

Table A-3. Number of Eligible Publications for Each Section

No.	Key Questions	Number of Eligible Publications
1	How can foods, beverages, and alcohol be affected directly or indirectly by man-made and natural events?	23

No.	Key Questions	Number of Eligible Publications
2	What are the best practices and/or interventions and actions associated with food, beverage, and alcohol safety affected directly or indirectly by man-made and natural events for licensed food vendors, liquor stores, private residences, and government enforcement?	48
Total eligible publications		71

A.6 Key Questions, Search Terms, and List of Literature Reviewed

Key Question #1: How can foods, beverages and alcohol be affected directly or indirectly by man-made and natural events?

The following key words were used in various combinations for conducting a literature search to answer this key question:

- Types of food/beverage/alcohol
- Types of food/beverage/alcohol
- Food package/packaging safety
- Glass products
- Metal canned products
- Plastic bags/wrappings
- Plastic bottles
- Polymers
- Aluminum bags/wrappings
- Cardboard bags/wrappings
- Foam bags/wrappings
- Sealing/closure methods (e.g., corked,
- Natural events
- Natural disasters
- Man-made events
- Man-made disasters
- Foods
- Beverage
- Alcohol (e.g., beer, wine, liquor)
- Food safety
- Contaminated
- Impacted
- Tainted
- Affected
- Physical changes
- Chemical changes
- Biological changes
- Increased porosity
- Greater porosity
- Increased permeability
- Greater permeability
- Aluminium
- Porous
- Discard

- Vegetables
- Fruits
- Meat
- Condiments
- Fresh foods
- Frozen foods
- Cereals and grains
- Primary
- Permeation/permeable
- Food freshness
- Food-grade
- Low
- Stopper
- Oxygen ingress

The following search results were reviewed for this key question:

Allahvaisi, S. (2012). Polypropylene in the Industry of Food Packaging. In: F. Dogan, Ed., *Polypropylene*. [InTechOpen, ISBN: 978-953-51-0636-4, DOI: 10.5772/34255] Available at: <http://www.intechopen.com/books/polypropylene/polypropylene-in-the-industry-of-food-packaging>. [Accessed: 17 Nov. 2017].

Bhunja, K., Sablani, S.S., Tang, J., and Rasco, B. (2013). Migration of chemical compounds from packaging polymers during microwave, conventional heat treatment, and storage. *Comprehensive Reviews in Food Science and Food Safety*, 12, pp.523-545.

Faria, D.P., Fonseca, A.L., Pereira, H., and Teodoro, O.M. (2011). Permeability of cork to gases. *Journal of Agricultural and Food Chemistry*, 59(8), pp. 3590-3597.

Fonseca, A.L., Brazinha, C., Pereira, H., Crespo, J.G., and Teodoro, O.M. (2013). Permeability of cork for water and ethanol. *Journal of Agricultural and Food Chemistry*, 61(40), pp. 9672-9679.

Government of Canada. (2013). *Home Canning Safely*. [online] Available at: <https://www.canada.ca/en/health-canada/services/general-food-safety-tips/home-canning-safety.html>. [Accessed: on 1 Jan. 2018].

Government of Canada. (2014). *Guide – Process Control Technical Information*. [online] Canadian Food Inspection Agency. Available at: <http://www.inspection.gc.ca/food/fish-and-seafood/imports/documents/process-control/eng/1412623332610/1412623333845>. [Accessed: 16 Nov. 2017].

Government of Canada. (2015b). *Safety of Food Sold in Glass Jars*. [online] Available at: <http://healthycanadians.gc.ca/recall-alert-rappel-avis/hc-sc/2015/54210a-eng.php>. [Accessed: 16 Nov. 2017].

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- Liukkonen-Lilja, H. and Piepponen, S. (2009). Leaching of aluminium from aluminium dishes and packages. *Food Additives & Contaminants*, 9(3), pp. 213-223.
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- Ooraikul, B. and Stiles, M.E. (2013). *Modified Atmosphere Packaging of Food*. [ISBN: 978-1-4615-2117-4] Springer Science & Business Media.
- Potter, N.N. and Hotchkiss, J.H. (2012). *Food Science*. 5th Ed. [ISBN: 978-1-4615-4985-7] New York: Springer Science & Business Media.
- Rahman, M.S. (1999). *Handbook of Food Preservation*. 2nd Ed. Boca Raton, Florida: CRC Press.
- Rasi, M. (2013). *Permeability Properties of Paper Materials*. Ph.D. Faculty of Mathematics and Natural Sciences of the University of Jyväskylä, Finland.
- Robertson, G.L. (2016). *Food Packaging: Principles and Practice*. 3rd Ed. [ISBN: 9781439862414, Cat.: K12892] CRC Press.
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Shin, J. and Selke, S.E.M. (2014). Food Packaging. In: S. Clark, S. Jung, and B. Lamsal, eds., *Food Processing: Principles and Applications*. 2nd Ed. John Wiley & Sons, Ltd.

Silva, S.P., Sabino, M.A., Fernandes, E.M., Correlo, V.M., Boesel, L.F., and Reis, R.L. (2005). Cork: properties, capabilities and applications. *International Materials Reviews*, 50(6), pp. 345-365.

Siracusa, V. (2012). Food packaging permeability behaviour: A report. *International Journal of Polymer Science*, 2012, pp. 1-11.

Key Question #2: What are the best practices and/or interventions and actions associated with food product, beverage, and alcohol safety affected directly or indirectly by man-made and natural events for licensed food vendors, liquor stores, private residences, and government enforcement?

The following key words were used in various combinations for conducting a literature search to answer this key question:

- Types of food/beverage/alcohol packaging
- Types of food/beverage/alcohol sealing
- Food package/package safety
- Glass products
- Metal canned products
- Plastic bags/wrappings
- Plastic bottles
- Polymers
- Aluminum bags/wrappings
- Cardboard bags/wrappings
- Foam bags/wrappings
- Sealing/closure methods (e.g., corked, flip-top, screw cap)
- Natural events
- Natural disasters
- Man-made events
- Man-made disasters
- Foods
- Vegetables
- Fruits
- Meat
- Impacted
- Tainted
- Affected
- Physical changes
- Chemical changes
- Biological changes
- Increased porosity
- Greater porosity
- Increased
- Greater permeability
- Food/water quality
- Wildfire
- Fire
- Flood
- Hurricane
- Power outage
- Emergency
- WHO
- Environmental Health
- Disasters

- Condiments
- Fresh foods
- Frozen foods
- Cereals and grains
- Beverages
- Alcohol (e.g., beer, wine, liquor)
- Food safety
- Contaminated
- BC Wildfires
- Emergency Action
- USDA
- After flood
- Issues
- Interior Health
- Recovery
- Red Cross

The following search results were reviewed for this key question:

British Columbia Centre for Disease Control (BCCDC). (2014c). *Evidence Review: Health Surveillance for Wildfire Smoke Events*. [PDF] Provincial Health Services Authority. Available at: http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/Health-Environment/WFSG_EvidenceReview_HealthSurveillance_FINAL_v2_edstrs.pdf.

British Columbia Centre for Disease Control (BCCDC). (2014). *Evidence review: exposure measures for wildfire smoke surveillance*. [PDF] Available at: http://www.bccdc.ca/resource-gallery/Documents/Guidelines%20and%20Forms/Guidelines%20and%20Manuals/Health-Environment/WFSG_EvidenceReview_Smokesurveillance_FINAL_v2_edstrs.pdf. [Accessed: 17 Nov. 2017].

British Columbia Interior Health Authority (BCIHA). (2017a). *After a Fire – Food Safety for Homeowners*. [PDF, HP-FS-9055 July 2017] Available at: <https://www.interiorhealth.ca/YourEnvironment/EmergencyPreparedness/Documents/After%20a%20Fire%20%E2%80%93%20Food%20Safety%20For%20Homeowners.pdf>. [Accessed: 16 Nov. 2017].

British Columbia Interior Health Authority (BCIHA). (2017b). *After a Fire – Returning Home*. [PDF] Available at: <https://www.interiorhealth.ca/YourEnvironment/EmergencyPreparedness/Documents/After%20Fire%20-%20Returning%20Home.pdf>. [Accessed: 16 Nov. 2017].

British Columbia Interior Health Authority (BCIHA). (2017c). *Fire Retardants: Recommended Precautions for Water and Food*. [PDF] Available at: <https://www.interiorhealth.ca/YourEnvironment/EmergencyPreparedness/Documents/forest%20fire%20-%20Precautions%20for%20Water%20and%20Food.pdf>. [Accessed: 16 Nov. 2017].

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Appendix B Jurisdictional Search Summary

The following are summaries of guidelines and recommendation that have been developed by various organizations, regulatory bodies and government agencies specific to food safety following natural and anthropogenic events.

B.1 Alberta Health Services (2011a, 2011b)

Cleaning the House After a Flood & Flood Water Precautions

Alberta Health Services (AHS) has developed and outlined several recommendations for the general public following flooding events. These documents outline some basic precautions when dealing with flood water and provide recommendations on how to approach cleaning up an individual's home after such an event. Recommendations specific to food safety include:

- do not drink or use any water that may have been contaminated by flood water, as contaminants such as *e. coli* may be present in the water.
- dispose of the following items if they have come into contact with flood water:
 - all meats, fresh fruits and vegetables;
 - all boxed foods;
 - all products in jars (*e.g.*, home preserves, bottled drinks); and
 - all medicines, cosmetics, and other toiletry items.
- the only safe flood-exposed foods are those sealed in metal cans that do not exhibit damaged exteriors such as seal damage or bulging.
 - undamaged cans should be washed and sanitized before opening.

