Health Canada Santé Canada

Canadian Handbook on Health Impact Assessment

Volume 2: Approaches and Decision-making

Canada

About the cover Illustration:

This painting depicts Mother Earth at one with nature. She is the giver of life. Throughout the history of humans, female life has been the life giver and the one who nurtures the young. As many cultures developed, the power of the female was cultivated into a very important part of the health and spirituality of the community. Many native communities carried these strengths to modern times with only brief lapses. But as we learn more about those ways, we will be come stronger and healthier.

Similarly, this holistic vision shows us how health is wrapped up in the balance of nature. The symmetry of this painting represents this balance between humanity and nature, earth and sky, night and day. The lush greenery, calming waters and (brilliant) sky symbolizes the bountiful resources that Mother Earth provides. These resources satisfy much more than our physical needs - they fulfill our spiritual, emotional and cultural needs as well. Without proper care, these resources become sullied and consequently, the health of all will suffer.

The streaks of white in Mother Earth's hair expresses her wisdom and the continuum of time. Her outstretched hands reveal her nurturing capacity. The leaf in her hand symbolizes the medicinal power of nature to those who have the wisdom to draw from it. It is only in embracing the traditional capacities of communities that we can protect and preserve our health and environment.

CANADIAN HANDBOOK ON HEALTH IMPACT ASSESSMENT

VOLUME 2: APPROACHES AND DECISION-MAKING

NOVEMBER 2004

A Report of the Federal/Provincial/Territorial Committee on Environmental and Occupational Health

Our mission is to help the people of Canada maintain and improve their health.

Health Canada

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The *Canadian Handbook on Health Impact Assessment* has a long history, evolving over time with input from a significant number of individuals. Only some are specifically mentioned here, though the contributions of all were crucial to the finalization of the Handbook. The Handbook was prepared under the general guidance of the Health Impact Assessment Task Force reporting to the Federal/Provincial/Territorial Committee on Environmental and Occupational Health (CEOH). The CEOH had membership from all provinces, territories, and the federal government. Membership on the CEOH and Task Force represented environment, health, and labour sectors. The Task Force members included representatives of Health Canada and Labour Canada, as well as the following representatives of provincial government bodies:

- Mark Allan, Department of Health and Community Services, New Brunswick
- George Flynn, Alberta Health, Alberta
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- Jerry Spiegel, Department of Environment, Manitoba

The Handbook started as a discussion paper prepared under contract by Kate Davies and entitled *The National Health Guide for Environmental Assessment: A Discussion Paper*. Consultations on the discussion paper took place in 1995 at six multisectoral workshops held in Dartmouth, Nova Scotia; Montreal, Quebec; Toronto, Ontario; Winnipeg, Manitoba; Vancouver, British Columbia; and Ottawa, Ontario.

Based on input from the 1995 workshops, a draft Handbook was written with contributions from several authors. Special thanks go to staff of Health Canada's Environmental Health Assessment Services for coordinating the preparation of the 1998 draft Handbook. In 2000, multistakeholder consultations on the draft Handbook were held in Dartmouth, Nova Scotia; Montreal, Quebec; Toronto, Ontario; Regina, Saskatchewan; Vancouver, British Columbia; and Ottawa, Ontario.

For both the 1995 and 2000 workshops, numerous provincial government and Health Canada regional staff assisted in the planning and delivery of and reporting on the workshops.

The final version of the *Canadian Handbook on Health Impact Assessment* was prepared on the basis of discussions at the workshops held in 2000 and contributions from several authors. Special thanks go to staff of Health Canada's Environmental Health Assessment Services, Healthy Environments and Consumer Safety Branch (HECSB), for their efforts in coordinating input to the Handbook.

Individual authors were involved in the writing of the various chapters of the Handbook. Their input is greatly appreciated. Significant contributions were made by Reiner Banken, Ugis Bickis, Marci Burgess, Pierre Chevalier, Wesley Cragg, Kate Davies, Pierre Dubé, Alan Emery, Pierre Gosselin, Philippe Guerrier, Henry Lickers, Pascale Méra, Robert Rattle, and Alain Webster; Industrial Economics Inc. in Cambridge, Massachusetts; and Health Canada staff in the Department's Environmental Health Assessment Services, the Biostatistics and Epidemiology Division, and the HECSB Office of Policy Coordination and Economics.

Finally, special recognition is given to Pierre Gosselin for his efforts in coordinating input into and finalizing Volumes 2 and 4 of this Handbook.

EXECUTIVE SUMMARY

This second volume of the *Canadian Handbook on Health Impact Assessment* focuses on the concepts, principles, and procedures to follow when evaluating the environmental and health impacts associated with the implementation of a project or program in a given region. The discussion includes criteria for conducting a health impact assessment (HIA) and presents several examples of impacts of development projects as a guideline for public health professionals.

The environmental assessments (EAs) conducted in Canada vary considerably in scope, depending on the requirements of the provinces/territories and the federal government. It would be impossible to cover the entire range of methodologies and disciplines that are available or useful. Volume 2 focuses on those that are likely to require the expertise of local or regional public health authorities.

The roles normally expected of public health authorities in an environmental impact assessment (EIA) are: 1) to participate in the process, be it public or strictly administrative, in order to clarify specific EA requirements relating to health; 2) to comment on the studies submitted by project and program proponents; and 3) to offer their views regarding the acceptability of projects under review, from a public health perspective.

More rarely, as in the case of government policies or projects sponsored by a provincial health ministry or the federal Department of Health (e.g., pesticide spraying to combat the insect vectors of the West Nile virus), public health authorities are required to participate more directly and to conduct much of the impact study themselves.

The discussion of the procedures and criteria for an HIA in relation to the implementation of a development project comprises six chapters of Volume 2 addressing the following topics:

- useful concepts in EA;
- sustainable development (SD) and health;
- analysing health risk data;
- risk management tools;
- public health notices and interventions in EA; and
- communication and credibility.

Useful concepts in EA: This chapter presents a number of useful concepts for examining the role and function of health professionals in EA. One such concept relates to the determinants of health, i.e., complex interacting factors that determine the health of individuals and populations. These include income, education, and social status and provide a basis for predicting most of the health disparities in a given population. Other determinants, such as primary health care, also play an important role. By comparison, exposure to environmental contaminants plays a much smaller role in problems of health, although that role appears to be increasing.

A second useful concept is the categorization of the types of EAs and their content on the basis of their respective levels of focus. Two levels of focus are evident in conducting an EA: mesosocial and macrosocial. At the mesosocial level, the main tools are local or regional environmental impact studies, which are conducted before projects are implemented. Once in place, projects are monitored for both environmental and health impacts. The principal tools at the macrosocial level are strategic environmental assessments (SEAs) and product life cycle studies, which attempt to predict impacts on an entire ecosystem, ecozone, province/territory, country, or continent.

This chapter also discusses the sequence of events in the EA process and the role of health professionals in the various steps at each of the two levels described above, including involvement in project justification and in establishing the scope and content of the HIA within the context of EA. Various levels of involvement for health organizations and professionals are suggested, along with corresponding criteria for involvement consistent with the scope and content of the HIA in question.

SD and health: The principles of SD play a valuable role in HIA within EA by serving as a framework for integrating the public health risks and benefits associated with a development project. The three key realms of SD are the ecosystem, the economy, and the social system. In conducting EAs, it is desirable to identify the health component as a key element of SD, on a par with the economic, environmental, and social components. This approach does justice to the interdependence of various determinants of healthy and equitable development. It also parallels and complements the principles underlying the very concept of health as outlined in the World Health Organization's definition of health.

Planning and implementing development projects based on SD principles help to ensure the inclusion of all the key aspects of health in its broadest sense: the biophysical environment, human health (including psychosocial impacts and quality of life), as well as socioeconomic impacts. Ultimately, the focus of all SD is human health, and this concept can be very useful in developing a clearer vision of the goals we must achieve to ensure that social development is consistent with the promotion and protection of public health.

Analysing health risk data: It is normally easy to obtain data on the benefits of a given project, program, or policy, because proponents usually give this aspect considerable prominence. The quality of the data provided with respect to the advantages and benefits of a project can vary and merits at least a cursory assessment. Assessing data that deal with the risks of a project can be a more difficult exercise. Several problems can arise in preparing or analysing an EA. These relate to consideration of a number of factors, such as spatial and temporal scales, risk groups, workers, new technologies, and methodologies. Details on these potential problems and how to address them are the focus of this chapter.

Risk management tools: Risk management is a key component of EA, particularly with respect to the participation of public health agencies. This chapter presents a framework and methods for risk management, including the current approach in Canada, the underlying risk management principles, and their connection with EA.

The objective of risk management is to identify potential sources of hazards, to assess their risk(s), and to determine the measures that need to be taken to reduce the risk(s). These are easier to attain if they are based on scientific data, consultations with affected persons, and the careful study of proposed solutions to determine their feasibility and their social acceptability. Risk management addresses the type of advice to provide to the population, the approach to adopt in order to communicate information on risks, and the mitigation strategies and standards to adopt.

Risk management based on benefits to be gained is an essential element of the public health notice (see below), which is itself a key component of EA. It is important to take a clear position as to what constitutes an acceptable risk and what does not and to indicate what improvements are necessary and desirable from a public health and public safety perspective.

Public health notices and interventions in EA: Public health practitioners can become involved in the EA process in many different ways. The potential goals of public health interventions include impact prediction, surveillance, prevention, and mitigation, as well as the correction of impacts once they have occurred. Accordingly, this chapter is devoted primarily to providing a detailed description of the analysis and preparation involved in producing a public health notice, whose objectives are to contribute to the inclusion of adequate measures to protect public health and safety; eliminate, reduce, or mitigate environmental and social impacts that have an adverse effect on health and quality of life; promote impacts that are beneficial to health and quality of life; and maintain and improve life-sustaining ecosystems. This approach is consistent with the objectives of SD and the good practices recommended by the Organisation for Economic Co-operation and Development.

Public health notices and interventions can focus on specific projects or address the effects of legislation, regulations, programs, and policies of an economic nature, which often have a major impact on environment and health. The tools available are varied and draw on a number of disciplines. What is important, ultimately, is the health professional's ability to use these tools to analyse and interpret information in order to balance risks and benefits. Information must be made comprehensible and useful to the public and decision-makers. The onus is on health professionals to perform this task and to make their intervention available at the opportune time, as part of the EA process.

The challenge of making comparisons in the absence of standards in the context of risk management and public health notices is also addressed in this chapter. One suggested approach is to set explicit limits for judging the acceptability of risks – e.g., individual risk, collective risk, chemical substance thresholds, and ecological risk. This approach to risk management has the advantage of being comprehensive and setting clear limits, which facilitate decision-making, and can serve as a guide for public health practitioners, who may find it helpful for evaluating risk levels determined through impact studies. Specifying clear risk levels and criteria for intervention is a useful aspect of preparing a public health notice, since this provides a set of guidelines.

Another important aspect of public health notices and interventions is that it is often difficult to determine what will be socially acceptable regarding assessments of development projects. An awareness of the factors likely to provoke resistance in a given context can help in the design of projects that will find acceptance by the affected community.

Communication and credibility: The standard risk assessment process may sometimes fail to address the concerns being voiced by the public about issues that commonly arise with most large development projects, such as the equitable distribution of risks and the present and future credibility of proponents. This chapter offers advice on developing a process for communicating credibly and effectively with the public about assessments of development projects and for encouraging public participation.

Where the health network is concerned, a number of issues need to be considered in coordinating public participation – e.g., the specific risk evaluation context, data confidentiality, the stakeholders involved in the process, and avoiding any possible bias that might give rise to criticism and undermine credibility. Those charged with communicating risk have an interest in translating quantitative information into a form that will be more accessible to the general population. Risk comparison can help to place a specific situation in context.

Credibility is the key ingredient of successful communication. Factors that influence the credibility of those communicating with the public include the perception of empathy, competence and expertise, honesty and openness, and dedication to the cause. Ways of developing and maintaining credibility include having a high level of scientific professionalism and keeping a steady dialogue with the community and organized groups. Another essential aspect is rendering balanced judgments, while maintaining an exclusive focus on public health.

In addition to the above, this chapter offers practical guidance on how to prepare a communication strategy, outlines steps for effective risk communication, and suggests useful ethical principles to follow in conducting an EA.

Overall, the concepts and approaches described in Volume 2 of the *Canadian Handbook on Health Impact Assessment* provide useful contextual information and practical guidance for the involvement of public health professionals in EAs of development projects. The criteria and procedures for conducting HIAs within the context of EA serve as guidelines for practitioners to help them to fulfil their role in EA, especially for projects likely to require the expertise of local or regional public health authorities.

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1 INTRODUCTION

This second volume of the *Canadian Handbook on Health Impact Assessment* offers readers an integrated approach to the development of a public health perspective within the framework of environmental assessment (EA).

This volume and the two that follow are practical extensions of the first volume, which presented the rationale for the necessary presence of the health sector in the field of EA, as well as a summary of current practices in Canada and other countries. Volume 2 focuses on the procedures to follow when evaluating the implementation of a project or program in a given region. It also presents criteria for conducting an analysis and provides several examples of impacts as a guideline for public health professionals. Detailed examples of the application of health impact assessment (HIA) to development projects are presented in this volume.

The EAs conducted in Canada vary considerably in scope, depending on the requirements of the provinces/territories and the federal government. It would be impossible to cover the entire range of methodologies and disciplines that are available or useful. The present volume deals with the types of projects and programs that are likely to require the expertise of local or regional public health authorities.

The role normally expected of public health authorities in an environmental impact assessment (EIA) is to:

- participate in the process, be it public or strictly administrative, in order to clarify specific EA requirements relating to health;
- comment on the studies submitted by project and program proponents; and, finally,
- offer their views regarding the acceptability of projects under review, from a public health perspective.

More rarely, as in the case of government policies or projects sponsored by a provincial health ministry or the federal Department of Health (e.g., pesticide spraying to combat the insect vectors of the West Nile virus), public health authorities are required to participate more directly and to conduct much of the impact study themselves.

This volume comprises six main chapters, which focus on:

- useful concepts in EA, including determinants of health, types of EAs, and the role of health professionals (Chapter 2);
- sustainable development (SD) as a framework for integrating the risks and benefits to public health (Chapter 3);
- an analysis of the data on health risks (Chapter 4);
- a framework and methods for risk management (Chapter 5);
- the integration of a public health approach in developing public health notices and public health interventions in EA (Chapter 6); and
- the development of a process for communicating with the public (Chapter 7).

2 USEFUL CONCEPTS IN ENVIRONMENTAL ASSESSMENT

2.1 Introduction

This chapter presents a number of essential concepts for examining the role and function of health professionals in EA. Some of these concepts have been explored in greater detail in Volume 1 and will be dealt with briefly here, while others will be discussed more fully. These concepts are:

- the determinants of health (a review);
- the various types of EA and their content;
- the normal sequence of events in the EA process (a review);
- the role of health professionals in the process; and
- suggested levels of involvement for health organizations in a variety of situations.

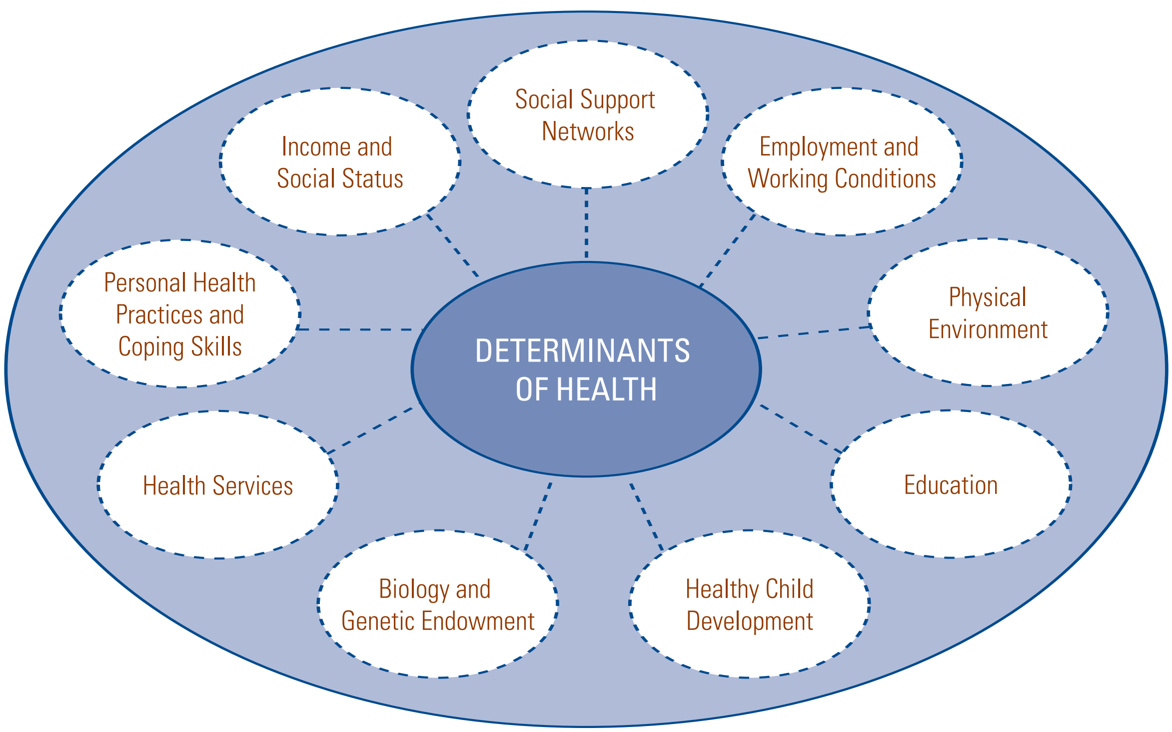
2.2 The Determinants of Health

Countless scientific studies have clearly established that the health of individuals and populations is determined by a number of complex interacting factors. These determinants of health are summarized in Figure 2.1 (see also Volume 1, Chapter 1).

The determinants of health include income, education, and social status and provide a basis for predicting most of the health disparities in a given population, either directly (through stress, control over one's life and social relationships) or indirectly (through lifestyle habits, access to services and information). Other determinants, such as primary health care (particularly during the critical childhood period), also play an important role. By comparison, exposure to biophysical contaminants in the environment plays a much smaller role in problems of health, although a number of recent studies suggest that that role is increasing. Moreover, some groups are more exposed or experience a greater sensitivity to pollutants than the general population.

Although most of these concepts may appear self-evident to many health professionals trained in Canada, it is important to note that this is not necessarily the case in other parts of the world. Doctors and nurses who work in the public health field, for example, are familiar with the determinants of health and the broader concept of health promoted by the World Health Organization (WHO), which defines health as a "state of complete physical, mental and social well-being" (WHO, 1947). However, they often overlook the fact that for many members of their profession, for professionals in other disciplines, and for a large segment of the population, health remains, above all, the absence of disease. Disease is often considered a misfortune that is unrelated to behaviour or the result of poor access to health care (Evans *et al*., 1994).

Figure 2.1
Determinants of Health



There are also numerous links between determinants of a social nature and those of an environmental order: lifestyle (automobile use, diet, etc.) is strongly influenced by living standards and community organization. EA must take these various determinants into account, since all can be favourably or adversely affected by a development project or policy.

2.3 Types of Environmental Assessment

The terms *environmental assessment* and *environmental impact assessment* are frequently used interchangeably. However, some maintain that an EA of a project is broader in scope than an EIA. Recently, strategic environmental assessment (SEA), or the EA of programs or policies, has become popular. (See Glossary, Appendix D, for definitions.)

As well, the academic field of EA has spawned a number of subdisciplines that are more conceptual than real, given that they are really components of EA. These include economic, fiscal, demographic, technological, and social assessment (Vanclay and Bronstein, 1995). Many would also include political analysis in this category.

Volume 1 of this Handbook offered a descriptive definition of EA. The definition in Box 2.1 provides a good summary of the various components of EA and may be more useful for health professionals.

Box 2.1
Environmental Assessment

EA is a comprehensive and systematic process designed to identify, analyse, and evaluate the environmental effects of a project in a public and participatory manner. It involves the use of technical experts, research and analysis, issue identification, specification of information requirements, data gathering and interpretation, impact prediction, development of mitigation proposals, external consultations, and report preparation and review.

Therefore, we are dealing with a complex and largely interdisciplinary process that requires the participation of multiple specialist stakeholders as well as that of the general public, who invariably experience the impacts of projects, programs, and policies. It is also a scientific process, albeit one that must rely on data that are often highly incomplete in order to predict impacts; as a result, it may appear to be more of an expert opinion-gathering process or an art than a rigorous scientific procedure. Accordingly, the health component of EA is but one of the many elements that enter into the decision-making process.

Two levels of focus are discernible: 1) mesosocial focus; and 2) macrosocial focus (see also Table 2.1):

- *Mesosocial Focus:* At this level, the main tools are local or regional environmental impact studies, which are conducted before projects are implemented. This aspect is regulated everywhere in Canada, but the rules that determine when an impact study is required vary from one province or territory to the next and at the federal level (see Volume 1, Chapter 4). Once in place, projects (factories, highways, etc.) are monitored for both environmental and health impacts. Environmental audits are also done to determine whether companies are managing their processes in a manner consistent with established standards such as ISO 14000 or the equivalent and whether they are managing the health and safety of workers in accordance with the applicable laws and regulations.
- *Macrosocial Focus:* The principal tools at this level are SEAs and product life cycle studies, which attempt to predict impacts on an entire ecosystem, ecozone, large administrative unit (e.g., a province or country), or continent. Follow-up activities take the form of reports on the state of the environment and the national accounts as they pertain to natural resources (forests, water, etc.), as well as reports on health (mortality, morbidity, biological contamination, surveys on habits and perceptions). Reports on health sometimes focus on a specific risk factor or a particular subgroup of the general population and examine the level of perceived or presumed risk. Exposure to organochlorines among Aboriginals and exposure to heavy metals among pregnant women are examples of issues addressed through this traditional public health approach.

Table 2.1
Types of Studies Conducted in Environmental Assessment

Stage	Mesosocial Level	Macrosocial Level
Prediction and investigation (Prior to project development)	■ Impact studies	■ Strategic studies ■ Product life cycle studies
Monitoring and follow-up (During and after project development)	■ Environmental and health follow-up (workers and neighbouring populations) ■ Audits (ISO 14000)	■ Reports on the state of the environment ■ National accounts – resources ■ Reports on health status

2.4 The Role of Health Professionals and Agencies

The role of health professionals varies depending on the function they fulfil within their organizations and on whether they become involved in local issues as private citizens. A number of demands are made of health professionals, and a variety of tasks are required to properly analyse a project or program submitted for review. In this section, these roles are examined with respect to project justification, the type of environmental evaluation under review, and the unfolding of projects over time. In concluding this section, a few criteria for involvement by health agencies are suggested.

2.4.1 Project Justification

In examining or preparing an EA, it is crucial to determine whether the goal of the assessment is simply to control the adverse impacts that have been identified with respect to the project or whether the assessment process will also attempt to determine whether the project is in fact justified and necessary. This latter option is included in a number of provincial/territorial processes. Ideally, this requires that a number of options, including project cancellation, be considered before the most appropriate one is selected. This is particularly so when the local population perceives that the development project or initiative may bring them no benefits and cause them significant inconvenience. Typical examples would be the installation of power lines in agricultural areas and the development of a regional landfill site, which would have potentially adverse impacts on local residents.

Those who oppose a project will always seek to question its soundness, regardless of whether such considerations are actually part of the process. Examples relating to waste management and the introduction of freeways into urban environments provide eloquent testimony in this regard. Health professionals must be mindful of this difficulty and take it into account, since their role does not consist of simply following a legal process, but entails protecting and promoting public health, regardless of whether a perceived risk is legitimate or not. In order to render their judgment on the acceptability of a project from a health perspective, they will need, in most cases, to concern themselves, at least minimally, with the justification for the project. This subject will be addressed in greater detail in later sections.

2.4.2 Assessment Content and the Role of Health Professionals

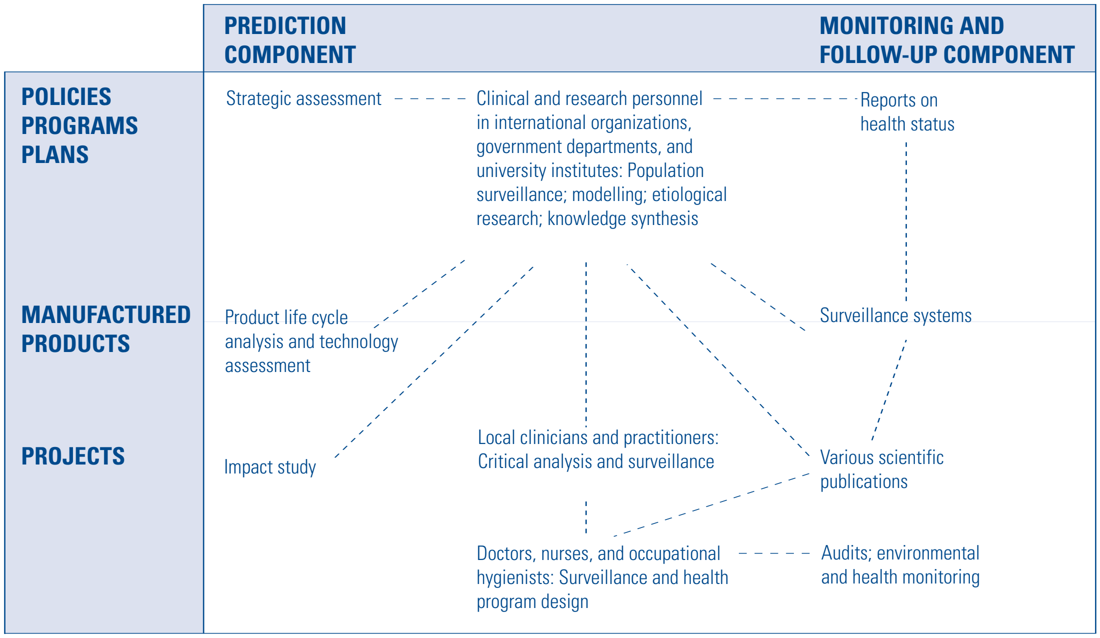
The information contained in the various types of assessments and follow-ups is necessarily different. For example, health monitoring for workers in a factory can be very detailed and narrow in scope and is sometimes conducted daily or on a continuing basis for some risk categories, such as exposure to chlorine. However, general population testing for the presence of heavy metals or organochlorines in mothers' milk is not conducted on a frequent basis, since temporal variations in these contaminants are usually slow to develop.

