Saskatchewan Guidelines for Reviewing Health Impacts in Environmental Assessments

December, 2014

Habitat
HEALTH IMPACT CONSULTING

This report was prepared for the Saskatchewan Ministry of Health.

Cite as: Froese, K. and M. Orenstein. 2014. Saskatchewan Guidelines for Reviewing Health Impacts in Environmental Assessment. Calgary, AB: Habitat Health Impact Consulting.

Table of Contents

Acronyms and Abbreviations

EA	environmental assessment
EcoRA	ecological risk assessment
EIA	Environmental Impact Assessment
EIS	environmental impact statement
ER	exposure ratio
ERA	environmental risk assessment
HIA	health impact assessment
HHRA	human health risk assessment
HQ	hazard quotient
MOH/RHA	Government of Saskatchewan Ministry of Health and Regional Health Authorities
ILCR	incremental lifetime cancer risk
SEARP	Saskatchewan Environmental Assessment Review Panel
TOR	terms of reference

1. Introduction

This document is intended to provide guidance to Saskatchewan Ministry of Health and Regional Health Authority staff for evaluating environmentally- and socially-mediated community health impacts of industrial projects in Saskatchewan. The guidance is framed within the context of Environmental Assessments (EAs) that are normally required for provincial and federal regulatory permitting of large projects.

The aim of this guidance is to ensure that specific local and regional community health concerns are addressed in the EA, and that the EA has supplied appropriate documentation and description of the methods used to arrive at conclusions about the importance of these health concerns. Historically, human health risk assessment (HHRA), which evaluates the potential human health effects of exposure to chemical contaminants, has been the primary mechanism for evaluating potential health impacts from industrial projects. While HHRA remains a key tool, this guidance document places HHRA within a broader, wholistic framework of community health and key factors that affect community wellbeing, such as housing, income, health care access, and other components of the social and biophysical environment. In doing so, the approach of this document aligns with the overall goals of public health protection in Saskatchewan [1].

The primary audience for this document is personnel from the Government of Saskatchewan Ministry of Health (MOH) and Regional Health Authorities (RHAs) who are tasked with reviewing the results of or providing input into an EA. This document will help them to ensure that the Terms of Reference and the EA itself adequately address community health issues.

In addition, the document may be useful for project proponents or the consultants helping them to prepare a regulatory application. The document will help them understand at an early stage what sorts of questions the MOH/RHAs will be asking, and also provides resource materials to help prepare the application.

It is assumed that readers / users of this document are already familiar with common aspects of the permitting process and the EA process, including federal and provincial regulatory requirements, stakeholder identification, stakeholder engagement, prioritizing impacts, etc.

2. Linkages to the Saskatchewan EA Process

The Saskatchewan EA process defines the sequential steps for scoping, preparation, review, and decision-making within the environmental assessment process for a new development project. An overview of the process can be found in the document *Environmental Assessment in Saskatchewan: A High-Level Overview of the Environmental Assessment Process for Developments within Saskatchewan under The Environmental Assessment Act* (June 2014), published by the Government of Saskatchewan Ministry of Environment).

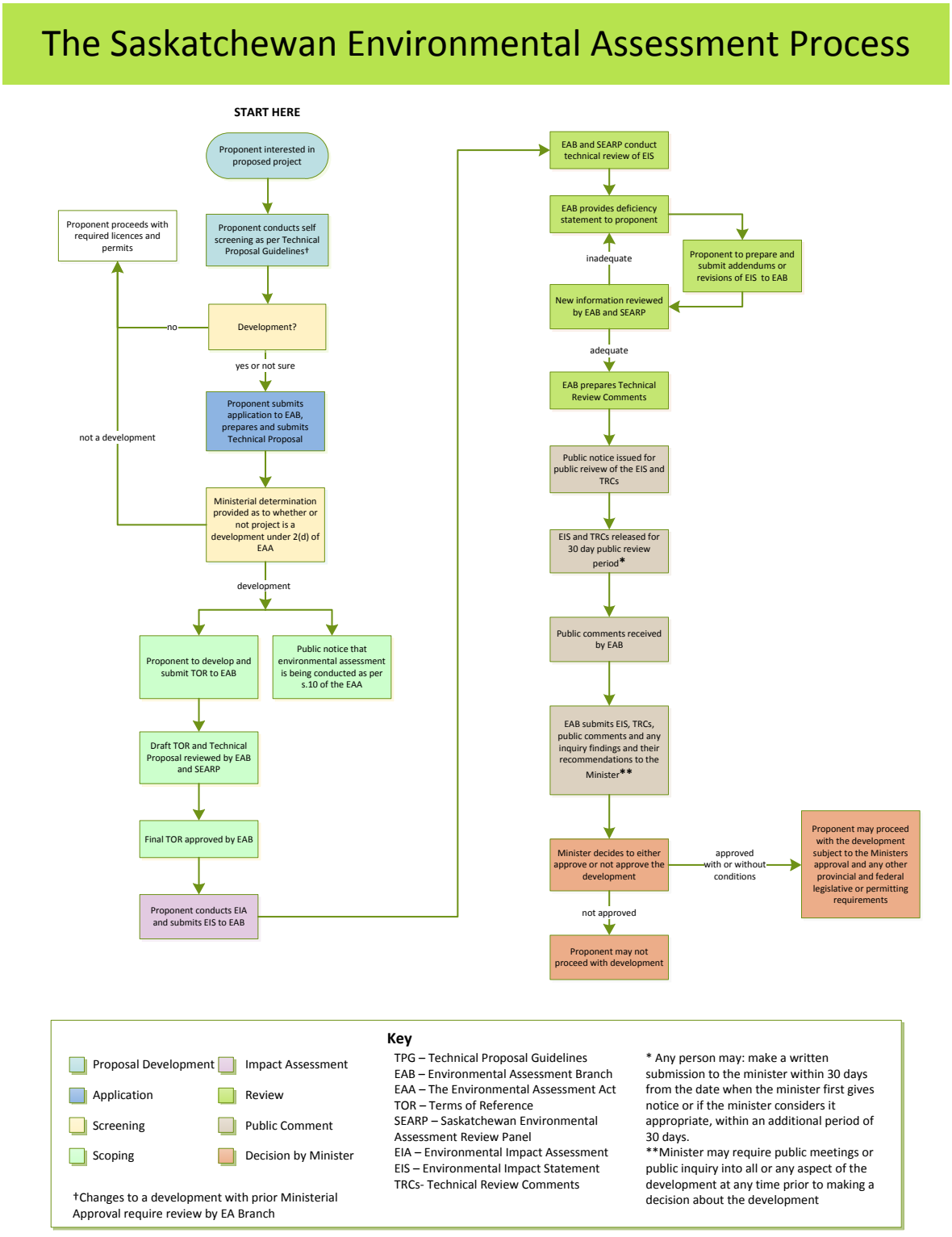
The process begins when a proponent submits a technical proposal to the EA Branch of the ministry for screening, in order to determine whether a proposed project is likely to trigger the criteria in section 2(d) of the Act and require a ministerial approval. Typically, technical proposals are circulated for environmental review by the ministry and other agencies as required. The EA Branch will provide formal notification with reasons for the determination of whether the proposed project is a 'development' under the Act, or if it is not a 'development' and may proceed as proposed, subject to any conditions and applicable provincial regulatory requirements (e.g., licenses, permits, leases and approvals) [2]. If the proposed project is determined to be a development, then further steps are triggered that include the development of Terms of Reference (TOR) for an Environmental Impact Assessment, the proponent submitting their Environmental Impact Statement (EIS) to the EA Branch, review of the EIS by the EA Branch, an opportunity for public comment, and a decision by the Ministry as to whether or not the proposed project is approved. **Figure 1** shows an overview of the steps in the EA process.

Along with the administrative and technical team in the EAB, members of the Saskatchewan Environmental Assessment Review Panel (SEARP) are engaged in the EA process. SEARP members are the direct contact between the EA Branch and the other ministries and agencies from which they are appointed. They may be called upon to provide multidisciplinary technical reviews and written comments at various points in the EA process: technical proposals (to help determine if a project constitutes a "development"), the TOR, the full EIS, and meetings with the proponent as necessary [3].

The MOH, as a member of the panel, directs the proposal to the RHA in which the project is planned. RHA officials are requested to review the proposal and provide comments back to the MOH. Often this is delegated to one individual to take the lead but it should often be done in a team approach within the RHA (e.g. PHI who would then review this with a MHO; there may be times where consultation would be sought from others within the health region such as nutritionist, epidemiologist, the EAB contact or from other members of SEARP such as agencies involved with environmental exposures, occupational health and safety, etc). The MOH in turn reviews and then forwards the official review to the EA Branch. If the MOH has additional concerns/comments regarding the project, the MOH/RHA will collaboratively review the proposal before providing the official comments. In addition, if there is need for a more technical review (e.g. human health risk assessment), the MOH will work with the RHA and other Ministries to initiate.

It is also important to note that the MOH relies on the technical skills of other SEARP panel Ministries to ensure that all aspects of impact to the public are considered and addressed.

Figure 1: Saskatchewan Environmental Assessment Process Overview



Source: Saskatchewan Ministry of the Environment (2012)

There are several points during the EA process in which MOH/RHAs have an opportunity to provide input. These are described in Table 1.

Table 1: Opportunities for MOH/RHA input during the EA process

EA Process Component	Type of MOH/RHA Input
Screening	Determination of whether a review by MOH/RHAs will be required
Terms of Reference Development by Proponent	Development of questions for inclusion in the TOR
Review	Review of the adequacy of the EIS in terms of addressing health concerns.

From the perspective of efficiency for the EA Branch, the project proponent, and the MOH/RHAs, it is better to have the MOH/RHAs involved earlier rather than later, so that issues are addressed up front rather than causing delays and extra expense in the approval process.

3. Key Health Supports

The Ministry of Environment, through the EAB, carries a legislative mandate to apply the Environmental Assessment Act specifically as it pertains to potential adverse environmental impacts (including economic, social, or cultural impacts as influenced directly or indirectly from impacts on the biophysical environment[1]) of industrial developments. The purpose of the involvement of the MOH in the EA process, as a member of SEARP, is to provide input to the Ministry of Environment to assist with the ministry's decision on a proposal and ensure that a proposed project or development is planned and carried out in a way that supports positive health outcomes within the population and minimizes potential adverse effects.

In this section, we present a comprehensive framework that encompasses areas critical to individual and population health outcomes that may be affected by development projects. This framework is organized around Key Health Supports (Table 2), which represent determinants of health that have been shown to be particularly important in the context of industrial development. They comprise specific pathways or components that may be impacted by a development project, and which can lead to changes in health outcomes.

This additional assessment (in some of the Key Health Supports) may not have the legislative power within the EA Act to reject the development; however, such a comprehensive assessment could greatly assist in:

- public- and environmental health planning to maximize positive benefits (particularly for local and regional stakeholders) of the development on community wellbeing;
- discuss options to mitigate potential adverse effects on community wellbeing;
- establish viable surveillance and monitoring approaches, and;
- designate financial and operational responsibilities for mitigation and monitoring. These may be determined to be within the role of the proponent, the MOH/RHA, other agencies, or the community.

As mentioned in the introduction, Human Health Risk Assessment (HHRA, also called Health Risk Assessment or HRA) has generally been the primary mechanism within EIAs to address human health issues that may be project related. However, the scope of HHRA is relatively narrow, as it focuses only on potential effects of human exposure to environmental contaminants.