B.2 Alberta Health Services (2013, 2016b)

Reopening Your Food Establishment After Flooding & Reopening Your Food Establishment After a Wildfire

AHS has outlined a series of recommendations for businesses to follow in order to safely reopen a food establishment following flooding and wildfire events. The recommendations provided include precautionary steps to take while inspecting facilities and infrastructure, cleaning and sanitization, and what to look for when inspecting food items. The resources outline the following with respect to food safety:

- discard and remove all food items that may have been submerged in flood water or impacted by moisture, unless the food is sealed in a hermetically sealed container that has not been damaged;
- discard all food items stored in refrigerator or freezer if the temperature was greater than 4°C at any time;
- discard any food item that has spoiled, regardless of ambient temperature;
- discard food/food related items exposed to heat, ash, chemicals, soot, water, and smoke including:
 - food stored in refrigerators, freezers, cupboards, drawers and containers;
 - open food;
 - packaged food (*i.e.*, paper, cardboard boxes, plastics, cloth, and cellophane) that can absorb moisture;
 - bottle and jars of food/beverages with screw top lids, crown/crimp top, snap-lids, twist caps, flip-tops, snap-opens, or similar items; and
 - single service items/utensils including individually plastics wrapped items.
- only commercially prepared foods in all-metal cans and retort pouches can be saved if they do not show any signs of damage, including bulging or dents. These items will need to be cleaned and sanitized before opening.

B.3 Alberta Health Services (2016a, 2016c)

Reopening Your Building After a Wildfire & Returning to Your Home

AHS has developed several guidance documents specifically related to returning home after a wildfire. These documents outline health and safety considerations during the initial restoration work that may be required following a wildfire event. Within these guidance documents, the following topics were outlined with respect to food safety:

- inspect all food related items and discard the following items:
 - food stored in refrigerators, coolers, and freezers if the temperature exceeded, or may have exceeded, 4°C at any time;
 - any food item that has spoiled regardless of storage temperature;
 - any open food item;
 - food that has been damaged by fire or smoke including dry goods (*e.g.*, flour, sugar, spices, *etc.*), even if package has not been opened;
 - unrefrigerated raw vegetables or fruits;
 - food that was stored in porous containers including, but not limited to, cardboard, foam containers, *etc.*;

- any canned food that exhibits bulging rusting or dents; and
- jarred food, as the heat from the fire could potentially compromised the safety seal.
- clean and disinfect all canned foods before opening to ensure the contents do not become contaminated; and
- “If in Doubt, Throw it Out”.

B.4 Canadian Food Inspection Agency (2012)

Food Safety in an Emergency

The Canadian Food Inspection Agency (CFIA) has outlined several ways the general public can ensure food safety in an emergency such as earthquakes, floods, landslides, tornadoes, winter storms, and wildfires. The main recommendations the CFIA outlines include preparedness and planning, safe food and water handling, and cleaning and sanitization. The online resource outlines the following with respect to food and water safety:

- local authorities will be the main issuer of information regarding safe use of tap water. follow instructions to use bottle water or boil water advisory for cooking, cleaning, and bathing.
- do not use contaminated water for brushing teeth, making baby formula, making ice, wash and preparing food, washing dishes, or washing hands.
- do not eat any food that may have come in contact with animal waste, chemicals, extraneous material, flood water, snow or ice, soil, and dirt.
- if purchasing food from a commercial establishment, ask retailers and restaurateurs to explain how food was kept safe.
- check the condition of stored food. discard any containers that have been damaged or have passed their “best before” date.
- discard any cans/containers showing the following signs of damage:
 - crushing/dents that prevent stacking or opening;
 - deep rusting;
 - holes;
 - leaks;
 - punctures; and
 - swelling.
- food containers that are not waterproof and could have come in contact with flood water should be discarded, including:
 - pull tops;

- screw-caps; and
- snap lids.
- discard the following items if they have come in contact with flood water or hazardous material:
 - baby formula containers;
 - cardboard juice containers;
 - home-canned foods; and
 - milk containers.
- “when in doubt, throw it out”.
- only undamaged, commercially-prepared foods in sealed, unopened, airtight, waterproof cans, jars and pouches are safe for use after proper inspection, cleaning and disinfection procedures have been followed:
 - remove labels on cans or pouches (any porous material in contact with dirt of bacteria);
 - clean can using 5 ml (1 tsp) of bleach per 750 ml (3 cups) water for 2 minutes; and
 - air-dry all cleaned cans, jars and pouches to prevent potential contamination when containers are opened.

B.5 Canadian Red Cross (2016)

Guide to Wildfire Recovery

The Canadian Red Cross (CRC) has developed a guide to wildfire recovery. The document provides information, tips and suggestions to the public on what to do following an evacuation due to wildfires including preparing to return home, inspection of property and start of clean up, taking inventory, basic needs (*i.e.*, food, water, and medicine), taking care of yourself, your children and others, as well as special considerations and mental recovery. Recommendations specific to food safety include:

- perishable foods, food packaged in cardboard or plastic, or any food or medicines directly exposed to heat, smoke, fumes, or water should be discarded;
- discard all food in glass jars, as probability exist that seal has been broken and exposed to heat;
- discard all canned (metal) goods if potential exists that it was exposed to heat which could have impacted integrity of container; and
- dispose of the following items if exposed to smoke, soot, or heat from fire:
 - contents of freezer or fridge including all meat and produce (fresh/frozen);

- all boxed foods;
- all bottled drinks and products in jars (potentially damaged seals); and
- cans with large dents or with external damage.

B.6 Ontario Public Health Division (2011a)

Food Safety After a Fire

The Ontario Public Health Division (OPHD) developed a fact sheet that provides information on food safety following a fire. The fact sheet summarizes ways in which food can become contaminated as a result of fires, what to do with food that is potentially contaminated by fire related impacts, how to clean food and food related surfaces after a fire, and what business/food establishments should do following a fire. The key recommendations by the OPHD with respect to food safety following a fire include:

- discard all food that may have been exposed to fire, heat, fumes, smoke and/or chemicals that may have been used during fire suppression activities;
- discard food stored in permeable packaging including:
 - cardboard;
 - plastic wrap;
 - screw-topped jars;
 - bottles; and
 - home-canned products (sugar, flour, candies, cereal products, bakery products, dried beans, rice and other grains).
- discard food stored in refrigerator or freezer if fridge/freezer seal are not air tight and potential exists for contamination from fumes, smoke, water, etc., including:
 - dairy products;
 - fresh/frozen fish and meats; and
 - any food with unusual colour/odour.
- discard food packaged in cans or jars that may have been exposed to heat. These items may show signs of heat damage including splits or ruptures;
- “if in Doubt, Throw it Out!”; and
- only food in commercially sealed, undamaged, unopened, water proof airtight metal cans may be considered safe. These items will need to be cleaned and sterilized as per cleaning instructions:
 - thoroughly wash with soap and water ensuring all dirt, silt, water, chemicals, etc. are wiped away;

- rinse with clean water;
 - sanitize by immersing item in 5 ml (1 tsp) bleach per 750 ml (3 cups) water or hot water of greater than 77°C (170°F); and
 - air dry.
- food establishments/businesses should notify all public health authorities and seek assistance. The food establishments/businesses should discontinue service until the appropriate steps have been taken to protect the public's health.

B.7 Ontario Public Health Division (2011b)

Food Safety After a Flood

The OPHD developed a fact sheet that provides information on food safety following a flood. The fact sheet summarizes ways in which food can become contaminated as a result of a flood, what to do with food that is potentially contaminated by flood related impacts, how to clean food and food related surfaces after a flood, and what businesses/food establishments should do following a flood. The key recommendations by the OPHD with respect to food safety following a flood include:

- discard food stored in permeable containers that are not waterproof including:
 - screw-caps;
 - snap lids;
 - pull tops; and
 - crimped-cap.
- discard all food wrapped in paper, plastic cloth, fiber or cardboard;
- discard all food that has come in direct contact with flood water;
- discard home-canned food in glass containers that have come in contact with flood water. the jar may be washed and sterilized; however, the flat lid component will need to be discarded;
- discard commercially-canned foods that exhibit the following signs of damage:
 - bulging;
 - swelling;
 - leaking;
 - punctures;
 - dents;
 - holes;
 - fractures; or

- rusting.
- discard porous items that may come in contact with food or with a person's mouth including:
 - baby bottle nipples and pacifiers;
 - wooden bowls; and
 - plastic, paper, or foam storage containers and utensils.
- discard commercially-bottled carbonated beverages if cap is crusted with silt;
- "if in doubt, throw it out!";
- only food in commercially sealed, unopened water proof airtight jars or metal cans should be considered safe. these items will need to be cleaned and sterilized as per cleaning instructions:
 - thoroughly wash with soap and water ensuring all dirt, silt, water, chemicals, etc. are wiped away;
 - rinse with clean water;
 - sanitize by immersing item in 5 ml (1 tsp) bleach per 750 ml (3 cups) water or hot water of greater than 77°C (170°F); and
 - air dry.
- food establishments/business should notify all public health authorities and seek assistance. The food establishments/business should discontinue service until the appropriate steps have been taken to protect the public's health.