Similarly, the role of health care providers varies according to the organization to which they belong and the training they have received (see Figure 2.2). It must be emphasized that all these various roles are complementary and essential, since the study of macrosocial aspects would not be possible without the input of clinicians from across the country. As well, practitioners count on large-scale studies in order to adapt their daily practice to emerging or newly recognized risks.

As alluded to above, the content of EA studies can vary considerably, depending on the subject matter, the type of study, the available data, and the methodology employed.

The length and detail of the environmental impact study are often commensurate with the complexity of the project. However, there have been exceptions to this rule. The SEA conducted by the federal government in connection with the North American Free Trade Agreement (NAFTA) comprised only 120 pages (Government of Canada, 1992) and concluded that the Agreement would be virtually innocuous in terms of its environmental impacts, although it dealt with a decision of the highest importance that would permanently alter natural resource consumption patterns and commercial exchanges across the continent. Under pressure from the United States, a parallel accord on the environment was added to NAFTA. At the time, however, no adequate data, provisional models, or evaluation framework existed to permit an in-depth study.

Figure 2.2
Roles Performed by Health Professionals in Environmental Assessment



In addition, it is often difficult to foresee how millions of companies and hundreds of millions of consumers will conduct themselves or exactly where impacts will be felt. These factors can render decision-making very difficult; as a result, dominant philosophical and moral models, such as business-friendly biases and neo-conservatism, tend to guide decisions. Recently, more exhaustive studies have shown that major impacts have taken place and that some of these have been positive, while others have been negative (CEC, 2002).

Reports of standard environmental impact studies, such as those conducted for large factories, mines, and freeways, often contain as many as 1000 pages, while studies examining even larger projects, such as northern mines and hydro-electric developments, may contain as many as 5000-10000 pages.

Many complex studies of this nature are read by only a few. Most stakeholders simply consult the sections that concern them. While the health component is normally allotted a single chapter in these studies, a more thorough reading of the impact study as a whole is necessary to fully understand the context. The “determinants of health” framework clearly shows that in the majority of cases, EA requires a team effort involving both health professionals and specialists in a variety of environmental, economic, social, and technical areas that can have an impact on health. Health professionals need to consult broadly to understand and accurately assess the value of the more technical aspects of these studies. An up-to-date review of basic texts and important reference material on EA can be found on the web site of the International Association for Impact Assessment (IAIA) (http://www.iaia.org/) or that of its Francophone secretariat (AIEI) (http://www.aiei.org/). (See also Chapter 9, Bibliography.)

2.4.3 Sequence of Events and Involvement of Health Professionals

Regardless of the type of EA being examined, there is one constant where health professionals are involved: they must perform their appropriate role and contribute their input to the process. Theirs is an important primary prevention activity, ultimately comprising secondary prevention activities (e.g., screening, follow-up), as well as various clinical functions involving workers and affected populations. Certain measures relating to emergency planning also require the presence of health professionals. The EA process has been in existence for approximately 30 years in North America, and one frequent shortcoming is underestimating public health considerations. Thus, it is crucial that health professionals, as well as health agencies and institutions, play a significant and active role in the process.

2.4.3.1 Macrosocial Focus

At the macrosocial level (large ecosystem, province, country, continent), the task consists most often of examining the broad thrust of public policy (energy, transportation, agriculture, etc.) to ensure that public health concerns are included early in the process. Some countries, Canada among them, conduct SEAs. Worldwide, however, practices tend to be more makeshift and informal (Thérivel and Partidario, 1996), and the public health component is frequently neglected. The same is often true at the provincial level, although efforts have been made in recent years to improve the situation, for example in British Columbia (Lewis, 1998) and Quebec (CSEQ, 1998). These efforts include interdepartmental agreements that require a systematic examination (by representatives of the Department of Health, among others) of policies, programs, regulations, and guidelines that may have an impact on the environment (MSSS and MEQ, 1987, 1996).

It is therefore necessary for public health officials, professional bodies (of doctors, sanitarians, etc.), and other non-governmental organizations to become involved at the earliest stages of policy formulation. This can be accomplished by working with political parties, government departments, interdepartmental committees, and parliamentary commissions and by participating in public consultations and other mechanisms designed to give voice to concerns. Institutional settings may vary from one jurisdiction to the next, depending on the administrative structures in place.

Still, the formal analysis of the environmental impacts of government policies, plans, and programs on public health is a science that has yet to be explored and a discipline that remains relatively undeveloped. As a result, policy statements and ideological declarations are encountered more frequently than is substantive analysis of health and environmental impacts. However, some organizations have begun to address this need by undertaking often detailed assessments of draft legislation and regulations to determine their impact on public health. For example, SEAs focusing on issues of health were recently conducted on new anti-tobacco legislation (MSSS, 1998), as well as on regulatory proposals regarding the quality of drinking water (MEF, 1992). The European Union is particularly active in this area, due to the imminent coming-into-force of its guidelines on strategic assessment (European Union, 2001), which translate into broad-scale assessments like the one undertaken by the WHO with respect to transportation throughout the continent and its impact on health (WHO-Europe, 2004).

The scope of SEAs is broad and can include an examination of the following elements (Thérivel and Partidario, 1996; Buckley, 1998; Goodland, 1998) in terms of their environmental and health impacts:

- public policy, including administrative policies (such as privatization and budget cuts);
- budgets and taxation;
- international and national treaties;
- significant pollutants (e.g., dioxins, mercury);
- geographic regions (e.g., the Arctic, rivers);
- temporal trends (e.g., urbanization, agricultural land use);
- technology (e.g., biotechnology in food production);
- economic sectors (e.g., impact of the automobile); and
- generic project categories (e.g., co-generation of electricity using gas).

Although EAs in Canada already focus on a number of these elements, this practice is neither systematic nor automatic. However, the current trend is to include this type of analysis, which is an essential part of developing policies that are consistent with the principles of SD. In the absence of such analysis, governments often end up adopting policies that run counter to these principles. Project assessment cannot compensate for an initial concept that is unsound.

2.4.3.2 Mesosocial Focus

At the local or regional level, the role of health professionals is more clearly defined, since legal and administrative processes are more firmly established and the stages of project development more clearly circumscribed. These stages may vary from one province or territory to the next, but usually adhere to the following five-step model, which was described in Volume 1, Chapter 2:

1) *Project Description:* Describe the project and determine whether or not an EA is required.
2) *Scoping:* Scope or identify the key issues to be considered in an EA (including guidelines).
3) *Determining the Significance of Public Participation:* Assess the potential effects and determine their significance for the public.
4) *Mitigation and Follow-up:* Identify mitigation measures to prevent, minimize, or compensate for the impacts, and monitor the project once it is in operation.
5) *Recommendations:* Make recommendations on the fate of the project and conditions attached to its approval.

Health professionals can play a useful role at every stage of the process. In the preliminary stages, their role involves determining the content of the guidelines for preparing an impact study. While these guidelines have tended, in the past, to be specific to individual projects, the current trend is towards generic guidelines for entire classes of projects (MEF, 1998), including a health component developed in consultation with public health authorities. An example of these kinds of generic guidelines is provided in Box 2.2. In some Australian states, such as Tasmania (PEHB, 1997), a separate process is favoured for health component guidelines, but these remain generic guidelines that can be applied to all projects.

Project-specific guidelines remain preferable. Samples of project-specific guidelines are available from the Canadian Environmental Assessment Agency (CEAA, 1998) or from provincial/territorial departments or ministries of the environment. The major difference between these two approaches lies in the discretion (and responsibility) given to proponents under the generic approach. Proponents are required to identify significant impacts; determine health problems requiring study; select methodologies; determine which multicriteria analyses are to be conducted; etc. They must also justify their choices. The generic approach demands a high level of expertise and automatically requires that proponents conduct broad consultations to ensure that their impact studies will withstand scrutiny.

Among other things, project-specific guidelines state which chemical products or hazards are to be examined, the species that will be considered, and the tests and methodologies that will be used. Therefore, the onus is on the proponent to adhere faithfully to the requirements. This approach often generates an abundant literature of questionable usefulness, examining insignificant impacts. Box 2.3 provides a sample of project-specific guidelines.

An analysis of the methodological soundness of impact studies, including conclusions and recommendations, is a cornerstone in developing local action to prevent or mitigate health impacts. Once again, a team effort is required to monitor the start-up of projects and their subsequent operation. This analysis and monitoring are described in greater detail in the following sections.

2.4.4 Criteria for the Involvement of Health Agencies

Consideration of health aspects is a key part of the EA process. Key factors in bringing about greater harmonization of EIAs and HIAs include:

- the expectations of the public and of government departments and organizations involved in EA;
- resource-sharing among regions, including the provision of expertise to regions where this is lacking; and
- the development of a common procedure for conducting assessments (CSEQ, 1993).

Despite these efforts, the study of the health component remains a neglected aspect of the EA process (Davies and Sadler, 1997). It is estimated that up to 90-95% of all EAs conducted in the world are deficient in the areas of health and safety (Slooff, 1995).

The degree of involvement of health agencies and professional associations in EA is clearly dependent on available resources and on the interest (in the broadest sense) that a given project or policy generates. Health agency involvement can be viewed as occurring at two levels: the departmental level and the local or regional level. The regional role largely consists of critically analysing projects, contributing to and taking part in public consultations, and performing monitoring and follow-up activities that normally fall to local or regional public health agencies. At the departmental level, the involvement of public health agencies can take a very different form. In the case of strategic assessments, the general expectation is that the department of health in question will take charge of conducting and funding the necessary research. Given that the questions involved are often complex and difficult to address, this can be a difficult task to integrate into current programming.

Box 2.2
Sample Generic Guidelines for Describing the Impacts of a Hydro-electric Power Line
(Note: Elements pertaining to health are bolded)

- Disturbances to the aquatic environment caused by water crossings: effects on water levels, discharge, and ice regime; effects on riparian vegetation and fauna (fish and waterfowl), etc.
- Impact of the development project on the quality of soil, surface water, and ground water **(drinking water in particular)**.
- Effects on faunal populations and their habitats, with a particular attention to threatened or vulnerable species or species likely to be designated as such and to the habitats of such species (surface area affected, number of species affected, population density, etc.).
- Effects on vegetation, in particular plant species that are threatened, vulnerable, or likely to be designated as such.
- Impact on current and anticipated land use, in particular the effect on **recreational uses** of creating new access to the area, including such uses as vacation homes, hunting, and fishing.
- Anticipated effects on the region's agricultural potential, acreage (loss of), and economic value of the land; effect on access to the land and on the movement of farm machinery; changes in agricultural drainage; and consequences for farm animals.
- Anticipated effects on the area's forestry potential, acreage (loss of), and economic value of the land; and the significance of these losses for the forestry activity in the region.
- **Impact on** existing or projected **public infrastructures**, such as roads, electrical power lines and stations, water intake, parks and other natural sites, bicycle paths and other recreational amenities, hospitals, schools, etc.
- Effects on lot sizes and building set-backs, including changes in building access, destruction of existing land subdivisions, fragmentation of land holdings, and expropriations.
- **Changes in levels of exposure to electromagnetic fields for residents in the vicinity of the proposed line.**
- **Biological effects of electromagnetic fields on public health, including an overview of current national and international research on the topic.**
- Economic impacts of the project, including job creation, the attraction of energy-intensive industries to the region, and effects on land and property values, local government revenues, etc.
- **Disadvantages** linked to the construction phase **(disruptions in the transportation network, noise, dust, etc.)**.
- **Repercussions linked to vegetation control on rights-of-way, including potential impacts on public health.**

Source: MEF (1998)

Box 2.3
Sample Project-specific Guidelines: Pesticide Spraying
(Note: Elements pertaining to health are bolded)

- Impact prediction should be as factual an exercise as possible. It should demonstrate the nature, magnitude (quantitative aspect), scope (spatial aspect), duration (temporal aspect), risks, and uncertainty factors of any change to significant elements of the environment. Impact predictions will be general in nature, given the fact that the location and size of the areas to be sprayed with pesticides have not yet been established.
- The initiator must first develop predictions with respect to impacts on human health, using the toxicological risk analysis technique. Particular attention should be paid to workers involved in spraying, as well as to the populations that live in nearby areas, including Aboriginal populations.
- **Risks to be considered include any new risk of cancer, as well as other effects that are harmful to health, including immunosuppressive effects and potential effects on reproduction and development.**
- **The risk analysis must begin by identifying toxic pesticides that may pose a significant risk to public health. For these substances, analysis includes a detailed examination of potential exposure for individuals residing in or near the spray area. Exposure analysis should consider all potential pathways of exposure, with particular attention to inhaled substances and the consumption of locally grown fruits and vegetables (e.g., wild fruit and local vegetable gardens).**
- **A detailed description of all the models used to simulate the transfer or fate of pesticides in the environment must be provided, along with the values of the variables used for modelling purposes.**
- **The initiator must also provide a brief overview of the toxicological and epidemiological studies performed on the substances under review and indicate the basis established to estimate risks (reference doses or quantitative methods employed to assess any new risk of cancer).**
- Impact predictions must also encompass organisms that are not targeted, including mammals, birds, fish, amphibians, land and aquatic microorganisms, and, more particularly, pollenizers and vegetation.
- The proponent must pay particular attention to bird populations and provide a summary of the work dealing with direct and indirect effects (such as efforts to capture insect-eating birds).
- Predictions concerning impacts on water, air, and soil must also be provided.
- Finally, particular attention should be paid to cumulative impacts.

The following are two examples of the types of issues confronting central agency managers (EEA, 1995):

1) a comparison of various scenarios for managing household waste, including their respective impacts on health; and
2) the justification, environmental impacts, and health impacts of agricultural subsidies.

Similar issues arise in sectors that consume large amounts of energy and resources, such as industry, energy, transportation, forestry, and tourism.

The criteria outlined below can be used to assist organizations in determining the scope of the effort that is required. These criteria can also help organizations and institutions acting as project or program proponents to make way for more substantial involvement on the part of the health sector in preparing and analysing an EA study.

The effort or degree of involvement required on the part of health authorities can be defined in a number of ways. Listed below, for information purposes, are examples of the types of efforts that are frequently required in order to document the public health components of an EA, presented by category of degree of involvement:

- *Low Level of Involvement:* Use of guides and simple literature reviews; determination of compliance with standards in force; informal consultations by key communicators; and succinct written notices. This level of involvement normally requires one or two weeks of work on the part of a well-trained professional.
- *Average Level of Involvement:* The preceding items, as well as informal consultations with specialists and key communicators; determination of compliance with the strictest standards in the world; and brief written notices. This level of involvement generally requires two to four weeks of work.
- *Significant Level of Involvement:* Exhaustive literature reviews; formal consultations with specialists; formal public consultations; risk analyses; additional reports and briefs; and dissemination through the usual channels. Depending on the nature and scale of the project, a significant investment of time and resources may be required, on the order of one to three full-time person-months (including various experts). Fortunately, this level of involvement is not frequently required and can normally be absorbed into current operations.

- *Very Significant Level of Involvement:* The preceding items, as well as surveys, epidemiological studies, and psychosocial studies; additional reports and briefs; and major dissemination initiatives. The resources required for this level of involvement exceed those normally brought to bear within the framework of a regular regional public health agency intervention. Given that epidemiological studies alone can cost hundreds of thousands of dollars, the budget may be quite high, and the intervention itself may require a considerable period of time (see Volume 3, Chapter 6, for details on epidemiological studies). This kind of involvement should be planned as a special project, in cooperation with the appropriate authorities.

The first two levels of involvement should normally be part of the duties of public health teams; the process is usually managed by environment sector professionals, in collaboration with colleagues from other specialized sectors.

The last two levels of involvement are most often the domain of larger teams normally found within government departments, institutes, or universities. However, interventions at these levels are sometimes managed by regional organizations, if adequate specialist support can be provided. Indeed, large projects are often undertaken in remote regions. It is still essential to actively involve regional public health agencies and health professionals charged with managing the future implementation of a project.

2.4.4.1 The Departmental Level

All program, planning, and policy initiatives in economic sectors with a major impact on the environment should involve health authorities at an early stage. Agreements to this effect already exist in several Canadian provinces and are part of the federal EA process. The sectors most likely to interest the health sector include:

- land use management and urban planning (community facilities);
- industries (including mining);
- energy generation and transmission;
- road, rail, and air transportation;
- agriculture, aquaculture, and fisheries;
- forestry;
- tourism and recreation; and
- waste management.

Since health care services have grown to represent approximately 10% of the gross domestic product (GDP) and produce their own waste and other impacts, it would be appropriate for them to address their own contribution. Therefore, it is important to add:

- health care and health care services.

Aside from the impacts already identified, other criteria include:

- technological innovations, which are best examined in depth prior to implementation; and
- public interest, which is something to which all public health agencies must remain responsive. Of course, the anticipated scale of any initiative remains a determining factor.

Public health authorities must also examine a number of other aspects (PEHB, 1997), including:

- the likelihood of large-scale demographic or geographic changes within the community, including impacts on infrastructure;
- the likelihood of human exposure to physical, chemical, or biological contaminants;
- the likelihood of impacts on vulnerable groups (e.g., children, the elderly, the chronically ill);
- the likelihood of impacts on disease vectors in the environment or on recreational resources;
- the likelihood of impacts on the food chain, including agricultural land; and
- the likelihood of impacts on liability risks.

Increasingly important are concerns about what is commonly referred to as “global change.” This includes climate change, ozone depletion, and ecosystem change and their known or suspected role in increased liability risks, new infectious diseases, and the geographic spread of tropical disease carriers and toxic algae.

Frequently, there is a sharp increase in the number of small-scale projects within a given region, province/territory, or country. In recent years, for example, there has been a significant increase in the number of hog farms in several regions of Canada. When considered on its own, a hog farm may appear to have a relatively low impact on the environment or on human health. However, when there are 50 such projects within a given watershed, the impact can be very great indeed. Similar issues arise with the proliferation of thermal power stations and small-scale hydro-electric dams. Sound analysis requires situating the project within a broader context. In Table 2.2, we suggest degrees of involvement (defined above) for central public health agencies.

Table 2.2
Suggested Degree of Involvement for Central Public Health Agencies (based on the definitions in section 2.4.4)

	Small-scale Initiatives	Large-scale Initiatives	Large-scale Initiatives Involving Technological Innovations or Strong Public Interest
Economic sectors that have a strong impact on the environment	Average	Significant	Very Significant
Economic sectors that have a more moderate impact on the environment	Low	Average	Significant

2.4.4.2 The Local or Regional Level

The criteria outlined at the departmental level also apply at the local or regional level. Added to these are criteria that are more concerned with the scale of a project (expressed in monetary terms) in relation to the size of the host community. Parameters to determine the appropriate degree of involvement for public health authorities and their partners are suggested in Table 2.3. The sectors which are deemed to have a high impact on the environment at this level are the same as those at the departmental level.

Table 2.3
Suggested Degree of Involvement for Regional and Local Health Agencies (based on the definitions in section 2.4.4)

Type of Community	Small-scale Projects (<$1 M)	Medium-scale Projects ($1 M to $10 M)	Large Projects ($10 M to $1 B)	Very Large Projects (>$1 B)
Small/isolated	Low	Significant	Very significant	Very significant
Small (<10,000 inhabitants)	Low	Average	Significant	Very significant
Average (10,000 to 100,000 inhabitants)	Low	Low	Significant to very significant	Very significant
Large (>100,000 inhabitants); or Very large (>1 M inhabitants)	Low	Low	Average to significant	Significant to very significant

M = million; B = billion.

3 SUSTAINABLE DEVELOPMENT AND HEALTH

3.1 Introduction

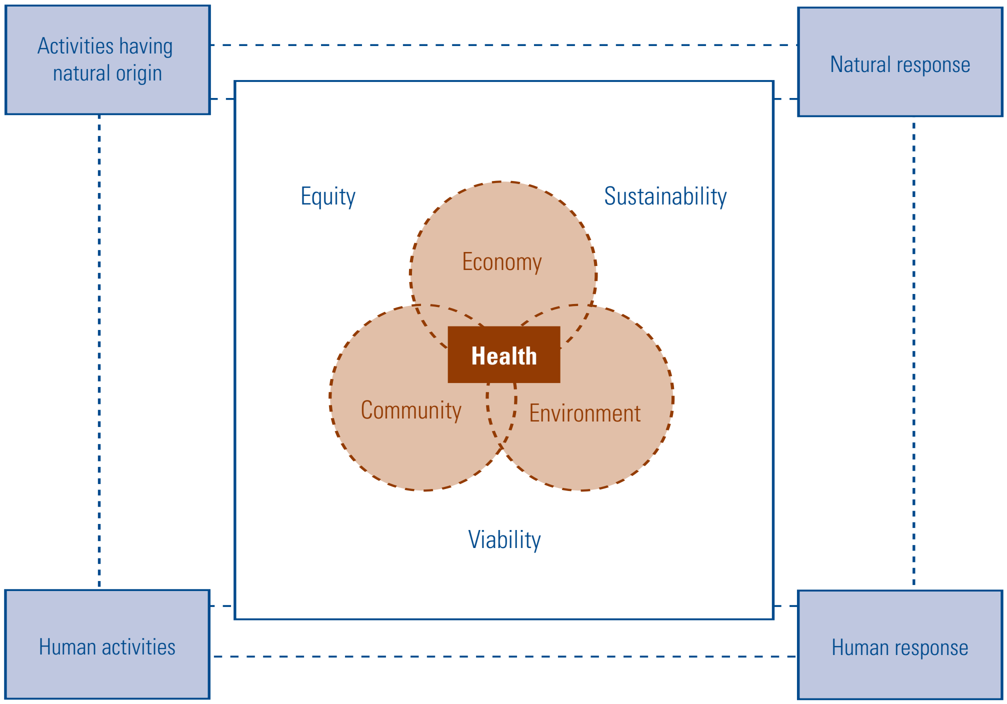
The preceding sections have examined the critical role health professionals can play in EA. To adequately fulfil this role and to base their views on reliable criteria, health professionals need a shared world view, one that includes values connected with health protection, risk and disease prevention, and the promotion of behaviours that sustain health. This vision must also encompass other aspects, including economic development, as well as environmental and ecosystem protection. This is the approach behind the concept of SD, which is now part of many federal and provincial/territorial laws, as well as international treaties. Even the highly conservative Organisation for Economic Co-operation and Development, which brings together the world's 29 richest countries, is now using this concept to chart its future course (OECD, 1997).

3.2 Definitions

The definition of SD has been the subject of much debate, which has been joined by many excellent publications. The human health component is neglected in some publications (e.g., CCME, 1993) and highlighted in others (Health Canada, 1997a), according to the respective mandates of each organization. In conducting EAs, it is desirable to identify the health component as a key element of SD, on a par with economic and environmental components (see Figure 3.1). This approach does justice to the interdependence of various determinants of healthy and equitable development.

Whereas health professionals generally include the social component in their definition of health, in EA the practice is different. EA practitioners often classify health as a facet of the social component, particularly in matters not related to toxicology or technological risk (these normally fall into the environmental component). Since the approach favoured has more to do with past training than any other factor, these classifications are of little importance: it is sufficient to know that they exist.

Figure 3.1
Health in the Context of Sustainable Development



Source: Gosselin *et al.* (1991)

What is important is to understand the goals of SD and to derive operational principles that may be useful in developing public health input. In this connection, the line of thought suggested by Robert Goodland and Herman Daly (1995) presents many important similarities with the official policy of governments across Canada in matters of health, the environment, and the economy. In fact, the Ministers of Health and the Environment of all governments in Canada adopted an important statement to this effect in 1996 (see Box 3.1). This statement recognizes the interdependence of health, the environment, and the economy. The challenge that remains is to put the goals outlined in Figure 3.2 into practice in our daily decision-making.

Box 3.1
Principles for Health/Environment Cooperation

The Ministers of Health and of Environment recognize that human health, ecosystem health, and the economy are interdependent. We believe that:

- all Canadians must have the opportunity to live, work and play in environments that are in harmony with nature;
- ecosystem health is essential to the health of all life forms on Earth;
- development occurring today must not prevent current and future generations from pursuing their own development and meeting their environmental needs;
- where there is a risk of serious or irreversible damage, lack of scientific certainty should not be invoked as a reason to postpone the implementation of effective measures to halt environmental degradation;
- sustainable development needs to be better understood at the scientific level, which implies sharing knowledge and adopting innovative technologies;
- preventive measures are preferable to corrective ones;
- the Canadian population needs to be better informed to make decisions that promote and maintain human and ecosystem health;
- Canadians have a responsibility to make decisions that promote human and ecosystem health. The Canadian government must ensure that its own decisions protect the health of the population and the environment, creating conditions that encourage individuals and communities to adopt practices that are consistent with the principles of sustainable development.

Areas of Cooperation

In witness whereof the various governments commit themselves, in the interest of present and future generations of Canadians, to do their utmost to:

- expand knowledge and exchange information on human health, ecosystem health, and the determining factors of each;
- identify priority areas requiring Canada-wide action;
- support cooperation between departments and ministries of Health and the Environment and other departments and ministries which have a role to play;
- develop interdisciplinary strategies to promote human and ecosystem health;
- strengthen links between governmental and non-governmental organizations;
- facilitate and promote public awareness programs and public participation.

Source: CCME (1996)

Figure 3.2
Objectives of Sociosanitary, Economic, and Environmental Sustainability

Sociosanitary Objectives
Empowerment
Participation
Equity
Alleviation of poverty
Social cohesion
Health and demographic stability
Institutional development

Economic Objectives	Environmental Objectives
Development for all countries; equity	Ecosystem integrity
Growth for less developed countries	Conserve carrying capacity
Efficiency	Climatic stability
Alleviation of poverty	Conserve biodiversity

As Grø Harlem Brundtland suggested in the report that originally put forward the concept of SD (WCED, 1987), the focus of all SD is ultimately human health, which is dependent on social, economic, and environmental sustainability. Clearly, this is a very ambitious objective, but it can also be useful in developing a clearer vision of the goals we must achieve to ensure that social development is consistent with the promotion and protection of public health.