[1] Interpretation of "environment" in the Saskatchewan Environmental Assessment Act, Section 2 (e) (iii)

Table 2: Key Health Supports for the Health Review

Key Health Support	How this Key Health Support May Be Affected by Resource Development	Specific Components to Consider
EXPOSURE TO ENVIRONMENTAL CONTAMINANTS	Exposure to environmental contaminants is considered within a human health risk assessment (HHRA). The HHRA process evaluates whether non-negligible risks of adverse health effects may occur from exposures to contaminants via food, air, water, or soil. Health Canada guidelines provide a consistent basis for HHRA, with some differences in technical details of the assessment specified in different provincial or territorial jurisdictions in Canada. Chemical toxicity reference values published by Health Canada and other agencies are derived to be protective of the most sensitive receptor groups (e.g. infants and toddlers; elderly).	• Human exposure to contaminants (air, water, soil, food consumption) • Behaviour change and stress/anxiety related to perceived contamination
NATURAL / BIOPHYSICAL ENVIRONMENT	Clean air, water, and soil are requirements for a healthy community. Resource development or resource extraction results in chemical emissions from various aspects of the project development, and these may affect individuals directly or they may affect the biophysical environment, which can indirectly affect individuals and communities. The exploration phase is usually the least emissions-intensive, whereas the construction and development phase is often the most emissions-intensive. The contaminants emitted depend on the resource that is extracted, due to differences in resources extracted, extent of construction required, whether refining processes are required, and the supporting equipment.	• Quality or availability of cultivated or wild foods (game, fish, plants) • Environmental degradation of ecosystems that supply water, raw materials, and fuel • Protection from natural disasters via environmental buffers (e.g. wetlands, grasslands, forest)
EMPLOYMENT, INCOME AND ITS DISTRIBUTION	Employment, income and its distribution are important to health on both an individual level and a population level. On an individual level, those in lower income brackets tend to have higher rates of chronic disease, higher stress levels, heart disease, and have lower life expectancy than those in higher income brackets. Unemployment, precarious employment and poor working conditions are also strongly associated with poor health outcomes. Conversely, employed individuals and those in higher income brackets typically experience better health outcomes (e.g., higher life expectancy, better child health status, better mental health, lower rates of cardiovascular disease, lower mortality). These mental and physical health effects associated with employment and income extend not only to the employed (or unemployed) individuals, but also to their families and communities. Finally, income distribution plays a significant role in determining health; that is, the larger the income gap between the rich and the poor in a society, the worse health is for the entire population, both rich and poor.	• Income and employment • Economic equity – distribution of benefits, including project-based employment and local revenues • Economic stability (boom and bust cycle)
MOBILE WORKER / COMMUNITY INTERFACE	Mobile workers – those workers who commute to and from resource projects and live temporarily in work camps, hotels, motels, private rental suites, and personal RVs – have been identified as a key effect driver in resource projects. More specifically, it is the mobile worker-community interface (i.e., the interaction between mobile workers and local residents), which largely determines the magnitude and range of effects. While mobile worker populations have been associated with a number of negative effects, including increased fear, distrust and social disruption among local residents, an increased drug and sex trade, higher traffic volumes and collisions, and increased rates of sexually transmitted infections, there is also potential for these workers to contribute positively to local communities (e.g., volunteering skills in local building projects, mentoring young people). Importantly, the mobile worker-community interface can be proactively managed by communities and by industry, in turn influencing the nature of effects for both mobile workers and local people. Mobile workers can also increase pressure on the biophysical environment, for example through increased local hunting, recreational access; large work camps can increase demand for water	• Discrimination or racism • Infectious disease transmission (gastro-intestinal, respiratory and STIs)

Key Health Support	How this Key Health Support May Be Affected by Resource Development	Specific Components to Consider
	and water treatment, and have affects on light pollution, noise, and traffic.	
DEMOGRAPHIC AND SOCIAL ENVIRONMENT	Demographic and social environments are two concepts that are intricately linked to each other. The demographic environment refers to the size of the population as well as its composition in terms of age, sex, ethnicity, etc., while the social environment describes an individual's relationship with his or her family, peers, community and workplace. At an individual level, having strong social connections is an important determinant of longevity and quality of life. Strong social connections in a community have also been found to promote feelings of security sense of belonging. Communities with high levels of social connection have lower cardiovascular and cancer-related mortality, and lower injury mortality (both accidental and suicide). Resource development projects often bring about changes in both the demographic and social environments, with Project-related demographic changes strongly influencing the social environment. Other project-related factors, such as shift work schedules, can also significantly shape the social environment.	• Community demographics • Social capital • Psychosocial stressors (drugs/alcohol, prostitution, feelings of safety/security) • Effects on the family

FOOD SECURITY	Food security refers to secure access to nutritious foods in sufficient quantity and quality to maintain good health. Conversely, food insecurity refers to the inability to secure an adequate supply of healthy foods. Resource development projects, and the population influx that often accompanies them, often increase local costs (housing, food, etc.) making it more difficult for low-income residents to afford both food and shelter. Additionally, resource development projects have the potential to affect the availability of or access to important subsistence food resources.	• Affordability of store foods
		  ○ Potential for price increases/decreases
		  ○ Change in purchasing power via employment
		• Availability of subsistence foods
		• Use of income to support subsistence activities
		• Competition between paid Project-related employment and sufficiency of time for subsistence activities
		• Food sharing

HOUSING	Healthy housing is safe, affordable and provides privacy. The physical condition of housing can impact health directly; the hazards associated with lead paint, asbestos, mould, indoor air pollution, inadequate heating, and unsafe cooking facilities—as just a few examples—are well-known. Overcrowding also affects many health parameters such as transmission of infectious respiratory disease, mental health, educational success, domestic abuse and violence. Homelessness is associated with very high rates of disease and mortality. The effects of poor housing conditions are felt especially by older people and children. It is likely that the link between housing and health works in both directions, with housing affecting an individual's health and health also affecting an individual's housing opportunities.	• Crowding • Housing quality / conditions (sufficiency of heating, exposure to mould, fire safety, sanitary conditions)
CULTURAL SUPPORTS	Cultural supports refers to individuals and communities sharing cultural values and participating in cultural practices that strengthen traditional ways of life and promote cultural identity. Some of the ways in which resource development projects can affect traditional culture include: changing the demographic and social make-up of the local area; affecting the ability to access areas or resources for traditional pursuits (e.g., hunting and trapping); providing income that improves the ability to pursue traditional practices; and causing ecological disruption and affecting animal and plant populations and access to hunting and gathering grounds.	• Traditional culture (e.g aboriginal or other) • Participation in subsistence activities • Generational knowledge transmission

Key Health Support	How this Key Health Support May Be Affected by Resource Development	Specific Components to Consider

HEALTH CARE SERVICES	Health care services include hospital services, health care clinics, and allied health services such as pharmacy, public health, mental health and addictions services, laboratory services, health promotion and other specialty areas. These services focus on meeting the primary health care needs of residents.	• Demand on and capacity of:
		  ○ Primary health care services
		  ○ Hospitals including emergency departments
		  ○ Ambulance and other emergency response and medical transport
		  ○ Mental health and addictions services
		  ○ Environmental health protection services

LOCAL / MUNICIPAL INFRASTRUCTURE AND SERVICES	Access to infrastructure, services and programs provides individuals with supports to ensure safety and help maximize quality of life. In addition to health care services (described above), other services that are important to community health and wellbeing are: emergency services, utilities, transportation, recreation, education, and family and community services. Access to services and programs is not evenly distributed among communities and can be influenced by location, household income, time availability, mobility, language barriers, and knowledge of how to access resources. Biophysical environment factors that affect infrastructure and services can include: municipal water sources and treatment needs, irrigation, flood mitigation, forest management and fire mitigation.	• Capacity and safety of water treatment • Demand on and capacity of fire and other protective services

It is important to remember that the purpose of identifying possible effects on key health supports is ultimately to predict changes in health outcomes at a population level. That is, from a population health perspective it is insufficient for an EA to describe, for example, only the extent of new housing stock or the change in number of people per dwelling; rather, the EA should also discuss how Project-induced changes in housing could affect rates of communicable disease, injury, mental well-being, etc.

Table 3 describes categories of health outcome that should be kept in mind.

Table 3: Categories of Health Outcomes That May Be Affected by Key Health Supports

Health outcome	Explanation
Communicable disease	Communicable diseases are illnesses that are transmitted (or 'communicated') from one person to another, including sexually transmitted infections, respiratory infections and gastrointestinal illnesses. These can be transmitted through direct contact, through air, or through contaminated surfaces. A number of communicable diseases are routinely tracked by provincial and national agencies.
Chronic conditions	Non-communicable diseases, or chronic conditions, such as hypertension, diabetes, stroke, cardio-vascular disorders and cancer, are the leading cause of death and disability across Canada. They detract from quality of life, often trigger other health problems, and are costly to the health care system.
Nutritional disorders	Metabolic conditions such as high cholesterol, high blood pressure, diabetes, overweight, obesity and elevated risk of cardiovascular disease can result from an overabundance of caloric intake. Nutritional deficiencies such as anemia and hypothyroidism result from low levels of necessary nutrients and may occur even when the quantity of food is sufficient, if the food consumed is not sufficiently nutritious. Hunger is also an important health outcome on its own.
Physical injury	Injuries or fatalities arise from unintentional sources such as traffic collisions, falls, drowning, etc. or from intentional violence or self-harm. They are the top cause of death for Canadians under age 40.
Mental health and wellbeing	Mental health is "a state of well-being in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to his or her community."[5] Mental wellbeing does not refer to the absence of a mental illness such as depressive disorders, schizophrenia, or bipolar disorder. Instead, it refers to the attainment of a high level of capacity and resilience among all members of the population.

