GatePost

Risk Analysis

ENVIRONMENTAL HEALTH IN RED HEAD: THE ENERGY EAST PROJECT

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Introduction

Evaluating human health in environmental impact assessments (EIAs) is normally based on projected exposures to chemicals emitted from a proposed industrial project in a human health risk assessment (HHRA). The approach compares exposures to individual chemicals to established toxic reference values.

Proposed industrial projects must comply with engineering and emissions regulations. Therefore, the concentrations of compounds emitted from a proposed project are expected to be below guideline values, and are inherently expected to result in low overall risks to individuals and populations nearby. Nevertheless, a coherent and complete evaluation of transient, continuous, and accidental emissions during construction, operation, and closure processes is necessary to assure stakeholders, stewards, and regulatory officials that impacts on individual and community health and wellbeing have been adequately considered, and steps have been taken to mitigate risks.

This review of TransCanada's Human Health Risk Assessment, as filed in the company's National Energy Board application and relevant to the proposed Red Head, Saint John tank farm and marine terminal, reveals there are a number of outstanding points about this project. These include: benzene emissions may be understated, the worst-case scenarios were not accounted for, and there is minimal discussion of the impact of odours from the proposed infrastructure.

Health-related Application volume

High-level review of assumptions and conclusions, focusing on the tank terminal and marine terminal in Red Head

The human health assessments for the Energy East project, and for the tank farm and marine terminal at Red Head in particular, are limited in scope – they are restricted to a basic evaluation of airborne contaminant concentrations in the areas surrounding oil storage tanks and marine facilities, and whether those concentrations exceed relevant guidelines.

Specific concerns with the HHRA

The set of compounds assessed is limited to a small set of volatile organic carbons (VOCs) and reduced sulphur compounds (mercaptans). These are a small subset of chemical components of the heavy oil that TransCanada expects to transport in the pipeline – a discussion of how the compounds to be evaluated were selected is not obvious. Other compounds or compound classes, for example, polycyclic aromatic hydrocarbons (PAHs) from the tanks or from gas flaring may also be considered, or an explanation should be provided of why they are not considered.

For the compounds assessed, TransCanada states that reference concentrations were chosen from various jurisdictions, but they do not indicate the reasons why certain values were chosen from one jurisdiction over another. For example, they use the Alberta Ambient Air Quality Objectives [1] values for benzene (1 hr guideline = 30 ug/m^3; annual average guideline = 3 ug/m^3) rather than Ontario Ministry

[1] Alberta Ambient Air Quality Objectives and Guidelines Summary. August 2013. (http://environment.gov.ab.ca/info/library/5726.pdf)

of Environment (OME) values [2] (24 hr guideline = 2.3 ug/m^3; annual average guideline = 0.45 ug/m^3). Using the OME values results in significantly different risk characterization results for benzene emissions in the Saint John area. In fact, the annual predicted benzene concentrations at sensitive receptor locations around Red Head would exceed the Ontario guideline – 0.74 ug/m^3 estimated versus the guideline of 0.45 ug/m^3. This results in a concentration ratio of 1.6 as opposed to TransCanada's reported ratio of 0.25. This could change the classification of effects from "not significant" to "significant." Therefore, an explanation for using the Alberta guideline rather than the Ontario guideline should be provided.

Additionally, TransCanada should provide details on how they are classifying significant versus non-significant of the project impacts. Is there an explanation of how the ranking is completed? Specifically, health effects are classified as reversible because the effects are expected to stop when exposure stops. We need to assume that this refers to the end of the project – however, the pipeline and terminal are anticipated to operate for at least 40 years. An explanation of how this is determined should be provided, because this implies that 40 years of possible health effects are acceptable if symptoms theoretically diminish after the tanks and terminal cease operations.