3.3 Significance of the Three Realms of Sustainable Development

For those who may not be familiar with the scientific studies that led to the concept of SD, a number of references to background information are provided in the bibliography at the end of this volume of the Handbook. Here we will examine a few basic concepts (ecosystem, economy, and social system) that may be of assistance to the reader. Those who wish to deepen their knowledge of the subject are urged to consult the excellent web sites of the following: SD Gateway; UNSD (United Nations Sustainable Development); and Université libre de Bruxelles. (See Chapter 9, Bibliography, under these entries.)

3.3.1 Ecosystem

The most significant trend observed throughout the 20th century has been typified by a demographic explosion and the marked deterioration of many ecosystems around the world. The Earth's population has undergone a five-fold increase in less than a century, and the demand for fresh water, arable land, energy, wood, fish, and many other resources has often outstripped the capacity of ecosystems to regenerate. This view is shared by every organization in the United Nations and thousands of scientists around the world, who have come to realize that human beings are taking up more and more space, harming other species, and interfering with the ability of air, soil, and water to renew themselves (Keating, 1993). In addition, the unintended pollution caused by a number of technological innovations such as polychlorinated biphenyls (PCBs) and the automobile has only made matters worse.

It is also important to note that many services that we derive from our ecosystems – such as water and air purification, waste recycling, and food production – are never recognized in our national accounts, whose best known statistic is the GDP. In our current economic system, the fact that a dollar value is not attached to ecosystems often means that managers give these considerations little or no attention. This attitude persists despite the fact that ecosystems provide irreplaceable services, as classified by Costanza *et al*. (1997) (Box 3.2), which we all need to survive, such as ground water and the atmosphere itself.

Costanza *et al*. (1997) applied their classification in attempting to estimate the monetary value of the services provided by the ecosystems in different biomes (water, land, etc.). Their estimate, which they have termed conservative, is US$33 trillion per year. By comparison, the GDP of the entire planet is approximately US$18 trillion per year. Most of these ecological services are indispensable to life on Earth, and many form the basis of our economic activities. Yet they are rarely considered in cost-benefit analyses and seldom integrated into the decision-making process. There are many reasons to rigorously protect our life-sustaining ecosystems, including human life itself, our economic activities, and the fact that ecosystems are irreplaceable. A Canadian initiative currently being conducted by the National Round Table on the Environment and the Economy is intended to address this issue within the context of SD (NRTEE, 2002). (See Volume 3, Chapter 4, of this Handbook for more information on economics and human health.)

Box 3.2
Classification of Services Provided by the Ecosystem

- Gas regulation
- Climate regulation
- Disturbance regulation
- Water regulation
- Water supply
- Erosion control and sediment retention
- Soil formation
- Nutrient cycling
- Waste treatment
- Pollination
- Biological control of pests
- Refugia
- Food reproduction
- Raw materials
- Genetic resources
- Recreation
- Culture

Source: Costanza *et al.* (1997)

3.3.2 Economy

There are now hundreds of studies attesting to the effects of adequate or deficient incomes on health. This variable is so significant that epidemiological studies control for it in an attempt to isolate its effects from other, less important causal factors. A number of international publications have demonstrated the link between low incomes and poor health in developing countries (e.g., UNDP, 2003), but these disparities exist in Canada as well (CPHA, 1997). Some of these studies show disparities in life expectancy of as much as 10 years between the residents of affluent and poor neighbourhoods within the same city. The relationship is sometimes indirect, as in the case of behaviours that are harmful to health; but it can also be direct, as with the permanent stress induced by financial insecurity (see Evans *et al.*, 1994). This effect of deficient financial means would appear to be cumulative, and this relationship is reflected in a dose-response curve (Lynch *et al.*, 1997).

In general, an average income is sufficient to ensure good health, beyond minimum subsistence. The experience of many countries shows that investments in primary health care (e.g., vaccination, care for pregnant women), in education (primary and secondary levels), and in environmental health (e.g., drinking water, waste management, air quality) are crucial factors in the relationship between economics and health. Clearly, an adequate income for individuals does not suffice: sound government decision-making is required, particularly regarding investments in pollution control, preventing environmental degradation, and promoting the benefits derived from our ecosystems.

3.3.3 Social System

The economic system and the social system are closely linked and interdependent. Direct and indirect links can also be demonstrated between health and the social system. Even in Canada, health professionals sometimes need to be reminded that after genetics and age, the social environment is probably the most important determinant of health (Evans *et al*., 1994). The relationships that evolve among individuals or groups of individuals influence their state of health. These relationships can encompass the ways in which work is organized, criminality, power structures, culture, dietary influences, and other factors. Some would also include equitable income distribution within the social sphere.

Individuals' sense that they can control their own lives also appears to be highly important, as is the ability to rely on family or social support networks in case of need. Significant disparities in mortality and morbidity can be observed in situations where individuals feel they have little control over their professional lives. The studies conducted by Marmot and Theorell (1988) with British civil servants showed age-specific mortality rates that were three times higher among lower-level employees than among upper management, even after adjustments were made for the usual risk factors (e.g., hypertension, smoking, and blood lipid levels). In studies performed by Wilkinson (1989, 1992), death rates adjusted over time, as well as comparative rates between countries, show similar disparities relating to the distribution of material resources within populations. (See Volume 3, Chapter 3, for more information on social impact assessment.)

These disparities in the area of health can be significantly reduced if governments are prepared to invest wisely in education, primary care, and environmental management (Caldwell, 1988). This can be observed by contrasting the experiences of nations of comparable economic standing but markedly different sanitary conditions. Equitable income distribution among individuals is also a key variable that has an enormous influence on population health. It has been observed that countries in which wealth is distributed more equitably achieve a higher level of population health than do other nations of comparable affluence (UNDP, 1997).

Increased social stress can also bring about a significant deterioration in the health of a population, as the recent experience in Russia eloquently demonstrates (Leon *et al*., 1997). In 1994, a Russian male had only a 50% chance of living beyond the age of 60, as compared to a 90% chance among Canadian males. Tobacco and alcohol consumption, poor nutrition, significant social and economic instability, depression, and deteriorating health care have all been identified as causal factors in this new situation (Notzon *et al*., 1998). Between 1990 and 1995, the life expectancy for Russian men decreased by approximately seven years.

3.4 Sustainable Development as a Daily Focus

Often those responsible for making political and economic decisions are unaware of many of the issues that have been raised in this chapter. As a result, many common prejudices sometimes fill this information gap and influence decision-making. Consequently, the dissemination of information regarding the links between the economy, health, and the environment is another task faced by health professionals in preparing public health notices in connection with EAs.

Adopting the SD framework as a criterion in preparing public health notices in EA means that health agencies must provide their views on:

- the likelihood that contaminants or anticipated hazards will have an impact on health and quality of life and, ultimately, health agencies' views on desirable levels;
- the foreseeable equity in the distribution of risks, disadvantages and benefits, and, ultimately, public health agencies' views as to what would constitute a desirable distribution; and
- the impact of the initiative being considered on the preservation of life-sustaining ecosystems and on the services derived from these ecosystems and, ultimately, health agencies' views on desirable impact mitigation measures.

From a public health perspective, most initiatives, projects, programs, and policies contain both positive and negative elements. It is important that these be brought into balance. Still, many useful actions that can move society towards SD require a social consensus, which develops gradually and often slowly. Therefore, it can be useful to propose concrete compensatory or mitigation measures for specific projects. Such actions can include planting a forest or creating wetlands to compensate for losses brought about by new construction projects or setting up a social development trust fund for a community coping with the residual inconvenience caused by a new factory.

For public health agencies, opposing the development of a project on the basis of SD principles is sometimes a delicate matter, since this is not part of their main mandate. On the other hand, it is entirely appropriate to give greater weight to this criterion in the case of government policies and programs or mega-projects (or a series of projects) that can have a major impact on the course of a society. Energy supply policies, subsidies favouring the automobile, and hydro-electric developments in virgin wilderness are examples of high-impact initiatives that must now undergo the test of sustainability.

The concept of sustainability implies the existence of a limit to resource use. Limits are accepted when it comes to elevators or bridges; more to the point, parking lots have a limited number of spaces, and common sense should tell us that a lake contains a finite number of fish. However, many people are not prepared to admit that such limits should apply to our use of natural resources (Cairns, 1997). Economist Kenneth Boulding (1966) summed up this position rather well more than 35 years ago:

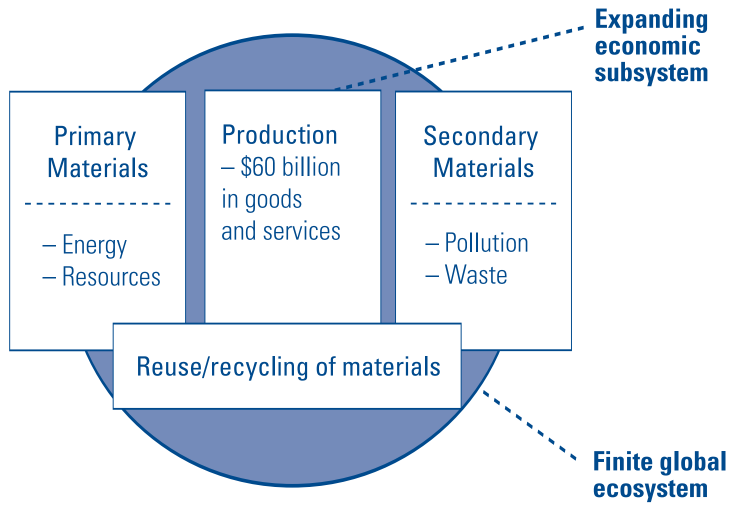
> "Anyone who believes exponential growth can go on forever in a finite world is either a madman or an economist."

Figure 3.3 illustrates this concept in concrete terms by displaying the relative weight of the human economic subsystem in relation to the planetary ecosystem. This relative weight, which represented $60 billion in produced goods and services in 1900, has grown to $20 trillion in 1990, an amount 333 times greater. Obviously, the ecosystem of planet Earth did not grow in that period.

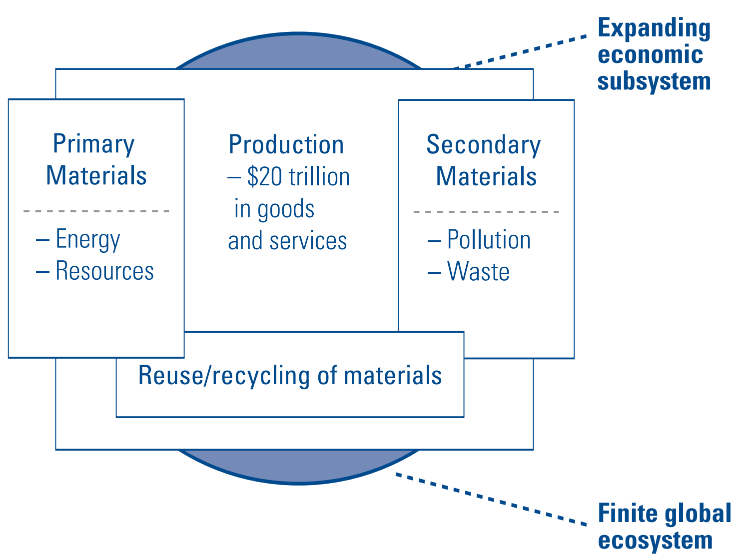
It bears repeating that project-related public health notices mainly deal with the effects of contaminants on health and quality of life and on the fair distribution of risks and benefits. The ecosystem integrity component applies most often in the case of strategic assessments or when a mega-project (or a series of projects) is being proposed. With smaller projects, the focus is on preserving the recreational or cultural uses of ecosystems, although it is generally recognized that avoiding all forms of inconvenience may be difficult at times. In such cases, it becomes important to adequately replace ecosystem loss, either in the immediate vicinity or elsewhere in the region, and to adequately compensate the affected populations.

Figure 3.3
World Ecosystem in Relation to the Economic Subsystem

A: Ecosystem and economic subsystem in 1900



B: Ecosystem and economic subsystem in 1990



Source: CCME (1993)

3.5 Developing and Implementing Projects Based on Sustainable Development Principles

We offer concrete SD principles in a variety of categories as guidelines for developing policy or implementing major projects. These principles were developed during broad multiparty consultations from 1994 to 1996 with a view to developing sustainable projects and are inspired by the major orientations of Agenda 21 (Keating, 1993), the WHO (1997), and a number of Canadian publications that deal with this topic (including CCME, 1993; NRTEE, 2002). The proposed principles can ultimately serve as criteria for examining projects and policies and developing useful initiatives to promote SD. Boxes 3.3 to 3.5 summarize the basic principles that apply to projects.

Many of the principles that are mentioned in Boxes 3.3 to 3.5 overlap with those that the WHO now views as essential public health functions (WHO-PAHO, 2000a). The Directing Council of the Pan American Health Organization (PAHO), which brings together all health ministers throughout the Americas, including representatives from Canada, adopted Resolution CE 126.R18 at its session of September 25-29, 2000. This resolution outlines the 11 essential functions of public health, including several in which EA plays an important role, namely:

- monitoring and regulation in matters of environmental and occupational health;
- reducing the impact of emergencies and disasters on health;
- social participation and empowerment of citizens in decisions relating to health; and
- ensuring access to health services for vulnerable and high-risk groups.

Box 3.3
Specific Sustainable Development Principles: The Biophysical Environment

Natural Resources (including energy resources): One of the goals of SD is to ensure that natural resources are managed rationally and that access to renewable and non-renewable resources is equitable. The basic principles in this regard are the following:

- Never exceed the regeneration rate of renewable natural resources.
- Exploit non-renewable resources only at a rate and at a price that will permit their eventual replacement with renewable resources.
- Improve knowledge and monitoring of natural resources.
- Promote the conservation of natural resources by reducing the pressure on these resources (overconsumption; air, water, and soil pollution), especially in areas that hold a particular attraction.

Biodiversity and Habitats: SD seeks to maintain ecosystem integrity through an integrated management approach, whose basic principles are the following:

- Minimize the loss of genetic, species, and ecosystem diversity.
- Ensure landscape and habitat conservation, including both our natural and architectural heritage.
- Clean up and restore habitats that have been altered or destroyed.
- Limit or prohibit human activities that can translate into adverse impacts on natural species and architectural heritage.
- Develop human activity in harmony with the natural environment.

Box 3.4
Specific Sustainable Development Principles: The Human Environment

Health: SD also implies taking action to promote and protect health and prevent disease. The basic principles are the following:

- Reduce gaseous, liquid, and solid emissions in order to minimize risks to public health from the contamination of food, water, air, or soil.
- Develop and improve emergency plans to deal with environmental accidents, as well as measures to monitor the environment, especially exposure to substances that are harmful to human health.
- In the workplace, replace hazardous technologies and materials with alternative products and technologies that are less harmful.
- Create conditions that promote healthy lifestyle habits (physical exercise, good nutrition, anti-tobacco measures, etc.).

Quality of Life: Improving quality of life is an important aspect of SD. The basic principles are the following:

- Reduce or eliminate irritants (e.g., noise, unpleasant odours, visual degradation of the landscape) that affect quality of life for human populations, in both rural and urban areas.
- Promote the revitalization of rural and urban environments.
- Make nature and culture accessible to the public through leisure and community-based activities.
- Develop a social and physical environment that favours the dissemination of information and involves citizens of all ages in community management.

Economy and Employment: The concept of SD implies that actions taken must be economically viable and fair for affected populations, particularly in the case of regional development. The basic principles are the following:

- Create employment, particularly for young people living in communities and areas dealing with high levels of unemployment and social assistance.
- Improve and maintain quality of life within the framework of existing employment.
- Internalize the costs and benefits of external project effects (e.g., pollution), including the public health protection aspect.
- Improve the level of education and training of individuals to enable them to play an active role in society.

Box 3.5
Specific Sustainable Development Principles: Stakeholders

Achieving SD goals requires a concerted effort by all stakeholders, including private citizens, corporations, public and private organizations, and government.

Citizens: Development cannot occur in a sustainable manner without the active involvement of citizens. The basic principles are the following:

- Develop measures to encourage the population to modify its attitudes, habits, and behaviour, with a view to reducing overconsumption of water, energy, natural resources, and chemical products and reducing the production of waste that is harmful to the environment.
- Intensify measures designed to promote reduced use, reuse, and recycling; and the reclamation of primary and secondary resources.
- Support concrete cooperative actions designed to promote the accountability of citizens and citizens' groups, and encourage them to address their own individual impact on the environment.
- Aim for a fair balance in the distribution of advantages and disadvantages connected with development.

Corporations and Public and Private Organizations: The involvement of employers, companies, workers, and public and private organizations is essential and provides the ability to intervene on a variety of levels. The basic principles are the following:

- Reduce and monitor air, water, and soil pollution.
- Limit the production of goods and services that are harmful to ecosystems and human society; promote the quality and sustainability aspects of goods and services.
- Ensure that pollution and waste do not exceed the environment's ability to absorb them.
- Implement measures to reduce use, encourage reuse, recycle, and develop primary and secondary resources.
- Develop technological innovations that increase production efficiency by reducing the use of natural resources, energy, and water.
- Develop and utilize new technologies that offer better performance from an environmental standpoint.

Box 3.5 (Cont'd)

Governments: The various levels of government are key players in the promotion of SD. The basic principles are the following:

- Promote education and awareness among all social groups (e.g., the public, non-governmental organizations, universities, and industry) with respect to the importance of SD.
- Foresee and prevent problems instead of attempting to solve them only after they have occurred.
- Improve and adapt policies, legislation, and existing financial and fiscal measures, with a view to promoting activities that protect and improve ecosystems and to discouraging actions that are harmful (e.g., overconsumption of natural resources, disposal of solid or dangerous waste, greenhouse effect, acid rain, and ozone depletion).
- Organize information (EA tools, data regarding indicators) to make it more accessible (available, reliable, and factual).

Notes:

4 ANALYSING HEALTH RISK DATA

4.1 Introduction

It is normally easy to obtain data on the benefits of a given project, program, or policy, because proponents usually give this aspect considerable prominence. The quality of the data provided with respect to the advantages and benefits of a project can vary and merits at least a cursory assessment. This aspect is discussed in greater detail in Chapter 6 of this volume and in Volume 3 (see sections dealing with the economy, Chapter 4; and the assessment of social impacts, Chapter 3).

Assessing data that deal with the risks of a project can be a more difficult exercise. The public generally expects that the responsible public health agency will examine this issue in depth and that, in the final analysis, risks will be negligible. For their part, proponents tend to expect a review that will recommend an acceptable or reasonable degree of risk. Definitions of these terms tend to be somewhat ambiguous, given that the people who bear the burden of risk are often not the people who derive the benefits. The issue of risk management and the concept of acceptable risk are discussed in Chapter 5 of this volume.

4.2 Common Problems in Conducting an Analysis

Several problems can arise in preparing or analysing an EA. These relate to consideration of a number of factors:

- spatial and temporal scale;
- risk groups;
- workers;
- new technologies;
- relevance of existing health data; and
- methodology.

A brief overview of frequently encountered problems relating to these factors is provided in the sections following.

4.2.1 Spatial and Temporal Scales

It is often difficult to identify a single analytical scale for the assessment of health impacts. On a spatial scale, the zone of influence varies depending on the nature of the exposure to a risk factor. For example, the zone affected by the effluent produced by a smokestack is different from the area affected by noise; economic spin-offs of development projects can "travel" as well. On a temporal scale, toxicity can be variously described as acute, chronic, or even transgenerational. Therefore, it is important to specify desirable spatial and temporal scales for every significant risk. This aspect has often been neglected in impact studies (João, 2000), despite the fact that the choice of scales is a crucial decision. For example, Table 4.1 presents a real-life case of scale determination and demonstrates how this can exert a considerable influence on the perceived importance of a pollution problem.

Table 4.1
Percentage of Households Affected by Air Pollution Caused by the Hastings Eastern Bypass (United Kingdom) (after João, 2000)

Choice of Scale	Number of Households Identified Through their Addresses	Percentage Affected by Pollution
Area within 200 m of the centre line	58	100
Area within 1000 m of the centre line	1653	3.5
Area within 2000 m of the centre line	7101	0.8

When studies are based on official maps and related attributes, proponents in some countries often select massive but poorly detailed scales (e.g., 1:500 000), which provides a means of "overlooking" certain fragile areas or historical sites and also serves to reduce impact study costs. The Inter-American Development Bank now stipulates minimum scales (e.g., 1:50 000) for these studies in order to avoid such problems. Health professionals must remain vigilant and make sure that they check any data that appear to be incomplete.

4.2.2 Risk Groups

Similarly, the types of groups that are judged to be at risk will vary based on the type of problem being addressed. Generally speaking, we know that certain individuals are more susceptible to contaminant exposure due to:

- physiology (e.g., newborns, children, pregnant or breastfeeding women, the elderly);
- illness (e.g., the immunocompromised and those suffering from respiratory conditions or allergies);
- lifestyle (e.g., Aboriginals who consume large amounts of game meat, smokers);
- behaviour (e.g., children's habit of putting objects in their mouths); and
- insecure living conditions (e.g., among immigrants).

It is also important to specify, for each significant risk factor, which populations warrant study. Some social groups are more likely than others to see their quality of life being affected by a project, due to factors such as:

- the distribution of available employment;
- the training required for such employment;
- the internal management practices of a newly installed company; and
- the distribution of impacts from a land use perspective.

4.2.3 Workers

Generally, workers are the group most exposed to contaminants. Still, within the framework of an environmental impact study, it is difficult to predict exposures and to determine the concrete measures that need to be taken, however desirable this might be.

For example, it is practically impossible to adequately simulate contaminant emissions for an industrial process before engineering details have been worked out, which normally occurs after a proponent has been authorized to proceed with the project. Consequently, it is preferable to place the emphasis on workplace health and safety programs that make use of the best practices available for environmental monitoring and health surveillance. This applies at all stages of a project, although the stages presenting the greatest risk are construction and the "breaking-in" phase. Regrettably, occupational health services are frequently neglected during these stages. (See Appendix B, Volume 4, for more details on occupational health and safety.)

The relationship that develops between new workers and local communities can also assume considerable importance in some situations. A typical example is the development of large sites in isolated regions. This relationship can have a positive or adverse impact on the health of individuals and communities.

4.2.4 New Technologies

Frequently, projects submitted for EA include a new technology component. When information on the new technology is lacking, this can further complicate the process. The following principles may assist in evaluating the potential performance of new technologies:

- In most industrial processes, there is a financial incentive to use the least amount of natural resources possible (water, wood, energy, etc.) when such resources are sold at market price. As a result, the efficiency of new technology can be compared with that of the technology being replaced by examining resource consumption per unit of production. Greater efficiency implies less waste, although total production volumes also need to be taken into account.
- The experience and seriousness of proponents and their consultants need to be assessed, based on similar projects developed in the past.
- Proposals put forward by proponents with respect to the surveillance of technology performance, as well as the monitoring and control of emissions, must be rigorous and completely transparent, given the newness of the situation.

4.2.5 Relevance of Existing Health Data

Making use of existing health data in EA raises a number of important methodological problems (Davies and Sadler, 1997):

- Health information is usually collected for specific purposes and can be difficult to modify or adapt for use in EA. For example, most medical data are difficult to use in EA because this information is usually collected for other purposes – e.g., physician billing, insurance, health care planning, or health care utilization studies. As a result, the accuracy of diagnoses recorded in various health information/data files/sources varies considerably.
- Although most countries collect national health statistics, there is often a shortage of information on health status and the determinants of health for specific communities and for individuals. In particular, there is a shortage of information on morbidity, psychological well-being, and socioeconomic factors.

- Health information is rarely examined in relation to environmental quality. Although the biophysical environment is a recognized determinant of health, the study of precisely how the environment affects health is still in its infancy. More particularly, causal relationships remain difficult to establish with respect to individuals.

Existing health data are therefore used primarily to identify populations at serious risk or vulnerable groups in the targeted regions, as well as to develop a basic socio-economic profile. This approach – which is entirely correct from a methodological and scientific perspective – often clashes with the perceptions of the population and of managers: many feel that each situation is unique and warrants specific study, which is generally impossible due to the costs and requirements of epidemiological and statistical methods (see Volume 3, Chapter 6). This is always a delicate topic to explain; nonetheless, providing such explanations is crucial.

4.2.6 Methodology

A variety of methodologies can be useful in assessing environmental health impacts. Box 4.1 succinctly presents the principal methods used in EA, and a number of methodologies are discussed in the third and fourth volumes of this Handbook. It is important to remember that every methodology offers both advantages and disadvantages (Davies and Sadler, 1997), which means that a considerable amount of professional judgment is required in selecting an appropriate approach. Such considerations as cost and the expertise available within a given team must also be taken into account. For example, geographic information systems still require a considerable investment and in no way represent a panacea for geospatial analysis. Experienced EA practitioners such as Canter (1998) have stressed that the simplest methods in terms of data, personnel, and technology requirements are also those that prove the most enduring (see Box 4.1). Such methods include the study of analogues and the use of checklists, expert opinion, and matrices. The *Canadian Handbook on Health Impact Assessment* promotes primarily the use of these four methods for regular projects.

It is also important to develop a coherent approach and to provide reports of great transparency that specify limits. Ultimately, it is always preferable to consult a few experts or citizens' groups by phone than to take no action at all; such consultations represent an effective and low-cost methodology.