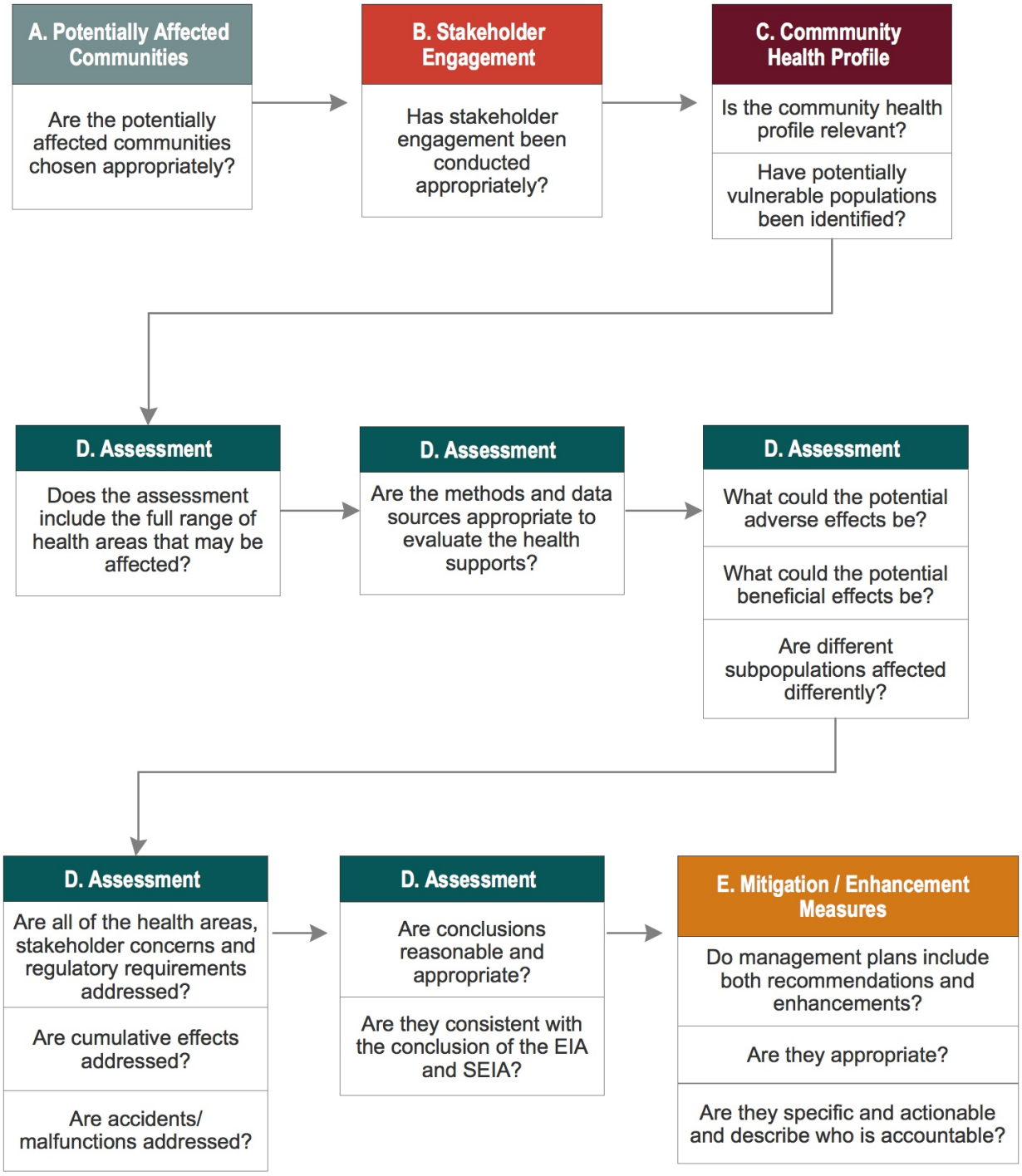
4. Reviewing the EIS

In reviewing the adequacy of the EIS, there are a number of elements that the MOH/RHA reviewers will need to address. This section describes those elements and discusses specific aspects of each that will help the reviewer to identify whether or not the EIS is reasonable and appropriate. Figure 2 provides a graphical overview of the elements discussed.

It should be noted that there are several distinct approaches that an EIS can take to report on health effects. For example, the EIS may include a stand-alone section entitled “Health”, “Community Health”, “Human Health” or some variation in which all health concerns are brought together and addressed in one section of the document. Alternatively, the EIS may report on issues relevant to human health, but scattered throughout the EIS under sections such as air quality, economics, infrastructure and services, etc. There is no single correct approach, as long as the full suite of health issues are addressed explicitly. From the perspective of the MOH/RHA, it is preferable that the EIS include a named section on human health that, at the very least, provides an indication of where in the report analysis of effects on human health can be found. This will reduce the effort that is required by MOH/RHA personnel to identify how the EIS approaches issues of interest and make it easier for the public to identify and understand conclusions on the predicted health effects of the proposed project.

In approaching the EIS review, it is preferable for MOH/RHA personnel to adopt a team approach that brings together the expertise of a diverse range of personnel. This may include the MHO, personnel from public health and environmental heath, and others such as epidemiologists, public health managers, primary care managers, or the emergency measures coordinator depending on the characteristics of the proposed development and the specific geography and demographics of the potentially impacted area. There are several advantages to the using a team approach for the review: first, the subject matter included in the EIS may be quite broad and beyond the expertise of any one individual. Second, an important component of the review will be identifying how the proposed project may affect access to or capacity of health care services, and the input of different services will be helpful in accurately gauging this effect.

Figure 2: Health Assessment Elements and Review Questions



A. Potentially Affected Communities

An important part of any EIS is setting geographic boundaries for where effects will be considered. This may be done as a single region, or as separate local and regional study areas. In identifying potentially affected communities or regions from a health perspective, there are a number of criteria that can be used, and MOH/RHA's review of the EIS should consider whether the potentially affected communities have been defined appropriately. The list below, adapted from the *HIA Toolkit* published by the Alaska Department of Health and Social Services [4], describes a number of parameters that could be used as 'clues' in figuring out whether or not a community should be considered in the assessment, from a health perspective.

- Close geographic proximity to the project
- Potential changes to water sources and quantities
- Locations in projected release areas for contaminants of concern (e.g., plume)
- High likelihood for influx, resettlement, or relocation
- Intense work force recruitment potential
- High likelihood for change in key subsistence resources
- High likelihood for change in transportation infrastructure
- Potential for economic change including regional staging centers
- Existing large burden of diseases or health problems
- Existing high level of exposure to an environmental hazard

It should be remembered that different communities may be identified for different reasons; that different communities may be affected differently than one another; and that within any given community, different subsets of the population may experience different effects.

B. Stakeholder Engagement

"Stakeholders" primarily refers to those people, groups or organizations who are at risk of adverse effects (directly or indirectly) from a proposed project over the project lifecycle. Most notably these are members of local and regional communities, and often include particularly vulnerable subgroups. In some circumstances, the definition of 'stakeholder' may be used more broadly and include members of municipal, provincial, or federal agencies, non-governmental organizations, or corporate shareholders.

There are many models of what is considered to be "stakeholder engagement" in the context of industrial development. These can range from impersonal information conveyance (selling the project) by a project proponent, all the way to shared decision-making, or from surficial engagement to meaningful engagement. Exactly what constitutes "meaningful" engagement will likely differ from one community to the next, and from one project phase to the next.

It is important to recognize that stakeholder engagement is different than the Duty to Consult. The common law duty to consult is a government-to-government responsibility, and is directed specifically

toward relationships with Aboriginal peoples and recognition of their original treaty rights [5]. From a provincial perspective, the duty to consult is acknowledged in the environmental assessment process: "*Where the Minister's decision on a development leads to actions that have the potential to adversely impact Treaty and Aboriginal rights and the pursuit of traditional uses, the province has a duty to consult (DTC) with First Nations and Métis communities in advance of the decision."* [2] Duty to Consult is a federal and provincial government obligation that may not be delegated to third parties; therefore, governments may not download the responsibility to project proponents, nor may project proponents use this consultation process as an alternative for project- and task-appropriate stakeholder engagement.[6]

Stakeholder interaction begins at the earliest stages of the proponents' project conception, and should strive to be a deliberate, positive, and constructive process. By choosing such an approach early in the project conceptual development, well before the EA process begins, proponents and stakeholders can develop a mutually beneficial relationship that encompasses the following attributes:

> *"Engage with relevant stakeholders in order to provide meaningful opportunities for their views to be taken into account in relation to planning and decision making for projects or other activities that may significantly impact local communities…. Stakeholder engagement involves interactive processes of engagement with relevant stakeholders, through, for example, meetings, hearings or consultation proceedings. Effective stakeholder engagement is characterized by two-way communication and depends on the good faith of the participants on both sides. This engagement can be particularly helpful in the planning and decision-making concerning projects or other activities involving, for example, the intensive use of land or water, which could significantly affect local communities."* [7, 8]

Appropriate stakeholder engagement will influence the EIA in a number of different ways.

- It will build trust and improve relationships among all stakeholders, including communities and corporations;
- It will help ensure that the assessment will have credibility among the stakeholders;
- It will capture or identify stakeholders' concerns, including those related to health;
- It will provide data relevant to analyses of certain health issues;
- It will help identify community values to support the ranking and prioritization of effects.

In terms of what an MOH/RHA reviewer should look for in the EIS document, there should be evidence or documentation to show that:

- Stakeholder engagement was conducted;
- The stakeholders were chosen appropriately to represent affected communities and a wide range of viewpoints and opinions, including those of vulnerable subgroups;
- There was opportunity for meaningful engagement;
- Stakeholder opinion is represented in the EIS document;
- The engagement informed the selection of assessment areas, for example, in informing the proponent when developing the Terms of Reference, and subsequently addressing issues of concern in the EIA.

C. Community Health Profile / Baseline

The purpose of the community health profile within the EIS is to describe current (or baseline) health conditions that are relevant for the potentially affected communities or region. This should not be an administrative exercise, but an informative one. Profiling the health status of the community/region is intended to:

- identify the current status of health conditions such that predictions can be made about the extent of change;
- help identify problem areas in order to ensure that the proposed project does not exacerbate these problems and, where possible, appropriately leverages the opportunity to improve health; and
- identify potentially vulnerable subsets of the population who may experience health effects differently or more acutely than the general population.

The information to be assembled in the community profile within the EIS should be specific to the proposed project and the community context in order to avoid a scattershot approach that presents a large volume of irrelevant data. The types of data that may be relevant to present from a health perspective include:

- **Demographic** information such as population size and distribution of age, sex, income and education levels;
- Information on **health outcomes** such as life expectancy, rates of specific types of injury, disease, or chronic health conditions;
- Information on **health-related behaviors** such as smoking, physical activity or diet;
- Information on **key health supports** such as housing, employment, food systems, water and sanitation supply, and the social environment;
- Information on **local health care services**.

The data needed for the community health profile should be compiled from a number of different sources. These include published sources such as databases, reports, research literature and other secondary data sources. A number of key sources for this information are listed in Appendix B. However, much of the information needed will not be available as existing secondary information and should be collected by interviews with local key informants: for example, people working in the health system or for local municipalities.

As identified above, an important part of community profiling is identifying potentially vulnerable populations, that is, subsets of the population that may disproportionately bear adverse health effects. In many cases, vulnerability can be predicated on attributes such as **biological factors** (e.g. age, pre-existing disabilities), **social constructs** (e.g. gender, ethnicity), **material conditions** (e.g. income or employment status) or **exposure to adverse environments** (e.g. populations located in specific geographic areas). However, vulnerability is not necessarily limited to these groups and each EIS must consider whether there are other populations that would be particularly vulnerable to some or all health

impacts [9]. An important part of the role the MOH/RHA review is to identify whether the EIS appropriately defines vulnerable populations and presents the community profile / baseline and the assessment in a way that enables readers to understand differential effects among vulnerable populations.

D. Assessment

After the EIS has described current (baseline) conditions, the next section usually presents a prediction of the effects that may be associated with the proposed project alternatives. In its review of the assessment, MOH/RHA should determine the extent to which the EIS discusses the full range of health issues that may be associated with the Project and provides an adequate discussion / assessment for each. The steps outlined below and the attached tools will help the MOH/RHA reviewer to systematically consider the completeness and appropriateness of the EIS assessment.

Does the assessment include the full range of health areas that may be affected?

The first question to be asked is whether the EIS examines the full suite of health issues that may be affected by the project in question. In Section 3 of this document, a framework of 10 key health supports was described. The MOH/RHA reviewer must ascertain whether the EIS has adequately considered and evaluated the potential effects of the project on various components of these key health supports.

Table 4 presents a quick-reference guide that may help the MOH/RHA reviewer in the initial identification of key health supports that may be relevant for a given project. Each row in the table describes common parameters of resource development projects. The large dots indicate where there is a potential interaction between that project parameter and the identified key health support. [Note: The nature of the interaction is not described in the table, but is described in Section 3 of this document.] A potential interaction indicates that it may be appropriate for the EIS to address some aspect of that health area.