B.8 Manitoba Public Health (2015a)

Guideline of Emergency Action Plan for Food Establishments: Fire

Manitoba Public Health (MPH) developed a guideline on emergency action plans for food establishments following fires. The guideline outlines definitions of what is a reportable fire, actions to be taken following a fire, assessing building safety, assessing food safety, general clean up, and construction and renovations. The main points outlined in the guideline specific to food and beverage safety following a fire include:

- discard the following items:
 - opened goods;
 - cartons or boxes showing smoke residue on exterior;
 - food products that have water damage visible, unless in sealed containers; and
 - burnt food products.

- discard the following food items that have been affected as a result of fire:
 - dairy products;
 - dry goods (sugars, candies, flour, cereal products, bakery products, beans, rice, and grains);
 - food products in glass with metal screw-type or metal slip covers;
 - fish and meats (frozen or fresh);
 - produce (fresh or dried);
 - single service items (*i.e.*, individually wrapped utensils in plastic sleeves);
 - products and beverages in plastic bottles;
 - meat and meat products that exhibit signs of having been scorched or partially cooked; and
 - fruits and vegetables that have been in the presence of any degree of heat.
- assess the following items for potential contamination:
 - alcoholic beverages – contact the Liquor and Gaming Authority of Manitoba (LGA) for disposal options.
 - canned goods – discard any canned good showing any signs of bulging, leaking, having been in the presence of excessive heat, or are deemed uncleanable. If canned goods are deemed safe, they may be cleaned, sanitized, and held for 3 weeks before further inspection for signs of blowing or leaks; if present, such cans should be discarded.
 - canned soft drinks – see note above as per canned goods.
 - glass bottled soft drinks – unless protected by plastic outer wrap or if bottles have sealed screw on lid, bottle should be discarded.
- if refrigerator/freezer door seal is intact and airtight and there has been no interruption to power greater than 2 hours, contents will be satisfactory for consumption.

B.9 Manitoba Public Health (2015b)

Guideline of Emergency Action Plan for Food Establishments: Flood

Manitoba Public Health (MPH) developed a guideline on emergency action plans for food establishments following floods. The guideline outlines the response to flooding events (including minor leakages or flooding throughout the building), assessing building safety, general clean up, food safety, and construction and renovations. The main points outlined in the guideline specific to food and beverage safety following a flood include:

- discard exposed food, bulk foods, fresh produce, meat, poultry, fish, and eggs;

- discard any foods with soft packaging (*e.g.*, paper, plastic, cloth, or fiber);
- discard any food items stored in cardboard boxes (even if the content appears dry);
- discard all food in glass jars. This includes unopened jars with waxed paper, foil, cellophane, or cloth covers;
- discard all food, liquids, or beverages in crown capped bottles or containers with pull tab tops, corks, or screw caps;
- discard all food in opened containers and packages (*e.g.*, food in bags or canisters); and
- discard all cans that are dented, leaking, bulging, rusted, or have damaged labels.

B.10 British Columbia Interior Health Authority (2017b)

After a Fire – Returning Home

The British Columbia Interior Health Authority (BCIHA) produced an online document that outlines health and safety considerations and tips for the public when returning home after a fire. The document outlines way to protect yourself and family members, assessing water quality, and restoring your home. Critical information outlines in the documents as it relates to food safety following a fire includes:

- prior to using water system for consumption (drinking, cooking, or bathing) the following actions should be taken:
 - flush the system to remove all stagnant water from lines (cold and hot water taps – 5 min each) before use;
 - for residence on community water systems, direct all questions to local water supply (*i.e.*, municipality, utility provider, *etc.*), they will provide the most up to date and accurate assessment;
 - for residence on private/individual water systems, check for any evidence of fire impacts and use alternate sources of drinking water until water source is assessed or tested. Private surface or groundwater sources potentially affected by fire retardant application should be tested to ensure compliance with the Canadian Drinking Water Quality Guidelines; and
 - be aware of public notice in areas where fire retardant was used in watershed.
- discard food in refrigerators, coolers and freezers if the temperature exceeded 4°C at any time;
- discard any food that has spoiled, regardless of temperature even if temperature is less than 4°C;
- discard all dry food in contact with fire or smoke (*i.e.*, flour, sugar, spices, *etc.*);

- discard unrefrigerated raw vegetable or fruits;
- discard all foods that were stored in porous containers such as cardboard, foam containers, *etc.*;
- discard all canned foods that exhibit bulging, rusting or dents;
- discard jarred foods that may have become compromised from heat, this includes home-canned items.;
- “If in Doubt, Throw it Out!”;
- fruit and vegetable gardens may have come in contact with fire or fire suppression chemicals. The following steps should be taken:
 - regularly wet down garden and lawn until smoke and ash have been diluted and/or reabsorbed into the air;
 - rinse fire retardant off vegetation (*i.e.*, trees, shrubs, and plants);
 - it is not recommended to consume vegetables grown below soil surface that was affect by fire; and
 - consumption of vegetables and fruits from gardens, forest, or alpine areas to which fire retardant has been directly applied is not recommended.

B.11 British Columbia Interior Health Authority (2017a, 2017c)

After a Fire – Food Safety for Homeowners & Water and Food Quality (Information for Evacuees Returning after a Fire)

The BCIHA released an information bulletin summarizing food safety, water quality and septic systems for evacuees returning after a fire. In addition, the BCIHA release an information notice for homeowners detailing food safety following a fire. Both documents outline general food safety precautions to note when assessing food after a fire including:

- to prevent bacterial growth and spoilage the following recommendations and notes should be followed:
 - refrigerated foods must be under 4°C and frozen foods must be maintained at or below 18°C.
 - a full freezer will keep food frozen for up to 2 days and a half full freezer will keep food frozen for approximately 1 day.
 - refrigerator or coolers will keep food cold for approximately 4 hours.
- check food items and use the following recommendations:

- spoiled or sour milk and other dairy products can be used as an indicator that the fridge had lost power at some point and that all food contained within it should be discarded.
 - ice cream that has thawed and refrozen and fish product that have bad smells upon thawing are indicator that the freezer has been without power at some point and all food should be discarded and not refrozen.
- “If in Doubt, Throw it Out”.

B.12 Government of British Columbia (2017)

Returning Home after a Wildfire

The Government of British Columbia (BCGOV) developed an online resource for the public that provides information and recommendations for returning home after a wildfire. The online resource outlines several aspects of the response and recovery stage of dealing with a wildfire including traveling home, taking care of yourself and your family, re-entering your home, drinking water and food safety, cleaning, documentation, repairs, caring for livestock or animals, and general information on fire retardant. Specific information presented that outlines recommendations with respect drinking water and food safety includes:

- tap water should only be consumed in local official have assured the public it is safe to drink. obtain bottled water or disinfect tap water (*i.e.*, boil or tablets for consumption and bleach for non-drinking needs).
- if water supply is from well or cistern that has been damaged, assume the water is not safe to drink and contact local authority for instructions.
- discard food that is spoiled and any food that has been stored in a refrigerator or freezer that has lost power, even if it has since been restored.
- discard all foods/items exposed to heat, ash, chemicals, soot, water, and/or smoke including:
 - food stored in fridges, freezers, cupboards, drawers, and containers;
 - all open foods;
 - packaged foods, including paper, cardboard boxes, plastics, cellophane;
 - bottle and jarred food with screw top lids or crown/crimp caps;
 - single service items/utensils including individually plastic-wrapped items; and
 - any cans that exhibit dents or bulging.
- if freezer has been exposed to fire, or has been without power for more than three days, discard all contents.

- partially frozen food can be refrozen if it has not been fully thawed and the item still contains visible ice crystals.
- “When in doubt, throw it out”.

B.13 Nova Scotia Department of Agriculture (2013)

Food Safety After a Power Outage

The Nova Scotia Department of Agriculture (NSDA) issued a fact sheet regarding food safety after a power outage. The fact sheet outlined how power outages can cause food to become unsafe and what to do with unsafe food. The following information regarding food and beverage safety was presented:

- do the following if you have warning that your electrical power will be interrupted or if you live in an area subject to power failures during storms:
 - turn the refrigerator or freezer control to its coldest setting;
 - deep several freezer gel packs frozen in your freezer;
 - if there is space in your freezer, fill containers such as empty milk cartons with water and freeze to help maintain cold temperatures; and
 - have one or more coolers on hand to store refrigerated foods.
- if there is any possibility of flooding, raise basement freezers off the floor (e.g., by putting the unit on cement blocks).
- keep an appliance thermometer in your refrigerator or freezer at all times to let you know how cold your unit remains during the power outage.
- foods will generally remain cold in a refrigerator for four to six hours if the door is kept closed.
- the following are often implicated with foodborne illness and should be discarded if stored above 4°C (40°F) for two hours or more:
 - raw or cooked meat, poultry, seafood, and luncheon meats;
 - casseroles, stews, or soups;
 - milk and soft cheeses;
 - homemade mayonnaise or dressings;
 - cooked pasta, potatoes, or rice; and
 - salads made with any of these foods.
- foods that can be stored above 4°C (40°F) for several days include:

- butter and margarine;
 - hard or processed cheese;
 - fresh fruits and vegetables;
 - mustard, ketchup, olives;
 - salad dressings, peanut butter, barbeque sauce; and
 - jams and jellies.
- frozen foods in a fully stocked chest or upright freezer will stay frozen up to two days and for about one day in a half-filled freezer.
 - food that has thawed but is still cold may be refrozen.
 - raw meat or poultry should first be cooked before freezing.
 - fish and shellfish should not be refrozen if they have completely thawed.
 - frozen dinners, desserts and ice cream should not be refrozen.
 - prepared foods may be refrozen but should be marked so they can be used as soon as possible.