Box 4.1
Brief Description of 22 Types of Methods in Environmental Impact Assessment

1. *Analogues* refer to information from existing projects of a type similar to the project being addressed; monitoring information related to experienced impacts is used as an analogy to the anticipated impacts of the proposed project.
2. *Checklists* are used frequently, and there are many variations of checklists. Conceptually, checklists typically contain a series of items, impact issues, or questions that the user should address.
3. *Decision-making checklists* are related primarily to comparing and conducting trade-off analyses for alternatives. In this regard, such methods are useful for the synthesis of information in relation to each viable alternative.
4. *Environmental cost-benefit analysis* (ECBA) represents an emerging method. ECBA supplements traditional cost-benefit analysis with increased attention to the economic value of environmental resources and to the valuation of impacts of the proposed project and alternatives on such resources.
5. *Expert opinion*, also referred to as professional judgment, represents a widely used method. Specific tools to facilitate information development include Delphi tools, the use of the adaptive EA process to delineate qualitative/quantitative models for impact prediction, or the separate development of models for environmental processes.
6. *Expert systems* refer to an emerging method that draws upon the professional knowledge and judgment of experts in particular topic areas. Such knowledge is encoded, via a series of rules or "heuristics," into expert system shells in computer software.
7. *Indices or indicators* refer to selected features or parameters of environmental media or resources that represent broader measures of the quality/quantity of such media or resources. Specifically, indices refer to either numerical or categorized information that can be used in describing predicted and assessed impacts on the environment. Indices are typically based on selected indicators and their evaluation.
8. *Laboratory testing* and scale models refer to specific tests and/or experiments that are conducted to gain qualitative information relative to the anticipated impacts of particular types of projects in given geographical locations.
9. *Landscape evaluation methods* are useful primarily for aesthetic or visual resource assessment. These are derived from indicators, with the subsequent aggregation of relevant information into an overall score for the environmental setting (similar to method #7).
10. *Literature reviews* refer to assembled information on types of projects and their typical impacts. As noted for analogues (#1 above), such information can be useful for delineating potential impacts, quantifying anticipated changes, and identifying mitigation measures.
11. *Mass-balance calculations* refer to inventories of existing conditions in comparison to changes in such inventories that would result from the proposed action. Inventories are frequently used for air and water pollutant emissions, along with solid and hazardous wastes to be generated.

Box 4.1 (Cont'd)

12. *Interaction matrices* represent a widely used type of method within the EIA process. Variations of simple interaction matrices have been developed to emphasize particular desirable features.
13. *Monitoring (baseline)* refers to measurements used to establish existing environmental conditions and to interpret the significance of anticipated changes from a proposed action.
14. *Monitoring (field studies)* of receptors near analogues (as defined in #1 above) represents a specialized approach, in that it is possible to monitor actual impacts resulting from projects of a similar type to the project being analysed.
15. *Networks* delineate connections or relationships between project actions and resultant impacts. They are also referred to as impact trees, impact chains, cause-effect diagrams, or consequence diagrams. Networks are useful for showing primary, secondary, and tertiary relationships.
16. *Overlay mapping* was used early in the practice of EIA, with the usage consisting of the assemblage of maps overlaying a base map and displaying different environmental characteristics. The application of *geographical information systems* via computer usage is an extension of this method and has been an emphasis in recent years. This technology represents an emerging method.
17. *Photographs* or photomontages are useful tools for displaying the visual quality of the setting and the potential visual impacts of a proposed action. This method is related to landscape evaluation (#9 above).
18. *Qualitative modelling* refers to methods wherein descriptive information is used to address the linkages between various actions and resultant changes in environmental components. Such modelling is typically based upon expert opinion (professional judgment, as described above in #5).
19. *Quantitative (mathematical) modelling* refers to methods that can be used especially for addressing anticipated changes in environmental media or resources as a result of proposed actions. Quantitative models can range from simplified models to very complicated three-dimensional computer-based models requiring extensive data input.
20. *Risk assessment* refers to an emerging tool initially used for establishing health-based environmental standards. It encompasses the identification of risk, performance of an exposure assessment, consideration of dose-response relationships, and evaluation of the associated risks. Risk assessment can be viewed from the perspective of both human health and ecological risks.
21. *Scenario-building* refers to considering alternative futures as a result of differing initial assumptions. Scenario-building is utilized in the planning field, and it has EIA applicability, particularly in the context of SEAs.
22. *Trend extrapolation* refers to methods that use historical trends, extending them into the future based on assumptions related to either continuing or changed conditions.

Source: Canter (1998)

Notes:

5 RISK MANAGEMENT TOOLS

The objective of risk management is to identify potential sources of hazards, to assess their risk(s), and to determine the measures that need to be taken to reduce the risk(s). Proposed development projects may encompass a number of dangers. What risks do they present, and what should be done about them? Such decisions are easier to make if they are based on scientific data, consultations with affected persons, and the careful study of proposed solutions to determine their feasibility. Scientific data must be collected so that the concerns of affected persons can be taken into account and to ensure that solutions are achievable from the standpoint of resources and technology and are socially acceptable. Decisions may address the following aspects: the type of advice to provide to the population; the approach to adopt in order to communicate information on risks; and the mitigation strategies and standards to adopt.

Risk management remains a key component of EA, particularly with respect to the participation of public health agencies. Recent reforms are easier to understand when examined in the context of the recent history in this field.

5.1 Risk Management: A Brief History

5.1.1 1960 to 1990

The Atomic Energy Control Board (AECB, 1994) summarized the history of risk management as follows:

> "... the *first virtually safe dose* proposed in the United States was designed to limit the risk of cancer to one in one hundred million (10^{-8}) for a lifetime of exposure…, the idea being that if the total population of the United States were to be exposed to a virtually safe dose, or a dose very close to it, only one or two persons would be affected among the country's total population (approximately 150 million at the time). Soon after, it became clear that this criterion placed an almost intolerable burden on regulatory agencies charged with guaranteeing the

safety of food additives, while ensuring that the considerable advantages of these additives could be exploited. The majority view then became that a risk of one new case of cancer per million inhabitants could be considered negligible. At this rate, only three new cancer cases per year would occur if all Americans were exposed.

"Over the course of the next few years, the standard of *one in one million* became institutionalized as an *acceptable* risk, and when it became understood in the latter part of the 1960s and early 1970s that ambient exposure carried a risk of cancer, the concept of a negligible lifetime risk (set at one in one million, or 10^{-6}) was frequently applied, especially in the United States…. Early on, the greatest source of concern was generalized risk, such as that induced by exposure to polychlorobiphenyls (PCBs) or pesticide residues in the environment. Later, the same standard was applied to risks that are far less generalized, such as the risk encountered in the areas surrounding industrial sites and hazardous waste disposal sites.

"In time it became clear that a risk of one in one million (10^{-6}) was in fact a highly rigorous standard in cases where the number of individuals exposed was relatively small.… For the U.S. Environmental Protection Agency (EPA), risk levels equal to or higher than one in ten thousand are considered acceptable in setting maximum levels of contamination by cancer-causing agents in drinking water, when it is technically or economically unfeasible to achieve greater reductions. However, the general view is that risk levels higher than one in ten thousand are excessive, even when very few individuals are exposed, and require the implementation of measures to reduce both exposure and risk…."

Without making this an official policy, Canada and its provinces/territories adopted a similar approach, within their respective areas of jurisdiction. At the time, risk management was generally defined as a decision-making process in which the results of risk assessment were integrated with other considerations. The U.S. National Research Council (NRC, 1983) defined risk management as:

"a decision-making process involving the consideration of information of a political, social, economic and technological nature, in addition to data concerning risks, in order to develop, analyze and compare regulatory options; the goal of this process is to select the most appropriate response with respect to potential risks that may pose a chronic threat to health."

For its part, the CCME (1996) has defined risk management as:

"the selection and implementation of a strategy to control risk, followed by the monitoring and assessment of that strategy to determine its effectiveness; the choice of a particular strategy can be based on an examination of the information obtained in the course of the risk assessment."

This definition is substantially the same as the one adopted by Health Canada (1997b).

Throughout the last few decades, no proposals have been put forward to adopt a consistent approach to quantifying an acceptable level of residual psychosocial risk. It would appear that negotiation practices, external advisories (issued by commissions, government departments, municipalities, and others), and consultations among the various stakeholders involved are the only formal criteria being used to decide what constitutes an acceptable level of psychosocial risk for communities. However, there are a number of municipal regulations and government guidelines with respect to the most common irritants (e.g., noise, odours, dust).

5.1.2 1990 to Today

Over the years, the concept of risk management has come under considerable criticism, particularly from industry, environmental groups, and academics (NRC, 1994), for, among other things, the highly variable cost of measures undertaken with respect to health (from $200 000 to $5 billion per life saved, for example). Current thinking is shifting risk management towards an approach and a definition broader than those traditionally employed. In recent years, several organizations have reviewed and analysed the conceptual framework put forward by the

National Research Council in 1983, including its principles, organizational aspects, and methodological elements (NRC, 1994, 1996; California EPA, 1996; Presidential/Congressional Commission on Risk Assessment and Risk Management, 1997a, 1997b; NERAM, 1999; Health Canada, 2000; INSPQ, 2000).

In 1997, the Presidential/Congressional Commission on Risk Assessment and Risk Management (1997a, 1997b) issued its two final reports. The Commission was created by the U.S. Congress in the wake of changes made to the *Clean Air Act*. Its mandate was to conduct a study into the political implications of, as well as the uses of risk assessment and risk management in, programs created under federal law to prevent cancer and other chronic diseases that can result from exposure to chemical substances.

The work of the Commission made it clear that the traditional approach to assessing and reducing risk was in need of change. The Commission issued numerous recommendations and introduced new dimensions to traditional approaches used in risk management, as well as a broader and more integrated definition of risk management itself (Presidential/Congressional Commission on Risk Assessment and Risk Management, 1997a):

> "Risk management is the process of identifying, evaluating, selecting, and implementing actions to reduce risk to human health and to ecosystems. The goal of risk management is to apply scientifically sound, cost-effective, integrated actions that reduce or prevent risks while taking into account social, cultural, ethical, political, and legal considerations."

The framework for risk management proposed by the Presidential/Congressional Commission comprises six steps:

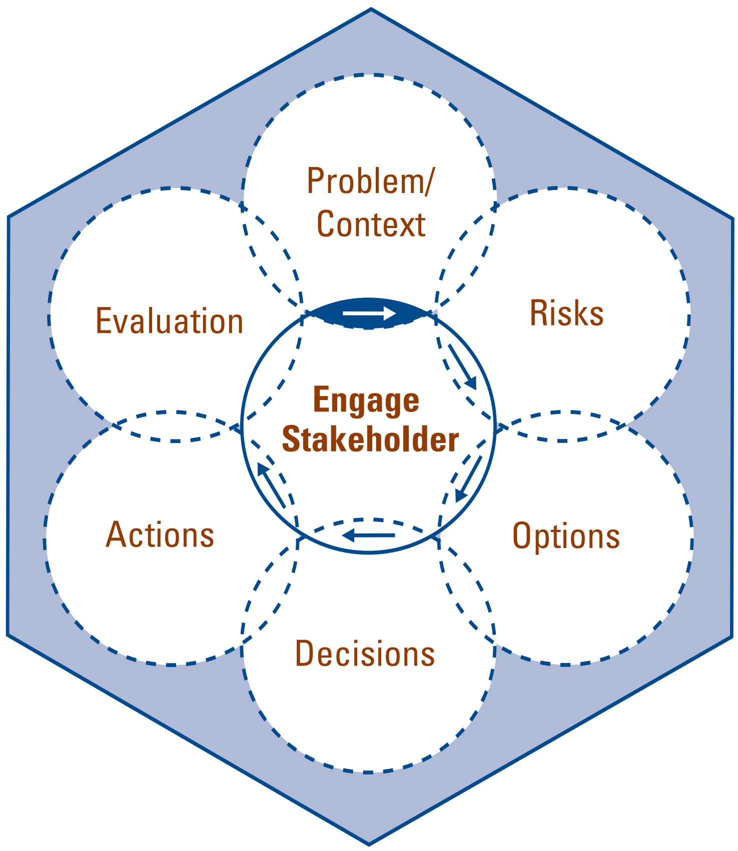
1) developing a broad definition of the problem;
2) analysing the risk;
3) examining options for addressing the risk;
4) making decisions;

5) taking actions to implement the decisions; and

6) conducting an evaluation of the actions' results.

The relationships between these steps are shown in Figure 5.1. Every step is conducted in cooperation with stakeholders, beginning with efforts to develop a definition of the problem. In addition, the approach may include an iterative process, requiring that previous steps be repeated if new information is found at a given stage.

Figure 5.1
Frame of Reference Proposed for Risk Management in the United States



Source: Presidential/Congressional Commission on Risk Assessment and Risk Management (1997a, 1997b)

The proposed framework emphasizes cumulative risks and takes into account the benefits and costs, as well as the social, cultural, ethical, political, and legal aspects of risk reduction options. According to the Commission, the advantages of this framework are that it:

- provides an integrated approach to solving public health and environmental problems;
- ensures that decisions rely on the best scientific evidence;
- emphasizes collaboration, communication, and negotiation with the public;
- produces risk management decisions that are more likely to be successful; and
- accommodates new information that may emerge at any stage of the process.

The "risk" stage refers to the risk assessment process, but it should also include and emphasize the goals of risk management. Analysts must make use of scientific information in combination with their own professional judgment. The result of risk assessment is a "characterization" or "estimation" of risk, which should provide stakeholders and decision-makers with all relevant information. The integrity of assessments must be ensured by enlisting external reviewers. To the greatest extent possible, the analysis conducted should address such dimensions as the multisource, multimedia, multichemical, and multirisk contexts. It should also seek to identify the perceptions of stakeholders and take these into account in presenting results.

We are currently witnessing the formal inclusion of psychological and social decision-making, replacing the perception that these are mere irritants that interfere with a process conducted among experts. The review of the risk management process that is currently under way at Health Canada is expected to give considerable weight to these prevailing trends, some of which have already been incorporated into the Department's practices. Recent global crises related to contaminated blood and mad-cow disease have demonstrated the need to find new ways to manage risks.

5.2 The Current Approach to Risk Management in Canada

In practice, many of the principles of risk management have been evolving over the last several years as Health Canada and the provinces/territories have strived to continuously improve the policy development and decision-making process. Defining these principles in an explicit way, as a key element of the revised approach, can help to ensure a common understanding among individuals who participate in, are interested in, or are affected by the risk management decision-making process. It can also help to ensure that the principles are implemented more consistently across all health protection programs.

5.2.1 Underlying Risk Management Principles

While every attempt should be made to apply the principles of risk management to specific risk issues and situations, it should be noted that their application may be limited in certain instances due to legislative or other requirements or restrictions. The underlying principles adopted by Health Canada and the provinces/territories are presented in Box 5.1, and a summary of this approach is provided in Appendix C of this volume.

Box 5.1
Underlying Risk Management Principles

1) Maintain and improve health (this is the primary objective).
2) Involve interested and affected parties.
3) Communicate in an effective way.
4) Use a broad perspective.
5) Use a collaborative and integrated approach.
6) Make effective use of sound science advice.
7) Use a "precautionary" approach.
8) Tailor the process to the issue and its context.
9) Clearly define roles, responsibilities, and accountabilities.
10) Strive to make the process transparent.

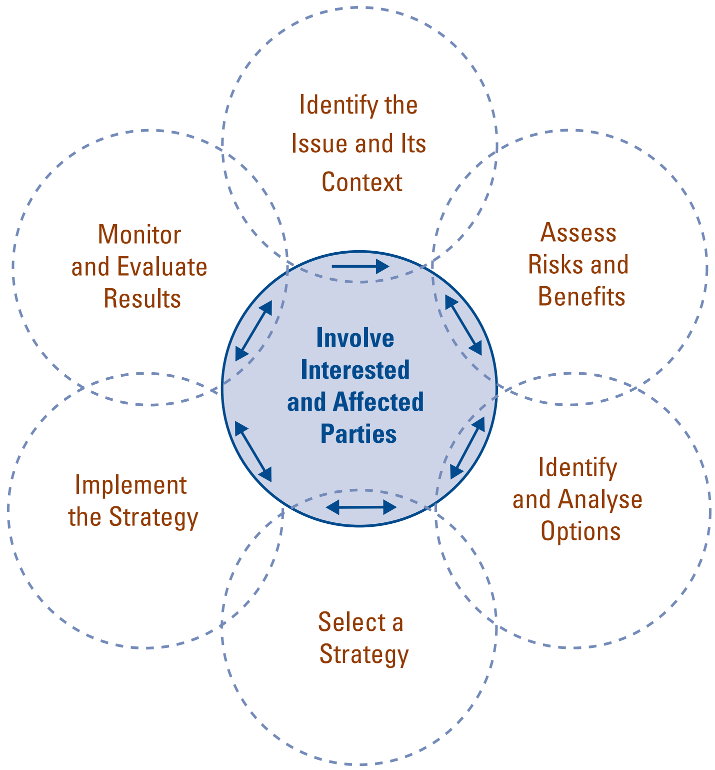
Note: The complete document is available on the Health Canada web site at:
http://www.hc-sc.gc.ca/hpfb-dgpsa/hcrisk_e.pdf

The proposed risk management decision-making framework depicted in Figure 5.2 consists of a series of interconnected and interrelated steps, which may be grouped into three phases:

1) issue identification (identify the issue and put it into context);
2) risk assessment (assess risks and benefits); and
3) risk management (identify and analyse options; select a strategy; implement the strategy; and monitor and evaluate the results).

The framework reflects the involvement of interested and affected parties throughout the process, including partners, the public, and other stakeholders.

Figure 5.2
Risk Management Decision-making Framework Adopted by Health Canada



Source: http://www.hc-sc.gc.ca/hpfb-dgpsa/hcrisk_e.pdf

Generally speaking, the risk management decision-making process begins at the top of Figure 5.2 and proceeds clockwise through the other steps; although the steps are depicted as a series of circles, there is a general linear progression. Each step involves a decision point as to whether to proceed to the next step, revisit a previous step, or end the process. The process is flexible in that one may move back and forth between steps or revisit steps based on available information. For example, a previous step may be revisited when there is a need to improve the accuracy and completeness of information or when new information becomes available and needs to be considered. We will return to the more practical aspects of risk management in the next chapter. A number of Health Canada publications (e.g., Health Canada, 1995a, 1995b) constitute a good source of information on risk characterization methods in the field.

5.3 Connection with Environmental Assessment

Risk management based on benefits to be gained is an essential element of the *public health notice*, which is itself a key component of the complex process called EA. It is important to take a clear position as to what constitutes an acceptable risk and what does not and to indicate what improvements are necessary and desirable from a public health and public safety perspective. This section deals with project analysis, although the proposed approach can also be applied to programs and policies.

One noteworthy contextual element is the fact that public health notices deal with public facilities or factories with a normal life span of 25-50 years, and sometimes more, as in the case of large factories, mines, and dams. The time frame for policies, programs, and important fiscal initiatives is often shorter, with provisions made for review after 5 or 10 years. Once established, however, programs tend to endure and often entail a succession of construction projects, demolitions, and renovations, with their attendant environmental and health impacts. In Canada, for example, recent policies have led to a succession of hospital mergers, building transformations, and clinic constructions. Public health notices must take the longevity of projects into account and make rigorous requirements to protect public health.

A public health notice cannot take the place of the authority responsible for making the final decision with respect to specific projects and policies. Rather, it must take a rigorous, independent, and clear position in favour of mitigating the adverse aspects of initiatives and promoting the benefits. A variety of criteria have been proposed for guiding decision-making and developing a position. The standard public health criteria are presented in Volume 1 of this Handbook and in the international study by Sadler (1996).

It is also useful to contextualize public health within the framework of the general criteria used in EA. An excellent summary of these criteria was recently produced by the Commission for Environmental Cooperation (CEC), a body created under NAFTA (CEC, 1997) to assess the significance of transboundary impacts requiring a comprehensive review. The CEC list can also serve more general purposes, as demonstrated by Box 5.2. It also integrates and gives equal importance to environmental, social, health, and economic considerations, in keeping with the approach advocated in this Handbook.

Box 5.2
Factors for Determining Significant Adverse Transboundary Impacts

The determination of whether adverse transboundary environmental impacts are significant involves consideration of the following factors:

Context: Context factors potentially relevant to the determination of significance of a transboundary environmental impact include, for example:

- the potentially affected human populations and vulnerable segments of the population (e.g., children, the elderly);
- geographic extent (region and localities);
- ecological context;
- unique characteristics of the geographic area (e.g., proximity to historic or cultural resources, parklands, wetlands, wild and scenic rivers, or ecologically critical areas);
- where provided by the Potentially Affected Party, standards regarding the protection of health or the environment as specified in international, national, and subnational legal instruments;
- probability of occurrence; and
- scientific uncertainty.

Intensity: Intensity factors potentially relevant to the determination of severity or magnitude of transboundary environmental impacts include, for example:

- degree of toxic and other impacts on public health or safety;
- degree to which environmental impacts involve unique or unusual risks;
- duration, potential for recurrence, and frequency of impacts;
- degree of irreversibility of impacts;
- degree to which biodiversity is affected;
- degree to which natural ecological systems and landscapes are transformed; and
- degree to which a project may foreclose or reduce the quality or availability of renewable and non-renewable resources.

Source: CEC, 1997

6 PUBLIC HEALTH NOTICES AND INTERVENTIONS IN ENVIRONMENTAL ASSESSMENT

6.1 Introduction

The preceding chapters have demonstrated that health practitioners can become involved in the EA process in many different ways. The potential goals of public health interventions include impact prediction, surveillance, prevention, and mitigation, as well as the correction of impacts once they have occurred. In fact, much of our work consists of correcting past mistakes.

Public health notices and interventions can focus on specific projects, such as the construction of a road or factory, or address the effects of legislation, regulations, programs, and policies of an economic nature, which often have a major impact on environment and health. (See Volumes 3 and 4 of this Handbook.)

The tools available are varied and draw on a number of disciplines. What is important, ultimately, is the health professional's ability to use these tools to analyse and interpret information in order to balance risks and benefits. Regardless of how valuable information may be, it must be made comprehensible and useful to the public and decision-makers. The onus is on health professionals to perform this task with respect to the public health component and to make their intervention available at the opportune time, as part of the EA process.

The SD framework has been retained as a general criterion for the purposes of public health analysis, which deals mainly with:

- the likelihood that contaminants or anticipated irritants will have an impact on health and quality of life, as well as the ultimate issue of desirable levels;
- the foreseeable equity in the distribution of risks, disadvantages, and benefits, and, ultimately, their desirable distribution; and
- the impact of the initiative being considered on the preservation of life-sustaining ecosystems and on the services derived from these ecosystems, and, ultimately, desirable impact mitigation measures.

The objective of a public health notice is to contribute to the inclusion of adequate measures to:

- protect public health and safety;
- eliminate, reduce, or mitigate environmental and social impacts that have an adverse effect on health and quality of life;
- promote impacts that are beneficial to health and quality of life; and
- maintain and improve life-sustaining ecosystems.

This approach is consistent with the objectives of Health Canada with respect to SD (Health Canada, 1997a) and the good practices recommended by the Organisation for Economic Co-operation and Development (OECD, 1996). It has also been adopted by a number of governments, including that of New Zealand (PHC, 1995).

This chapter is devoted primarily to providing a more detailed description of the analysis and preparation involved in producing a public health notice.

6.2 Drafting a Public Health Notice

A public health notice should include the following elements:

1) a review of the available data, a determination of the quality of data, and an assessment of the degree of reliability in estimating both adverse and beneficial impacts (health and social components);
2) a comparison of the risk levels obtained with current standards or with levels generally considered to be safe;
3) an identification of grey areas and adverse impacts for which no social consensus or standards exist;
4) a review of comments and positions of the various publics and populations that will contribute to determining the social acceptability of the project;
5) a summary of advantages and disadvantages, which addresses the likelihood of impacts, the equity in their distribution, as well as ecosystem preservation; and
6) a statement on the acceptability of the project from a public health perspective, which addresses physical, psychological, and community health impacts.

6.2.1 Review of Existing Data: Matrices of Health Impacts

The two matrices presented in Tables 6.1 and 6.2 can assist in evaluating the completeness of the available data on possible adverse health impacts. Table 6.1 outlines a matrix of health impacts for the biophysical environment and health component, and Table 6.2 the health impacts for the determinants of health (except for biophysical aspects) and quality of life component. In short, the object is to determine whether the information provided by the proponent for each of the cells in Tables 6.1 and 6.2 is:

- complete (i.e., is the literature review up to date?);
- accurate (i.e., unbiased); and
- transparent with respect to any uncertainty or weakness in the basic scientific data (i.e., unknown or little-known risks are clearly identified) or any limitations of the prediction models that were used.

The terms used in Table 6.2 are defined in Appendix B.

The terms used are different when dealing with impacts that are biophysical in nature or are related to other determinants. Thus, the categories used will vary depending on whether an impact is positive or negative, even though, in reality, the same field is being addressed (Table 6.3).

Some projects help reduce environmental risks to health – for example, when an outdated coal-fired electric power plant is replaced by a gas turbine, or when emergency health care services are improved by providing more rapid means of transportation.

Assessing the quality of data dealing with socioeconomic or environmental impacts is more delicate, since health professionals often do not have access to the necessary expertise. However, this exercise remains an essential part of formulating public health notices, because it is important to determine whether the project justification is consistent with current policy or whether the social or economic studies conducted are in keeping with current methodological standards. By referring to their own knowledge of the environment and consulting with experts and public health officials, practitioners can usually acquire a fairly solid understanding of the subject.

Table 6.1
Matrix of Health Impacts: Biophysical Environment and Health Component

STRESSOR/ EXPOSURE	Nature of Stressor	Impact on Environment	Affected Area	Control Measures	Standards or Recommendations	Effects on Health	Population at Risk	Probability of Occurrence	Biological/ Environmental Monitoring Indicators	Information/ References
Technological Disaster										
Gaseous Emissions or Emissions to Air										
Liquid Emissions or Emissions to Water										
Solid Emissions or Emissions to Soil										
Nuisances										

Table 6.2
Matrix of Health Impacts: Determinants of Health (Except for Biophysical Aspects) and Quality of Life Component

Determinant	Impact	Area of Influence	Population Concerned	Probability of Occurrence	Control Measures	Health Effects
Socioeconomic Aspects						
Income						
Employment **- short term** **- long term**						
Health Services and Infrastructure						
Education/Training						
Social Support Networks						
Personal Health Practices						
Healthy Child Development						
Quality of Life						
Perception						
Landscape						
Recreational Uses						
Cultural Activity						

Table 6.3
Adverse and Positive Impacts

Adverse Impacts	Positive Impacts
Damage, emissions, contaminants	Protection of ecosystems, biodiversity
Irritants	Quality of life
Psychosocial impacts	Socioeconomic benefits

Frequently encountered pitfalls include the following:

- When no official public policy exists for overseeing a given project, formulating a justification becomes more difficult; a project (such as the development of a large hog farm) can sometimes serve as a test for similar projects to come. Situations like these require closer scrutiny.
- Economic studies deal only with the spin-offs (in terms of employment) of the monetary resources that will be spent. Caution is advised in dealing with these “pre-scientific” studies, since any expenditure can bring about job creation to a greater or lesser extent, depending on the sector involved. Generally speaking, health care services are among the sectors that create the most employment, which is not the case for heavy industry. If the main argument in favour of a project is limited to the study of the project’s economic spin-offs, this is a clear sign that the argument is a weak one.
- When more exhaustive economic studies are available (e.g., cost-efficiency or cost-benefit studies), the debate will centre on a number of methodological assumptions that are essential to any study. Examples include the discount rate to be used, the project time frame, and the area being studied. In this situation, it may be useful to ask the proponent to present several scenarios in which different levels are used for a number of key variables. Thus, the soundness (or weakness) of the models used for these variables can be assessed. Consulting with independent experts can also be helpful here.
- The distribution of advantages and disadvantages almost invariably gives rise to problems. Local authorities should always be consulted to determine whether the proponent’s proposals and requirements are realistic. The employment component can be a delicate area: companies often require a high level of technical training, which can be difficult to find in some centres. The impact on municipal and regional services (water, waste management, fire department, police, roads, health services, etc.) is frequently underestimated in these studies. In order to avoid future disappointment and to temper the enthusiasm in some municipal quarters, complete transparency regarding any uncertainty in predicting impacts is advisable.