The TOR are developed by the proponent and approved by the Ministry of Environment (after review by SEARP). The TOR delineate what topics the EIS must, at a minimum, address. If the TOR does not specify the need for the EIS to include evaluation of health effects, then there is effectively nothing that requires proponent to do so. Nonetheless, this does not preclude MOH/RHA from commenting in the review process on potential health effects that may have been missed in the TOR and the EIS.

Table 4. Links between typical project elements and Key Health Supports

	Income And Its Distribution	Mobile Worker / Community Interface	Demographic and Social Environment	Food Security	Housing	Cultural Supports	Health Care Services	Infrastructure	Natural / biophysical environment	Exposure to Contaminants
Workforce / Employment										
Large workforce relative to size of local population	●	●	●	●	●		●	●		
Substantial local hiring	●	●		●	●	●				
Substantial mobile workforce	●	●	●	●	●	●	●	●		
Camp vs. in-town accommodations	●	●	●	●	●	●	●	●		
Local Community Context										
Size of community		●	●		●		●	●		
Limited housing stock				●	●					
Geography – northern vs. southern			●	●		●	●	●		
Geography – rural vs. urban		●	●	●	●	●	●	●	●	
Agricultural base	●			●						●
Large Aboriginal population		●	●	●	●	●				
Affects Aboriginal lands				●		●			●	
Large subsistence dependence				●		●				●
Project Infrastructure / requirements										
Project will involve road building or improvement			●	●		●	●	●		●
Raw material needs (e.g. sand and gravel)	●							●		
Project will involve land take	●			●	●	●				
Project will involve water take				●		●		●		
Reliance on municipal services (e.g. fire, police)		●					●	●		
Biophysical Environment										
Environment is a source of food, either cultivated or wild (game, fish, plants)				●		●				●
Environment is a secure source of freshwater – quality and quantity					●	●		●		●
Env't is a source of raw materials and fuel	●				●			●		
Environment buffers against natural disasters (e.g. wetlands to mitigate flooding; grasslands and forest for erosion control)				●	●			●		
Air quality – local and regional							●			●
Soil quality – local and regional				●						●
Sustainable nutrient cycle in soils				●						
Local and regional water cycle				●						
Environment is tied to cultural, spiritual, aesthetic values			●			●				●
Environment is a source of recreation//tourism	●		●							
Other projects in area										
Cumulative impacts	●	●	●	●	●	●	●	●		●

Are the methods and data sources appropriate?

Not all types of data sources are appropriate for answering all questions and the EIS should draw on different information sources where appropriate, that may include:

- Peer-reviewed literature
- Published or grey literature reports from government or other organizations
- Quantitative models
- Academic subject area expert opinion
- Key informant interviews
- Stakeholder/resident opinion, gathered through focus groups, one-on-one interviews, community workshops, etc.

What comprises the most appropriate data source will depend on the pathway being examined. For areas where strong epidemiologic evidence exists, systematic reviews can be an excellent source of information if they are applicable to the specific context of the local area. However, published information is unlikely to be available for all the health impacts being examined, or may not be applicable to the population, location, policy or project. In this case, a different type of evidence, such as information from key informants or other stakeholders, is likely to be more appropriate [9]. No matter what type of information is used, it is important to remember that the EIS should not "cherry pick" information to support a given conclusion. It should also be transparent about data sources, methods and evidence.

What could the potential effects be?

For each of the key health supports that have been identified as potentially relevant for the project, the MOH/RHA reviewer should attempt to identify whether the EIS has completely and appropriately identified:

- **the potential adverse effects**
- **the potential beneficial effects**
- **What parts of the population would be affected** (in particular the potential for different effects on vulnerable groups)

Table 5 presents critical questions that should be considered for each key health support that has been identified as potentially relevant. These critical questions will help the MOH/RHA reviewer think about the ways that projects could affect key health supports in terms of both adverse and beneficial effects.

Table 5. Key Health Supports: Critical Questions

Key Health Support	Critical Questions
EXPOSURE TO ENVIRONMENTAL CONTAMINANTS	❖ What impact could the proposed project have on **contaminant emissions** in the local and regional areas? ❖ How could the impacts affect **community well-being** in the local and regional areas? o Direct impacts, such as toxicity-based health effects (evaluated in the HHRA) o Indirect impacts, such as increased stress from the perception of risk o Longer-term health impacts due to changes in behavior due to perceived risks of continuing subsistence, recreational, or cultural activities (hunting, fishing, country foods as important part of diets).
NATURAL / BIOPHYSICAL ENVIRONMENT	❖ How might the proposed project impact the **biophysical environment** at the local and regional scales? For example, could local or regional infrastructure requirements increase or decrease access to public land, which may impact (positively or negatively) recreational activities, including hunting, fishing, off-roading? ❖ Could the proposed project directly or indirectly affect **food security**, for example: by contaminating foods or food sources; by increasing the perception of risk from country food sources; ❖ Could the proposed project directly or indirectly affect **cultural supports**, for example: by reducing the frequency of culturally important activities such as hunting, fishing, gathering, or visiting sacred places
EMPLOYMENT, INCOME AND ITS DISTRIBUTION	❖ How might the proposed project impact **employment opportunities** or affect job stability? ❖ Could the proposed project affect **unemployment** levels in a community or among certain populations? ❖ Could current employment opportunities reliant on the **biophysical environment** (e.g. forestry, agriculture, gravel, fisheries, tourism, hunting and guiding, trapping) be affected by the proposed project? ❖ How will employment and income opportunities be **distributed** across the population? Will Project-related employment benefit any under-employed groups? ❖ How might **working conditions** change (e.g., physical work environments, shift work, workers' control over job circumstances)? ❖ Could the proposed project impact individual and/or family **income** levels, or income security? ❖ Could the proposed project impact health by reducing or increasing disparities in the **distribution of wealth**?

Key Health Support	Critical Questions
MOBILE WORKER / COMMUNITY INTERFACE	❖ Will the proposed project involve a **mobile workforce**? What is the projected size and demographic composition of this mobile workforce? ❖ Will mobile workers be housed in **work camps** or will they be housed within the community? ❖ Where will these work camps be **located** relative to the community? Will workers be allowed to leave the work camp and visit the local community? What **local services** will these mobile workers use (e.g. recreation, entertainment, shopping)? ❖ Will industry develop a "**Worker Code of Conduct**" to guide and enforce mobile worker behaviour while in the local area communities? ❖ In what ways will the mobile worker population draw on local **infrastructure and services** such as water and water treatment? ❖ To what extent will mobile worker transport add traffic to **public roads**? ❖ Will the workers use **outdoor resources**, such as hunting, camping, ATV or other land access? ❖ Will **noise or night-time light pollution** be increased by the use of mobile workers for the project? ❖ What is the **attitude of local communities** to mobile workforces? Do communities want to integrate mobile workers into the community (e.g., encouraging workers to access local shops and services as a way to stimulate the economy) or keep mobile workers and local populations separate?
DEMOGRAPHIC AND SOCIAL ENVIRONMENT	❖ Will there be an **influx** of newcomers into the community? How many people are expected to enter the community (temporarily and permanently)? Who will comprise this new demographic (e.g., age, sex, ethnicity)? ❖ How might this new demographic affect the **social environments** (e.g., social networks, social cohesion) of the host community? ❖ Will the proposed project affect opportunities for **involvement in community activities** (e.g., volunteering)? ❖ In what ways might the proposed project affect the **cultural values or practices** of an individual or group? Would an individual's experience of **discrimination or racism** be impacted by the proposed project? ❖ Do new workers and families have readily available **social supports** in place (access to newcomer groups or mental health professionals) to protect against feelings of isolation, loneliness, stress, anxiety and depression?
FOOD SECURITY	❖ Could the proposed project impact **access to healthy foods**, or an individual's ability to purchase healthy foods? ❖ Are there adequate **social supports** in place (e.g., food banks, food sharing programs) to help food insecure individuals and families? ❖ Could **contaminants** emitted due to the project undermine food security by directly contaminating food or impacting the supporting ecosystems? ❖ Could food security be undermined indirectly by increasing the **perception of risk** from country food sources (regardless of 'actual' levels of contamination? ❖ What **subpopulations** are particularly at-risk for food insecurity?

Key Health Support	Critical Questions
HOUSING	❖ Will the proposed project affect the **housing availability and affordability** (e.g., rental rates, housing prices)? ❖ How will any changes in availability or affordability affect overcrowding, disease transmission, food security, homelessness, displacement or other **social issues**? ❖ Among what **subpopulations** will these issues surface (e.g., single mothers and their children, the elderly)? ❖ Does the community have adequate **social supports** in place to address these potential issues related to housing? ❖ What impact could the proposed project have on **housing conditions** such as: ○ Mould and dampness ○ Poor heating and insulation ○ Poor ventilation ○ Poor air quality ○ Unsafe drinking water or lack of hot water ○ Poor waste disposal – e.g. garbage, sewage ○ Reliability of electricity network, both delivery and household network ○ Unsafe building design and structural hazards ○ Use of hazardous building materials ○ Poor noise insulation ○ General disrepair ○ Soil, water, or air contamination
CULTURAL SUPPORTS	❖ How might the proposed project (via population influx, jobs and income) affect **cultural values, beliefs and practices**? ❖ Will local **employment opportunities** take into consideration cultural supports (e.g., allowing Aboriginal people time off for hunting and other cultural activities/celebrations)? ❖ Will the project proponent develop an **Aboriginal Cultural Sensitivity** training program for non-Aboriginal workers to learn more about respectfully working with and adjacent to Aboriginal communities and peoples? ❖ How might the proposed project affect t**raditional lands, resources, and historic or sacred sites**?
HEALTH CARE SERVICES	❖ How might the proposed project affect the **demand** for health care services? ❖ How might the proposed project affect the **capacity** of health care services to respond (e.g., will health care services experience difficulty or improvements in recruiting and retaining health care professionals)? ❖ How might the proposed project affect local residents' **access** to health care services (e.g., wait times, distance travelled to services)? ❖ What **specific health care services** might be affected (for example, emergency departments, hospitals, general practitioner clinics, mental health and addictions services, environmental health protection services, emergency medical response)? ❖ How will the Project interface with **emergency medical care** and transport?

Key Health Support	Critical Questions
LOCAL / MUNICIPAL INFRASTRUCTURE AND SERVICES	❖ Will the proposed project impact the demand, capacity or financial viability of **municipal infrastructure and services**, including: o Emergency services (e.g. fire, ambulance, police) o Utilities (e.g., electricity, water, sewage, garbage) o Transportation and roads (e.g. public transportation, maintenance of roads) o Recreation (e.g. recreation centres, parks and programs, libraries) o Education (e.g. schools and training institutes) o Family and community services (e.g. adult, youth and family counselling; women's shelters) ❖ Will the proposed project impact the local or regional **biophysical environment** such that municipal infrastructure and services will be affected? ❖ Will the proposed project impact factors that influence an **individual's ability to access** these services such as mobility, financial means, language barriers, or knowledge about services or programs? ❖ Will the project proponent and local community work together to develop a **emergency management plan** in the event of a project malfunction/accident or natural disaster?