B.14 Nova Scotia Department of Agriculture (2015)

Food Safety After a Flood

The Nova Scotia Department of Agriculture (NSDA) issued a fact sheet regarding food safety after a flood. The fact sheet outlined how floods can cause food to become unsafe, what to do with unsafe food, cleaning up after a flood, preparation for flooding events, water supply and impacts to eating establishments. The following information regarding food and beverage safety was presented:

- inspect all food items thoroughly. all food items that have been in direct contact with contaminated flood water should be discarded.
- discard all food items wrapped/stored in paper, plastics cloth, fiber or cardboard including dry food items such as flour, sugar, candy, cereal, baked goods, dried beans and rice.
- discard all food items packaged in permeable containers that are not waterproof including:
 - screw-caps;
 - snap-lids;
 - pull tops; and
 - crimp-cap containers.

- discard home-canned food in glass containers that have come in contact with flood water. empty jars can be cleaned and sterilized; however, flat component of lid will need to be discarded.
- discard food that has come in direct contact with flood water including meats, fish, poultry, fruits and vegetables (raw or cooked).
- discard commercially-canned foods that exhibit signs of damaged including:
 - bulging;
 - swelling;
 - leaking;
 - punctures;
 - dents or holes;
 - fractures; and
 - rusting.
- discard all porous items that may come in contact with food of person's mouth including:
 - baby bottle nipples and pacifiers;
 - wooden bowls;
 - plastic, paper or foam storage containers; and
 - utensils.
- "When in doubt, Throw it Out";
- Only food in commercially sealed, unopened, undamaged, water proof, air tight jars or metal cans may be considered safe once cleaned and sanitized as per below guidance:
 - thoroughly wash with soap and water ensuring all dirt, silt, water, chemicals, etc. are wiped away;
 - rinse with clean water;
 - sanitize by immersing item in 5 ml (1 tbs) bleach per 750 ml (3 cups) water or hot water of greater than 77°C (170°F); and
 - air dry.
- food preparation and services should be discontinued until appropriate steps have been taken to ensure the protection of the public's health. notify a food safety specialist with NSDA, food protection as an inspection may be required.
- consumption of tap water will be determined by local authorities. if water supply is not safe to use the following as guidance:
 - use bottled water that has not been in contact with contaminated water;
 - follow proper methods to boil or disinfect water for cooking, cleaning, and bathing;
 - and

- if on private well and/or have on-site sewage disposal systems, contact Nova Scotia Environment for information on appropriate well disinfection and required approvals for repairs of on-site sewage disposal systems.

B.15 United States Department of Agriculture (1996)

Tornado Food Safety

The United States Department of Agriculture (USDA) published a consumer's guide to food safety following a tornado. The following information regarding food and beverage safety was presented:

- drink only approved or chlorinated water.
- consider all water from well, cisterns and other delivery systems in the disaster area unsafe until tested.
- check foods and discard any containing particles of glass or slivers or other debris.
- discard canned foods with broken seams.
- if the power is out, discard the following foods if kept over 2 hours at above 40°F:
 - meat, poultry, fish, eggs, and egg substitutes -- raw or cooked;
 - milk, cream, yogurt, and soft cheese;
 - casseroles, stews, or soups;
 - lunch meats and hot dogs;
 - creamy-based salad dressings;
 - custard, chiffon, or cheese pies;
 - cream-filled pastries; and
 - refrigerator and cookie doughs.
- discard opened mayonnaise, tartar sauce and horseradish if above 50°F for over 8 hours.
- the following foods should keep at room temperature a few days and discarded if anything turns moldy or has an unusual odor:
 - butter or margarine;
 - hard and processed cheese;
 - fresh fruits and vegetables;
 - dried fruits and coconut;
 - opened jars of vinegar-based salad dressings, jelly, relish, taco sauce, barbecue sauce, mustard, ketchup, olives, and peanut butter;
 - fruit juices;
 - fresh herbs and spices;

- fruit pies, bread, rolls, and muffins;
 - cakes, except if cream-cheese frosted or cream filled; and
 - flour and nuts.
- refreeze thawed foods that still contain ice crystals or feel cold.

B.16 United States Department of Agriculture (2007)

A Consumer's Guide to Food Safety

The United States Department of Agriculture (USDA) published a consumer's guide to food safety following serve storms and hurricanes. The guide addresses preparedness for possible power outages following weather emergencies, how to determine what food to keep or discard, steps to follow to salvage specific food containers, recommendations on safe drinking water, and removal of food odour from refrigerators, as well as a list of typical food and beverage items found in the household refrigerators and freezers and the recommended course of action for each (*i.e.*, save or discard). The following information regarding food and beverage safety was presented:

- be prepared for a potential power outage:
 - make sure freezer is at or below 40°F (-17°C) and the refrigerator is at or below 40°F (4°C).
 - freeze containers of water for ice in the event that it is required to help keep food cold in freezers, refrigerators, or coolers in power goes out.
 - freeze items such as leftovers, milk, fresh meat and poultry that is not needed immediately in order to maintain them at safe temperatures longer.
 - identify where to purchase ice and dry ice.
 - store food on shelves above potential contaminated water in case of flooding
 - have coolers on hand for potential use if power goes out for longer than 4 hours.
 - group food together in freezer to help keep cold longer.
- never taste food to determine if it is safe.
- keep fridge/freezer closed as much as possible to maintain cold temperatures.
- refrigerator will remain cold for approximately 4 hours. a full freezer will hold temperature for approximately 48 hours (24 hours if half full and door remains closed).
- food may be refrozen if it still contains ice crystals or is at 40°F (4°C) or below.
- discard refrigerated perishable food items such as meat, poultry, fish, soft cheese, milk eggs, leftovers and deli items after 4 hours without power.
- "When in doubt, throw it out!"

- do not eat food that has come in contact with flood water.
- discard any food that is not in water proof container and potential exist for contact with flood water. food containers that are not waterproof include:
 - screw-caps;
 - snap lids;
 - pull tops;
 - crimped caps;
- discard cardboard juice/milk/baby formula boxes and home canned foods if in contact with flood water.
- inspect and discard damaged cans the exhibit any of the following:
 - swelling;
 - leakage;
 - punctures;
 - holes;
 - fractures;
 - extensive deep rusting; and
 - crushing/dents that prevent stacking or opening with manual, wheel-type can opener.
- undamaged, commercially prepared foods in all-metal cans and retort pouches such as flexible shelf-stable juice or seafood pouches can be cleaned and sanitized using the following procedure:
 - remove all labels (porous material);
 - wash can or retort pouches with soap and water (hot if possible);
 - brush/wipe off any dirt or silt;
 - rinse item with potable water;
 - sanitize by immersing in boiling water for 2 minutes, or placing in freshly made solution of 1 tablespoon of unscented, liquid chlorine bleach per gallon of drinking water (15 minutes);
 - air dry can or retort pouches for minimum 1 hour;
 - relabel container with expiration date and content; and
 - any concentrated baby formula in reconditioned, all-metal containers must be diluted with clean, drinking water.
- use only bottle water that has not been exposed to flood water.
- if bottled water is unavailable, boil water as per the following:
 - if water is cloudy, filter it through clean cloth or allow sediment to settle and draw off clear water;

- boil water for one minute and allow it to cool; and
- store in clean containers with covers.
- if boiling water is not possible, disinfect using household bleach as per the following steps:
 - if water is cloudy, filter through clean cloth or allow sediments to settle and draw off clear water;
 - add 1/8 teaspoon (or 8 drops) of regular, unscented, liquid household bleach for each gallon of water;
 - stir well and let stand for 30 minutes before use; and
 - store in clean container with covers.
- if using well water that has been flooded, water should be tested and disinfected after flood water recedes. If well is suspected of being contaminated, contact local or State health department or agriculture extension agents for specific advice.

B.17 United States Department of Agriculture (2013)

Keeping Food Safe During an Emergency

The USDA produced an online resource that outlines how to keep food safe during an emergency. The webpage outlines how to prepare for an emergency, answers some frequently ask questions regarding food safety in an emergency, and provides a list of typical foods stored in refrigerators and freezers and the corresponding course of action (*i.e.*, discard or save) in the event of a power interruption. The following information regarding food and beverage safety was presented:

- do not eat any food that may have come in contact with flood water.
- do not store food outside (even if ambient temperature is <40°F).
- never taste food to determine if it is safe for consumption.
- discard any food that is not in a waterproof container including screw-caps, snap lids, pull tops, and crimped caps.
- discard cardboard juice/milk/baby formula boxes and home canned foods if they have come in contact with flood water.
- inspect cans for swelling, leakage, punctures, holes, fractures, extensive deep rusting, or crushing/dents severe enough to prevent normal stacking or opening with a manual wheel-type can opener. if cans exhibit any of the listed signs of damaged, discard food items.