The review of available data should conclude with a notice regarding the quality of the data, as well as requests for more detailed information or additional studies judged to be crucial for the future.

6.2.2 Making Comparisons Based on Existing Standards

When standards already exist, the task becomes considerably easier. In conducting EAs, however, it is important to remember that the life cycle of a facility can extend over many decades. Consequently, adherence to the strictest standards is advised when dealing with new facilities. The strictest standards are generally found in Western jurisdictions with a high population density (e.g., California, Europe), where pollution levels are higher than those in Canada.

Adopting this approach avoids the risk of using outdated standards as a goal for decades to come. With most new technology, it is possible not only to comply with the strictest standards, but often to achieve emission levels that are 100-1000 times lower. Since the trend in scientific studies conducted over the past 30 years is to detect increasingly subtle effects at very low levels of exposure, providing a margin of safety for the long term would appear to be a good idea.

When no standards exist, the situation varies depending on whether a risk to health is deemed to be serious and irreversible (e.g., cancer or death) or less severe (e.g., eye irritation, discomfort caused by noise, etc.).

6.2.3 Making Comparisons in the Absence of Standards

Acceptable risk levels that have been incorporated into standards may be applicable here. Standards generally provide for levels of acceptable risk on the order of one new death per million for a lifetime of exposure (70 years) – a level rightly considered to be very safe when applied to a small population, which is most often the case.

For example, if 1000 people live in the vicinity of a smokestack and are thereby exposed to a carcinogenic contaminant, one could theoretically wait up to 70 000 years for a case of cancer to occur. Therefore, such levels would appear to be adequate in the absence of standards. Levels of exposure lower than this would be considered negligible, meaning that no corrective measures would be required with respect to the project under review. It should also be mentioned that epidemiological methods cannot measure such risks, even when health status is rigorously monitored. Even if such risk levels were measurable, data on numerous other potential cancer causes extending over a period of 60-70 years, including personal health habits and heredity, would be required (see Volume 3, Chapter 6). The same disease can result from many different causes, and the human body has a limited number of ways of manifesting disease. For example, one could examine 100 organic or anthropogenic chemicals associated with liver disease, while overlooking such things as infectious agents, alcohol consumption, and nutrition.

In 1989, the Dutch government proposed that explicit limits be set for judging the acceptability of risks. This risk management framework (VROM, 1989) was subsequently made part of the Netherlands' environmental policy. This global approach to risk management has the advantage of being comprehensive and of setting clear limits, which facilitate decision-making. For almost 10 years, this framework has proven appropriate in the vast majority of risk management situations (de Boer and Sadler, 1996). Since 1993, it has also been recommended as a general reference for public health branches in the province of Quebec, where it has proven equally useful. It is summarized in Box 6.1 as a guide for public health practitioners, who may find it helpful as a template for evaluating risk levels determined through impact studies. Readers interested in the rationale underlying these levels may wish to consult the original document (VROM, 1989), which is also available from the Comité de santé environnementale du Québec (CSEQ, 1993).

6.2.4 Comparisons Based on the Principles of Sustainable Development

No standards exist to determine what percentage of new employment should accrue to local residents or whether the integrity of the landscape is being adequately protected. A number of authors have pointed to an established practice among proponents, which consists of ensuring that 10-25% of project-related jobs accrue to the host community. This would appear to be a threshold that significantly improves a project's acceptability (Hobart, 1982, 1984). Of course, higher levels of employment spin-offs are often achieved, depending on the human and entrepreneurial resources available in a given community. Some companies also implement compensation policies with respect to residual impacts, establishing a level ahead of time. (Hydro-Québec reserves 2% of capital costs for community-based projects.) More recently, other formulas for gaining greater host community involvement have been put forward, such as local share ownership or royalties for the use of natural resources, as a substitute for the 2% compensation formula.

Ideally, complying to the greatest extent possible with the concrete principles presented in section 3.5 of this volume should help to maintain a strong SD focus. However, this analysis would be done differently for a project (such as a cogeneration plant) than it would for a program or policy.

For example, a factory or highway development project cannot be expected to use non-renewable resources at a rate that would permit their eventual replacement with other types of resources, because that is not its role. Consequently, exercising good judgment is crucial in selecting the proper criteria. However, when one is asked to comment on the government's energy supply policies, examining this criterion is essential.

Box 6.1
Evaluating Risk Levels

Individual Risk

The proposed approach requires that practitioners take into account the fact that new risks are added to existing risks. In order to factor in this chemical or technological *background*, a level of one new death per 100 000 persons exposed for life (10^{-5}) has been suggested as an *acceptable level* for all combined risks within a given category (chemical, technological, radiation). Therefore, exposure to ionizing radiation is also included here. Exposure is calculated on the basis of a 24-hour day in both cases, which ensures an additional margin of safety.

Collective Risk

For collective risk, defined as the probability of 1 or more deaths, the *acceptable level* is set at 10^{-5}/year (i.e., per 100 000 persons per year); and at 10^{-7}/year (i.e., per 10 million persons per year) for 100 deaths or more; and so on. Any situation in which the probability or risk is greater than 10^{-5}/year necessitates the implementation of risk reduction measures.

Chemical Substance Thresholds

When chemical substances have a threshold beneath which no toxic effects can be measured, this threshold (known as the no-observed-effect level, or NOEL) is used, along with the standard margins of safety. This is the standard practice in Canada; however, the methods used to calculate margins of safety can vary in different countries, for different forms of exposure, etc.

Ecological Risk

The 1989 Dutch model defines acceptable risk to the ecosystem as a level of lethal concentration that eliminates 50% of test organisms (LC_{50}) for major hazards and a lethal concentration of 5% for chronic exposure to chemical substances. In the latter case, 95% of the organisms belonging to that species in the ecosystem would be protected. These standards apply to new situations and are to be considered a goal for existing situations.

Ultimately, SD depends on an equitable distribution of advantages and disadvantages across a given population and among regions and generations. The role of public health practitioners and agencies is to monitor the views of groups within the population and to take into account a number of interregional considerations (e.g., transportation of pollutants over great distances, contamination of the food chain), as well as intergenerational issues (e.g., long-term risks, resource or ecosystem depletion).

In summary, specifying clear risk levels and criteria for intervention is a useful aspect of preparing a public notice, since this provides a set of guidelines, however approximate, as well as comfort and discomfort zones for public health professionals and proponents. The risk levels presented above are fairly representative of the current situation in industrialized nations, but will require a significant effort in a number of economic sectors. Exceptions to these levels can also be made in order to correct existing high-risk situations (a risk level of 10^{-4}, for example) and to achieve a lower level of risk (such as 10^{-5}) at a reasonable cost. The levels indicated also compare favourably with several other social risks (e.g., cars, sports, unhealthy lifestyle) that are more closely linked to individual or collective choices made in the past.

6.2.5 Identifying Grey Areas and Other Adverse Impacts

A public health notice should identify any point that is contentious from a health perspective. After reviewing the risk levels outlined in the preceding section, the practitioner may conclude that actual risk levels appear to be high for one or more health hazards. It should be kept in mind that the method selected to analyse the risk can leave one exposed to criticism; consequently, any deficiency should be clearly pointed out.

Normally, several other risks of lesser toxicity and with a degree of probability often approaching 100% will be encountered. These risks most commonly arise in the form of:

- irritants (e.g., noise, unpleasant odours, traffic);
- psychosocial impacts (e.g., perceptions of the project, employment, income, municipal services, development of the affected community, etc.); and
- impacts on life-sustaining ecosystems (water, air, living organisms).

The role of health professionals consists of correctly identifying these impacts and verifying the accuracy of forecasts and the adequacy of proposed mitigation or compensation measures.

There are, in fact, many different types of measures for attenuating impacts, and it is often advisable to consult experts in each of the contentious areas identified to ensure that irritants are minimized. With some projects, such as open-pit mines and hog farms, the nuisance factor becomes highly contentious. Often it is not uncommon to find examples of proponents who showed little concern for the disturbance they caused their neighbours and who often failed to meet municipal, provincial/territorial, federal, or international standards. Due to these negative past experiences, the public's perception of such projects is often very negative. This can make it difficult to introduce a project even with new technology that would significantly improve the operations.

Psychological and social impacts constitute another crucial area of intervention for public health practitioners, one that merits considerable attention. Public health practitioners and agencies need to publicly acknowledge that the community's perception of a project is not only legitimate, but also capable of inducing its own health impacts. Any perception, be it negative or positive, is likely to influence the types of impacts that are felt in the community, in terms of employment, social cohesion, taxation, etc. Economists (see Volume 3, Chapter 4) are beginning to acknowledge that a healthy community is an important part of a well-functioning economy (Putnam, 1993). Social cohesion, civic involvement, mutual aid, and many other similar activities bind communities and make it easier to adapt to large- or small-scale changes. Examples can be found of well-planned and competently managed projects that have generated very positive social benefits despite their size. The benefits of North Sea oil development for the Scots of the Shetland Islands are one example (Hill *et al.*, 1998). Conversely, the social and economic upheaval currently experienced by many of Canada's First Nations as a result of development projects has produced a number of adverse social impacts and negative perceptions (Grondin *et al.*, 1994).

Impacts on life-sustaining ecosystems also need to be identified by public health authorities. With the increase in human economic activity and its attendant impact on ecosystems, it is important to ensure that these ecosystems remain intact or that future losses are completely replaced in the area sustaining the impacts, or elsewhere.

6.2.6 Reviewing Other Positions

It is important to cite (with the permission of the authors in question) the comments and positions expressed by various organizations and key individuals with respect to the project. This review can also encompass official documents (relating to public hearings, for example) and media coverage. Public health notices should also mention the experts and managers who were consulted by public health authorities, as well as the reports and other relevant documents that were reviewed.

6.3 Summary of Advantages and Disadvantages

Taking a clear position on the acceptability of a project requires sound professional judgment. A number of useful criteria for making this judgment have already been suggested in previous sections of this Handbook.

In summary, the proposed approach is based on the principles of SD and seeks to achieve extremely low levels of contamination; to distribute advantages and disadvantages equitably, in a manner that is widely accepted by the community; and to preserve existing ecosystems.

With experience, one discovers that projects often have elements that are acceptable, as well as others that are questionable or that require major modification. These aspects, as well as the work that remains to be done, should be pointed out, while keeping in mind that the role of public health authorities is not to address the engineering or other solutions required to solve a problem, but rather to indicate desirable overall directions.

6.4 Social Acceptability

Attempting to determine what will be socially acceptable can be difficult, as politicians and project managers often discover. It is possible, however, to identify factors that help to anticipate controversy and others that can facilitate project acceptance. A useful review of several waste management projects and programs undertaken in Canada (Toronto, Montreal, Quebec City, and Halifax) and in New York State identified some of these factors (Transfert Environnement, 1996). Waste management is, in fact, a good example, since it gives rise to many different risks, irritants, perceptions, and social and ecological impacts.

Transfert Environnement (1996) identifies two particularly sensitive factors that can easily become irritants and trigger resistance to a project:

1) accumulated frustration; and
2) symbolic triggers.

Details on each of these factors are presented in Box 6.2.

Many examples of this type of meta-analysis are available in the social sciences. An awareness of the factors likely to provoke resistance in a given context can assist in designing projects that will find acceptance and in presenting projects as part of a facilitating process. Clearly, respect for collective priorities and pro-active social attitudes are key ingredients of sound social management. Collective priorities have now been integrated into the environmental component and into certain aspects of SD, a fact that is reflected in many laws, regulations, professions, surveys, etc. Governments and corporations are also being called on to adopt a coherent approach. Issues that go beyond pollution management and recycling must now be addressed, including resource conservation, reuse of formerly contaminated sites, and community involvement in the development of environmental management systems. In short, more is required than simply providing sound management: the changes taking place reflect new social choices and a new collective vision.

Pro-active social attitudes, a subject discussed in detail by the U.S. Environmental Protection Agency (U.S. EPA, 1988), require honest, credible behaviour and attitudes on the part of proponents, as well as a genuine receptivity to the expectations of the community. However, much progress remains to be made in this area.

Box 6.2
Factors That Can Affect the Social Acceptability of a Project

1) *Accumulated frustration* can take many different forms. It can range from the perception of social injustice to the anger that sometimes spills over in areas where too many contentious projects have been developed or where pollution already exists (such as industrial zones). When this type of "psychosocial saturation" sets in, even projects that could improve current conditions are met with suspicion and rejection.

   Accumulated frustration relates to a broader phenomenon that some have referred to as the "amplification of social risk" (Kasperson, 1992). According to this model, the quantifiable hazards and risks of a project interact with a broad spectrum of social, psychological, and cultural processes that can either attenuate or amplify the level of perceived risk.

2) *Symbolic triggers* are components of a project or facility that create controversy. In the case of waste management projects, the authors point to a number of symbolic triggers, including the importing of waste, the involvement of a multinational corporation, the presence of smoke stacks or hazardous waste, the degradation of the visual aspects of the landscape, and unpleasant odours. The reactions these evoke are entirely human. The fact that good neighbourhoods are usually spared offence – due to zoning laws and the high price of land – can also represent a symbolic trigger. (See Volume 3, Chapter 2.)

7 COMMUNICATION AND CREDIBILITY

7.1 Effective Communication Tailored to Expectations

In a study examining the implementation of approximately 20 incinerator projects, Konheim (1988) observed that the standard risk assessment process failed to address the concerns being voiced by the public. Konheim (1988) outlined 10 recurring questions expressed by citizens and their representatives (Box 7.1). These concerns are highly consistent with the issues that commonly arise with most large projects, such as the equitable distribution of risks and the present and future credibility of proponents.

Box 7.1
Typical Questions Raised by the Public When Faced with the Development of Incinerator Projects

1) What are the specific risks compared with the benefits of the project? Are the risks to each group worth the benefits to be gained? What are the benefits and risks of alternative solutions? What are the benefits and risks of taking no action?
2) How did you calculate the risk? Is there one standard way of doing it, or are there several? Is there a prevailing consensus on the basic facts in the scientific community? Or are there dissidents?
3) Did you base your calculations on data from facilities already in operation, or is the database theoretical?
4) If you based the data on already-operating facilities, were they very similar to the proposed project? If not, how would their differences alter the analyses?
5) Does the design of the facility make the risk as low as it possibly can be? Can the facility be updated later if new ways are found to lower the risk?
6) Who in the community bears the burden of risk? Are older, younger, and sick people more at risk?

Box 7.1 (Cont'd)

7) What is the chance of a serious accident? If one occurred, what would be the worst possible impact? How often do accidents happen in currently operating facilities? Will their likelihood increase over time? What is their magnitude? Would the effects of an accident be irreversible? What provisions have been made to handle accidents?
8) Will risks be identifiable? Who will monitor the performance of the plant? Can the risks be reduced?
9) Can the public influence how the facility is designed and operated?
10) Does approving the project mean foreclosing future, potentially less risky options?

Source: Konheim (1988)

Konheim (1988) also reports that when an incinerator project was proposed in the New York City area, a citizens' advisory committee was more comforted by the qualitative conclusions of two physicians from Mount Sinai School of Medicine, indicating that health effects of the plant were "minimal" and "non-detectable," than they were by the quantitative predictions of a scientific expert to the effect that the risks of dioxins from the plant would be in the range of (0.24×10^{-6} to 5.9×10^{-6}). This suggests that the public's expectations are more often qualitative than quantitative in nature.

In their guide for government risk communication, Chess *et al*. (1988) stress the importance of understanding community expectations, developing and maintaining credibility, controlling the timing of disseminated information, interacting with the community, and taking the time to explain the various aspects of risk assessment – in short, engaging in public outreach.

According to Covello (1992), the key to effective communication is the confidence and credibility of the individual or organization conveying the message to the public. Studies have shown that organizations and individuals perceived as being credible in matters of risk assessment include health professionals, university professors, the media, non-profit health organizations, and respected local citizens who are considered to be impartial and well informed about risks. The research demonstrates that the general population views doctors and academics as being motivated by noble goals, the former being dedicated to healing and the latter motivated by the quest for knowledge and truth. Both groups are perceived as being economically independent from the organizations that hire them as consultants and therefore unconstrained in rendering their professional judgment.

Covello (1992) identifies four factors that influence the perception of confidence and credibility:

1) *The Perception of Empathy:* This would seem to be the most important factor. Does the communicator give the impression that he/she is interested in health, safety, the environment, and fairness? Does he/she take the time to listen to his/her audience? More often than not, the public makes up its mind about this factor from the initial contact. Once the public has passed judgment, perceptions can be very difficult to change.

2) *Perception of Competence and Expertise:* This perception is largely influenced by the past accomplishments of a government organization or agency and by factors that relate to the communicator, including training, experience, knowledge, and verbal skills.

3) *Perception of Honesty and Openness:* This perception is influenced by actions, words, and non-verbal communication. A communicator who is unable to meet the gaze of others and the placing of physical barriers between communicator and audience are forms of negative non-verbal communication.

4) *Perception that the Communicator Is Dedicated to the Cause:* This perception arises from the impression that the communicator is a hard worker who diligently strives to achieve goals connected with health, safety, and environmental protection. The audience normally forms this impression based on various verbal and non-verbal cues – for example, is the communicator available outside of office hours? Does the communicator remain for the entire public meeting?

Such studies are extremely useful in understanding the nature of effective communication. They suggest that successful risk communication is a complex art that requires skill, knowledge, training, and practice. They also suggest that risk communication involves intrinsic limitations, even when the communicator possesses all of these qualities. Credibility and honesty must be present from the outset.

Exchanges between citizens' committees/representatives and risk assessment experts during the public consultation phase are another key component of successful communication. In addition to helping experts gain a better understanding of the community's needs and expectations, citizens' representatives can play the role of risk communication facilitators. The mere fact that citizens are given the opportunity to review the risk analysis process (even if it is through their experts) tends to enhance credibility.

Citizens' committees also play an important role in examining issues of surveillance and environmental risk monitoring. It has been noted that the public is generally less fearful of risks over which it feels it has the ability to exercise some control. Involving community representatives constitutes a definite investment: when a future course is charted and decisions made, the public will recognize that it was not excluded but, rather, made an integral part of the process (either directly or through its representatives).

Where the health network is concerned, a number of issues need to be considered in coordinating public participation. These include:

- the specific risk evaluation context;
- respecting data confidentiality (when necessary);
- respecting the stakeholders involved in the process; and
- avoiding any possible bias that might give rise to criticism and undermine credibility.

Ideally, public participation should be generated and encouraged by the organization responsible for managing the process. Public health organizations should always support the involvement of citizens and seek to develop their expertise, which is sadly lacking in many fields and regions.

Those charged with communicating risk have an interest in translating numbers (often expressed as a fraction with a denominator of several thousand or several million) into an order of magnitude that will be more accessible to the general population. For example, Carrier *et al*. (1991) have estimated that the average individual risk of cancer for the 6800 citizens residing less than 500 m from the Des Carrières incinerator in Montreal is 1 in 2.04 million. This somewhat abstract assessment has been translated into a collective annual risk of one chance in 300 after 70 years of incinerator operation. In other words, it would take 300 years to confirm that one case of cancer among 6800 individuals developed as a result of incinerator operations. Mathematical conversions of this kind can help the public to better understand communicated risk levels.

Risk comparison can also assist in putting a specific situation in context, although this approach has both advantages and disadvantages. In their handbook for plant managers, Covello *et al*. (1988) organized 14 types of comparisons into five categories, based on their likelihood of success with the public. Selecting one of these categories over others should be done with caution, since some risk comparisons are less acceptable than others, depending on the public that is being addressed (see Box 7.2). However, a number of authors (e.g., Rahm-Crites, 1998) recognize the usefulness of such comparisons, pointing to the evolution of the concept of risk and the maturity of the public.

Whenever possible, the preferred approach is to use measured or estimated concentrations of substances in the environment and to compare these with concentrations deemed to be acceptable on the basis of toxicological and epidemiological studies.

Box 7.2
Classification of Risk Comparison Categories

1. First-class Risk Comparisons:

- comparing the same risk on two different occasions;
- comparing risks against existing standards;
- comparing different estimates of the same risks.

2. Second-class Risk Comparisons (second option, less acceptable):

- comparing risks that are inherent to an activity, with the risks occurring in the absence of such activity;
- comparing the risks associated with different solutions applied to the same problem;
- comparing the same risks as they occur at other sites.

3. Third-class Risk Comparisons (third option, less acceptable than the previous two):

- comparing average risks with the most serious risks encountered at a specific time or at a specific site;
- comparing risks generated by a source producing a specific hazardous effect with the risks generated by all sources producing the same effect.

Box 7.2 (Cont'd)

4. Fourth-class Risk Comparison (fourth option, rarely acceptable):

- comparing risks with costs or comparing the risk/cost ratio with other risk/cost ratios;
- comparing risks and benefits;
- comparing professional risks and environmental risks;
- comparing a risk with other risks generated by the same source, installation, or agent;
- comparing a risk with other causes linked to the same illness or trauma.

5. Fifth-class Risk Comparisons (last option, rarely acceptable; use with the greatest caution!):

- comparing a risk with other risks that are completely unrelated.

Source: Covello *et al*. (1988)

It is also important to specify whether risks are acute or chronic and to address the probability of occurrence for each substance under review.

Regardless of the numeric value attached to a risk, it is impossible to express risk without specifying:

- any uncertainty associated with obtaining values;
- any uncertainty associated with the extrapolations made (high dose/low dose, animal experiments, and extrapolations for humans); and
- that the risk is not evenly distributed throughout the population; that some individuals will have a greater exposure (in terms of concentration or duration of exposure); and (in the absence of specific risk estimates for particular subgroups within the population) that some individuals will manifest greater sensitivity when exposed.

If the communication of risks and results in public outreach still seems somewhat nebulous to readers, they should know that they are not alone! This was also the conclusion of several organizations and researchers cited in a methodological review by Rahm-Crites (1998). Their conclusion was that this field is still at the experimental stage and that solid information on effective and efficient approaches is lacking.

Still, it is important to invest in two key areas, which are preparation and credibility. Both of these areas are examined below.

7.2 Preparing a Communication Strategy

Effective communication requires careful planning. A U.S. EPA approach is outlined in Box 7.3. Whichever approach is used, effective communication involves several essential steps that are elaborated below:

Box 7.3
Rules of Effective Risk Communication

The seven rules of effective risk communication recommended by the U.S. EPA (1988) provide a good summary of the desired approach, although the difficulty inherent in applying them should not be minimized:

1) Accept and involve the public as a legitimate partner.
2) Carefully plan and evaluate your efforts; this includes establishing clear objectives.
3) Listen to the public's concerns.
4) Be honest, frank, and open.
5) Collaborate with other credible sources (organizations or individuals).
6) Meet the needs of the media (be open and accessible).
7) Speak clearly and with compassion.

1) *Ensure that the notice is specific with respect to risks/benefits and proposals:* The magnitude of the risk to be communicated, the benefits involved, and the options to be proposed must be clear in the mind of the communicator.

2) *Establish communication objectives:* Risk communication objectives should be clearly defined. Is the purpose of the message to inform the public about a risk to health? Is the purpose to improve understanding? Does the message imply that a change in behaviour is in order? Does the public health notice propose new options?

3) *Identify the various target audiences:* Identify the target population for risk communication and segment the various groups within that population. Do not overlook professional audiences (public servants, doctors, engineers, etc.), including your own colleagues.

4) *Remain mindful of the sociocultural environment:* A solid understanding of the prevailing values of a community and its subgroups is important since it enables practitioners to choose the means of communication that are best suited to social and cultural preferences about information dissemination. This step allows for necessary adjustments with respect to power and information dissemination structures.

5) *Select an approach that is appropriate for the target groups and the sociocultural environment:* This can take the form of oral, written, or visual communication, or a combination of all three. It is also important to identify the individual (or individuals) most likely to communicate the message successfully. Four communication techniques are available: public relations, paid advertising, resource materials, and community-based activities.

– *Public relations* include activities conducted with a view to obtaining the free cooperation of individuals or the media. Press conferences, letters, open-line and other radio and television programs, exhibits, information booths, and contests are some examples of activities that fall into this category. Working with the media can provide an easy way to convey a message to a large audience, given the considerable credibility the media enjoys with the public. However, since the media controls content, problems can sometimes arise.

– *Paid advertising* includes any form of promotion through the press and electronic media (radio, television, Internet), including community, commercial, local, regional, and national media. It provides a way of reaching selected groups, but often at a substantial cost.

– *Resource materials* include print and audio-visual tools such as posters, brochures, slide presentations, video, and instructional games. This approach facilitates the inclusion of more complex elements. However, the method of dissemination and the target audience must be chosen with care. Again, significant costs are sometimes involved.

– *Community-based activities* are defined as any direct communication with a target audience. Public assemblies and information sessions fall into this category. Involvement in community events can be another useful way of getting a message across. Generally speaking, this technique can have considerable impact, since it appeals to community values and the need for identification. The cost involved is usually low.

Based on the situation at hand and the objectives pursued, a combination of these communication techniques can also be effective.