Assessment of effects of exposure to contaminants (Human Health Risk Assessment)

The assessment in the EIS of human health effects from exposure to project related contaminants will likely use a methodology that is distinct from the assessment of other health effects. Human Health Risk Assessment (HHRA) is generally the approach that is used.

HHRA plays a very important role in confirming whether or not project emissions exceed toxicity-based exposure limits. Exposure to chemical contaminants can have significant health consequences, from acute toxic effects causing severe morbidity or death to chronic health effects or DNA damage leading to carcinogenesis. By evaluating current conditions, project operations, and combined emissions of the proposed project along with other existing and proposed projects, it is possible to gain an understanding of the magnitude of possible impacts from a contaminant exposure perspective. Because of the continuing importance of this issue, an EIS will frequently need to include an HHRA. There are several well-established and acceptable methodologies for undertaking HHRA, and these are discussed further in **Appendix A.** The most significant resource for HHRA in Canada is Health Canada's Guidance for Human Health Preliminary Quantitative Risk Assessment [10].

It should be remembered that from a health standpoint, particularly from a population health and community wellbeing perspective, the reliance on the HHRA for the primary health-based evaluation of a project ignores the factors that play much more significant roles in overall public health of a community. These can be described as determinants of health: here we have defined key health supports as major factors in community health and wellbeing, specifically focused towards the ways in which large industrial projects may impact communities. While environmental contaminants emitted as part of a project may increase risks of acute, chronic, or carcinogenic health effects, they also factor into various aspect of other key health supports that have a broader effect on community wellbeing. For example, contaminant emissions in a specific region can cause groups to avoid that area, resulting in less hunting, recreation, or cultural/spiritual activities, which can undermine traditional lifestyles and customs or food sources. If these ecosystem services cannot be obtained elsewhere, or replaced with other activities that provide equal benefits, the overall wellbeing of the community may be affected.

Are stakeholder concerns, cumulative effects and accidents/malfunctions addressed?

The assessment of the EIS generally reports on predicted effects associated with construction, operation and perhaps decommissioning (depending on the project) of the proposed project under normal conditions. However, two other scenarios that are important to consider are cumulative effects and accidents/malfunctions. Each of these is generally housed under a separate section of the EIS report and is not incorporated into the general assessment of proposed alternatives.

Accidents and malfunctions consider the potential effect of unlikely but possible scenarios. These situations, which include situations such as explosions, fires, spills, etc., represent situations where there is an extremely high risk of severe adverse health effects. This may require the MOH or RHA to consult or refer concerns to Ministry of Labour Relations and Workplace Safety colleagues directly or through the EAB for the project.

From a health perspective, the potential contribution to community health impacts from cumulative development is extremely important. Cumulative effects may be defined as 1) the multiple effects of more than one project – e.g. the proposed project, along with other existing and proposed projects; or 2) multiple factors that each contribute to an impact on a particular health support. Because the health of individuals and populations is influenced by interacting factors throughout the environment, it is very important for the MOH/RHA review to examine whether the EIS has adequately considered cumulative effects from a health perspective.

Are any conclusions about the significance of the effect appropriate?

Finally, the MOH/RHA reviewer should decide whether the conclusions in the EIS about the significance of the effect seem warranted based on the assessment. It should be noted that "significance" in an EIS does not generally refer to statistical significance, but rather uses an algorithm that combines severity, likelihood and other parameters to characterize effects as "significant" or "not significant". Elements rated as "significant" may have the potential to stop the project from obtaining approval.

The MOH/RHA reviewer should also make note of whether the conclusions about health issues are consistent with conclusions in the overall EIA and with specific disciplinary chapters.

E. Mitigation / Enhancement Measures

The MOH/RHA review should also identify whether the EIS has identified appropriate and adequate strategies to mitigate health risks and enhance potential health co-benefits in its management plans.

There are several important aspects to consider. The first is whether the management plans sufficiently address the predicted health effects identified the assessment. That is, if the assessment identifies

potential adverse impact on health, are there any provisions in the management plans to minimize or mitigate that risk?

A second question is whether management plans address both mitigation and enhancement. That is, in addition to describing measures to mitigate adverse effects, do the management plans also provide measures that will enhance potential health co-benefits of the proposed project?

The third question is whether the management plans are presented with the level of detail that provides the MOH/RHA reviewer with confidence that they will actually be carried out. For example, are responsibilities assigned? Is a timing or schedule assigned? Are monitoring indicators described?

For management plans to achieve the greatest likelihood of being successfully implemented, the specific items within them should be:

1. Responsive to the impacts predicted in the EIS
2. Specific to the impacts predicted in the EIS
3. Technically feasible
4. Enforceable, with accountability described
5. Within the purview of the individual / organization deemed responsible

Monitoring is the process of following up on specific indicators over time to ascertain whether the health of the population changes or not, and adaptive management is an iterative approach that uses monitoring indicators to improve subsequent management policy or practice. Ideally, the management plans presented in the EIS will include indicators for monitoring health, and an adaptive management approach that enables a flexible and responsive adjustment to management plans in order to respond to emerging problems.

Appendix A: Human Health Risk Assessment Methodology

Human health risk assessment (HHRA) is a scientific process used to evaluate and characterize health risks to humans from exposures to chemical contaminants in the environment. The HHRA provides quantitative results that are interpreted to indicate whether or not health effects could be expected from chemical emissions of the proposed project. The assumptions used in an HHRA are generally conservative to ensure that any risks of adverse health effects would be over-estimated rather than under-estimated. This is part of Health Canada's approach to ensure that susceptible groups such as infants/toddlers and the elderly are protected.

HHRA is commonly conducted in conjunction with a similar examination of ecological receptors (ecological risk assessment, or EcoRA) to form an overall environmental risk assessment (ERA) [11, 12]. The goal of ERA is to assist environmental and health protection agencies, among others, in making risk management decisions that minimize or eliminate exposure pathways between chemical contaminants and human or ecological receptors.

Human health risk assessment (HHRA) is currently the primary focus of health assessments in environmental impact assessments. In order to help MOH/RHA reviewers understand whether an HHRA has been conducted appropriately, this Appendix presents an overview of how HHRA is conducted, and a checklist of HHRA elements that guide the reviewer through specific steps of the HHRA.

How an HHRA works

For a risk to exist, three factors must be present: hazard, receptor, and pathway. In the HHRA context, a *hazard* may be a chemical (e.g. benzene, arsenic, or lead) or a physical substance (e.g. particulate matter) that can cause adverse health effects at sufficiently high concentrations. A *receptor* is an individual human. A *pathway* is a mechanism for the individual to be exposed to the hazard via ingestion of food, water or soil; inhalation of air, particulate matter, or vapour; or dermal absorption via soil, water, or vapour.

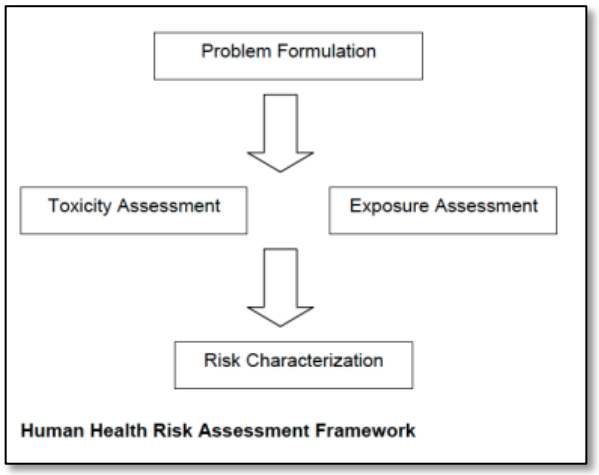
A basic human health risk assessment approach follows a four-step procedure (Figure 3). These four steps are [10, 13-16]:

- *Problem formulation* is used to identify the hazard(s), the receptor(s), and pathways for receptors to be exposed to the hazards. This stage narrows the scope of the HHRA to substances that are relevant to the project and which exceed screening guidelines; relevant human receptors who live, work, or otherwise spend time in the area potentially impacted by the project; and identifies relevant pathways for exposure via food, water, air, and soil.
- *Toxicity assessment* of the hazardous substances looks at the health effects that could occur at a particular exposure level. Toxic reference values or cancer slope factors are derived in this

step, and are based on how a particular agency defines "acceptable risk", i.e. what level of health protection is considered adequate and safe.[2]

- *Exposure assessment* estimates the amount of contaminant (the dose) that a receptor may be exposed to via inhalation, ingestion, and dermal contact. The concentrations of hazardous substances in food, water, air, and soil are measured or estimated based on project emissions, and receptor behaviours (such as amounts of fish or meat consumed, volume of water consumed, time spent at specific locations) are used to calculate the amount of hazardous substance an individual could receive per day (total daily dose).
- *Risk characterization* evaluates the estimated exposure amount (dose) in comparison to toxic reference dose for non-cancer hazards and cancer-causing substances.
-

Figure 3. Basic risk assessment framework.



Risk characterization is a comparison between the estimated exposures to chemicals of concern and the respective toxic reference values for the modes of exposure (ingestion, inhalation, or dermal absorption).

A hazard quotient (HQ) is calculated for chemicals that are known to have a threshold response – i.e. toxic (non-cancer) responses only occur above a certain exposure threshold. The HQ is defined as follows:

$$HQ = \frac{Total\ Daily\ Dose}{Tolerable\ Daily\ Intake}$$

Total Daily Dose (or total exposure) in mg/kg/d is estimated from chemical concentrations in soil, water, air, and food, and the respective exposure amounts of each media; the Tolerable Daily Intake (TDI) (also in mg/kg/d) is derived by Health Canada and other regulatory agencies and provided as Toxic Reference Values for chemicals that have known adverse effects. Because chemicals are absorbed differently depending on the exposure mechanism, some chemicals have exposure-specific TDI values. Therefore, exposure-specific HQs should be calculated and then summed to calculate the total HQ.

[2] For example, the US-EPA designates an increased incidence of cancer in a lifetime (ILCR) of 1 in 1,000,000 as acceptable, whereas Health Canada designates 1 in 100,000 as acceptable.

For many jurisdictions, if the HQ is less than 1, it is assumed that risks of adverse health effects are negligible. Health Canada defines HQ less than 0.2 as negligible risk [10], unless all sources of chemical exposures, including background exposures, are included in the dose calculation.

An ILCR (incremental lifetime cancer risk) is calculated for carcinogenic chemicals of concern. It is defined as any additional occurrence of cancer in a lifetime (defined as 80 years by Health Canada [10], 70 years by US-EPA [17]) above the overall occurrence of cancer[3] as a result of exposure to the chemical of concern. It is important to note that it is occurrence of any cancer in a lifetime that is considered in the ILCR, not cancer mortality. The ILCR approach is based on the assumption that there is no threshold for the possible carcinogenic effect, meaning that any exposure above zero theoretically carries some risk of cancer over a lifetime.

$$ILCR = Lifetime\ Average\ Daily\ Dose\ x\ Cancer\ Slope\ Factor$$

The slope of the dose/response relationship provides the cancer slope factor (in $(mg/kg/d)^{-1}$). Because of different absorption mechanisms, exposure-specific slope factors may be calculated for certain carcinogenic chemicals. The total chemical-specific ILCR should be calculated from exposure-specific ILCR calculations.

Because cancer risks are based on lifetime exposures, the average daily dose is calculated over a lifetime, amortizing exposures for each major age bracket from infant – toddler – child – teenager - adult. Health Canada defines an ILCR of less than or equal to 10^{-5} (1 in 100,000) as essentially negligible risk [10].