LIMITATIONS / UNCERTAINTIES OF SCIENTIFIC MODELING

Risk estimates are based in this HHRA on concentrations of airborne contaminants modeled at various locations near the facilities. From various discussions of the accuracy of the CALPUFF model used to estimate these concentrations, we know that the model can both over and under-estimate concentrations at any particular time/location by more than 2x (e.g. Wood and Blewitt 2012)[3]. Explanations of the uncertainty of the CALPUFF model usually emphasize the *over-estimation* aspect, stating that the model is usually conservative and that actual concentrations are likely to be much lower than those predicted.

The implications of such uncertainties need to be discussed, because in the case of 2x over-estimation, the emissions from the tank farm and marine terminal are projected to be well below guidelines, whereas in the case of under-estimation by 2x the emissions, fine particulate matter (PM2.5 and PM10) may actually exceed the 24-hour and annual average concentration guidelines. If the modeled benzene concentrations are underestimates, the actual future concentrations could exceed Ontario guidelines in certain cases. TransCanada should provide an analysis and discussion of the potential health risk implications of these uncertainties.

To further emphasize the concept of uncertainty, Appendix Tables listing concentrations of VOCs report concentrations to extremely precise numbers – up to 6 significant figures, in fact (Energy East, Vol 4, Appendix 2B). While there may be some reasons for using these numbers in calculations, the greater issue is the implied confidence in the computer model output, and thus, the implied confidence in the health risk calculations.

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[2] OME 2012. Ontario's Ambient Air Quality Criteria. Standards Development Branch, Ontario Ministry of the Environment. (http://www.airqualityontario.com/downloads/AmbientAirQualityCriteria.pdf)

[3] Wood, D. and Blewitt, D. 2012. "Are EPA regulatory models capable of providing accurate estimates of future air quality?" presented at the US EPA 10th Conference on Air Quality Modeling, Research Triangle Park, NC. March 13-15, 2012. http://www3.epa.gov/scram001/10thmodconf/presentations/3-18-modeling_policy_issues.pdf

Catastrophic event analysis in the Application

Scenarios covered:

TransCanada evaluated leaks from an engineering risk perspective and assessment of historical pipeline leaks using the National Energy Board and Pipeline Hazardous Materials Safety Administration (U.S) [4] incident databases. TransCanada calculated the risks of pipeline failure in terms of the odds per year, per kilometre of pipeline that an event would occur. Their conclusion was that the odds are very low of any particular kilometre of pipeline failing, and if a failure occurred, it would most likely result in a small spill of minimal consequence.

However, spills do occur. Communities remain concerned about the consequences should a larger pipeline rupture or tanker loading incident occur. For example, the Enbridge pipeline rupture near Marshal, Michigan in 2010 was an event that would have been calculated as extremely unlikely. A series of events coincided to result in a major oil release – corrosion related pipeline failure, an unusually high rain event, leak detection and response processes, both technical and human, were insufficient or not followed. The result was over 3 million litres of diluted bitumen spilled into a tributary of the Kalamazoo River and contaminated a 50 kilometre stretch of the river. As of a year ago, the costs associated with the spill are greater than $1.2 billion USD.[5] While direct human health risks from the leaked oil remain small, the disruption to lives and livelihood, and concerns about issues such as property values and long-term effects on wellbeing remain.

Scenarios not covered

Scenarios not covered include any catastrophic pipeline ruptures in rural or urban areas, or catastrophic worst case spill scenarios for the Red Head tank farm and marine terminal, and the pipeline connecting the two facilities.

Adequacy of health implication assessment of scenarios

In the available documents, TransCanada has not evaluated possible health or community wellbeing effects of catastrophic events. TransCanada calculated a low risk of catastrophic event occurrence, therefore, their conclusion is that it is not necessary to evaluate potential implications of low-likelihood events on human health / community wellbeing.

The NEB has required other proposed pipeline projects to undertake human health (and ecological) risk assessments of various catastrophic spill scenarios. In two cases these more extensive assessments came in response to information requests from other government agencies or other intervenors.