- Discard any raw food or food in permeable packaging (*i.e.*, cardboard, plastic wrap, screw-topped jars, bottles, *etc.*) stored outside of refrigerator.
- items in fridge/freezer may be susceptible to contamination by fumes as the refrigerator/freezer seals are not airtight.
- chemicals used to fight fires contain toxic material and can contaminate food and cookware. any food exposed to such chemicals should be discarded as chemicals cannot be washed off food. cookware can be decontaminated by washing with soap and hot water, then submerged for 15 minutes in disinfecting solution consisting of 1 tablespoon unscented, liquid chlorine bleach per gallon of water.
- undamaged, commercially prepared foods in all-metal cans and retort pouches (*i.e.*, flexible, shelf stable juice or seafood pouches) can be saved as per the following steps:
 - remove labels (porous and can hold dirt and bacteria);
 - thoroughly wash can or retort with soap and water (hot water if available);
 - brush or wipe away any dirt or silt;
 - rinse can or retort with potable water (if available) since dirt or residual soap will reduce the effectiveness of chlorine sanitation;
 - sanitize can by either:
 - immersing in water and allowing the water to come to a complete boil for 2 minutes, or
 - immersing in a freshly made solution consisting of 1 tablespoon of unscented, liquid chlorine bleach per gallon of potable water (or cleanest, clearest water available) for 15 minutes.
 - air dry can or retort pouches for at least 1 hour before opening or storing.
 - if labels were removed, relabel can or retort pouches with content and expiration date.
 - food in reconditioned cans should be used as soon as possible.
 - any concentrated baby formula in reconditioned, all-metal containers must be diluted with clean, potable water.
- pots, pans, dishes and utensils should be washed in soap and water (hot water if available), rinsed in clean potable water and sanitized as per the bleach solution listed above and allowed to air dry.
- use bottled water that has not been exposed to flood water; however, if bottled water is not available then disinfect water using the following procedures:
 - first filtering water through clean cloth or allowing sediment to settle before drawing off the clear water;
 - boil water for 1 minute and store in clean container with a cover; or

- add 1/8 teaspoon (or 8 drops) of regular, unscented, liquid household bleach for each gallon of water. stir water well and let stand for 30 minutes. store disinfected water in clean containers with covers.
- for areas where water is supplied by a private well that has been flooded, the water will need to be tested and disinfected after the flood water has receded. if water well is suspected of being contaminated, contact local or state health department or agriculture extension agent for advice.

B.18 United States Department of Agriculture (2017b)

USDA Offers Food Safety Tips for Areas Affected by Flooding

The USDA created an online resource that outlines how to keep food safe during flooding. The webpage outlines how to prepare for an emergency during a flood. The following information regarding food and beverage safety was presented:

- do not eat any food that may have come into contact with flood water, including raw fruits and vegetables, milk, and eggs.
- discard any food that is not in a waterproof container if there is any chance that it has come into contact with flood water. food containers that are not waterproof include those packaged in plastic wrap or cardboard, or those with screw-caps, snap lids, pull tops, and crimped caps. flood waters can enter into any of these containers and contaminate the food inside. also, discard cardboard juice/milk/baby formula boxes and home canned foods if they have come in contact with flood water, because they cannot be effectively cleaned and sanitized.
- inspect canned foods and discard any food in damaged cans. can damage is shown by swelling, leakage, punctures, holes, fractures, extensive deep rusting, or crushing/denting severe enough to prevent normal stacking or opening with a manual, wheel-type can opener.
- in advance of losing power, follow the following steps:
 - keep appliance thermometers in both the refrigerator and the freezer to ensure temperatures remain food safe during a power outage. safe temperatures are 40°F (4°C) or lower in the refrigerator, 0°F (-17°C) or lower in the freezer.
 - Freeze water in one-quart plastic storage bags or small containers prior to a storm. These containers are small enough to fit around the food in the refrigerator and freezer to help keep food cold.

- freeze refrigerated items, such as leftovers, milk, and fresh meat and poultry that you may not need immediately to help keep them at a safe temperature longer.
 - know where you can get dry ice or block ice.
 - have coolers on hand to keep refrigerator food cold if the power will be out for more than four hours.
 - group foods together in the freezer—this ‘igloo’ effect helps the food stay cold longer.
 - keep a few days’ worth of ready-to-eat foods that do not require cooking or cooling.
- after a power outage, follow the following steps:
 - check the temperature inside of your refrigerator and freezer.
 - discard any perishable food (such as meat, poultry, seafood, eggs or leftovers) that has been above 40°F for two hours or more.
 - check each item separately.
 - throw out any food that has an unusual odor, color or texture or feels warm to the touch.
 - check frozen food for ice crystals.
 - the food in your freezer that partially or completely thawed may be safely refrozen if it still contains ice crystals or is 40°F or below.
 - never taste a food to decide if it is safe.
 - “When in doubt, throw it out.”

B.19 United States Food and Drug Administration (2015)

Food and Water Safety During Power Outages and Floods

The United States Food and Drug Administration (USFDA) published a fact sheet regarding food and water safety during power outages and floods. The fact sheet outlined how to prepare before a power emergency, what to do if power goes out and what to do when power is restored, what to do if flooding occurs, disinfecting techniques, keeping food safe, general information about foodborne illness. The following information regarding food and beverage safety was presented:

- if power goes out, following tips should be used to keep food safe:
 - keep fridge/freezer door closed. fridge can maintain cool temperature for 4 hours while a full freezer can maintain freezer temperatures for approximately 48 hours.
 - blocks of ice can be used to maintain cool ambient fridge temperatures for longer periods of time (15 pounds of ice will keep an 18 cubic foot fully stocked freezer cold for 2 days).

- if at any point food was stored at above 40°F (4°C) for more than 2 hours (or 1 hour if temperatures are above 90°F/32C.) food will need to be discarded.
- discard any food that may have come in contact with flood water.
- discard any food and beverage that is not in a water proof container if there is any chance that it has come in contact with flood water.
- discard all cardboard, juice/milk/baby formula boxes and home canned foods if they have come in contact with flood water.
- discard all food that is not contained in water proof containers including:
 - screw-caps;
 - snap lids;
 - pull tops; and
 - crimp caps.
- discard any food in damaged cans as defined by the following features:
 - swelling;
 - leaking;
 - punctures;
 - holes;
 - fractures;
 - extensive deep rusting; and
 - crushing/denting that impacts normal stacking or opening of can with a manual wheel-type can opener.
- undamaged, commercially prepared foods in all-metal cans and “retort pouches” such as flexible shelf-stable juice or seafood pouches can be cleaned and sanitized using the following procedure:
 - remove all labels (porous material);
 - wash can or retort pouches with soap and water (hot if possible);
 - brush/wipe off any dirt or silt;
 - rinse item with potable water;
 - sanitize by immersing in boiling water for 2 minutes, or placing in freshly made solution of 1 tablespoon of unscented, liquid chlorine bleach per gallon of drinking water (15 minutes);
 - air dry can or retort pouches for minimum 1 hour; and
 - relabel container with expiration date and content.
- the following steps should be taken to keep water safe during and after flooding:
 - only use water from safe source for drinking and washing or preparing food.

- use bottled water that has not been exposed to flood water.
- boil or disinfect water according to the following:
 - if water is cloudy, filter through clean cloth or allow sediment to settle then draw off clear water for boil/disinfecting;
 - boil water for 1 minute; or
 - add 1/8 teaspoon (8 drops) unscented, liquid chlorine bleach per gallon of water, stir well and let stand for at least 30 minutes; and
 - store in clean containers with covers.
- if well is flooded water will need to be tested and disinfected after flood water recedes. if water is suspected of being contaminated, contact local or state health department or agricultural extension agent for advice.
- thoroughly wash metal pans, ceramic dishes, and utensils (including can openers) with soap water (hot water if available). rinse and sanitize by boil in clean water or immersing in solution of 1 tablespoon unscented, liquid chlorine bleach per gallon of potable water for 15 minutes.
- thoroughly wash countertops and cooking surfaces with soap and water (hot if available). Rinse with clean water and sanitize with solution listed above. Allow to air dry.

B.20 United States Food and Drug Administration (2017a)

Food Safety for Consumers Returning Home After a Hurricane and/or Flooding

The USFDA produced an online resource that outlines how to keep food safe after a hurricane or flooding. The webpage outlines how to assess all food, food preparation areas and equipment to decide what to keep or throw away. The following information regarding food and beverage safety was presented:

- do not eat any food that may have come directly into contact with flood water. If in doubt, throw it out.
- do not eat food packed in plastic, paper, cardboard, cloth, and similar containers that have been water damaged.
- discard food and beverage containers with screw-caps, snap lids, crimped caps (soda bottles), twist caps, flip tops, and home canned foods, if they have come in contact with flood water. These containers cannot be disinfected.