HHRA Interpretation Notes

Hazard Quotient:
HHRA is an important tool in evaluating whether projected emissions exceed risk-based exposure limits, and understanding the major exposure pathways for different groups of people. However, we suffer from both a lack of interpretation on what the results of the HHRA mean for health and wellbeing, and over-interpretation of what the results may indicate. Both of these arise from the same issue – that the output of the HHRA – the exposure ratio (ER) (or hazard quotient (HQ)) – does not provide a quantitative estimate of an adverse health outcome; rather, it indicates whether an "acceptable" exposure level may be exceeded. If not, then the interpretation is that "health effects will not occur". If the ER is greater than 1 (or 1.0), it only indicates that health effects "may" occur, not that they "will" occur. The US-EPA definition of the ER (or HQ) is as follows:

*"The ratio of the potential exposure to the substance and the level at which no adverse effects are expected. If the Hazard Quotient is calculated to be less than 1, then no adverse health effects are expected as a result of exposure. If the Hazard Quotient is greater than 1, then adverse health effects are possible**. The Hazard Quotient cannot be translated to a probability that adverse health effects will occur, and is unlikely to be proportional to risk.** It is especially important to note that a Hazard Quotient exceeding 1 does not necessarily mean that adverse effects will occur." [17]* [Bold emphasis added.]

---

[3] The Canadian average lifetime cancer risk is 1:2.5 (2 out of 5 Canadians are expected to develop cancer in their lifetimes). Reference: Canadian Cancer Statistics 2014

The concept that the ER is unlikely to be proportional to risk is arguably the most difficult to grasp within the overall exercise of the HHRA. The sense of a good or bad outcome from the HHRA as defined by an ER less than or greater than the reference point (whether 1 or 0.2) has introduced many challenges in risk communication and in risk management decision-making. Often, the discussion of uncertainties in the HHRA calculations attempts to discount any results above 1, because the common view is that any results above 1 means people are being exposed to unacceptable risks. This view can have a variety of consequences; for example: risk assessors may revise and iterate exposure calculations until they arrive at ER values less than 1; or individuals and communities and industry critics attribute a variety of observed health outcomes to chemical exposures (most notably cancer). Communication between risk assessors and stakeholders (regulatory, including Health; community) is necessary to ensure that the initial assumptions and any revisions to these assumptions in the exposure calculations are defensible and realistic.

Interactions with other factors:
The HHRA process does not typically take into account specific factors that are known to increase certain risks – for example, if evaluating the risk of lung cancer from arsenic ingestion or asbestos or radon inhalation, the effect of smoking on increasing risk is not part of the standard HHRA, even though there is a known interactional or synergistic effect. The HHRA approach is conservative – it generally over-estimates risks so that risk management decisions can be made that would be protective of the majority of the affected population. However, specific groups may be more susceptible to certain health effects – e.g. smokers, immunocompromised individuals, those with respiratory conditions, or those with obesity.

HHRA Review Toolkit
A HHRA Review Checklist and Toolkit is provided below as a guide for reviewing HHRAs in the context of standard EIS submissions. It is directed specifically towards MOH/RHA personnel to ensure that the risk assessment has been done appropriately to the project; it may also be used to help direct proponents on HHRA review criteria. The checklist is based generally on Health Canada's guidance for peer review of HHRAs [18], but it has been modified to reflect the different emphasis on projected risks from planned projects rather than existing contaminated sites.

HHRA Review Checklist and Toolkit

Query	Learning Resource	Databases & Tools
RISK ASSESSMENT FRAMEWORK		
• Does the HHRA describe the framework being used?	Federal Contaminated Site Risk Assessment in Canada, Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 [10] Guidelines for assessing Human Health risk from environmental hazards [16] Framework for Cumulative Risk Assessment [15] Framework for Human Health Risk Assessment to Inform Decision Making [14]	
PURPOSE AND OBJECTIVES	Framework for Cumulative Risk Assessment [15]	
• Is the purpose of the risk assessment clear?		
• Did the Terms of Reference clearly state the health-related issues that should be addressed?		
• Is it clear how the HHRA addresses these health concerns?		
• Is the scope and complexity of the risk assessment clear and appropriate for the purpose?		
STAKEHOLDER ENGAGEMENT	See Section 4B, Stakeholder Engagement	
• Were stakeholders and stakeholder engagement activities identified?		
• Was stakeholder engagement employed in defining the purpose and objectives or Terms of Reference for the health issues or specifically for HHRA?		
PROBLEM FORMULATION	Federal Contaminated Site Risk Assessment in Canada, Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 [10] Federal Contaminated Sites Action Plan – Ecological Risk Assessment Guidance [19] Framework for Cumulative Risk Assessment [15] EPA Risk Assessment: Human Health Risk Assessment [12]	
Site Characterization and Baseline	Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment. Draft. Volume 1. Guidance Manual [20]	
• Are all relevant site characteristics and planned activities documented?		Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment. Draft. Volume 2. Checklists [21]
• Have all relevant media been investigated and data needed for the risk assessment been presented?		
• Were sufficient samples collected from all relevant and potential sites, to characterize the sites with respect to contaminant types and concentrations? For EIS assessments, this is focused on baseline sampling.		
• Were the sampling and statistical methods used adequate?		POPs Toolkit, Quality Assurance and Quality Control [22]

Query	Learning Resource	Databases & Tools
• Are details provided to explain the sampling and analytical testing quality assurance and quality control measures employed? Was the QA/QC acceptable?		Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment. Draft. Volume 4. Compendium of Analytical Methods for Contaminated Sites [23] POPs Toolkit, Field Sampling Procedures [22]
• How were non-detects in the dataset(s) dealt with? Was it an appropriate and defensible approach?	Methods for Handling Non-detect or Censored Data [24] Much ado about next to nothing: Incorporating non-detects in science [13]	Statistical Software ProUCL 5.0.00 for Environmental Applications for Data Sets with and without Nondetect Observations [25]
• Were the chemical analyses completed by a laboratory that was accredited in accordance with the requirements of CALA and/or the ISO 17025 Standard?		
Identification of Chemicals of Potential Concern (COPC)	Federal Contaminated Site Risk Assessment in Canada, Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 [10] Guidance on Human Health Risk Assessment for Environmental Impact Assessment in Alberta [13]	
• Were all chemicals and substances associated with the project identified? Including chemicals anticipated to be present in planned emissions or discharges, and chemicals that are used, handled, stored or disposed and which may be inadvertently or accidentally released to the environment under various conditions?		
• Were current and potential future land-use identified?		
• Were the screening methods used scientifically defensible and applied correctly?		
• If chemicals were screened out for reasons other than comparison to screening guidelines, were the reasons for exclusion adequately justified?		
Receptors and Pathways	Federal Contaminated Site Risk Assessment in Canada, Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 [10]	Federal Contaminated Site Risk Assessment in Canada, Part IV: Spreadsheet Tool for Human Health PQRA and Spreadsheet tool for Human Health DQRA [26, 27]
• Have all relevant receptor groups been identified?		
• Have the locations and land-use of receptors been identified?		
• Have all receptor age groups been identified?		
• Have all relevant direct and indirect exposure pathways been considered?		
• Have the frequency, duration and probability of such exposures to each receptor group been identified? Was stakeholder input considered when establishing these parameters?	Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment for Country Foods ($HHRA_{FOODS}$), Version 1.2 Draft [28]	
• Have potential contaminant release mechanisms been described? (e.g. volitization, fugitive dust emission, surface runoff/overland flow, leaching to groundwater etc.)		
• Have all potential contaminant transport mechanisms been described? (e.g. diffusion, advection, sorption, bioaccumulation, biomagnification, biodecay)		
• Was a conceptual site model, which identifies contamination sources associated COPCs, receptor groups, critical receptors, and potential exposure pathways provided? Was the conceptual model provided to stakeholders for review or comment?	Federal Contaminated Sites Action Plan – Ecological Risk Assessment Guidance [19]	

Query	Learning Resource	Databases & Tools
Development Scenarios	Guidance on Health Risk Assessment for Environmental Impact Assessment in Alberta [13]	
• Does the HHRA provide a risk assessment or consideration of potential project-area development scenarios including: 1) The Baseline Case 2) Baseline Case + Proposed Project 3) Planned Development Case (Baseline + Project + currently planned projects within the Local Study Area) 4) The project alone		
EXPOSURE ASSESSMENT	Federal Contaminated Site Risk Assessment in Canada, Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 [10]	Federal Contaminated Site Risk Assessment in Canada, Part IV: Spreadsheet Tool for Human Health PQRA and Spreadsheet tool for Human Health DQRA [26, 27]
Fate and Transport Modeling		
• Do the fate and transport models selected take into account applicability to the transport media and processes?		
• Do the fate and transport models selected take into account the availability of appropriate data?		
• Are the models selected scientifically defensible and accepted by regulators (HC, EC, DFO EPA etc.)		
• Are the main assumptions of the model(s) presented and explained?		
• Have the values of all the model-input parameters been justified and has a sensitivity analysis been performed? Has the uncertainty in key input parameters been qualitatively discussed?		
• Have the model-predicted values been calibrated to or compared against measurement data from the site? Where applicable has a mass balance check been performed? Do the comparisons of model predictions to measured values and checks make sense?		
Chemicals of Potential Concern: Exposure Concentration Estimation	Federal Contaminated Site Risk Assessment in Canada, Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 [10]	Federal Contaminated Site Risk Assessment in Canada, Part IV: Spreadsheet Tool for Human Health PQRA and Spreadsheet tool for Human Health DQRA [26, 27]
• Are predicted site exposure concentrations presented for multiple assessment scenarios? (e.g. the baseline case, application case, planned development and project alone)		
• Are the estimated exposure concentration statistics chosen defensible given sample size in the base case and model uncertainty in the other assessment scenarios? Do the reported significant figures reflect the uncertainty?		
Uptake in Country Foods	Federal Contaminated Site Risk Assessment in Canada, Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 [10] Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment for Country Foods ($HHRA_{FOODS}$), Version 1.2 Draft [28]	Federal Contaminated Site Risk Assessment in Canada, Part IV: Spreadsheet Tool for Human Health PQRA and Spreadsheet tool for Human Health DQRA [26, 27]