- Enbridge Gateway Pipeline: the initial HHRA for this project was limited to airborne contaminant exposures at the Kitimat tank farm and marine terminal, similar to that provided in the Energy East assessment. A later supplement to Enbridge's application included extensive risk assessments of three catastrophic pipeline break scenarios that could impact inland rivers. The results of these assessments were that some risks for First Nations using these areas for food sources may be at risk of effects from higher exposures to heavy oil derived contaminants.
- Kinder Morgan Trans Mountain Pipeline: the initial HHRA for this project was again limited to airborne contaminant exposures at the tank farms and Burnaby marine terminal. Later

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[4] Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation.

[5] Garret Ellison, New price tag for Kalamazoo River oil spill cleanup: Enbridge says $1.21 billion, Michigan Live, Nov 5, 2015 (http://www.mlive.com/news/grand-rapids/index.ssf/2014/11/2010_oil_spill_cost_enbridge_1.html)

supplements to the Trans Mountain application included a more detailed and comprehensive HHRA for the marine terminal, [6] and a much more extensive HHRA of catastrophic spill scenarios in the Burnaby urban area and the marine environment.[7] Trans Mountain's conclusions were that for acute and chronic conditions, risks of health effects are not significant; however, criticisms and Trans Mountain's responses of the HHRA methods and conclusions are also filed on the NEB project site.[8] Inland scenarios were not developed for human health or community wellbeing evaluation.

A 2014 review (Eykelbosh 2014)[9] of reported health impacts of oil spills concluded that various short-term and long-term health effects can occur, particularly for residents living in the contaminated zone, and for those involved in cleanup (volunteers and professionals). In addition to toxicological effects, there is more evidence of mental health and broader community impacts of such spills. The reviewer found that "mental health impacts were more sensitive indicators of harm than physical impacts," and that in particular, perceived risks from an oil spill were more harmful than actual toxicological effects.

What has not been addressed in the Application?

TransCanada does not address two very significant issues in their health and wellbeing assessment: catastrophic, unplanned events (spills, leaks, explosions, fires, etc.) and odours. The first addresses people's primary concerns of the possible consequences of a major event – the odds of it occurring may be very low, but the consequences could be very significant. The second addresses perhaps one of the most significant issues that could affect individuals' wellbeing on a day-to-day basis.

- As discussed previously, catastrophic events are not assessed, including a tank farm event, pipeline rupture, marine terminal spill, etc. In Sec 19.7, TransCanada states that: "potential effects of accidents and unplanned events on human health will be assessed in an addendum to Volume 6, to be submitted to NEB in Q4 2014." This addendum is not yet available on the regulatory filing website.
- Odours from the tank farm and activities at the marine terminal are not considered in the Application. Since mercaptans (reduced sulphur compounds) are included as a group in the HHRA, TransCanada implies that odourous compounds are assessed. Odours and odour assessment is more complex than modeling a single compound class and comparing it to a standard.
  - The Clean Air Strategic Alliance in Alberta recently published the "Good Practices Guide for Odour Management in Alberta." [10]
  - The relationship between odours and health is complex. Individuals experience odours differently – some may find an odour offensive while others may not detect it or may find it

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[6] Trans Mountain Pipeline ULC - Human Health Risk Assessment of Westridge Marine Terminal – Technical report. (http://bit.ly/1MEuuxf)

[7] Trans Mountain Pipeline ULC – Technical Update NO. 3, Part 1. B259-22 – HHRA Memo NEB IR No. 2.024b (http://bit.ly/1LoC7pQ)

[8] Trans Mountain Pipeline ULC - Reply to Living Oceans Society "Review of Kinder Morgan Pipeline Expansion Project Application – Human Health Impact Assessment: Expert Report" (http://bit.ly/1MEwh5z)

[9] Eykelbosh, A. 2014. Short- and long-term health impacts of marine and terrestrial oil spills. https://www.vch.ca/media/VCH-health-impacts-oil-spill.pdf

[10] CASA 2015. Good Practices Guide for Odour Management in Alberta: From prevention and mitigation to assessment and complaints. Clean Air Strategic Alliance, Edmonton, AB. (www.casahome.org)

pleasant. If health-related symptoms are present, different people may experience and describe symptoms in different ways, whether or not they can identify particular odour components.