- inspect the food and beverage containers thoroughly for damage and discard the following:
 - discard any visibly damaged containers;
 - undamaged, commercially-prepared foods in all-metal cans or retort pouches can be saved if you remove the labels, thoroughly wash the cans, rinse them, and then disinfect them with a sanitizing solution consisting of 1 cup (8 oz/250 mL) of unscented household (5.25% concentration) bleach per 5 gallons of water;
 - allow the cans to air dry and re-label the containers, including the expiration date; and
 - as an added precaution, if unsure that the container is damaged, the USFDA recommends boiling (rolling boil) the contents of the container for 5 minutes.
- if the power in a refrigerator goes out, keep the refrigerator and freezer doors closed as much as possible to maintain the cold temperature. The refrigerator will keep food cold for about 4 hours if it is unopened. A full freezer will keep the temperature for approximately 48 hours (24 hours if it is half full) if the door remains closed.
- buy dry or block ice to keep the refrigerator as cold as possible if the power is going to be out for a prolonged period of time. Fifty pounds of dry ice should hold an 18-cubic foot fully-stocked freezer cold for two days.
- once the power is restored, determine the safety of your food. If an appliance thermometer was kept in the freezer, check the temperature when the power comes back on. If the freezer thermometer reads 40° F or below, the food is safe and may be refrozen. If a thermometer has not been kept in the freezer, check each package of food to determine its safety. You can't rely on appearance or odor. If the food still contains ice crystals or is 40° F or below, it is safe to refreeze or cook.
- refrigerated food should be safe as long as the power was out for no more than 4 hours. Keep the door closed as much as possible. Discard any perishable food (such as meat, poultry, fish, eggs or leftovers) that has been above 40° F for two hours or more.
- perishable food such as meat, poultry, seafood, milk, and eggs that are not kept adequately refrigerated or frozen may cause illness if consumed, even when they are thoroughly cooked.

B.21 Centers for Disease Control and Prevention (2017)

Keep Food and Water Safe After a Disaster or Emergency

The United States Centers for Disease Control and Prevention (CDC) published an online resource that outlines ways to keep food and water safe after a disaster or an emergency. The

online reference source outlines measures that the public can take to identify what food items are not safe for consumption, best cleaning and sanitation practices, what practices to follow for feeding infants and young children, and safe drinking water precautions. The document also references the recommended mixture ratios of bleach for sanitizing food cans and surfaces. The following information regarding food and water safety was presented:

Food

- Discard food that has an unusual odor, color, or texture.
- Discard perishable foods (meats, poultry, fish, eggs and leftovers) from refrigerator if power has been interrupted for more than 4 hours.
- Discard food not in packages or cans.
- Discard foods or food containers that are bulging, open, or damaged.
- Discard any food if the container squirts liquid or foam when opened, or the food inside is discolored, moldy, or smells bad.
- Discard food containers with screw-caps, snap lids, crimped caps, twist caps, flip tops and snap-open and home canned foods, as well as cardboard containers including juice/milk/baby formula boxes.
- Commercially prepared cans and retort pouches (like flexible, shelf-stable juice and seafood packages) can be reused by following the procedure listed below:
 - remove all labels (if removable);
 - brush or wipe away dirt or silt;
 - wash can and pouches with soap and water (hot water if available);
 - rinse can and pouches with potable water (if available);
 - sanitize cans or pouches as per the following procedure:
 - place can or pouch in solution of 1 cup (8oz/240 mL) of unscented household bleach in 5 gallons of water for 15 minutes; or
 - submerge can or pouch in a pot of water, bring to a boil, and continue to boil for 2 minutes.
 - re-label cans or pouches with marker with content and expiration date;
 - use food in reconditioned cans or pouches as soon as possible.
- For feeding infants and young children when tap water is unsafe the following is recommended:
 - Breastfed infants should continue breastfeeding.
 - For formula-fed infants, use ready-to-feed formula if available; however, if not available use bottle water to prepare powder or concentrated formula.

- If bottled water is not available, check the status of drinking water with local authorities to ensure boiling will make it safe to drink.
- Use treated water (as per instructions below) to prepare formula if all other sources of water (*i.e.*, bottled or boiled) are not available.
- If preparing baby formula with boiled water, allow formula to cool before giving to infant
- Clean feeding bottles with bottles, boiled, or treated water before each use. Discard baby nipples or pacifiers that have come in contact with flood water as they cannot be sufficiently sanitized.
- Wash hands before preparing formula and before feeding an infant. If clean water is not available, an alcohol-based hand sanitizer will suffice.
- Clean and sanitize food-contact surfaces as per the following instructions:
 - wash with soap and hot, clean water;
 - rinse with clean water;
 - sanitize by immersing for 1 minute in solution of 1 cup (8oz/240mL) of unscented household chlorine bleach in 5 gallons of clean water; and
 - allow to air dry.
- Discard wooden cutting boards, baby bottle nipples, and pacifiers.

Water

- Do not use water if you suspect of have been instructed by local officials that it is unsafe for potable uses (*i.e.*, washing dishes, brushing teeth, washing and preparing food, making ice, or preparation of baby formula). This includes well water that may have been impacted by flood water or other natural disasters.
- Water can be made safe to drink via boil, disinfecting, or filtering; however, water impacted by fuel or toxic chemicals cannot be made safe by boiling or disinfection and an alternative water source will be required.
- Boiling water will ensure disease causing organisms (viruses, bacteria, and parasites) will be eliminated. Boiling instructions are as follows:
 - If water is cloudy, filter through clean cloth, paper towel, or coffee filter or allow sediments to settle.
 - Draw off clear water.
 - Bring clear water to rolling boil for 1 minute (3 minutes at elevations above 6,500 feet).
 - Let boil water cool.

- Store clean water in clean sanitized container that is durable, unbreakable material (*i.e.*, not glass) and has a top that can be closed tightly. Only use food grade containers for storing water and sanitize according to steps below:
 - Wash container with dish soap and water and rinse with clean water.
 - Sanitize container using a mixture of 1 teaspoon of unscented liquid household chlorine bleach per 1-quart water.
 - Cover container and shake well in order to sanitize all interior surfaces.
 - Wait 30 seconds and pour the sanitizing solution out.
 - Let empty sanitized container air-dry or rinse with potable water if available.
- If boiling water is not possible given the circumstances, water can be disinfected with chlorine bleach, iodine, or chlorine dioxide tablets which will kill most harmful organisms (viruses and bacteria). Of note, only chlorine dioxide tablets are effective in controlling more resistant organisms, such as the parasite *Cryptosporidium*. To disinfect water, use the following instructions:
 - If water is cloudy, filter through clean cloth, paper towel, or coffee filter or allow sediments to settle.
 - Draw off clear water.
 - When using 5–6% unscented liquid household chlorine bleach, add a little less than $\frac{1}{8}$ teaspoon (8 drops) per gallon of clear water (2 drops per liter), or $\frac{1}{4}$ teaspoon (16 drops) per gallon of cloudy water (4 drops per liter).
 - When using 8.25% unscented liquid household chlorine bleach, add a little less than $\frac{1}{8}$ teaspoon (6 drops) per gallon of clear water (2 drops per liter), or $\frac{1}{8}$ teaspoon (12 drops) per gallon of cloudy water (3 drops per liter).
 - When using iodine or chlorine dioxide tablets, use manufacturer's instructions.
 - Stir mixture well.
 - Let stand for 30 minutes.
 - Store disinfected water in clean, sanitized container with tight cover.
- If using a portable filter, choose one that has a pore size small enough to filter out both bacteria and parasites as most do not remove viruses or bacteria. Follow manufacturer's instructions for proper use. After filtering, add disinfectant (iodine, chlorine, or chlorine dioxide) to kill any viruses or remaining bacteria.

B.22 Michigan State University (2018)

Food Safety Issues to Consider After a Flood

Michigan State University published an online resource that outlines what needs to be done to have safe drinking water after a flood and ways to keep food safe after a flood. The online resource outlines measures that the public can take to identify what food items are not safe for consumption, best cleaning and sanitation practices, and safe drinking water precautions. The following information regarding food and water safety was presented:

- Clean and sanitize food preparation and storage areas with hot soapy water, sanitize with 1 tablespoon unscented liquid chlorine bleach per gallon of cleanest water available and allow to air dry.
- Foods not stored in waterproof containers should be discarded if there is any chance it came in contact with flood water.
- Food containers that are not water proof include those with screw-caps, snap lids, and crimped caps.
- Discard any cardboard juice/milk/baby formula boxes and home canned foods, if they were in contact with flood waters because they cannot be effectively cleaned and sanitized.
- Inspect all canned foods and throw away any damaged cans, including cans that show swelling, leakage, puncture, holes, fractures, extensive deep rusting, or crushing/denting that is severe enough to prohibit the stacking of the cans.
- Undamaged, commercially prepared foods in all-metal cans or retort pouches, such as flexible, shelf-stable juice or seafood pouches, can be saved after removal of labels (that may hide dirt and bacteria), washing with soap and cleanest water available (hot water if available), and sanitizing by placing in hot water and boiling for 2 minutes or placing in freshly made bleach solution (1 tablespoon bleach to 1 gallon of clean drinking water) for 15 minutes. Air dry and use as soon as possible.