Query	Learning Resource	Databases & Tools
• Were the uptake models for country foods based on up-to date research and applicable to the local study area?		Uptake equations and factors: Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment for Country Foods ($HHRA_{FOODS}$), Version 1.2 Draft [28]
• For each species assessed, did uptake modeling provide an estimate of whole- animal residue levels or tissue-specific residue levels for muscle or organ meat?		
Human Receptor Characterization	Federal Contaminated Site Risk Assessment in Canada, Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 [10] Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on HHRA for Country Foods v1.2 Draft [28]	Federal Contaminated Site Risk Assessment in Canada, Part IV: Spreadsheet Tool for Human Health PQRA and Spreadsheet tool for Human Health DQRA [26, 27]
• Were receptor characteristics drawn from Health Canada where applicable?		
• Were Traditional Knowledge and Land-Use studies incorporated into the Receptor Characterization?		
• Were assumptions about country food consumption supported by up-to-date local food consumption studies or consultation?		
• Were assumptions regarding exposure duration and exposure frequency appropriate and adequately justified?		
• Did stakeholders have a role in verifying the exposure assumptions?		
Exposure Estimation	Federal Contaminated Site Risk Assessment in Canada, Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 [10] Australian Exposure Factor Guide 2012 [29]	Federal Contaminated Site Risk Assessment in Canada, Part IV: Spreadsheet Tool for Human Health PQRA and Spreadsheet tool for Human Health DQRA [26, 27]
• Were Health Canada Equations used to estimate dose?		Federal Contaminated Site Risk Assessment in Canada, Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 [10]
• If no, were alternative equations provided, fully justified and referenced, and are all assumptions explained?		
• Does the proposal include sample calculations for estimating dose via each exposure pathway?		
• Can those calculations be reproduced (check the math)?		
• Are all equations dimensionally consistent and are all units correct?		
• Did the HHRA describe and characterize the likelihood, magnitude and duration of exposure to all COPCs and potential COPCs?		
• Did the HHRA employ at least three exposure scenarios, including a “worst case scenario” in which the receptors are exposed to the highest potential contaminant concentrations?		
Toxicity Assessment	Federal Contaminated Site Risk Assessment in Canada, Part 2: Health Canada Toxicological Reference Values (TRVs) and Chemical Specific Factors, Version 2.0 [30] TCEQ Guidelines to Develop Toxicity Factors [31]	Federal Contaminated Site Risk Assessment in Canada, Part IV: Spreadsheet Tool for Human Health PQRA and Spreadsheet tool for Human Health DQRA [26, 27]

Query	Learning Resource	Databases & Tools
• Have ambient environmental quality objectives or guidelines been used as an exposure limit for any exposure pathways? If so was the use of these appropriate?		
• Are the selected Toxicity Reference Values (TRVs) clearly stated and referenced for each chemical and for each pathway? Are they based on published regulatory exposure limits from accepted sources?		Specific TRVs - Federal Contaminated Site Risk Assessment in Canada, Part 2: Health Canada Toxicological Reference Values (TRVs) and Chemical Specific Factors, Version 2.0 [30]
• Are the health effects associated with each COPC and the basis for the TRV described?		
• For carcinogens, have pathway-specific slope factors or unit-risks been used where possible? And in cases where pathway- specific slope factors do not exist for all exposure routes, is the single slope-factor value defensible toxicologically according to toxicological studies?		
• If Bioavailability has been incorporated into the TRV, has this been done correctly?		
• In the case of a COPC for which no environmental regulatory agencies have an established exposure limit, has one been developed de novo? If so was adequate documentation provided?		
• Has the HHRA considered the toxicity of mixtures of COPCs? If so is this consideration adequate?		
RISK CHARACTERIZATION	Federal Contaminated Site Risk Assessment in Canada, Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 [10]	Federal Contaminated Site Risk Assessment in Canada, Part IV: Spreadsheet Tool for Human Health PQRA and Spreadsheet tool for Human Health DQRA [26, 27]
• Are the results of the risk assessment presented clearly, including the identification of COPCs associated with unacceptable risk?		
• Were risk assessment calculations completed correctly with examples provided for both threshold and non-threshold acting contaminants?		
Threshold Contaminants	Federal Contaminated Site Risk Assessment in Canada, Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 [10]	Federal Contaminated Site Risk Assessment in Canada, Part IV: Spreadsheet Tool for Human Health PQRA and Spreadsheet tool for Human Health DQRA [26, 27]
• Where pathway-specific TRVs were used, were HQs calculated for individual exposure pathways?		
• If an HQ > 0.2 was used to identify acceptable risks, were background exposures adequately estimated?		
• If exposure was adjusted for bioavailability, was the adjustment relative to the same study upon which the TDI was based?		
Non-Threshold Contaminants	Federal Contaminated Site Risk Assessment in Canada, Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 [10] Guidelines for Carcinogen Risk Assessment [32]	Federal Contaminated Site Risk Assessment in Canada, Part IV: Spreadsheet Tool for Human Health PQRA and Spreadsheet tool for Human Health DQRA [26, 27]
• Are all cancer risks greater than 1 x 10-5 defined as unacceptable?		
• Where pathway-specific slope factors exist, were the risks estimated separately?		

Query	Learning Resource	Databases & Tools
Considerations for Multiple Chemicals	Federal Contaminated Site Risk Assessment in Canada, Part 1: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0 [10] Framework for Cumulative Risk Assessment [15]	Federal Contaminated Site Risk Assessment in Canada, Part IV: Spreadsheet Tool for Human Health PQRA and Spreadsheet tool for Human Health DQRA [26, 27]
• For threshold-acting chemicals and non- cancer effects for carcinogens, were HQs assumed to be additive and summed for substances determined to have the same target organ, effect and mechanism of action?		
• For carcinogens have risks been summed for chemicals causing the same form of cancer in the same target organ?		
Locally acting Chemicals		
• Were any of the COPCs considered to be locally acting chemicals? If so were they evaluated using an appropriate exposure limit?		
UNCERTAINTY AND VARIABILITY		
• Were uncertainty and variability in the risk assessment addressed to the satisfaction of the reviewer?		
• Do the reported numbers and calculation results reflect the precision and uncertainty – i.e. are the data and results reported with appropriate significant figures?		
• Were the pathways and COPCs that drive the risk estimates identified and uncertainties associated with these discussed in particular?		
GENERAL INTERPRETATION		
• Were risks calculated for all chemicals and receptors of concern identified in the problem formulation?		
• Were any unusual site-related assumptions or professional judgments made earlier in the risk assessment reiterated in the conclusions of the risk assessment?		
• Do the conclusions reflect the purpose and scope set out initially for the HHRA?		
• Are the conclusions consistent with other sections of the EIS that are linked with human health? E.g. if caribou or other country foods are impacted, is this reflected in the interpretation of the HHRA?		

Appendix B: Databases and Other Sources for Developing Community Profiles

When proponents or their consultants are developing their EISs, they may ask MOH/RHA personnel for sources of information to be used to assess current health conditions in the area of the proposed project. In order to facilitate MOH/RHA's response to such requests, the list of data sources below is provided and may be reproduced and given to proponents or other requestors as needed. These sources represent existing repositories of high-quality data about health outcomes and health determinants for various regions in Saskatchewan as of 2014.

1. **Statistics Canada**

   Health profiles for most communities in Saskatchewan, based on data from the Canadian Community Health Survey, are available through Statistics Canada's website: http://www12.statcan.gc.ca/health-sante/82-228/index.cfm?Lang=E.

2. **Saskatchewan Bureau of Statistics**

   The Saskatchewan Bureau of Statistics has several documents outlining the population of Saskatchewan. Results can also be found here for the 2011 census, and the 2011 National Household Survey. Several links can be found at the following URL that may be of interest to learn more about the population and its characteristics: http://www.stats.gov.sk.ca/pop/

   Specific links that may be of interest from this website include;

   a. Saskatchewan Aboriginal People, from 2011 National Household Survey: http://www.stats.gov.sk.ca/stats/pop/2011Aboriginal%20People.pdf
   b. Monthly Report Database, to request specific information of interest: http://www.stats.gov.sk.ca/monthly%20reports

3. **Tourism Saskatchewan**

   Tourism Saskatchewan houses information on community services, recreational activities and statistics, as well as contact information for different cities, towns, villages, and northern villages, as well as some links to specific community web pages. Scroll to the bottom of the following webpage to get started: http://www.tourismsaskatchewan.com/places-to-go/communities

4. **SaskBiz.ca**

   SaskBiz.ca includes detailed community profiles for many of the communities in Saskatchewan, as well as a comprehensive database of community and region statistics. The website also provides a detailed map viewer, and a criteria search that is useful for finding out specific information for the types of communities. Criteria search has several useful options, such as 'quality of life' that include information on medical infrastructure or 'labour/workforce 2011' to learn about the number

of employed people in a community. This website is provided by the Government of Saskatchewan and uses information from Statistics Canada and several other government sources.
http://www.saskbiz.ca/default.asp

5. **The Encyclopedia of Saskatchewan**
   Provides basic descriptions of each community in Saskatchewan:
   http://esask.uregina.ca/themelist.html?themeID=885C8FBE-BCD4-8C82-1F8ECF2A717CE701

6. **The Saskatchewan Health Status Report**
   Describes the health of the Saskatchewan population and provides data for key indicators, including morbidity, mortality and injury.
   http://www.health.gov.sk.ca/health-status-report

7. **Population Health Unit, Northern Saskatchewan Health Indicators Report, 2011**
   Examines community characteristics, non-medical determinants of health, and health status indicators for the three northern health regions (Keewatin Yatthé Health Region, Mamawetan Churchill River Health Region and the Athabasca Health Authority). Valuable resource for understanding trends in population trends, chronic diseases, injury and communicable disease such as HIV, STI's and influenza, in Northern Saskatchewan:
   http://www.populationhealthunit.ca
8. **SaskH_20**
   This website complies information about water quality from the Government of Saskatchewan allows the user to look at recent water quality report for their community. It also provides information mapping levels of Arsenic, Lead-Nitrate-Selinium, Trihalomethanes and Uranium.
   http://www.saskh20.ca/mydrinkingwater.asp
   a. View inspections for landfills across Saskatchewan:
      http://www.saskh20.ca/landfills.asp
   b. Comprehensive drinking water information binder from the Water Security Agency;
      http://www.saskh2o.ca/DWBinder.asp

9. **Ambulance Services from the Government of Saskatchewan**
   Description of the different ambulance services available in Saskatchewan, including emergency air transport:
   http://www.health.gov.sk.ca/ambulance
   a. Policy for Northern Medical Air Transport:
      http://tinyurl.com/lqmk775
   b. STARS Saskatchewan:
      http://www.stars.ca/sk/

10. **Regional Health Authorities**
    Links to contact information for each regional health authority, as well as links to each regional health authority's webpage, where more detailed information can be found for the heath information, facilities, and community specific health information in each region:
    http://www.health.gov.sk.ca/health-region-list
    a. Cypress Health Region: http://www.cypresshealth.ca/
    b. Five Hills Health Region: http://www.fhhr.ca/

c. Heartland Health Region: http://www.hrha.sk.ca/
d. Keewatin Yatthé Health Region: http://www.kyrha.ca/
e. Kelsey Trail Health Region: http://www.kelseytrailhealth.ca/Pages/default.aspx
f. Mamawetan Churchill River Health Region: http://www.mcrrha.sk.ca/
g. Prairie North Health Region: http://www.pnrha.ca/bins/index.asp
h. Prince Albert Parkland Health Region: http://www.princealbertparklandhealth.com/menu_pg.asp
i. Regina Qu'Appelle Health Region: http://www.rqhealth.ca/
j. Saskatoon Health Region: http://www.saskatoonhealthregion.ca/
k. Sun Country Health Region: http://www.suncountry.sk.ca/
l. Sunrise Health Region: http://www.sunrisehealthregion.sk.ca/
m. Athabasca Health Authority: http://www.athabascahealth.ca

11. Health Services per Region

a. A list of all health facilities in each health region: http://www.health.gov.sk.ca/rha-designated-facilities
b. A list of health facilities operated by government affiliates in Saskatchewan, broken down into communities: http://www.health.gov.sk.ca/adx/aspx/adxGetMedia.aspx?DocID=2201,94,88,Documents&MediaID=3806&Filename=rha-health-affiliate-organizations-2010.pdf&l=English
c. A map of health facilities across Saskatchewan, broken down into types of facilities: http://www.health.gov.sk.ca/health-region-facilities
d. Northern Inter-Tribal Health Authority: http://nithacom.sasktelwebhosting.com/

12. Research Institutes

a. Saskatchewan Health Research Foundation
Up-to-date results from current research in Saskatchewan, the initiatives tab highlights several different areas of interest and reports including health services, Aboriginal People's health and rural and remote research:
http://shrf.ca/Homepage

b. Saskatchewan Health Quality Council
Includes research monitoring the performance of Saskatchewan's health care system. Several publications are available, or reports from specific projects are available on request:
http://hqc.sk.ca/

Appendix C: Reading on Health Impact Assessment

This toolkit has been modeled on many aspects of best practice in the field of Health Impact Assessment. Health Impact Assessment (HIA) is a process used to identify how a project, policy or program might influence health. The types of projects examined in HIA are generally not designed to influence the health of the population—for example, natural resource projects, economic policies, or land-use proposals. HIA is currently considered best practice in terms of a methodology to identify, characterize and act on the potential health effects of development projects, and in particular for health effects mediated through social determinants of health.