6) *Prepare the message:* Press releases, additional information, letters of invitation to public meetings, and any other material to be disseminated should be tailored to the various target audiences.

7) *Implement the communication program:* Coordinate activities and establish schedule targets.

8) *Evaluate the impact of the communication strategy:* As much as possible, the effectiveness of the communication strategy and its impacts (including any negative consequences) should be assessed. Evaluating the process can assist in making adjustments to a strategy already under way or in improving future communication strategies.

Some public health stakeholders tend to believe that their role in public outreach is solely a matter of communicating information to the public in an honest, easily understood manner. However, this may lead them to overlook a number of factors affecting the perceptions held by individuals. More often than not, this kind of omission leads to conflict and to the organization's credibility being called into question (Goldberg, 1992).

The involvement of citizens' committees or citizens' representatives with public health professionals can help to ensure success in establishing a dialogue with the public. It is important to remember that communication also involves listening to the views of others. More often than not, the communication of a public health notice or risk information is the final step in an arduous process in which time constraints frequently play a role. In spite of this, a way should be found to give communication the time and energy it requires.

7.3 Credibility: Useful Ethical Principles for Environmental Assessment

Credibility is difficult to establish and can easily be lost. It is also the key ingredient of successful communication.

Organizations and individuals must employ a variety of means to develop and maintain their credibility. These include maintaining a high level of scientific knowledge, competently using research methodologies, and maintaining a consistent presence and a steady dialogue with the community and organized groups. There is little point in attempting to establish a dialogue in the midst of a crisis or catastrophe: individuals and organizations are credible as a result of the work they have done in the past.

Another essential aspect is having an independent mind and rendering balanced judgments, while maintaining an exclusive focus on public health. That focus forms the very basis of the health professional's mandate, although it can be difficult to remain mindful of this when dealing with cases in which the emphasis is on economic or environmental considerations, which is always the case in EA. Practitioners must remain firmly rooted in the public health field and address other fields through questions or requests submitted to the competent authorities.

Box 7.4 presents a series of ethical principles that can be useful in conducting EAs.

Box 7.4
Useful Ethical Principles for Environmental Assessment

In fulfilling their role, health professionals must:

- perform their work in accordance with the most appropriate, tested, and up-to-date scientific information and methods;
- avoid all forms of discrimination, in accordance with the law;
- show discretion and respect for the rules of confidentiality under existing laws and regulations (with respect to both information on paper and electronically processed information);
- exercise their functions in an impartial manner;
- avoid any real or apparent conflict of interest, meaning any situation in which practitioners or organizations have ties with parties whose interests run counter to the interests of public health;
- ensure that, in any circumstance, the results of the public health risk assessment will be divulged at the proper time, if necessary; and
- promote ongoing training and the development of expertise by sharing experiences and knowledge.

8 CONCLUSION

In conclusion, it seems appropriate to recall that the approach suggested in this Handbook is supported by a number of political positions adopted over the last few years. The great declarations of Rio de Janeiro will be remembered in this regard, as well as many charters and statements adopted since then throughout the world under the aegis of international agencies, such as the United Nations and other organizations. These positions concern us all, but nothing matters as much as a statement endorsed by our own leaders. This statement exists, even though not much attention has been paid to it: in December 1996, all the federal and provincial/territorial ministers of health and of environment signed an important statement with inescapable implications for the EA process (see Box 3.1). This statement legitimizes the active involvement of health personnel in EA and the approach advocated here, which devotes more attention to the social and ecological aspects of public health, in addition to the physical health aspect. All that remains now is the most difficult but also the most rewarding phase, namely implementation. The complete procedure is summarized in Appendix A in very general form, along with checklists for the various stages and the tasks to be carried out. If you have read this volume, you will probably need only the dozen or so pages in the appendix to begin your first EA.

Notes:

9 BIBLIOGRAPHY

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Notes:

A

Appendix A: Summary of the Process and Checklists for Steps in Preparing a Public Health Notice

This appendix provides a summary of the process and checklists for each of the steps that health professionals in Canada are encouraged to follow in preparing a public health notice as part of the EA process.

A.1 Step 1: Determine the Type and Scope of Involvement

The involvement of health professionals will vary depending on whether they are asked to:

- analyse government policies or plans of provincial/territorial or national scope; or
- examine a local or regional development project put forward by a private proponent or government.

A.1.1 The Departmental or Government Level

With respect to policies, plans, and programs (PPPs) that are provincial/territorial or national in scope, the role of the health professional consists of contributing to or participating in public consultations and performing monitoring activities, as appropriate.

All PPPs in economic sectors that have a major impact on the environment should involve health authorities at an early stage. The sectors most likely to interest the health sector include:

- land use management and urban planning;
- industries (including mines);

- energy generation and transmission;
- road, rail, and air transportation;
- agriculture and fisheries;
- forestry;
- tourism and recreation;
- waste management; and
- health care services.

Health agencies should also remain responsive to other intrinsic aspects of PPP initiatives, regardless of the sector in question:

- technological innovations, such as those related to biotechnology and communications;
- the likelihood of large-scale demographic or geographic changes within a community;
- the likelihood of impacts on vulnerable groups;
- the likelihood of impacts on disease vectors in the environment;
- the likelihood of impacts on the food chain;
- a significant risk of damage caused by technology; and
- the likelihood of influencing:
  - climate change;
  - large ecosystems or ecosystems that are threatened; and
  - the appearance of new infectious diseases or the geographic spread of tropical diseases.

The suggested degree of involvement for central public health agencies with respect to departmental or governmental PPPs is shown in Table A-1:

Table A-1
Suggested Degree of Involvement for Central Public Health Agencies

	Small-scale Initiatives	Large-scale Initiatives	Large-scale Initiatives Involving Technological Innovations or Strong Public Interest
Economic sectors that have a strong impact on the environment	Average	Significant	Very significant
Economic sectors that have a more moderate impact on the environment	Low	Average	Significant

Note: For definitions of levels of involvement (Low, Average, Significant, and Very significant), please see Box A-1.

A.1.2 The Local or Regional Level

The criteria that apply to government PPPs (with respect to the economic sector and certain intrinsic aspects) also apply here; however, the perspective is a different one. The health professional must base his/her intervention on the impact study submitted by a project proponent or initiator, as well as respond to the questions and concerns of the affected population.

The suggested degree of involvement for public health agencies faced with local or regional projects is shown in Table A-2.

Table A-2
Suggested Degree of Involvement for Regional and Local Health Agencies

Type of Community	Small-scale Projects (<$1 M)	Medium-scale Projects ($1 M to $10 M)	Large Projects ($10 M to $1 B)	Very Large Projects (>$1 B)
Small/isolated	Low	Significant	Very significant	Very significant
Small (<10 000 inhabitants)	Low	Average	Significant	Very significant
Average (10 000 to 100 000 inhabitants)	Low	Low	Significant to very significant	Very significant
Large (>100 000 inhabitants); or Very large (>1 M inhabitants)	Low	Low	Average to significant	Significant to very significant

M = million; B = billion.

Note: For definitions of levels of involvement (Low, Average, Significant, and Very significant), please see Box A-1.

The degree of effort involved for each level of involvement of health professionals and agencies in EA is outlined in Box A-1.

Box A-1
Level of Effort by Degree of Involvement in Environmental Assessment

1) *Low Level of Involvement:* Use of guides and simple literature reviews; determination of compliance with standards in force; informal consultations by key communicators; and succinct written notices.
2) *Average Level of Involvement:* The preceding items, as well as informal consultations with specialists and key communicators; determination of compliance with the strictest standards in the world; and brief written notices.
3) *Significant Level of Involvement:* Exhaustive literature reviews; formal public consultations; risk analyses; additional reports and briefs; and dissemination through the usual channels.
4) *Very Significant Level of Involvement:* The preceding items, as well as surveys, epidemiological studies, and psychosocial studies; additional reports and briefs; and major dissemination initiatives.

A.1.3 Checklist for Step 1

Table A-3
Checklist for Step 1

Checklist Items	Specify the Appropriate Level of Involvement
1) Type of project (describe and specify): – Provincial/territorial or national scope (government PPP); – Local or regional scope (private or public proponent).	
2) Economic sector(s) involved.	
3) Intrinsic aspects of the PPP that justify a public health role (describe).	
4) Nature of involvement desired on the part of the public health sector.	
5) Desirable level of involvement on the part of the public health sector (low to very significant).	
6) Anticipated involvement at the scoping stage (if applicable).	
7) Anticipated involvement in the drafting of impact assessment guidelines (if applicable).	

A.2 Step 2: Drafting the Public Health Notice

A.2.1 Definition and Description of a Public Health Notice

A public health notice is normally a written document that is submitted to a government organization putting forward a PPP or a document submitted as part of the EA process for a specific project submitted by a private or public proponent.

A public health notice should comprise the following six major items:

1) *a data review*, including a determination of the quality of the data and an assessment of the degree of reliability in estimating adverse and positive impacts in terms of both biophysical health and the psychosocial and economic determinants of health;
2) *a comparison of risk levels* obtained with current standards or with levels generally considered to be safe or desirable;
3) *an identification of grey areas* for which no social consensus or standards exist;
4) *a review of comments and positions of the protagonists* (proponents, affected populations, interest groups, governments);
5) *a summary of advantages and disadvantages*; and
6) *a statement* as to the acceptability of the project from a public health perspective.

A.2.2 Health Components

The public health professional is required to compile information pertaining to the two main components of health (Appendix B presents a matrix for each of these components):

1) the biophysical environment and its influence on physical health; and
2) the socioeconomic and psychological determinants of health.

The six items outlined above should be applied for both the physical health and the determinants of health components, in order to:

- determine whether the information provided by the project proponent or initiator is complete;

- determine whether the information is accurate (is the interpretation presented biased?); and
- uncover any uncertainty or weakness in the basic scientific data (unknown or little-known risks, for example) or any limitations in the prediction models.

The data review, the comparison of risks, and the identification of grey areas are done differently depending on whether one is evaluating the physical health component or the (psychosocial and economic) determinants of health component.

A.2.2.1 The Physical Health Component

The study of risks to physical health resulting from changes to the biophysical environment (among other things) can be performed with the use of a specific matrix (Appendix B), where each cell is filled out with information provided by the proponent or collected by the health professional. The latter must pay particular attention to impacts on the health of at-risk populations, as well as to standards or criteria of acceptable risk. While proponents are required to include this information in their impact studies, health professionals may revise or modify predictable impacts on human health based on their own experience and expertise. Moreover, the initial impact study may have overlooked certain hazards or risks, in which case the health professional is required to conduct or request a more exhaustive study. With respect to specific health risks, the following *modus operandi* can be adopted, based on the type of data that are available:

1) Begin by referring to existing Canadian standards. Adherence to the strictest standards in the world (e.g., California and Western Europe may have stricter standards than Canada) is an option in order to provide a margin of safety for the long term.
2) In the absence of standards, acceptable risk levels should be used. This concept was developed to evaluate exposure to numerous physical, chemical, and biological contaminants and is frequently expressed as a maximum acceptable concentration (MAC). For some types of pollutants, particularly those deemed to be carcinogens, acceptable risk is generally defined as 1 new death per million persons for a lifetime of exposure (70 years).
3) In the absence of standards or data on acceptable risk, toxicological data relating to the no-observed-adverse-effect level (NOAEL) may be used.
4) With respect to irritants (noise, unpleasant odours, vibrations, dust, etc.), specific standards or guidelines sometimes exist. In many cases, however, the health professional is required to review epidemiological studies or earlier EA reports.

A.2.2.2 The Psychosocial and Economic Determinants of Health Component

From a public health perspective, psychological, social, and economic impacts warrant close attention. However, many of these impacts fall within a “grey area,” in that there are no applicable standards or guidelines. The basic premise should be that the perceptions of the public are legitimate and have (or can have) an impact on health.

Appendix B provides a sample impact matrix where these aspects can be taken into consideration. This matrix deals with the determinants of health other than those relating to physical health, grouped under the heading “socioeconomic aspects,” as well as other factors affecting “quality of life.” The latter have not been formally included as determinants of health, but, in practice, they frequently emerge as major sources of conflict in some development projects.

The lack of quantitative data or of a specific frame of reference can have certain consequences in terms of examining socioeconomic impacts:

1) Assessing the quality of the data dealing with the socioeconomic impacts of a project can be a delicate matter when health professionals do not have access to the necessary expertise.
2) Frequently, economic studies deal only with short-term monetary spin-offs, overlooking pressures on local communities, particularly on existing services and infrastructure.
3) Health professionals should be aware that they may find themselves at the centre of an intensely emotional debate when assessing socioeconomic impacts, particularly if they do not have access to credible and reliable data.

In the absence of established guidelines or standards, health professionals should:

- be responsive to public concerns (the grievances and perceptions of the population represent relevant indicators when one is evaluating the socioeconomic and psychological aspects of a project); and
- consult the relevant literature or impact studies that have dealt with similar issues.

A.2.3 Checklist for Step 2

Table A-4
Data Available for Risk Identification Purposes

Quality of the Information	Completeness of the Information (describe)	Accuracy of the Information (comment)
Data review		
Comparison of risk levels		
Identification of grey areas		
Review of other positions		
Summary of advantages and disadvantages		

A.2.3.1 The Physical Health Component

1) Identify stressors: This step involves filling out the first column (“nature of stressor”) of the matrix of health impacts (see Appendix B).

2) For each quantifiable stressor (or major stressor category), determine the nature of the information provided beforehand for risk assessment purposes (Table A-5).

Table A-5
Physical Health Risk Approach 1

Nature of the Data	Stressor or Hazard		
	Existing	In Canada or outside Canada	To be determined (research)
Standards			
Acceptable risk (guidelines or MAC)			
NOAEL			
Other toxicological data			

Table A-6, which takes a more synthetical approach, can also be used.

Table A-6
Physical Health Risk Approach 2

STRESSOR/EXPOSURE	Nature of Stressor	Standard (Canadian or other)	Acceptable Risk (MAC)	NOAEL	Other Toxicological Data
Technological Disaster					
Gaseous Emissions or Emissions to Air					
Liquid Emissions or Emissions to Water					
Solid Emissions or Emissions to Soil					

A.2.3.2 Psychosocial and Economic Determinants of Health Component

1) Identification of determinants and relevant quality of life factors: This stage involves determining whether the proposed PPP or submitted impact study takes determinants of health and quality of life factors into account (see matrix of impacts on non-biophysical determinants of health in Appendix B for a more complete list of items to be checked).

2) For all relevant determinants and quality of life factors, determine the nature of the information provided in the departmental proposal or impact study (Table A-7).

Table A-7
Psychosocial and Economic Risk

Nature of the Information	Determinant or Quality of Life Factor		
	Present and adequate	Present, but remains to be verified	Absent, to be gathered
Taken into account in the PPP or impact study			
The PPP or impact study comprises a qualitative or quantitative assessment			
Public opposition			
Existence of relevant literature or previous impact studies			

As with physical health risks, a summary table (Table A-8) can also be used.

Table A-8
Psychosocial and Economic Risk Summary

Determinant	Impact	Area of Influence	Population Concerned	Probability of Occurrence	Control Measures	Health Effects
Socioeconomic Aspects						
Income						
Employment **- short term** **- long term**						
Health Services and Infrastructure						
Education/Training						
Social Support Networks						
Personal Health Practices						
Healthy Child Development						
Quality of Life						
Perception						
Landscape						
Recreational Uses						
Cultural Activity						

The preceding information is used to prepare a six-point public health notice, based on the data provided by the government department or project proponent.

Table A-9
Public Health Notice

Components of the Public Health Notice	Status		
	Incomplete	Pending	Complete
Data review			
Comparison of risk levels			
Identification of grey areas			
Review of other positions			
Summary of advantages and disadvantages			
Conclusion			

A.3 Step 3: Disseminating the Public Health Notice

A.3.1 Effective Communication

The key to effective communication is the confidence and credibility of the individual or organization conveying the message to the public. Health professionals must be mindful of the fact that communication is a complex art that requires know-how and a certain amount of training. Most importantly, their public health notices must convey an authentic message that reflects a concrete position; in short, their notices must present a meaningful conclusion.

There are four factors that influence the perception of confidence and credibility:

1) *empathy* and the genuine interest shown with respect to health issues (more often than not, the public makes up its mind about this factor on the basis of the initial contact);
2) *competence and expertise*;
3) *honesty and openness*: a perception influenced by words and non-verbal communication; and
4) the *right of review granted citizens* during the public notice drafting process.

A.3.2 Elements Specific to Public Health Notices

In addition to the general factors mentioned above, three elements that are specific to the dissemination of public health notices warrant close attention. These are:

1) risk expression;

2) the communication strategy; and

3) credibility.

A.3.2.1 Risk Expression

Those charged with communicating risk have an interest in translating numbers into an order of magnitude that will be more accessible to the general population. In the case of a population of 6800 citizens residing less than 500 m from an incinerator, it would be preferable to translate the average individual risk of one new case of cancer in 2.04 million in the following way:

- one chance in 300 annually after 70 years of incinerator operation; or
- it would take 300 years to confirm that one case of cancer among 6800 individuals living in the area developed as a result of incinerator operation.

Risk can also be expressed qualitatively, for example by referring to a risk situated between 0.24×10^{-6} and 5.9×10^{-6} as "minimal and undetectable."

Even when a risk is expressed numerically, it is important not to neglect the following elements:

- any uncertainty associated with obtaining the values;
- any uncertainty associated with the extrapolations made (e.g., extrapolations from animal experiments); and
- the fact that the risk is not evenly distributed throughout the population: some individuals may have a greater exposure or manifest greater sensitivity when exposed.

A.3.2.2 Communication Strategy

Effective communication requires careful planning. This involves several essential steps:

1) *Ensure that the notice is specific with respect to risks/benefits and proposals:* All of these elements must be clear in the public health notice and in the mind of the communicator.
2) *Establish communication objectives:* Is the purpose to inform the public about a risk to health, to suggest that a change in behaviour is in order, to propose new options with respect to the proponent's proposal, etc.?
3) *Identify the various target audiences:* Clearly identify the target population, as well as the principal groups within that population.
4) *Remain mindful of the sociocultural environments:* It is important to understand the prevailing values of a community and to tailor the notice accordingly.
5) *Select an appropriate communication approach:* The choice of an oral, written, or visual communication (or a combination of these methods) will depend on the target population and the impact one seeks to make with the notice.
6) *Public relations:* In some situations, public health agencies may decide to inform the general population through press releases or press conferences if they feel that the EA process does not provide a means of highlighting significant health impacts. With this approach, which can include all types of media (newspapers, radio, and television), it is easy to convey a message to a very large audience; this, in turn, can have an impact on the EA process.

A.3.2.3 Credibility

Credibility, for a person or organization, is based on a number of principles, the most important of which are the following:

1) Perform the work in accordance with recognized scientific information and methods.
2) Avoid all forms of discrimination.
3) Show discretion and respect for the rules of confidentiality.
4) Exercise functions in an impartial manner.
5) Avoid any real or apparent conflict of interest.

A.3.3 Checklist for Step 3

A.3.3.1 The Communicator

The communicator chosen to orally deliver the content of the notice meets the following criteria:

- demonstrates empathy;
- has the requisite competence and expertise;
- is capable of showing openness; and
- has some experience with this type of work.

A.3.3.2 Risk Expression

- Have numerical values been adapted in order to make them more accessible to the general population?
- Has any uncertainty (associated with obtaining the values or with extrapolations) been taken into account so it can be divulged?

A.3.3.3 Communication Strategy

- Verify and validate each step in the communication strategy, as indicated in Table A-10.

Table A-10
Communication Strategy

Step	Being Prepared or Submitted for Study	Completed or Choice Made
Content of the notice		
Identification of objectives		
Sociocultural context taken into account		
Method of communication (written, oral, etc.)		
Public relations (press conference, press release, etc.)		

B

Appendix B: Detailed Matrices of Risks and Benefits

Table B-1
Matrix of Health Impacts: Biophysical Environment and Health Component

STRESSOR/ EXPOSURE	Nature of Stressor	Impact on Environment	Affected Area	Control Measures	Standards or Recommendations	Effects on Health	Population at Risk	Probability of Occurrence	Biological/ Environmental Monitoring Indicators	Information/ References
Technological Disaster										
Gaseous Emissions or Emissions to Air										
Liquid Emissions or Emissions to Water										
Solid Emissions or Emissions to Soil										
Nuisances										

Table B-2
Matrix of Health Impacts: Determinants of Health (Except for Biophysical Aspects) and Quality of Life Component

Determinant	Impact	Area of Influence	Population Concerned	Probability of Occurrence	Control Measures	Health Effects
Socioeconomic Aspects						
Income						
Employment **- short term** **- long term**						
Health Services and Infrastructure						
Education/Training						
Social Support Networks						
Personal Health Practices						
Healthy Child Development						
Quality of Life						
Perception						
Landscape						
Recreational Uses						
Cultural Activity						

B.1 Impact Assessment Descriptors

Six descriptors are used to assess impacts on socioeconomic and quality of life determinants: impact, area of influence, affected population or organisms, probability of occurrence, mitigation measures, and health effects. The terms used to describe socioeconomic impacts are frequently qualitative in nature since, unlike biophysical impacts, they are difficult to quantify.

1) *Impact*: A project's impact is defined using the following terms: negative (-), neutral (0), or positive (+); in many cases, there are multiple impacts (including a range of negative, neutral, or positive effects).

2) *Area of Influence:* Defined using the terms “local” (small towns or small cities) and “regional” (encompassing several municipalities, counties, or administrative regions); an impact can have several areas of influence at the same time.
3) *Affected Population Concerned:* A range of terms is used, depending on the nature of the project. The most common are workers, unemployed workers, fishers, hunters, Aboriginal people, environmental groups, chambers of commerce, municipalities, provinces/territories, hospitals, dispensaries, clinics, and tourism organizations.
4) *Probability of Occurrence of an Impact:* Described as probable (+), very probable (++), or highly probable (+++).
5) *Control Measures:* A range of terms and expressions is used, depending on the nature of the project.
6) *Health Effects:* These are described and defined using the same terms as those used with respect to the type of impact (i.e., negative, neutral, or positive; or indeterminate, as the case may be); as well as a number of generic expressions (stress, anxiety, psychological distress) or appropriate qualifiers (which vary depending on the nature of the project).

In some cases, the terms “not applicable” (N/A) and “not determinable” or “indeterminate” (N/D) are used when it is impossible to qualify or quantify an effect on the descriptor.

B.2 Definitions of Determinants Used

Impacts on determinants of health include the entire range of effects described as positive or negative, direct or indirect, and perceptible or significant by the social stakeholders associated with a given project, program, or policy. A number of variables also come into play, either singly or in combination, to produce effects that influence the health, quality of life, and well-being of individuals and communities. The variables deemed to be the most important are socioeconomic (employment, income, infrastructure investments, access to services, natural resources, and leisure); cultural (traditions, values, and the like); or psychological (perception of risk, stress, psychological distress, etc.).

B.2.1 Socioeconomic Factors

B.2.1.1 Income

Generally speaking, income is directly linked to the ability to secure employment and is therefore connected with the “employment” variable. It has been demonstrated that health status improves as income rises to a given level (which varies, based on regional and cultural factors). Moreover, the greater people’s incomes, the more likely they are to consider themselves healthy, a perception confirmed by the disparities observed between areas inhabited by the wealthy and those inhabited by the poor. Problems linked to income distribution within a community can also emerge over time.

B.2.1.2 Employment

Development projects can frequently have a positive impact on employment at the local or regional level. However, it is important to distinguish between temporary (short-term) jobs, which are normally associated with the construction phase of a project, and permanent (long-term) jobs, which are more commonly associated with the operational aspects of a given project. Some projects, such as those involving the construction of roads, hydro-electric dams, or power lines, can have a positive effect during the construction phase, followed by a neutral effect later on if, for example, the maintenance of facilities is not entrusted to local or regional workers. Projects that generate permanent jobs may require the hiring of skilled workers from outside the region, which, in the long term, can have a neutral or even negative effect (depending on the perception of the population).

It is generally recognized that unemployment and underemployment are associated with health problems. Lack of stable employment is associated with increased levels of psychological distress, not only for the people affected, but also for their families and communities. Unemployment is also linked to more frequent use of health care services, as well as a number of morbidity factors, such as anxiety and depression. Conversely, work-related stress, the pace of work, and the opportunity to make decisions (or lack thereof) can also have positive or negative effects. Certain lifestyle changes (e.g., diet, sedentariness, addiction) are also associated with different types of employment.

B.2.1.3 Infrastructure

Infrastructure includes services that are essential to the proper functioning of society, such as material infrastructure (e.g., distribution of drinking water, sewage systems, roads), as well as so-called soft infrastructure, such as fire prevention and police services. Some projects may trigger the development of various forms of infrastructure (roads, professional service centres, waterworks, sewage systems, etc.), which generally have a positive impact on quality of life. Infrastructure can also have a negative effect, such as when unchecked development leads to sprawl and, frequently, to higher municipal taxes.

B.2.1.4 Health Services

Health care services are provided by a range of institutions, including hospitals, medical clinics, community health centres, and dispensaries (with the latter being largely found in remote or northern areas). Development projects generally have little impact during the construction phase, aside from a temporary increase in the supply of health services. In remote areas, however, a project may have an impact arising from the fact that work camps frequently offer more elaborate health services: if the local population has access to these services, the impact will be positive. A project that generates large numbers of permanent jobs can lead to a permanent increase in health care services, in both quantitative terms (increase in the number of services) and qualitative terms (introduction of specialized services). Access to health care services can prevent illness, reduce pain and suffering, and restore well-being and social functioning. However, the services that have the greatest impact on long-term health are preventive care, perinatal care, and early childhood care (see the determinant “healthy child development”).

B.2.1.5 Education

A development project can have various impacts on education. For example, the presence of large numbers of permanent jobs may lead to the construction of educational institutions (primary and secondary schools, colleges, or pre-university), libraries, and cultural facilities, all of which promote the intellectual development of the community. In addition, the presence of large numbers of highly educated persons (as in the case of a project that requires highly specialized personnel) may encourage institutions to offer training to the communities located at a distance from their main campuses. It has been shown that higher educational attainment is positively associated with health status. This is because education offers individuals the knowledge and skills they need to solve problems and take charge of their lives. An increase in the number of educational institutions is associated with increased opportunities to secure good-quality employment.