B.23 Minnesota Department of Health (2010)

Food Safety after a Fire

The Minnesota Department of Health (MDH) issued a fact sheet that outlines food safety and clean up tips for the public in the aftermath of the fire. The factsheet outlines how food may become contaminated following a fire, what to do with food and beverage items that have been in or near a fire, cleaning and sainting tips, and what to do in the case where power was disrupted during a fire event. The fact sheet also provides a list of typical foods stored in a refrigerator and

the corresponding course of action (*i.e.*, discard or save) in the event of a power interruption. The following information regarding food and beverage safety was presented:

- All foods and beverages stored in a permeable packaging such as cardboard, foil, paper, screw top jars or bottles, or plastic wrap should be discarded.
- All unwrapped fruits and vegetables should also be discarded.
- Foods stored outside of refrigerator and which were exposed to smoke and fumes should be discarded.
- Foods stored in the fridges and freezers that are not air tight may have come in contact with smoke and fumes and will need to be discarded.
- Discard ice from freezer (dispensing and serving bins).
- Any food that may have come in contact with fire suppression chemicals will need to be discarded.
- Discard any disposable single-service utensils (plastic plates, cups, *etc.*) that were exposed to smoke.
- Never taste food to determine if it is safe.
- Food not fit for human consumption is also not safe for your pets.
- “When in doubt, throw it out”
- In the event of a power interruption:
 - Keep refrigerator and freezer door closed as much as possible.
 - Check for signs of power interruption or outage (*e.g.*, liquid or refrozen meat juices, or soft/melted ice cream).
 - Check with utility companies for power outages in the area if you were not present during the event.
 - Minimize frequency of entering and exiting walk in coolers as contaminants are tracked in via clothes and shoes.
 - Discard any food with unusual odour, colour, or texture.
 - Discard any meat, poultry, seafood, milk, or eggs that have potentially been in the danger zone (>41°F/5°C) for over 2 hours.

B.24 University of Florida (1998)

The Disaster Handbook

The University of Florida (UF) Institute of Food and Agricultural Sciences Extension (IFAS) originally published the Disaster Handbook in 1998. The handbook was intended to assist the University of Florida Extension personnel and their communities in times of disasters. The document acts as a guide to disaster preparedness, survival in disaster situations, and recovery from disasters. Chapter 4 of this document specifically outlines information on the concerns

immediately following a natural disaster including safety, emotional recovery, emergency food and water, health and sanitization, wildlife and pest issues, community recovery, and assistance programs and insurance concerns. Information included in sections of Chapter 4 that are directly related to food and water safety following a disaster include:

Meal Preparation and Food Safety after a Flood (Section 4.9)

Food and water may become impacted by flood water as contaminants such as silts, raw sewage, oil or chemical waste can come in contact with it. After returning home, thoroughly inspect any food items that were left in the home as flood water may have dripped on or seeped into these items. If in doubt of the safety of a food item, throw it out to avoid risk of disease. Do not attempt to save the following items:

- opened containers and packages which have come in contact with flood water;
- unopened jars and bottles with paper waxy seals such as containing mayonnaise or salad dressing;
- containers of spice, seasoning, and flavoring;
- flour, grains, sugars, and coffee in canisters or bags;
- paper, cloth, fiber, or cardboard boxes, even if the content seems dry (*i.e.*, salt, cereals, pasta products, rice, and any “sealed” packages of crackers, cookies, or mixes within a later paper box);
- dented seams, bulging, rusty or leaking tin cans, as well as cans that have been displaced from their normal storage area as the seams may have been damaged;
- jam or jelly sealed with paraffin;
- containers with non-sealed, fitted lids (example: cocoa or baking powder);
- commercially-bottle carbonated beverages that have signs of crusted silt on cap;
- foil or cellophane packages;
- all fresh vegetables and fruits which do not have a peel, shell, or coating which can be removed before use;
- fresh meat, fish poultry which have been in contact with flood water; and
- home-canned foods in jars (cannot guarantee preservation method and potential for contamination).

Other packaged foods will require careful examination of sealed drums, metal-linked casks or cases, and wooden barrels which are often used for liquids. Have health teams inspect drums, barrels, casks, *etc.* If leaks are found, ensure containers are stored out of reach of any persons and destroy containers as soon as possible. Examine sealed foil or cellophane containers for damage or leaks. If the content of these containers is normally granular or powdered and is presently in cake form or non free-flowing form, discard. Sound foil packages that have staining on the inner paper wrapper should be discarded. Unbroken packages with evidence of outer

water contamination may be wiped dry and used. The following foods/containers are considered safe if properly washed, sanitized, and cooked before consumption:

- tin cans that are not damaged can be washed and sanitized before opening. for added safety, the contents should be boiled before use.
- potatoes can be washed, sanitized, dried, peeled, and cooked before use.
- citrus fruit can be washed, sanitized, peeled and heated to 160°F for 10 minutes before use.
- apples and other fruits can be washed, sanitized, peeled, and cooked before consuming.

Cans and commercial glass jars that are free of rust or dents should be washed and sanitized before they are opened. Use the following steps for proper inspection, cleaning, and sanitation:

- inspect cans and destroy any that show indications of spoilage (e.g., bulges or dents).
- remove labels and thoroughly wash with strong detergent solution with a scrub brush to remove all silt.
- immerse clean containers for 15 minutes in cold (60 – 70°F) chlorine solutions.
- remove containers from sanitizing solution, rinse with clean water and air dry before opening.
- relabel if possible and use as soon as possible.
- Alternatives methods to disinfect cans/jars include:
 - placing container in boiling water and continuing to boil to 10 minutes, let cans cool and dry to prevent rusting, and relabel if possible.
 - immersing the cans/jars in alternative sanitizing solutions recommended by local authorities and rinsing with clean water.

Garden produce may not be safe for consumption if it has come on contact with flood water; however, this will depend on the kind of produce, maturity of produce at time of flood event, time of year flood occurred, severity of flood, the duration of the flooding event, bacterial content of flood water, and likelihood of contamination from sewage or other bacterial contaminants. In general, immature fruits and vegetables (*i.e.*, more than two weeks immature at the time of flooding) should be safe for consumption at the time of maturity; however, for additional safety, the produce should be disinfected. Avoid using mature fruits and vegetables that were close to harvest at the time of the flooding events, unless they can be disinfected, peeled, and thoroughly cooked before consumption. Some fruits and vegetables are more susceptible to bacterial contaminations including leafy vegetables such as lettuce, cabbage, mustard, kale, collards, spinach, Swiss chard, and celery. Other fleshy vegetables and berry fruits such as tomatoes, cucumbers, summer squash, strawberries, and peppers would also be more susceptible to bacterial contamination.

Garden produce that are root, bulb, or tuber crops (e.g., beets, carrots, radishes, turnips, onions, and potatoes) as well as produce with a protected fruit or impervious outer skin (e.g., peas, melons, eggplant, or winter squash) could be washed, sanitized, peeled and cooked thoroughly before consumption. If produce is deemed to be safe for consumption, the following procedure should be followed to disinfect:

- Wash in strong detergent solution with clean scrub brush to remove all silt.
- Immerse produce in chlorine solution for 15 to 20 minutes.
- Rinse produce thoroughly with potable water.
- Peel (if possible) and cook thoroughly before consumption.

Meal Preparation and Food Safety during and after a Power Failure (Section 4.10)

Power failure can result in limited heat, loss of refrigeration and limited water supply. As a result of loss of refrigeration there is an increased risk of food contamination or spoilage. If a power outage is anticipated, set refrigerator/freezer setting to the coldest level to build up a cooling reserve. Keep the freezer and refrigerator closed as much as possible to preserve the cold temperatures. If closed tight, a full freezer will maintain its temperature at least a day, more depending on insulation and frequency of access. If ice crystals are present or the food item has been kept at, or below, 40°F for no more than 2 days the food items can be refrozen. If the temperature of food from the refrigerator or freezer is above 50°F it should be discarded. For food that has thawed, the following recommendations apply:

- fruits – If items do not exhibit an unusual taste or odour they can be refrozen. Fruits that have begun to ferment are safe to eat; however, they will have an off flavor and should be used in cooking.
- frozen dinners – Do not refreeze once thawed.
- vegetables – Do not refreeze thawed vegetables as bacteria growth in these foods items is rapid and can be toxic. Refreeze only if ice crystals are present throughout package. Discard if there is any uncertainty to the condition of a vegetable.
- meat and poultry – If questionable odour is present, or if freezer temperature has exceeded 40°F for more than 2 hours, discard. Discard all stuffed poultry. Immediately cook thawed but unspoiled meat or poultry. Cooked meat can be refrozen if temperature has not exceeded 70°F for more than 2 hours, or ice crystals are still present throughout meat.
- fish and shellfish – These items are extremely perishable. Refreeze only if ice crystals remain throughout the package. There may not be an offensive odour even if product has spoiled.
- ice cream – Do not refreeze ice cream; discard or consume in liquid form if not spoiled.