Several excellent guidance documents and other resources exist on HIA that may comprise useful references for further reading. These include:

- International Council on Mining and Metals (ICMM), 2010. *Good Practice Guidance on Health Impact Assessment.* London, UK: ICMM
- International Finance Corporation (IFC), 2009. *Introduction to Health Impact Assessment.* Washington, D.C., US: International Finance Corporation.
- State of Alaska HIA Program (2011). *Technical Guidance for Health Impact Assessment (HIA) in Alaska.* Anchorage, AK: Alaska Department of Health and Social Services.
- Ross C, Orenstein M and Botchwey, N (2014). *Health Impact Assessment in the United States*. New York: Springer.
- Birley, M (2011). *Health Impact Assessment: Principles and Practice.* New York: Earthscan.
- National Research Council Committee on Health Impact Assessment (2011). Improving Health in the United States: The Role of Health Impact Assessment. National Academies Press.

Appendix D: Using a Wholistic Approach

One of the main pitfalls of the current approaches used in most environmental assessments is a lack of wholism. The reasons for this are many; however, one reason is that scientists, engineers, etc. are trained to focus on only those aspects that are central to their discipline, and as questions arise, they delve ever deeper into the details of their disciplines because their training and disciplinary mentors tell them that is where the answers must lie. Over time, the tendency is for those requiring the assessments (regulatory agencies), those who do them (natural and social scientists; engineers), and the industries responsible for them to settle into a static way of doing them. The end result is an EA that is assembled from a series of isolated assessments on many aspects of a proposed project and its projected impacts, and because the evaluations were designed from the planning stages to fit individual disciplinary requirements, any efforts to take a wholistic view of the impacts (the summary "integration" chapter) remain superficial.

An illustrative example:

The expectation by many stakeholders is that a chemical risk assessment *should* point to direct health effects, most notably cancer, and that if it doesn't, it is dismissed as being influenced by industry or government. Those who carried out the assessment may conclude that there are extremely low risks of adverse health effects. Scientific and mathematical limitations (undetectable concentrations of contaminants; too small a population to be able to evaluate rare cancers) make it impossible to numerically answer questions about cancer A arising because of industry B. The result is that a community feels it is not being heard, that their concerns are not being addressed.

A wholistic approach based on overall well-being, rather than specific cause vs. effect, would begin by looking at the community's values, their perception of risks from industry activities, and community health determinants that all contribute to a sense of well-being. So while a specific concern about cancer being caused by the industry may not be answered numerically, the concerns of community wellness can be addressed – if people are worried about chemical contaminants in country food, they may not hunt or gather as they once did (lifestyle change); they may not consume as much country food and substitute with other food, perhaps with lower nutritional value, from a store (dietary change); the perception of risk adds stress (mental health); incidence of cancer among family and community members and the belief that the industry is causing the cancer contributes to stress: the impact of chemical emissions from the industrial activity may be primarily social effects that in turn can result in health outcomes (e.g. reduced physical fitness, diabetes, high blood pressure).

However, there currently are aspects of guidelines that, if applied, could lead to more wholistic assessments that are more meaningful to a broad range of stakeholders, while continuing to meet the needs of regulatory agencies. For example, risk assessment frameworks [10, 14-16] have a stakeholder communication component that is recommended to begin at the very onset of project development to identify and define the concerns and issues that should be addressed in the assessment. The stakeholder engagement should then continue on an iterative basis throughout the assessment and through to the risk management decision-making. Health Canada provides guidance on how to involve stakeholders [33]. Stakeholder values come into play, which means that an approach and set of tools that fits one project in one area (e.g. a uranium mine in northern Saskatchewan) is not

likely to fit in another area (e.g. potash mine or oil fracking field in southern Saskatchewan), because not only are the possible chemical emissions different, the communities are different, with their own sets of values, social structures, community resilience, etc.

Ultimately, it is the underlying philosophy of the EA approach that will define how the stakeholder engagement takes place and the extent to which this defines the scope and scale of the EIS. If the regulatory requirement is to characterize the potential physical science and engineering-based impacts, while separately characterizing the social and economic effects, then a linear check-box type of EIS will be performed. If the regulatory requirement is to characterize the potential impacts on stakeholder/ community wellbeing, and defining wellbeing as a complex relationship among a set of social, economic, and environmental determinants, then a more wholistic approach to the EA will be necessary, in essence following the spirit of the regulation as opposed to a strictly literal interpretation of the regulation.

Fundamentally, a wholistic approach requires developing an assessment approach to fit the purpose, rather than narrowing the purpose to fit the standard assessment approaches.

References

1. Saskatchewan Health, *A Brief Orientation to The Public Health Act, 1994*. 2006.
2. Saskatchewan Ministry of the Environment, *Environmental Assessment in Saskatchewan: A High-Level Overview of the Environmental Assessment Process for Developments within Saskatchewan under the Environmental Assessment Act*. 2012, Government of Saskatchewan.
3. Saskatchewan Ministry of the Environment, *Technical Review Guidelines: A Guide to the Technical Review Process for Environmental Impact Assessments Within Saskatchewan Under the Environmental Assessment Act*. 2012.
4. State of Alaska HIA Program, *Technical Guidance for Health Impact Assessment (HIA) in Alaska*. 2011, Alaska Health and Social Services.
5. Aboriginal Affairs and Northern Development Canada, *Aboriginal Consultation and Accommodation - Updated Guidelines for Federal Officials to Fulfill the Duty to Consult - March 2011*. 2011.
6. Government of Saskatchewan, E.A.B., *Proponents Guide: Consultation with First Nations and Metis in Saskatchewan Environmental Impact Assessment*. 2014.
7. OECD, *OECD Guidelines for Multinational Enterprises*. 2011, The Organisation for Economic Co-operation and Development (OECD).
8. Shift Project Ltd., *Discussion Paper: Stakeholder Engagement and the Extractive Industry Under the OECD Guidelines for Multinational Enterprises*. 2013.
9. Ross, C., M. Orenstein, and N. Botchwey, *Health Impact Assessment in the United States*. 2014, New York: Springer.
10. Health Canada, *Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2.0*. 2012, Contaminated Sites Division, Safe Environments Directorate.
11. U.S. EPA. *EPA Risk Assessment: Basic Information*. 2013 [cited 2013 18 December 2013]; basic definitions of risk assessment and introduction to the US-EPA approaches to RA]. Available from: http://epa.gov/riskassessment/basicinformation.htm#arisk.
12. U.S. EPA. *EPA Risk Assessment: Human Health Risk Assessment*. 2013 [cited 2013 18 December 2013]; Available from: http://epa.gov/riskassessment/health-risk.htm.
13. Alberta Health and Wellness, *Guidance on Human Health Risk Assessment for Environmental Impact Assessment In Alberta*. 2011, Health Protection Branch.
14. U.S. EPA, *Framework for Human Health Risk Assessment to Inform Decision Making*. 2012, Office of the Science Advisor, Risk Assessment Forum, U.S. Environmental Protection Agency,.
15. U.S. EPA, *Framework for Cumulative Risk Assessment*, in *Risk Assessment Forum*. 2003, U.S. Environmental Protection Agency,.
16. EnHealth, *Environmental Health Risk Assessment: Guidelines for assessing human health risk from environmental hazards.* . 2012, Government of Australia Department of Health,.
17. U.S. EPA. *Technology Transfer Networks Air Toxics - 2005 National-Scale Air Toxics Assessment*. Air Toxics WebSite 2011 [cited 2014 May 23]; Available from: http://www.epa.gov/ttn/atw/natamain/gloss1.html.
18. Health Canada, *Federal Contaminated Site Risk Assessment in Canada, Part III: Guidance on Peer Review of Human Health Risk Assessments for Federal Contaminated Sites in Canada.* 2010, Contaminated Sites Division, Safe Environments Directorate,.
19. Environment Canada, *Federal Contaminated Sites Action Plan. Ecological Risk Assessment Guidance.* 2012, Environmental Stewardship Branch.
20. Canadian Council of Ministers of the Environment, *Guidance manual for environmental site characterization in support of environmental and human health risk assessment. Draft.* 2012,

Canadian Council of Ministers of the Environment.

21. Canadian Council of Ministers of the Environment, *Guidance manual for environmental site characterization in support of environmental and human health risk assessment. Draft.* 2012, Canadian Council of Ministers of the Environment.
22. Hatfield Consultants. *POPs Toolkit*. 2010 [cited 2014 May 21]; Available from: www.popstoolkit.com.
23. Canadian Council of Ministers of the Environment, *Guidance manual for environmental site characterization in support of environmental and human health risk assessment. Draft.* 2013, Canadian Council of Ministers of the Environment.
24. Contaminated Site Clean-Up Information (CLU-IN). *Methods for Handling Non-detect or Censored Data*. 2009 [cited 2014 May 22]; Available from: http://www.clu-in.org/conf/tio/ltmo_092408/Nondetects_handout.pdf.
25. U.S. EPA, *ProUCL*. 2013, US EPA.
26. Health Canada, *Federal Contaminated Sites Risk Assessment in Canada: Spreadsheet tool for human health detailed quantitative risk assessment (DQRA).* 2011.
27. Health Canada, *Federal Contaminated Sites Risk Assessment in Canada: Part IV - Spreadsheet tool for human health preliminary quantitative risk assessment (PQRA).* 2011, Contaminated Sites Division, Safe Environments Directorate,.
28. Health Canada, *Federal Contaminated Site Risk Assessment in Canada, Supplemental Guidance on Human Health Risk Assessment for Country Foods (HHRAFOODS), Version 1.2 (Draft)*. 2010, Contaminated Sites Division, Safe Environments Directorate, Health Canada.
29. EnHealth, *Environmental Health Risk Assessment: Australian Exposure Factor Guide*. 2012, Government of Australia Department of Health,.
30. Health Canada, *Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors, Version 2.0* 2010, Contaminated Sites Division, Safe Environments Directorate, Health Canada.
31. Texas Commission on Environmental Quality, *TCEQ Guidelines to Develop Toxicity Factors*. 2012, Toxicology Division, Texas Commission on Environmental Quality.
32. U.S. EPA, *Guidelines for Carcinogen Risk Assessment*, in *Risk Assessment Forum*. 2005, U. S. Environmental Protection Agency.
33. Health Canada, *Improving Stakeholder Relationships: Public Involvement and the Federal Contaminated Sites Action Plan. A Guide for Site Managers.* 2006, Contaminated Sites Division, Safe Environments Directorate, Health Canada.