- Odours are also unlikely to be solely due to individual chemicals – chemical mixtures may interact in many different and unexpected ways. This aspect makes modeling and assessing odours a challenging issue. We currently understand chemical toxicity on a chemical-by-chemical basis and have a poor understanding of the toxicology of mixtures with regard to odours and with regard to the majority of potential environmental contaminants.
- The Alberta Energy Regulator (AER) investigated odour-related health and wellbeing effects from heavy oil production [11] in a rural farming community near Peace River. (AER 2014)[12] This case is an example of the challenges associated with identifying odours and their relationship with impacts on wellbeing. Many volatile and known odour-causing compounds were monitored, however, all compounds remained well below Alberta Ambient Air Quality Objectives or below concentrations set by the Texas Commission on Environmental Quality (TCEQ). Despite regulatory objectives being met, some farm families in the area experienced significant health effects and ultimately had to move away from their farms.[13] The storage tanks at Red Head appear to be designed differently, with little or no headspace for vapours to form, and a closed vapour collection or extraction process. While this design should mitigate vapour release into the air, both TransCanada and the Red Head community should be aware of the Peace River case.

The most important issue in cases like this is the acknowledgement that health and wellbeing impacts could occur even if regulatory guidelines are being met.

LIMITATIONS OF THE HHRA APPROACH

The EIA process is by default a linear approach to the question of whether a project will cause significant adverse effects on the environment. The assessment is divided into many segments, and each are evaluated more or less independent of one another (i.e. a silo-based approach). In the context of this review (health), this silo-based approach does not address the holistic nature of individual and community health and wellbeing. Evaluation of health is typically restricted to chemical exposure and the limitations of single chemical - toxicity based HHRA. Meaningful interpretation and communication of the results of an HHRA and what it actually may mean to individuals and communities continue to be significant challenges.

More complexity and sophistication in the HHRA itself is unlikely to provide a better prediction of health effects of the project. Wellbeing depends on many factors (e.g. Health Canada's determinants of health [14]), and exposure to environmental contaminants is only one consideration. Additionally, aside

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[11] In this oil production area, producers pump an emulsion of oil and water from the wells and hold it in heated tanks while the emulsion breaks down and the oil and water separate. Because the tanks are heated, they must be vented. In this case, the tanks were vented to the outside atmosphere, rather than the vapours collected in a closed system.

[12] AER 2014. Proceeding 1769924. Odours and Emissions from Heavy Oil Operations in the Peace River Area. Alberta Energy Regulator. (https://www.aer.ca/applications-and-notices/hearings/proceeding-1769924)

[13] Edmonton Journal, October 7, 2014. (http://bit.ly/1PF2Kyz)

[14] Public Health Agency of Canada. "What Determines Health?" (http://www.phac-aspc.gc.ca/ph-sp/determinants/index-eng.php#determinants), accessed 17 November 2015.

from factors such as education, employment, social support and culture, concepts such as trust and risk perception play a substantial role in a community's overall sense of wellbeing. In the context of a project's effects on health, few of these factors are considered in the EIA process.