If power outages occur, the following food safety related information applies to refrigerator items:

- most chopped meats, poultry, and seafood sandwich fillings should not be left unrefrigerated for longer than 2 hours.
- extend food supply by cooking all unspoiled items immediately. Note, cooked meat is required to be held above 140°F if it cannot be cooled below 45°F within 2 hours.
- items that are free of preservatives (*i.e.*, uncured sausage) are vulnerable to contamination. Keep frozen until ready to consume and cooked before completely thawed.
- raw ground meats (*e.g.*, hamburger), pork, fish, and poultry spoil quickly. Discard if refrigerator has been without power for longer than 12 hours.
- hard cheeses will keep at room temperature for extended periods of time; however, other cheeses (*e.g.*, cream cheese, opened containers of cheese spread, cottage cheese) spoil quickly. Discard when unusual flavor develops. If surface mold develops on blocks of cheese, cut off 1-inch depth below the surface of the cheese and discard.
- discard spoiled milk. Sour milk may be used in baking.
- custards, gravies, creamed foods, ground meat, poultry, and seafood sandwich filling will spoil quickly. Discard if these items have been raised to room temperature.

B.25 International Food Safety Authorities Network (2005)

Food Safety in Natural Disasters

The International Food Safety Authorities Network (INFOSAN) published an information notice regarding food safety in the events of a natural disaster. The document outlines several issues that require immediate attention following natural disasters including, preventative food safety measures, inspecting and salvaging food, provision for safe food and water, recognition and response to outbreaks of foodborne disease, and consumer education and information of food safety. The following information regarding inspecting and salvaging food was presented:

- all food that have been deemed fit for consumption should be labelled.
- any food deemed unfit for human consumption should be discarded.
- discard canned foods that exhibit broken seams, serious dents, or leaks and any jars with cracks present.
- undamaged canned goods and commercial glass jars of food should be washed and sanitized before opening. Any food item exposed to chemicals, however, should be thrown away.
- inspect refrigerators and freezers for signs of power interruption. If food has remained cold and otherwise unaffected, the food is likely safe for consumption.

- if power is interrupted, food contained in the fridge/freezer should be used before it is kept in the danger zone (*i.e.*, 5 – 60°C) for more than 2 hours.
- while some food items can be stored within the danger zone for prolonged periods of time, any item that exhibits signs of spoilage (*i.e.*, off odour, colours, or texture) should be discarded.
- check all food items for physical hazards (*i.e.*, glass, wood splinters, and stone) that may be been introduced.
- moldy food should be discarded.

B.26 World Health Organization (2006)

Ensuring Food Safety in the Aftermath of Natural Disasters

The World Health Organization (WHO) developed a guide for ensuring food safety following a natural disaster. The documents intentions was to provide guidance to public health and other authorities on food safety issues in disaster situations, remind authorities of the importance of restoring and maintaining basic support for food safety infrastructure, elevated the importance of vigilance against foodborne risks that may be introduced, provide a quick reference for those involved with emergency food aid (*i.e.*, refugee camp managers and food distributions centres), and provide guidance in communication tools in order to convey simple messages to the public detailing food preparation in disaster areas. The following information regarding inspecting and salvaging of food and beverages was presented:

- food preparation centres, slaughterhouses, markets and catering establishments should be inspected, in particular those handling perishable products such as milk, prior to food entering the market place.
- all salvaged food that is deems fit for consumption should be labeled accordingly and consumers should be informed as to the measures taken to ensure the food is safe.
- in areas where flooding has occurred, intact food should be moved to dry locations, ideally away from walls and off the floor.
- any food stock that has been determined to be unfit for human consumption should be marked and disposed of.
- discard canned food with broken, dents, or leaks; and jars with cracks.
- undamaged canned goods and commercial glass jars of food are likely to be safe; however, to ensure added safety containers should be sanitized prior to opening as per the following steps:
 - wash jar/can thoroughly.
 - if label is removed, print new label on can prior to cleaning with indelible ink.

- immerse can/jar in sanitization solution (2 teaspoons chlorine bleach per quart of room temperature water) for 15 minutes.
- air dry before opening.
- food exposed to chemicals should be discarded as chemicals typically cannot be washed off completely.
- food stored in permeable containers such as cardboard, screw-top jars, and bottles that are difficult to clean should be discarded.
- inspect refrigerators to determine if power supply has been interrupted or if flood water have impacted the unit. If no indications of potential impacts are present, food is likely safe for consumption.
- if power is not available, all attempts should be made to use refrigerated items before they are held in the danger zone (*i.e.*, 5 – 60°C) for more than 2 hours. Meat, fish, and poultry are high priority items. If these items have not reached the danger zone they may be immediately stored in freezer or cooked and frozen to increase the preservation time.
- some items typically stored in the refrigerator can be stored within the danger zone longer such as butter, margarine, fresh fruits and vegetables, open jars of concentrates and sauces, and hard processed cheese; however, if at any time signs of spoilage (*e.g.*, odour, texture, gassiness, or mouldiness) occur, the item(s) should be discarded.
- check all food items for physical hazards (glass, wooden splinters, *etc.*) that may have been introduced during an earthquake.
- mould growth is more likely to occur on stored dry vegetables, fruits, and cereals in humid environments and situation where food has become wet.
- intact food should be moved to dry locations, away from walls and off the floor. Pallets, boards, heavy branches, bricks, or plastic bags/sheets should be placed under bags of food to keep them from direct contact with the floor. Wet bags should be allowed to dry in sun before storing and damaged bags should be re-bagged and stored separate from damaged ones.
- loose or spilled food items should be swept up and discarded immediately to discourage rodents.

B.27 World Health Organization (2002)

Environmental Health in Emergencies and Disasters

WHO developed a practical guide for dealing with the environmental health management aspects during emergencies and disasters. The document outlines some key attributes of environmental health in emergencies and disasters such as the nature of emergencies and disasters, pre-disaster activities, emergency response, recovery and sustainable development, shelter and

emergency settlements, water supply, sanitation, food safety, vector and pest control, control of communicable diseases and prevention of epidemics, chemical incidents, radiation emergencies, mortuary service and handling of dead, health promotion and community participation, and human resources. Below is a summary of the information presented in Chapter 9 of this document that is directly related to food safety following a disaster:

- Assessment of cropped areas that may have been impacted by human excreta, in the case of flooding, is required to determine protective measures including delayed harvest or thorough cooking precautions to reduce risk of transmitting fecal pathogens.
- Unsalvageable foods with irremediable damage (*i.e.*, microbiological, chemical, or physical) or any food item exposed to conditions that would likely result in such contamination should be destroyed.
- Potential exists for contamination to occur without visible signs, such as seepage through crown caps and screw tops. The guiding principal is “if there is any doubt as the safety of the food, it should be destroyed”.
- Food safety authorities should be ensuring food is adequately protected, not being exposed to sources of contamination, and not kept under conditions to which bacterial growth may occur.
- Following a disaster food, industries, slaughterhouses and catering establishments should be inspected and only resume activities when the premises have been cleaned and disinfected, electricity/water and other utilities have been restored, and proper equipment and staff are available.
- Control should be in place to prevent irredeemably damaged foods are not distributed to markets and that food retailers and vendors are not selling food that has been potentially contaminated.
- Food stored in bags should be placed on pallets, boards, heavy branches, bricks, or clean, dry plastic bags, or anything that ensures the items are not directly on the floor. Products should be at least 40 centimeters from walls and at least 10 cm off the floor. Stored structures should have good roofs and ventilation.
- Food entering the region during relief operations should be monitored from the port of entry onward. Food that is determined to be unfit for human consumption via laboratory analysis or inspections should be condemned and rejected.
- The WHO’s golden rules for safe food preparation include:
 - **Cook raw food thoroughly** - All parts of the food must reach at least 70°C. Uncooked fruits and vegetables should not be eaten, unless item can be peeled. If milk has not been pasteurized, it should be boiled before use.
 - **Eat cooked food immediately** – Food should be consumed immediately following cooking to prevent bacteria growth within cooling food items.

- **Prepare food for one meal** – Food should be prepared fresh and in quantities reflective of a single meal. Prepared food that is to be stored for more than 4-5 hours should be cold (*i.e.*, below 5°C) or remain hot (*i.e.*, above 60°C).
- **Avoid contact between raw foods and cooked foods** – Cross-contamination should be prevented at all costs, whether by direct contact (contact with raw food) or indirect contact (contact with the same food preparation surface).
- **Choose foods processed for safety** – Canned goods or dry foods are more easier to keep safe in the event of a disaster.
- **Wash hands repeatedly** – Thoroughly wash hands before preparing, serving, or eating food, and after any interruption (*i.e.*, after the use of a toilet/latrine, changing a baby, or touching animals).
- **Keep all food preparation premises meticulously clean** – Take extra precautions in cleaning and sanitizing any surface used for food preparation. Scraps of food should be discarded, food should be stored in closed containers to protect from insects, rodents, and other animals. Use of traps for flies, mice, rats, *etc.* may be required.
- **Use safe water** – Only safe, potable water should be used for drinking as well as food preparation, as is the case when reconstituting milk from powder.
- **Be cautious with foods purchased outside** – Exercise caution when purchasing food from vendors or restaurants where hygienic conditions may be compromised due to environmental conditions. Beverages such as hot tea/coffee, wine, beer, carbonated water and soft drinks, packaged fruit juices, and bottled water are typically safe to drink; however, ensure packaging is undamaged or impacted in any way.
- **Breast-feed infants and young children** – Breast milk is the ideal source of nourishment for infants and young children. If food and water is contaminated, breast milk will ensure a safe and nutritionally adequate food supply for infants and young children.

B.28 References

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