B.2.1.6 Social Support Networks

Social support networks include families and friends who provide needed emotional support, as well as the social environment of schools and workplaces. Development projects can have a positive impact on these networks if they generate employment and income over the long term. However, the presence or persistence of opposition to a project on the part of some groups within a community can have a transformative effect on social support networks. Indeed, projects that give rise to vigorous opposition are likely to have a negative impact on social support networks. Examples of such projects would include landfill sites, industrialized agricultural production (livestock in particular), pesticide use, and highly polluting industries.

Social support networks are important because they help individuals to overcome health problems and other difficulties. A social environment that encourages and reinforces good personal health practices and informed choices, as well as healthy behaviours and coping skills, is crucial to good health. Lack of social interaction can lead to unhealthy personal health practices, such as alcohol abuse, smoking, and poor eating habits (see the following determinant).

B.2.1.7 Personal Health Practices and Coping Skills

Personal health practices encompass diet, physical fitness, and tobacco, alcohol, and drug consumption. The habits and customs of daily life also fall under the heading of personal health practices. Coping refers to the ways in which people react to stress and the events of daily life, as well as to their capacity for self-reliance and their ability to solve problems. Many kinds of projects can have a negative effect on personal health practices. In the last 30 years, the most commonly cited example has been the construction of hydro-electric dams, which have submerged vast areas of Aboriginal territory. These projects have frequently and substantially transformed the hunting, fishing, and traditional plant-gathering habits of Aboriginal peoples. In many instances, the replacement of traditional diets with industrially processed foods has had a deleterious effect on the health of Aboriginal people. In a different context, road construction projects that lead to higher speed limits and increased traffic can have an impact on the habits of pedestrians or the recreational activities of children. Projects that generate foul-smelling emissions may cause affected individuals to remain indoors, thus limiting their outdoor activities. It has been shown that foul odours can induce stress and psychological distress over time.

Adaptation to change can sometimes take a long time. Older people may experience greater difficulty in adapting; there are also individuals of all ages who refuse to adapt because they view the destruction or modification of their environment as unacceptable. The inability to adapt or to cope can be a source of psychological distress, resulting, over time, in somatic manifestations and health problems.

B.2.1.8 Healthy Child Development

Prenatal care, early childhood experiences, and the related issue of parental competence have a powerful effect on health and well-being in later life. Studies have shown that the physical and emotional care that children receive influence their ability to cope, as well as their health throughout their lives. Healthy child development is also associated with other determinants, such as family income or the income of mothers; low income is associated with low birth weights and dietary deficiencies in early life, as well as with family health practices that are detrimental to child development. Generally speaking, the impact of development projects on healthy child development is felt indirectly and manifests itself after several years. A project that has a negative impact on one or more of the determinants presented above is also likely to have a negative influence on child development. Conversely, a project whose (direct or indirect) impact is to improve the income of mothers, as well as early childhood services, will quickly produce positive effects with respect to this determinant.

B.2.2 Quality of Life

B.2.2.1 Perception

Perception refers to the manner in which a project is viewed by those who live within the zone of influence or are likely to be affected in some way. As stated in the definition of the "social support networks" determinant, a community's perception of a project can be negative or positive. In most cases, it is a combination of the two, a fact that often leads to conflict. Projects that promise no significant long-term benefits (such as permanent jobs) but are likely to cause pollution are generally not well received by communities. Projects to build livestock production facilities, waste management sites, or nuclear power stations are almost always perceived in a very negative light.

B.2.2.2 Landscape

This aspect refers to the natural environment and its visual appearance; it encompasses mountain and forest zones, public parks, urban green spaces, and lakes and waterways. An appealing natural environment gives people a place to enjoy recreational as well as more contemplative activities. In turn, these activities produce a relaxing or calming effect. The ever-increasing popularity of wilderness areas and outdoor activities (camping, canoeing, mountain climbing, etc.) bear witness to the importance of the natural environment in people's lives. The term "landscape" can be applied to the built environment as well, particularly in cases where heritage buildings or cultural facilities are affected. Agricultural land can also be considered part of the landscape; indeed, during the growing season, it is viewed by many as having an aesthetic value equal to that of wilderness areas. Some kinds of projects, particularly those of a linear nature (e.g., roads, power lines, above-ground oil and gas pipelines) generally have a negative impact on the landscape. In addition to being visually unappealing, the destruction of the natural environment can lower property values. A person's subjective perception of the landscape is influenced by a number of variables, including age, income, and gender.

B.2.2.3 Recreational Use

Recreation takes many forms, including aquatic and outdoor activities, the use of public parks, and sport hunting and fishing. Areas that have an undeveloped recreational potential must also be taken into account when a project is being submitted. The disturbance or limitation of recreational uses should be viewed as a negative impact on quality of life. In some cases, a project can make it possible to develop recreational activities that were previously not possible. The use of artificial reservoirs for recreational purposes should be viewed as having a positive effect.

B.2.2.4 Cultural Activity

In Canada, development projects frequently threaten cultural activities on Aboriginal territories. These are generally activities that involve sacred places or sites specifically used for periodic traditional gatherings. Old cemeteries and Aboriginal burial sites should also be included in this category. In non-Aboriginal communities, cultural uses include any structure that has a heritage or cultural value (e.g., heritage buildings), as well as sites such as old cemeteries.

C

Appendix C: Health Canada's Underlying Principles of Risk Management

[Source: Adapted from Health Canada, 2000; http://www.hc-sc.gc.ca/hpfb-dgpsa/hcrisk_e.pdf]

A number of principles underlie the risk management decision-making process and provide a general basis for decisions made and actions taken. A key difference between the revised approach and that embodied in earlier frameworks is the formalization of a number of such principles and the more consistent integration of these principles in the steps of the decision-making process.

The principles described below reflect Health Canada's current decision-making philosophy. The principles respond to the changes in the operating environment, as well as other values that have been emphasized in both internal and external consultations. Some of the principles are based on ideas from other sources. The principles are interrelated and must be applied in a cohesive fashion.

In practice, many of these principles have been evolving over the last several years as Health Canada and the provinces/territories have striven to continuously improve the policy development and decision-making process. Defining these principles in an explicit way, as a key element of the revised approach, can help to ensure a common understanding among individuals who participate in, are interested in, or are affected by the risk management decision-making process; as well as to ensure that the principles are implemented in a more consistent manner across all health protection programs.

While every attempt should be made to apply the various principles below to specific risk issues and situations, it should be noted that their application may be limited in certain instances due to legislative or other requirements or restrictions.

Underlying Principles

1) Maintain and improve health (this is the primary objective).
2) Involve interested and affected parties.
3) Communicate effectively.
4) Take a broad perspective.
5) Take a population health approach.
6) Take a collaborative and integrated approach.
7) Make effective use of sound science advice.
8) Take a "precautionary" approach.
9) Tailor the process to the issue and its context.
10) Clearly define roles, responsibilities, and accountabilities.
11) Strive to make the process transparent.

1) Maintain and Improve Health

Give health and safety precedence over economic and other considerations when making risk management decisions. Balance the health and safety of Canadians with the right of individuals to make personal choices. Where these two interests are at odds, decisions must always favour the former over the latter.

2) Involve Interested and Affected Parties

Provide adequate opportunities for affected and interested parties to be involved in the risk management decision-making process. This includes the decision as to whether to apply a precautionary approach and which provisional risk management strategy should be implemented.

Involvement means providing individuals and groups with access to relevant information and giving them the opportunity to express their views and to influence policy decisions. It does not mean that unelected, unaccountable members of the public or other groups can make decisions. The nature and extent of the involvement may vary depending on a number of factors, including whether there is a need for a quick response (e.g., in an epidemic) and the level of resources available, and may range from active participation to ensuring that concerns are sufficiently addressed or that information is disseminated. Providing opportunities for involvement can build trust, lend credibility to decisions, and provide access to critical information. In order to be effective, the process for involvement must be clear, explicit, and carried out in a systematic way.

3) Communicate Effectively

Provide clear, accurate, relevant information to interested and affected parties in a timely manner, using a format that is useful and easily accessible to them. Communication is a two-way process and includes developing an understanding of the needs of interested and affected parties, reacting to concerns, and informing, consulting, and educating. An important aspect of effective communication is providing individuals with enough information to allow them to contribute to the decision-making process in an informed way. The specific nature and extent of this communication vary, as do the nature and extent of public involvement.

Health professionals have a responsibility to inform and educate Canadians about risks to their health and the process that is being used to assess and manage these risks. This includes helping individuals to understand that every choice brings with it some degree of risk and that certain risks are shared by society as a whole. It also includes providing information that allows individuals to make their own decisions on matters that concern their health, particularly when the degree of risk is low and the information is readily accessible. When possible, it also includes providing opportunities for individuals to contribute to the risk management decision-making process by expressing their concerns and perspectives and by providing knowledge and expertise that can help to shape the process and the decisions made.

Effective communication is especially important in cases where there are large discrepancies between perceptions and scientific assessments of risk. Special care must be taken when communicating with groups whose first language is neither English nor French, to ensure that their concerns are understood and that risk messages are communicated in an understandable manner.

4) Take a Broad Perspective

To the greatest extent possible, take into account a variety of information when identifying, assessing, and managing risks, while maintaining a focus on health and safety. A sufficiently broad understanding of the issue and its context is key to focusing risk assessment efforts, identifying risk management goals, selecting efficient and effective strategies, and appropriately allocating resources.

Risk assessment must be sufficiently broad to ensure adequate understanding of the risk and to identify effective risk management options. Where possible, assessments must take into account both data from "scientific" studies and information on determinants of health (e.g., social, cultural, ethical considerations; economic status), where these determinants are demonstrated to have an effect on the level of risk for specific populations.

Risk management decisions must consider a variety of information in order to ensure that the best risk management strategy is selected and that it is implemented in an effective manner. The expected effectiveness of potential risk management options and legislative, international trade, or other requirements and limitations are obviously key considerations. Taking a broad perspective means also taking into account factors such as risks vs. benefits; potential social, cultural, ethical, political, environmental, legal, economic, and other impacts; and the perspectives of interested and affected parties.

While it is important to strive for a broad perspective, it should be noted that the extent to which this is possible may be limited by existing legislation, which, obviously, takes precedence.

5) Take a Population Health Approach

As indicated earlier, "determinants of health" is the collective label given to factors and conditions that are thought to have an influence on health. These include income and social status; social support networks; education, employment, and working conditions; social and physical environments; personal health practices; and coping skills. Some determinants play a more prominent role than others for given health issues and interact in complex ways to affect population health.

Taking a population health approach involves focusing on the health of the population as a whole and on the health of subgroups within the population, by addressing factors that contribute to health and their complex interactions. The approach addresses not only the physiological, psychological, and behavioural components of health, but also the entire range of factors that contribute to our physical, mental, and social well-being. The overall goal of a population health approach is to maintain and improve the health status of the entire population while reducing inequalities in health status among population subgroups.

6) Take a Collaborative and Integrated Approach

Take a collaborative and integrated approach to identifying issues and assessing and managing risks. The volume and complexity of information, and the cross-cutting nature of many risk issues (e.g., contaminants in air, water, and food), make it impossible for a single individual or group to maintain the necessary expertise to deal with most health risks of concern to the Department. Working together can increase efficiency, effectiveness, and consistency of decisions; reduce duplication of effort; and identify gaps in science and policy.

Maintain sufficient in-house expertise to support policy making, to implement regulations, to set standards and regulations, and to respond to emerging health issues. To supplement this, take advantage of the expertise that exists within other national and international organizations, including those involved in health protection, academia, and industry. Do not duplicate existing efforts where these meet the level of scientific and health protection standards of your organization, taking current jurisdictional constraints into account.

7) Make Effective Use of Sound Science Advice

Success in improving and maintaining our health requires an evidence-based approach to decision-making. This can only be achieved by making effective use of sound science advice. Such an approach helps to address public confidence that decision-makers are using science in the best interests of Canadians, that science advice is credible, and that decision-makers are confident that this advice is based on a rigorous and objective assessment of all available information. In order to achieve these goals, the decision-making process must include measures to ensure the quality, integrity, and objectivity of science advice.

8) Take a "Precautionary" Approach

A key feature of health risk management is that decisions are often made against a backdrop of considerable scientific uncertainty. A precautionary approach to decision-making emphasizes the need to take timely and appropriately preventive action, even in the absence of a full scientific demonstration of cause and effect. This emphasis in decision-making is reflected in the final report of the Krever Commission of Inquiry, which concludes that a lack of full scientific certainty should not be used as a reason not to take preventive measures when reasonable evidence indicates that a situation could cause some significant adverse health effect.

This general concept has been expressed in a variety of contexts, especially in the area of environmental protection. The most widely quoted is Principle 15 of the Declaration of the Rio Conference on Environment and Development (1992). In the Canadian context, the *Canadian Environmental Protection Act, 1999* provides that:

> "…the government of Canada is committed to implementing the precautionary principle that, where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

There is considerable debate, both nationally and internationally, over the use of the phrases “precautionary approach” and “precautionary principle.” No definition is universally accepted. The Health Canada Decision-making Framework treats the concept of precaution as pervasive. As such, it does not require extremes in the actions taken. Instead, risk management strategies reflect the context and nature of the issue, including the urgency, scope, and level of action required.

9) Tailor the Process to the Issue and Its Context

Maintain flexibility throughout the risk management decision-making process. Using a flexible approach can lead to more effective and more acceptable risk management decisions. While recognizing that there are urgent situations that require quick action, the emphasis on timeliness and flexibility should never be at the cost of thorough and thoughtful, even if rapid, consideration of the steps and considerations identified in the framework.

Using a flexible approach includes:

- undertaking the process in a way that is best suited to different agents and situations;
- limiting the depth and breadth of the process to take into account the requirement for a timely response;
- revisiting previous steps when new findings provide important insights related to earlier deliberations and decisions;
- incorporating significant new information that may emerge throughout the process or following evaluation;
- using a variety of risk management options and levels of response, as needed, to provide a given level of health protection; and
- revisiting decisions periodically to determine whether a revised risk management approach or strategy is needed.

Using a flexible approach may also involve implementing a “two-track” process in certain situations. Such a process could include a reactive and timely response, involving an interim risk management strategy; and the pro-active, systematic development of a longer-term strategy that enhances the organization’s capacity to anticipate, prevent, and respond to new instances of the risk issue. Using a two-track approach allows the decision-making process to move forward without having to delay necessary action until more comprehensive work is done.

10) Clearly Define Roles, Responsibilities, and Accountabilities

Clearly define the roles, responsibilities, and accountabilities of all parties who participate in the risk management decision-making process. This includes identifying who is responsible for undertaking comprehensive risk assessments in cases where precautionary action has been implemented. Clearly delineating roles, responsibilities, and accountabilities helps to ensure that participants and other interested and affected parties know what is expected and what commitments have been made and thereby can lead to more efficient and effective risk management strategies. It also helps in the allocation of resources.

The responsibility for improving and maintaining health is one shared by individuals, communities, industry, and all levels of government. Health Canada has a primary role in protecting the health and safety of Canadians at the national level; however, it is but one component of a complex system of health protection, which includes, among others, various levels of government, government agencies, the health care and medical professions, the academic and health sciences research and development communities, manufacturers and importers, consumer groups, and individual Canadians. This makes it important to identify potential conflicts (e.g., conflicting regulations and overlapping jurisdictions of governments and related agencies), to eliminate gaps, and to ensure that health protection programs are delivered seamlessly across the country. It is also important to be specific about accountabilities, especially when there is shared responsibility, and to avoid giving the impression that a single organization is accountable for matters outside the organization's mandate or jurisdiction.

In addition to specifying the roles of various organizations, it is necessary to differentiate between the roles of scientists and policy-makers. While both may contribute to issue identification, their primary roles are to undertake risk assessment and risk management, respectively. The role of scientists is to assess risk based on the science (both biophysical data and information on risk factors) and to identify potential risk management options that are related to the level of risk. The role of policy-makers is to consider the results of risk assessments, together with a broad range of other considerations, and to use this information to make risk management decisions.

11) Strive to Make the Process Transparent

Clearly document all activities, considerations, assumptions, uncertainties, and decisions, to ensure that all aspects of the risk management decision-making process are clear and easily understandable. Bearing in mind any requirements for confidentiality, make this information accessible to interested and affected parties. Individuals who review the documentation should be able to understand how and why things were done, what decision-making processes were used, and who is accountable and responsible for various activities and decisions. Although it is important to maintain clear and comprehensive documentation, the extent of documentation needs to be balanced by resources and priorities, especially when the timeliness of the response is a key factor.

D

Appendix D: Glossary (Volumes 1-4)

Abiotic: 1) Having no life; lifeless; 2) independent of the vital processes of a living organism.

Actinomycetes: Any one of a group of bacteria found in soil that are structurally similar to certain fungi. Antibiotics such as streptomycin and chloramphenicol are derived from some actinomycetes.

Acute (toxicity): Toxicity manifested within a relatively short time interval after toxicant exposure (i.e., as short as a few minutes to as long as several days). Such toxicity is usually caused by a single exposure to the toxicant.

Adenocarcinoma: A cancer that originates in the epithelium (a thin layer or layers of cells forming a tissue that covers surfaces of the body and lines hollow organs) of a gland or duct.

Adenosine triphosphate (ATP): A compound found in the cells of organisms and consisting of adenosine and three phosphate groups. The removal of phosphate releases large amounts of energy for use in biological reactions or processes such as muscle contraction and the metabolism of sugars.

***Alternaria*:** Any one of a genus of fungi that cause fruit and vegetable blight, mould, or rot.

Alveolitis: Inflammation of the alveoli (the small air sacs of the lungs, where exchange of gases (oxygen, carbon dioxide) occurs.

Anadromous species: Species that travel up rivers from the sea to spawn (e.g., of salmon and shad).

Anaerobic bacteria: 1) Bacteria that can live without free oxygen or bacteria that cannot live in the presence of oxygen; 2) bacteria living, growing, or residing where there is no free oxygen. Some anaerobic bacteria get their oxygen from the matter released during fermentation, which takes place in the absence of free oxygen.

Anuria: The absence of urine; the inability to urinate.

Aplastic anemia: A severe anemia caused by failure of the bone marrow to produce various blood elements, such as red blood cells, as a result of exposure to, for example, certain antibiotic drugs, poisons, or ionizing radiation (e.g., large doses of X-rays), or for unknown reasons.

Audiometry: The testing of the sense of hearing.

Auxin hormone: Any hormone of a group synthesized in the protoplasm of the young, active parts of plants, which regulates plant growth and development.

Baseline status: Refers to the conditions prior to the construction and/or preparation of the development/remediation project.

Benefit transfer technique: An economic tool that uses estimates from existing research to valuate the potential health benefits and detriments of development project scenarios under consideration. The main advantage of benefit transfer is that the process is less expensive and time consuming than primary valuation techniques. The benefit transfer technique consists of five steps: 1) describe the project case; 2) identify relevant studies; 3) review relevant studies for quality and applicability; 4) transfer the benefit estimates; and 5) address uncertainty.

Bioaccumulation: Occurs when a substance is assimilated into an organism through eating another organism (plant or animal). Depending on the substance, it may be passed through the body fairly quickly or it may accumulate (concentrate) in certain tissues or organs. Small animals bioaccumulate toxic substances, for example, by feeding on smaller organisms, and as they in turn are eaten by larger animals, they pass the absorbed contaminants along to the next higher level in the food web.

Bioaerosol: A suspension of airborne particles, large molecules, or volatile compounds that are living or were released from a living organism; also defined as a suspension of non-viable microbial cells with which endotoxins can be associated. Individual aerosol particles range from submicroscopic (<0.1 µm) to greater than 100 µm in diameter.

Biological monitoring: A tool used to assess environmental or occupational exposures and involving the analysis of appropriate bodily fluids (e.g., blood, urine, exhaled breath) or tissues and comparing the results with guideline values such as maximum acceptable concentrations (MACs) or biological exposure indices (BEIs).

Biomagnification: The increase in the concentration of toxic chemicals with each new link in the food chain. For example, a pesticide sprayed on vegetation can concentrate in the fat of animals and fish that eat vegetation and then is further concentrated in the fat of meat and fish eaters, resulting in an overall biomagnification of the chemical.

Boundaries: Spatial boundaries are set on the basis of the geographical limits of project impacts. Temporal boundaries deal with the timing and the life span of the impacts arising from the project. Jurisdictional boundaries refer to the legal requirements to which the project must adhere.

Calcination: The act or operation of calcining – i.e., burning or incinerating (something) to ashes or powder.

Canadian Environmental Assessment Agency: Federal government organization that administers the *Canadian Environmental Assessment Act* and reports directly to the Minister of the Environment.

Carboxyhemoglobin: The compound formed in the blood when inhaled carbon monoxide combines with hemoglobin, thereby restricting the amount of oxygen that the blood can carry; the resulting condition is known as carboxyhemoglobinemia.

Case-control study: (Syn: case-referent study, case comparison study) A type of observational analytical study. Enrolment in the study is based on the presence ("case") or absence ("control") of a disease of interest. Histories of previous exposures to some suspected risk factor(s) are then compared between cases and controls, controlling for potential "confounders." Causal factors should occur more frequently among cases than among controls.

Central agency: Component of government playing a key role in the successful formulation and implementation of government policies and programs by overseeing interdepartmental mechanisms of information-sharing, consultation, and coordination. In the case of the Canadian federal government, the Privy Council Office, Treasury Board, and the Department of Finance are its central agencies.

Chronic (toxicity): The adverse effects manifested after a long period of uptake of small quantities of a toxicant. The most serious manifestation of chronic toxicity is carcinogenesis, but other types of chronic toxicity are also known (e.g., reproductive and neural effects).

Clastogenic: Causing chromosome breaks and aberrations.

Cohort: A well-defined group of people who have had a common experience or exposure and who are then followed up after entry in the cohort (e.g., date of hire, date of birth, date of moving into a neighbourhood) for the incidence of new diseases or events, as in a cohort or prospective study. A group of people born during a particular period or year is called a birth cohort.

Cohort study: (Syn: follow-up, longitudinal, or incidence study) A type of observational analytical study. Enrolment in the study is based on membership in a "cohort" and on exposure characteristics. Disease, death, or other outcome rates are ascertained over the follow-up period and are compared between different exposure subsets of the cohort.

Confounding: The undesired mixing of effects of extraneous risk factors with the main effect of the targeted risk factor(s). The influence of cofactors (e.g., smoking) biases (distorts) the observed main effect of interest (e.g., dusts and lung cancer). Confounding is usually controlled for by multivariate analysis and other statistical adjustment techniques.

Conjunctival congestion: Congestion of the conjunctiva, the mucous membrane that covers the front of the eyeball and the inner surface of the eyelids.

Cost-benefit analysis (benefit-cost analysis): The principal analytical framework used to evaluate public expenditure decisions. It attempts to evaluate a project before it is undertaken to help stakeholders (in the case of environmental assessment) and decision-makers determine in what form and at what scale it should be undertaken, and indeed whether it should be undertaken at all. Cost-benefit analysis involves the following steps: 1) identification of the project or projects to be analysed; 2) enumeration of all project impacts, both favourable and unfavourable, present and future, on all members of the public (e.g., a community) if a particular project is adopted; 3) valuation of these impacts in monetary terms (favourable impacts are registered as benefits, and unfavourable impacts as costs); and 4) calculation of the project's net benefits (total benefits minus total costs).

Country foods: Foods that are harvested by hunting, trapping, or fishing; and produce such as that grown in vegetable gardens and orchards or collected from naturally occurring sources (e.g., wild berries).

Creatinine: A constituent of urine produced by the breakdown of creatine (a compound found chiefly in the muscles of vertebrate animals, which is involved with supplying energy for voluntary muscle contraction); also found in blood, muscle, plants, soil, etc.

Cross-sectional study: (Syn: prevalence study) An observational study in which the presence of exposure and the presence of disease (or other health-related variables) are ascertained simultaneously at the time of the study. Participants are sampled irrespective of their disease or exposure status. While being less expensive than others, such studies have little statistical power, i.e., few cases and few people exposed. They are best used to describe prevalence of diseases or exposures in a population.

Cryptosporidiosis: A gastrointestinal infection caused by the enteric protozoan *Cryptosporidium*, usually through waterborne transmission and resulting in symptoms of gastroenteritis. The most common sources of this protozoan include domestic animals (e.g., cattle, sheep), contaminated recreational waters, drinking water treatment systems, and well and spring water.

Decibel (dB): A unit for measuring the relative intensity of sounds, equal to 1/10 of a bel. The decibel scale used for this measurement is logarithmic, with every 3-dB increase indicating a doubling of noise intensity. The term dBA is the dB sound pressure level filtered through an A filtering network to approximate human hearing response at low frequencies. The decibel is also used to describe levels of sound power and is the logarithm of sound power level. A two-fold increase in the power output of a source will result in a 3-dB increase in power level and correspondingly a 3-dB increase in sound power level at any distance from the source. Sound power level will be reduced 6 dB for every doubling of distance from a source.

Decision-makers: Persons (e.g., cabinet ministers, senior officials, regulatory authorities, etc.) who help determine if a project should be permitted to proceed.

Determinants of health: Interacting factors that influence the health status of individuals and populations and that determine health differentials and inequalities. These factors are many and varied and include biology and genetic endowment, income and social status, social support networks, education, employment and working conditions, physical environment, personal health practices and coping skills, healthy child development, and health services. These determinants of health are interlinked, and differentials in their distribution lead to health disparities in a given population.

Distributional analysis: An economic analytical technique that evaluates the distribution of project impacts across segments of the economy. For example, an economic impact analysis might examine the impacts of a project on the revenues and profits of particular industries or on employment in those industries. Economic impact analysis can help to identify the segments of the economy within the local region that stand to gain or lose from a project's development and can also help to predict the likely distribution of impacts between geographic regions.

Dose: In the context of this volume, dose refers to the contaminant intake from the consumption of a food and is measured in units of µg/kg body weight per day. It is the product of the mean of the levels of the contaminant of potential concern found in the food (C_f in µg/g) and the rate of consumption of the food (IR_f, in g/day), divided by body weight (BW, in kg); i.e., Dose = $C_f \times IR_f$ / BW.

Dyspnea: Difficult or laboured breathing.