Questions the community might ask TransCanada, the NEB, or the NB Government

- An addendum to Volume 6 of the Application is referred to in the Health section. Has TransCanada completed this assessment? What is the scope of the assessment? Does it include reasonable worst-case scenarios for the Saint John oil storage tanks and marine terminal?
- In a June 30, 2015 letter to Gordon Dalzell, TransCanada states that an HHRA is planned for the terminal and tank farm facilities to evaluate the aerial contaminant emissions. *Is this different than the current HHRA, dated September 2014? If so, has TransCanada completed this risk assessment?*
- Why was the Alberta guideline for benzene used rather than the more stringent Ontario guideline?
- Currently, a monitoring program related to human health concerns is considered unnecessary because the effects assessment concludes there will be no risks of health effects. Will TransCanada commit to developing and implementing a monitoring program that is both chemical and health-based? Such a monitoring program would ideally begin well before construction of the tank and marine facilities begin to establish a baseline of selected parameters. The company should discuss their anticipated response to future community or individual concerns. As a starting point, CASA's guide offers various tools for tracking odour character and health symptoms, prevention and mitigation, and ongoing odour assessment tools.
- Will TransCanada commit to meaningful and relevant community health monitoring, beginning prior to construction if the project goes ahead?

About the Author

Dr. Ken Froese is an independent expert with over 20 years of experience in health and environmental risk assessment. He has worked with industry, government, First Nations, and non-governmental organizations in senior project direction and management and technical report writing. He has served as an expert witness, provided courtroom testimony, and has been on international peer review panels.

APPENDIX

A SUMMARY OF 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. HHRA is currently the primary focus of health assessments in environmental impact assessments. It 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). The goal of the 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.

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 <u>ingestion</u> of food, water or soil; <u>inhalation</u> of air, particulate matter, or vapour; or <u>dermal absorption</u> via soil, water, or vapour.

A basic human health risk assessment approach follows a four-step procedure. (Figure 1). These four steps are:

- *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.[15]

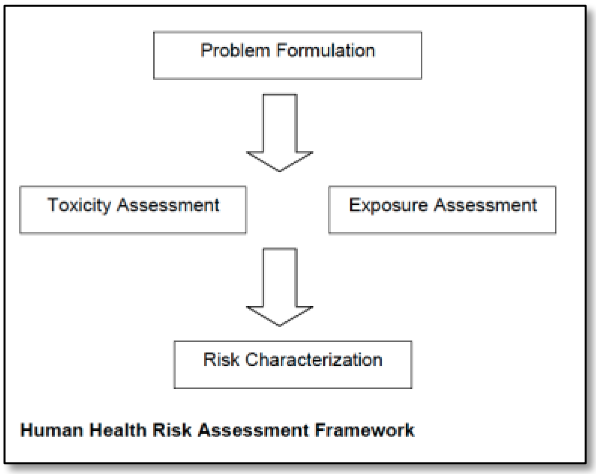
- *Exposure assessment* estimates the amount of contaminant (the dose) that a receptor may be exposed to via inhalation, ingestion, and dermal contact. The concentrations of hazardous substances in food, water, air, and soil are measured or estimated based on project emissions, and receptor behaviours (such as amounts of fish or meat consumed, volume of water consumed, time spent at

[15] 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.

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 1. 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.

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, 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, 70 years by US-EPA) above the overall occurrence of cancer[16] 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.

HHRA Interpretation Notes

<u>Hazard Quotient:</u>

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.” [Bold emphasis added.]

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 mean people are being exposed to unacceptable risks. This view can have a variety of consequences. For example, risk assessors may revise and iterate exposure

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[16] 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

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, immune-compromised individuals, those with respiratory conditions, or those with obesity.

Using a Holistic Approach

One of the main pitfalls of the current approaches used in most environmental assessments is a lack of holism. 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 even 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 for those requiring the assessments (regulatory agencies), those who do them (natural and social scientists; engineers), and the industries responsible for them is 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 holistic view of the impacts (the summary “integration” chapter) remain superficial.

However, there currently are aspects of guidelines that, if applied, could lead to more holistic 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 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. 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. oil storage tanks in New Brunswick), because not only are the possible chemical emissions different, the communities are different, with their own sets of values, social structures, community resilience, etc.

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