Ecological bias and fallacy: The relationship observed between variables at an aggregate level in an ecological study does not necessarily represent the relationship that exists at an individual level. This phenomenon is said to result from an ecological bias. Inferring that the relationships at the individual level are the same as those observed at an aggregate level is called the "ecological fallacy" (an error of inference due to failure to distinguish between different levels of organization). One must be extremely careful in making inferences or generalizations about individuals based on ecological studies.

Ecological risk: The toxicological risk to an ecosystem.

Ecological study: (Syn: aggregate study, correlational study) A type of observational study in which the units of observation are populations or groups of people rather than individuals. The question asked is: Do geographical populations with a higher occurrence of a specific exposure tend also to be those with a higher occurrence of health outcomes or mortality? In ecological studies, data on aggregate measures (averages or rates) of exposure and of health outcomes are obtained for each "ecological unit of analysis" (i.e., geographically and chronologically defined populations), and the relationship between the summary exposure and outcome measures is analysed across ecological units. Ecological studies are often a preliminary step in investigating a suspected exposure-outcome relationship, particularly in the investigation of environmental health impacts, and the results from these studies should be confirmed by cohort, case-control, or cross-sectional studies.

Ecosystem: A biological community of interacting organisms and their physical environment.

Endocarditis: Inflammation of the endocardium (i.e., the smooth membrane that lines the cavities of the heart).

Endospore: 1) The inner coat or wall of a spore of certain plants; endosporium; 2) a spore formed within a cell of certain bacteria.

Endotoxin: A toxic substance that remains inside the organism (e.g., bacteria) that produces it. Endotoxins are cell wall components of Gram-negative bacteria and are inherently toxic and can lead to various problems, but this occurs mainly when they are present in very high concentrations or when the microorganisms that produce them are viable.

Enterobacteria: Intestinal bacteria, especially those belonging to a large family of rod-shaped coliform bacteria that includes the genera *Escherichia* (e.g., *E. coli*) and *Klebsiella*.

Enterotoxin: An intestinal toxin produced by certain bacteria that causes symptoms of food poisoning.

Environment: Refers to the components of the Earth and includes: 1) land, water, and air, including all layers of the atmosphere; 2) all organic and inorganic matter and living organisms; 3) the social, economic, recreational, cultural, spiritual, and aesthetic conditions and factors that influence the life of humans and communities; and 4) a part or combination of those things referred to in 1) and 3) and the interrelationships between two or more of them.

Environmental assessment: A comprehensive and systematic process designed to identify, analyse, and evaluate the environmental effects of a project in a public and participatory manner. Environmental assessment involves the use of technical experts, research and analysis, issue identification, specification of information requirements, data gathering and interpretation, impact prediction, development of mitigation proposals, external consultations, and report preparation and review. In this Handbook, the term “environmental assessment” is used synonymously with “environmental impact assessment,” “impact assessment,” etc.

The International Association for Impact Assessment defines environmental impact assessment as the process of identifying, predicting, evaluating, and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made.

Environmental assessment practitioner: Someone who is involved in the environmental assessment process (i.e., government employee, knowledgeable person in the environmental assessment field, etc.).

Environmental audit: An internal evaluation by a company or government agency, to verify its compliance with legal requirements as well as its own internal policies and standards. It is carried out by either outside consultants or employees of the company or facility from outside the work unit being audited. Audits can identify compliance problems, weaknesses in management systems, or areas of risk. The findings are documented in a written report.

Environmental effect: Any change that the project may cause in the environment, including any change it may cause to a listed wildlife species, its critical habitat or the residences of individuals of that species, as those terms are defined in subsection 2(1) of the *Species at Risk Act*; and including any effect of any such changes on health and socioeconomic conditions, on physical and cultural heritage, on the current use of lands and resources for traditional purposes by Aboriginal persons, or on any structure, site, or thing that is of historical, archaeological, paleontological, or architectural significance.

Environmental epidemiology: The application of epidemiology to suspected environmental health problems. It seeks to determine whether a link exists between diseases or health outcomes and environmental factors. Environmental epidemiological studies are used to assess the health status of populations exposed to suspected environmental sources of pollution and to identify potential health problems; to identify more vulnerable subgroups within environmentally exposed populations; to assess the health risks or effects of environmental exposures; and to assess the contribution of environmental factors to suspected environmental diseases, deaths, or other health conditions.

Epidemiology: The study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems.

Equity assessment: An economic technique that examines the distribution of project impacts on different segments of society – i.e., across a range of demographic variables, such as income group, race or ethnicity, age, gender, and others. Equity assessments are often designed to provide information on how a project is likely to affect groups that are significantly disadvantaged (e.g., low-income households) or particularly vulnerable to adverse impacts (e.g., children or the elderly).

Erysipeloid: 1) An infectious disease, resembling erysipelas (an acute infectious disease that causes fever and chills and a rapid spreading, deep-red inflammation of the skin, caused by streptococcus), but not attended with fever, contracted by people who handle animals infected with erysipelas; 2) an acute or chronic bacterial disease of hogs, and less commonly of turkeys and sheep, characterized by enteritis, red patches on the skin, and arthritis.

Eutrophication: The accumulation of nutrients in lakes and other bodies of water, causing rapid growth of algae, which deplete the water of oxygen.

Experimental study: A study in which the investigator specifies (ideally by random allocation) the exposure category for each individual (clinical trial) or community (community trial), then follows the individuals or community to detect the effects of the exposure. Only therapeutic and preventive experimental studies can ethically be conducted on human individuals or communities. Hence, epidemiological studies conducted under health impact assessments rely on "observational" and not on experimental epidemiological studies.

Exposure ratio (ER): Also termed the Hazard Index, it is the ratio of the dose (i.e., contaminant intake from food consumption, in µg/kg body weight per day) and the toxicological reference value (TRV, also in µg/kg body weight per day) for a specific contaminant; i.e., ER = Dose/TRV.

Fetotoxic: Toxic to the fetus or embryo.

Fluorosis (dental): A disease condition characterized by a mottled tooth enamel and caused by the ingestion of excessive amounts of fluorine in drinking water. Fluorosis negatively affects tooth development, particularly in children less than six years of age, and, on a longer-term basis, leads to osteoporosis.

Genotoxic: Toxic to the genetic material (i.e., genes, made up of DNA) in an organism's cells.

Genotoxic carcinogens: Cancer-causing agents that are toxic to the genetic material (i.e., genes made up of DNA) in an organism's cells.

Giardiasis: An infection caused by the protozoan parasite *Giardia lamblia* and characterized by a form of gastroenteritis known as beaver fever. This enteric pathogen is the most commonly implicated agent in waterborne disease outbreaks in North America and other parts of the world. A waterborne outbreak often occurs as a result of human or animal fecal contamination of a water supply. Natural hosts include beaver, muskrat, and deer.

Government departments/ministries or agencies: The federal, provincial, and/or territorial government institutions partaking or providing guidance in the environmental assessment.

Health: Defined by the World Health Organization as a complete state of physical, mental, and social well-being and not merely the absence of disease or infirmity. Consistent with this definition, health has been defined in this Handbook in terms of its physical and sociocultural dimensions. "Health and well-being" is synonymous with this definition of "health" and has been used to emphasize the inclusion of physical health and sociocultural well-being. The Aboriginal definition of health is "obtaining and maintaining a balance of all aspects of the self – mental, emotional, spiritual, and physical – with and through the help and involvement of the family and the community."

Health impact assessment: A combination of procedures, methods, and tools by which a policy, program, or project may be judged as to its potential effects on the health of a population and the distribution of those effects within the population (see: http://www.who.int/hia).

Health professional: A person who has formal education and/or experience in how the environment and other factors can affect human health and well-being. This includes professionals in the medical field (i.e., doctors, nurses, epidemiologists, toxicologists, etc.), professors and experts in the social science field, and the occupational health and safety experts in government and industry.

Health promotion: The process of enabling people to increase control over and improve their health; and the combination of educational and environmental supports for actions and conditions of living conducive for health. "Environmental," in this context, usually refers to the social, political, economic, organizational, policy, and regulatory circumstances bearing on health and not the physical environment or the provision of medical services.

Helminthes: Parasitic worms.

Hepatitis: 1) Inflammation of the liver; 2) a contagious viral disease characterized by inflammation of the liver, fever, and usually jaundice. Infectious hepatitis is known as hepatitis A, and serum hepatitis as hepatitis B.

Hepatotoxic: Toxic to the liver.

Histological diagnosis: Medical diagnosis based on the analysis of the microscopic structure of the tissues and cells of animals and plants.

Immunosuppression: Suppression of the immune system. Immunosuppression may result from certain diseases such as AIDS or lymphoma or from certain drugs such as some of those used to treat cancer. Immunosuppression may also be deliberately induced with drugs, as in preparation for bone marrow or other organ transplantation to prevent the rejection of the transplant.

Incidence rate ratio: A measure of effect, the incidence rate ratio is the incidence rate of the health outcome in the exposed group relative to the incidence rate in the unexposed group. The incidence rate ratio is usually the preferred measure of effect because it accounts for duration of exposure and follow-up time for each member of the cohort(s).

Indigenous health impact assessment: The health impact assessment methods and approaches identified by indigenous communities in Canada. Indigenous health impact assessment is based on three concepts: 1) indigenous communities rely heavily on naturalized knowledge systems; 2) health impact assessment is very closely linked to environmental impact assessment; and 3) health impact assessment as a process depends on measurement and evaluation of health indicators, and indigenous communities themselves must develop their own specific community health indicators.

Leachate: Any substance that has undergone leaching – i.e., the dissolving out of soluble parts from, for example, ashes, ores, or other matter – by running water or other liquid through slowly; a substance subjected to the action of percolated water. The contaminated water or leachate in landfill sites is a complex, highly variable mixture, consisting of various organic and inorganic compounds and microorganisms. It is generated by precipitation or by other moisture that enters the landfill from the breakdown of organic matter or from ground water. It is generally characterized by a strong odour and dark brown colour and contains high levels of pollutants.

Life Indicators Wheel: An important part of the indigenous environmental assessment process, the Life Indicators Wheel holds that community health depends on some balance of the corporal and spiritual "opposites" and of the intellectual/visceral. Community life indicators (i.e., values, morale, responsibility, spirituality, economics, environment, politics, and religion) are represented on the perimeter of the wheel. The health of the community is the balance point in the centre of the wheel, and community health indicators are developed from one-on-one links across the centre (i.e., environment-morale, economics-values, politics-responsibility, and religion-spirituality). The Life Indicators Wheel and community health indicators reflect and support the values of cultural sustainability of traditional First Nations societies.

Lipopolysaccharide: A compound formed by a lipid (a type of fatty substance; includes fatty acids, oils, waxes, and steroids) and a polysaccharide (a complex sugar); e.g., bacterial lipopolysaccharides.

Meta-analysis or Bayesian approaches: Statistical methods used in the benefit transfer process to derive values from the study case and apply them to the project case, and which combine estimates from several studies of similar effects; the resulting estimates may be more accurate and reliable than point estimates or valuation functions. Meta-analysis can be used to integrate the results when many relevant studies are available; the Bayesian approach includes data on the project case as well as data from existing studies.

Methemoglobin: A compound that can be formed from nitrates and nitrites and that restricts or prevents transportation of oxygen by the blood, resulting in a condition known as methemoglobinemia. Ingesting water containing more than 10 mg/L of nitrates can, in the long term, promote methemoglobin formation.

Mitigation: The elimination, reduction, or control of a project's adverse environmental effects, including restitution for any damage to the environment caused by such effects through replacement, restoration, compensation, or any other means.

Mucocutaneous irritation: Irritation of the mucous membranes of the skin (e.g., the lining of the nose, throat, and other cavities of the body that are open to the air; tissue containing glands that secrete mucus; mucosa).

Multifactorial: Having many contributing causes, as in, for example, the context of disease risks.

Multiple myeloma: A very painful cancer usually affecting a number of bones, originating in bone marrow, and causing lesions of the bone and of certain soft tissues such as the kidneys.

Myeloma: A malignant tumour of the bone marrow.

Myocarditis: Inflammation of the myocardium, the muscular part of the wall of the heart.

Naturalized knowledge systems: This term is used in various contexts and generally refers to traditional indigenous or Aboriginal knowledge. A key element of indigenous health impact assessment, naturalized knowledge systems are bodies of ideas, values, and concepts that social systems use to function within their environment. This process is dynamic and cumulative – i.e., it adapts itself to new technological and socioeconomic conditions as they emerge. Naturalized knowledge systems are based on the principles of respect, equity, and empowerment. They focus on the understanding of the importance of the environmental knowledge of First Nations communities and the complexity of traditional approaches to environmental systems. Naturalized knowledge systems link the observation and appreciation of the physical world with the philosophy and attitudes created and supported by the close interaction among the environment, health, and lifestyle.

Neoplastic: Having to do with a neoplasm – i.e., a new, abnormal growth of tissue, such as a tumour.

Nephrotoxic: Toxic to the kidneys.

Net efficiency criterion: Decision-making within the context of benefit-cost analysis depends on the net efficiency criterion – i.e., in any choice situation, one selects the alternative that produces the greatest net benefit. In some cases, of course, the net benefits of all alternatives evaluated may be negative – i.e., their costs outweigh their benefits; in such cases, the best alternative is to do nothing, which produces a net benefit of $0.

Neuroendocrinological system: The physiological system having to do with the nervous system and the endocrine glands (i.e., the glands that secrete hormones directly into the blood).

Neurotoxic: Being or caused by a neurotoxin; toxic to the nervous system.

Observational study: A class of epidemiological studies that are "observational" in nature, and where nature is allowed to take its course. Changes or differences in one characteristic are studied in relation to changes or differences in others, without the intervention of the investigator. There are four types of observational studies: 1) cohort; 2) case-control; 3) cross-sectional; and 4) ecological. Each study design has its own economic and scientific advantages and disadvantages.

Occupational hygiene: Generally defined as the art and science dedicated to the anticipation, recognition, evaluation, communication, and control of environmental hazards or stressors in, or arising from, the workplace that may result in injury, illness, or impaired well-being of workers and/or members of the community. These hazards or stressors can be biological, chemical, physical, ergonomic, or psychosocial. Occupational hygiene also deals with the assessment of the extent of risk posed by the hazards and the development of effective strategies to eliminate or control the risks (risk management).

Occupational hygienist: An occupational health professional with expertise in the anticipation, recognition, evaluation, communication, and control of environmental hazards in, or arising from, the workplace that may cause injury, illness, or impaired well-being of workers and/or members of the community. These hazards can be biological, chemical, physical, ergonomic, or psychosocial. The International Commission on Occupational Health uses the term "occupational health professional" to encompass occupational health physicians and nurses, occupational hygienists, ergonomists, and safety specialists (see: http://www.crboh.ca).

Odds ratio: The standard measure of effect used in case-control studies. The odds ratio is a measure of association that quantifies the relationship between an exposure and health outcome in a comparative study; also known as the cross-product ratio. In incidence case-control studies, the odds ratio approximates the incidence rate ratio.

Oocyst: A thick-walled structure in which sporozoan zygotes develop.

Opportunity cost: Represents the value of goods and services that society loses by forgoing allocation of a resource to its best alternative use. While market prices generally reflect opportunity costs, adjustments may be necessary in certain instances – e.g., when the size of a project is so substantial that it may actually influence the market price of a resource.

Organoleptic: Using various sense organs to determine flavour, texture, or other quality.

Osteoporosis: A disease in which the bone spaces or Haversian canals become enlarged and the bones become weak and brittle. It occurs especially in elderly people, causing bones to break easily and heal slowly.

Osteosclerosis: An abnormal hardening and increased density of bone, especially at the ends or outer surface, often caused by an infection or a tumour.

Paresthesia: An abnormal sensation of prickling, tingling, or itching of the skin.

PCB congeners: Each polychlorinated biphenyl (PCB) molecule consists of two six-carbon rings with one chemical bond joining a carbon from each ring. Chlorine can attach to any of the other 10 carbons. There are 209 possible arrangements called "congeners"; congeners with the same number of chlorines are called isomers. PCB molecules with the two rings in the same plane (i.e., the two rings are not twisted) are termed "coplanar." Coplanar molecules have dioxin-like properties. There are currently 13 PCB congeners listed by the World Health Organization with interim toxic equivalent factors for human intake of dioxin-like PCBs. The potential toxicity of various PCB mixtures present in the environment varies, depending on the composition of the PCB mixture.

Pericarditis: Inflammation of the pericardium, the membranous sac enclosing the heart.

Perinatal: Of or having to do with the period of a child's life including the five months preceding birth and the first month after birth.

Prevalence ratio: The prevalence of a specific health outcome in an exposed group relative to its prevalence in an unexposed group; i.e., a comparison of two groups in terms of prevalence of the specific health outcome.

Product life cycle analysis: Analysis taking a "cradle to grave" approach to thinking about products, processes, and services. It recognizes that all product life cycle stages (extracting and processing raw materials, manufacturing, transportation and distribution, use/reuse, recycling, and waste management) have environmental and economic impacts.

Project: Any proposed physical undertaking or activity required to undergo an environmental assessment. Most environmental assessment legislation defines the types of development projects subject to environmental requirements.

Proponent: An individual, organization, or company that proposes a development project.

Psychosocial (risk): Of or involving the influence of social factors or human interactive behaviour.

Public: Local residents, environmental groups, Aboriginal people, local businesses, and other citizens. Does not include proponents or government departments (see definition of stakeholder).

Putrescible: Likely to putrefy or rot.

Pyrolysis: Chemical decomposition produced by exposure to high temperatures.

Randomized controlled trial: The ideal experimental epidemiological study design, in which individuals are randomly assigned to different preventive or therapeutic interventions and are then followed prospectively to assess any differences in outcomes between the intervention ("test") groups and the control group(s). Such randomization tends to make study groups comparable in every respect that can affect the outcome. Most often, randomized controlled trial studies are conducted "blind" – i.e., participants do not know which treatment/exposure they are receiving. Ideally, randomized controlled trials are "double blind": neither the participants nor the observers (including caregivers) know which treatment/exposure is given to whom until the end of the trial.

Receptor: Refers to the human population residing in the development/remediation project area that may be exposed to potential contaminants from the consumption of country foods. In those cases where no communities exist near the project site, receptors can be humans who frequent the area to gather country foods.

Recommended maximum weekly intake (RMWI): In the context of food consumption, it is the product of the toxicological reference value (TRV, in µg/kg body weight per day) for a specific contaminant and body weight (BW, in kg), divided by the mean of the levels of the contaminant of potential concern found in the food (C_f, in µg/g); multiplied by 7 (i.e., days in a week); that is: RMWI (in g/week) = $(TRV \times BW/C_f) \times 7$.

Regional public health authorities: Provincial/territorial or regional government bodies with responsibility to address public health concerns (e.g., Medical Officers of Health).

Relative risk: (Syn: risk ratio) A ratio of the risk of some health-related event such as disease or death among the exposed group to the risk among the unexposed group. This measure is usually used in cohort studies, and sometimes in cross-sectional studies. It is sometimes used as a synonym for "odds ratio" or "incidence rate ratio" if the disease is "rare" (i.e., incidence rate <10%).

Revealed preference methods: Economic valuation methods that are based on observed behaviours that can "reveal" the values of non-market goods based on prices and preferences for related market goods or services. Revealed preference methods include wage-risk studies, cost-of-illness studies, and averting-behaviour studies.

Risk assessment: The qualitative or quantitative estimation of the likelihood of adverse effects that may result from exposure to specified health hazards or from the absence of beneficial influences. Risk assessment attempts to calculate or estimate the risk to a given target system following exposure to a particular substance, taking into account the inherent characteristics of the substance of concern as well as the characteristics of the specific target system. The process includes four steps: 1) hazard identification, 2) dose-response assessment, 3) exposure assessment, and 4) risk characterization (see: http://www.who.int/health_topics/risk_assessment).

Risk management: A decision-making process involving considerations of political, social, economic, and technical factors with relevant risk assessment information relating to a hazard so as to develop, analyse, and compare regulatory and non-regulatory options and to select and implement the optimal decisions and actions for safety from that hazard. Essentially, risk management is the combination of three steps: 1) risk evaluation; 2) emission and exposure control; and 3) risk monitoring.

Septicemia: Blood poisoning, especially in which microorganisms and their toxins enter the bloodstream.

Silviculture: The cultivation of woods or forests; the growing and tending of trees as a branch of forestry.

Social impact assessment: The process of analysing, monitoring, and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment. Social impact assessment is a project planning and decision-making tool that describes the social context within which development projects are undertaken; assesses, in advance, the social impacts of a policy, program, or project on affected communities; and proposes mitigation measures to avoid, reduce, or compensate for the impacts. Social impact assessment also identifies those groups at risk or at benefit and, when possible, the extent of the impacts (see: http://www.iaia.org).

Social learning theory: Supports the ideas that people self-regulate their environments and actions and, though people are acted upon by their environments, that they also help create their surroundings.

Sociosanitary: Of or having to do with social health and well-being; favourable to social or public health. Issues such as public water supplies, sewage systems, air pollution, and radiation controls – as in the construction of dams, pipelines, incinerators, and the like – are examples of sociosanitary issues.

Spatial (scale): Of or concerning space; a geographical analytical scale for the assessment of health impacts. The zone of influence in a spatial scale varies depending on the nature of the exposure to a risk factor. For example, the zone affected by the effluent produced by a smokestack is different from the area affected by noise. When studies are based on official maps and related attributes, sometimes massive but poorly detailed scales (e.g., 1:500 000) are used, which provide a means of "overlooking" certain fragile areas or historical sites and also serve to reduce impact study costs. The Inter-American Development Bank now stipulates minimum scales (e.g., 1:50 000) for these studies in order to avoid such problems.

Sporulation: The formation of or conversion into spores or sporules (small spores), e.g., as in certain protozoa.

Stakeholder: Any individual, organization, or company that has an interest, financial or otherwise, in a project. Types of stakeholders commonly associated with environmental assessments include the proponent, government departments, local residents, environmental groups, Aboriginal people, local businesses, and others (see definition of public).

Stated preference methods: Economic methods used in valuating health effects and that typically employ survey techniques and ask respondents to state what they would pay for the anticipated reduction in adverse health effects (or what they would pay to avoid unfavourable health effects). These methods can be used to directly valuate the development project of concern and to assess the values for specific effects. Stated preference methods include contingent valuation, conjoint analysis, and risk-risk trade-offs.

Strategic environmental assessment: The systematic and comprehensive process of assessing the environmental effects or implications of a proposed strategic decision or action, policy, plan, program, and its alternatives. At the same time, strategic environmental assessment is the process of integrating the concept of sustainability into strategic decision-making. A good-quality strategic environmental assessment process informs planners, decision-makers, and affected public on the sustainability of strategic decisions, facilitates the search for the best alternative, and ensures a democratic decision-making process. This enhances the credibility of decisions and leads to more cost- and time-effective environmental assessment at the project level. For this purpose, a good-quality strategic environmental assessment process is integrated, sustainability-led, focused, accountable, participative, and iterative (see: http://www.iaia.org).

Stressor: Any stimulus that produces stress or strain.

Surveillance system: A systematic, ongoing process whose components are data collection, expert analysis and interpretation, and response (communication of information for action).

Sustainable development: Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.

Temporal (scale): Of or concerning time. In the context of health impact assessment, "temporal" refers to an analytical scale relating to the time scale for the assessment of health impacts. For example, on a temporal scale, toxicity can be variously described as acute, chronic, or even transgenerational. Therefore, it is important to specify desirable spatial and temporal scales for every significant risk. Scale determination is crucial and can exert a considerable influence on the perceived importance of a pollution problem.

Teratogen: A substance (e.g., a drug or other agent) that causes birth defects or malformations of the embryo or fetus.

Teratogenicity: The quality of being teratogenic, i.e., the tendency to cause malformations of the embryo or fetus or birth defects.

Tetany: A condition characterized by muscle spasm or prolonged contraction of a muscle.

Threshold limit values: The most universally accepted occupational exposure limits, established by the American Conference of Governmental Industrial Hygienists.

Occupational exposure limits are not "ideal" or "target" workplace levels, but rather the current maximum acceptable (airborne) levels of contaminants. In the case of occupational exposure limits adopted by regulation, they are legal maxima. Even in situations where exposures are below the occupational exposure limits, the former should be reduced to the lowest practical levels on a matter of principle.

Time-weighted average: A time-weighted average is the "average" exposure over the working day. The time-weighted average numerical limits that are listed assume that there is an 8-hour exposure. If worker exposure occurs over a longer period and/or there is not a 16-hour period between exposures, then adjustments may have to be made to these values from a legal standpoint and/or to conform to fundamental toxicological principles.

Toxicity: The ability of a substance to produce deleterious or adverse effects in the exposed organism.

Toxicological reference values: Reference values indicating the toxicity of specific contaminants and used for risk assessment purposes. Toxicological reference values are established by appropriate agencies and are used to determine the human health risks associated with exposure to contaminants in the development/remediation project area. For example, toxicological reference values specific to food-borne contaminants and approved by Health Canada are preferable for the assessment of human health risks posed by contaminants in country foods.

Toxicological risk analysis: The determination of the probabilities and magnitude of potential toxic effects due to exposure to xenobiotics or to ionizing radiation.

Transboundary environmental impacts: Typically refers to a local source of pollution that causes environmental impacts across political perimeters.

Transgenerational (toxicity): Toxicological effects occurring in the offspring of the exposed organism.

Trihalomethanes: A class of chemical organic compounds that are chlorination by-products formed when organic matter naturally present in surface water reacts with the chlorine added during the disinfection process (chlorine treatment of drinking water).

Uremia: An abnormal condition resulting from the accumulation in the blood of waste products that should normally be eliminated in the urine. Nephritis (inflammation of the kidneys) is a frequent cause of uremia.

Valuation of health effects: An assessment of the monetary value of the health effects of a development project. If a project is expected to have a favourable effect on human health, the benefit should be valuated by gauging individuals' willingness to pay for the anticipated reduction in adverse effects. Similarly, if a project is expected to have unfavourable health effects, then individuals' willingness to pay to avoid these effects should be added to the project's cost. By valuating health effects in this manner, economic analysis can integrate such impacts into a benefit-cost framework.

Zoonosis: Any of various infectious diseases that can be transmitted under normal conditions from animals to humans (e.g., tuberculosis, rabies).

Notes: