APPENDIX 2

Assessment Approach

LIST OF APPENDICES

APPENDIX 2A

Section 2.0 of CEAA CEA Practitioners Guide

Cumulative Effects Assessment Practitioners Guide

2.0 Assessment Fundamentals

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2.1 Cumulative Effects Defined

Cumulative effects are changes to the environment that are caused by an action in combination with other past, present and future human actions. [Numerous definitions of CEAs exist in the literature. Many of these are quite complicated and refer to technical aspects of cumulative effect's interactions. The Working Group prefers a simple definition based on an important additional requirement of CEA as compared to EIA: the specific consideration of effects due to other projects. This definition is intended specifically for single-project assessments as opposed to regional planning (in which case there is not necessarily a single project that serves as the starting point and focus of the assessment), and borrows the broad definition of "environment" as used in the Canadian Environmental Assessment Act.] A CEA is an assessment of those effects (*"Actions" Include Projects and Activities*).

CEA is environmental assessment as it should always have been: an Environmental Impact Assessment (EIA) done well. In practice, the assessment of cumulative effects requires consideration of some concepts that are not always found in conventional approaches followed in EIAs. Specifically, CEAs are typically expected to:

- assess effects over a larger (i.e., "regional") area that may cross jurisdictional boundaries; [Includes effects due to natural perturbations affecting environmental components and human actions.]
- assess effects during a longer period of time into the past and future;
- consider effects on Valued Ecosystem Components (VECs) due to interactions with other actions, and not just the effects of the single action under review;
- include other past, existing and future (e.g., reasonably foreseeable) actions; and
- evaluate significance in consideration of other than just local, direct effects.

Cumulative effects are not necessarily that much different from effects examined in an EIA; in fact, they may be the same. Many EIAs have focussed on a local scale in which only the "footprint" or area covered by each action's component is considered. Some EIAs also consider the combined effects of various components together (e.g., a pulp mill and its access road). A CEA further enlarges the scale of the assessment to a regional level. For the practitioner, the challenge is determining how large an area around the action

should be assessed, how long in time, and how to practically assess the often complex interactions among the actions. In all other ways, CEA is fundamentally the same as EIA and, therefore, often relies on established EIA practice.

Definitions and Concepts

Conditions for Potential Cumulative Effects

Cumulative effects may occur if:

- local effects on VECs occur as a result of the action under review; and
- those VECs are affected by other actions.

Key Terms Defined

Action: Any project or activity of human origin.

Assessment Framework: A description of a process that organizes actions and ideas, usually in a step-by-step fashion. Frameworks help to guide practitioners in carrying out an assessment.

Effect: Any response by an environmental or social component to an action's impact [Under the Canadian Environmental Assessment Act , "environmental effect" means, in respect of a project, "(a) any change that the project may cause in the environment, including any effect of any such change on health and socio-economic 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 and (b) any change to the project that may be caused by the environment, whether any such change occurs within or outside of Canada".].

Environmental Components: Fundamental elements of the natural environment. Components usually include air, water (surface and groundwater), soils, terrain, vegetation, wildlife, aquatics and resource use.

Region: Any area in which it is suspected or known that effects due to the action under review may interact with effects from other actions. This area typically extends beyond the local study area; however, as to how far will vary greatly depending on the nature of the cause-effect relationships involved.

Scoping: A consultative process for identifying and possibly reducing the number of items (e.g., issues, VECs) to be examined until only the most important items remain for detailed assessment. Focussing ensures that assessment effort will not be expended in the examination of trivial effects.

Threshold: A limit of tolerance of a VEC to an effect, that if exceeded, results in an adverse response by that VEC.

Valued Ecosystem Component (VEC): Any part of the environment that is considered important by the proponent, public, scientists and government involved in the assessment process. Importance may be determined on the basis of cultural values or scientific concern.

"Actions" Include Projects and Activities

Human actions often cause a disturbance to the environment. These actions

include projects and activities. Projects are typically some form of physical work that is planned, constructed and operated. Projects are usually identified by a specific name. Activities may be part of a project, or not associated with any particular project but arise over time due to ongoing human presence in an area. A mine development, a resource access road, or both together are examples of a project. Public traffic, hiking and hunting along that road are examples of activities.

For the purposes of a CEA, the effects on the environment of other projects and activities also have to be considered. For convenience, in this Guide, the term "Actions" is used when appropriate to represent both projects and activities. The term "project" is used only in reference to the project being proposed under assessment or under regulatory review.

In the *Canadian Environmental Assessment Act*, a project means "(a) in relation to a physical work, any proposed construction, operation, modification, decommissioning, abandonment, or other undertaking in relation to that physical work; or (b) any proposed physical activity not relating to a physical work that is prescribed or is within a class of physical activities that is prescribed pursuant to regulations made under paragraph 59(b) in the Act." The Act does not provide a definition for "activity"; however, it is commonly understood not to include a physical work. It is, therefore, considered in this Guide as any action that requires the presence, often temporary, of humans concentrated in a local area or dispersed over a large area.

Examples of Cumulative Effects

- Air: combined SO_2 emissions within a regional airshed from three operating natural-gas processing plants
- Water: combined reductions in flow volumes within a particular river resulting from irrigation, municipal and industrial water withdrawals
- Wildlife: combined black bear mortalities within a given wildlife management unit from hunter harvest, road kills and destruction of nuisance animals
- Vegetation: clearing of land resulting in the removal of a patch of regionally rare plant species
- Resource Use: continual removal of merchantable timber from a timber management area

Case Study
Cold Lake Oil Sands Project: Effects at a Regional Scale

Imperial Oil Resources proposed the expansion of an in-situ heavy oil facility in northern Alberta (IORL 1997a, è Appendix B). The following provides examples of some effects identified during early scoping exercises.

Environmental Component	Examples of Potential Regional Effects
Air Systems	Plumes from stack emissions combining with the plumes from nearby burns
Surface Water	Reductions of river water volumes due to use by the project, other energy projects and nearby communities
Aquatic Resources	Decrease in productivity of spawning habitat due to combined sedimentation from the project and regional forestry operations and activities
Soils and Terrain	Continued loss of soils
Vegetation	Less representation of certain plant species on a regional scale

Wildlife	Increased road access and changes to habitat resulting in further regional changes to numbers and distribution of certain wildlife species
Resource Use	Forestry activities, land use by the project, and increased road access changes the harvest potential for furbearer species

Case Study
Determining if there are Cumulative Effects: Joint Panel for the Express Pipeline Proposal

To assist in its deliberations on cumulative effects during the public hearings for a proposed pipeline in Alberta (NEB 1996), the Review Panel identified three requirements that must be met before they would consider as relevant any evidence related to cumulative effects:

1. There must be an environmental effect of the project being assessed.
2. That environmental effect must be demonstrated to operate cumulatively with the environmental effects from other projects or activities.
3. It must be known that the other projects or activities have been, or will be, carried out are not hypothetical.

In the Panel's subsequent Decision Report (Priddle *et al.* 1996), the Panel noted that a further requirement was that the "cumulative environmental effect is likely to result".

2.2 An Overview of Basic Concepts

2.2.1 Effects Pathways

Cumulative effects occur as interactions between actions, between actions and the environment, and between components of the environment. These "pathways" between a cause (or source) and an effect are often the focus of an assessment of cumulative effects. The magnitude of the combined effects along a pathway can be equal to the sum of the individual effects (additive effect) or can be an increased effect (synergistic effect). [There are numerous other types of interactions defined in the literature by such terms as linear, multiplicative, compounding, structural surprise, space cycling, and space lags, etc. Although of interest in understanding the complexity of cumulative effects, determining which type is actually occurring (aside from additive effects) and measuring the interaction is often difficult in practice.]

Case Study
Saskatchewan Uranium Mines: Pathways of Radionuclides

A study of the effects of various proposed uranium mine developments in northern Saskatchewan (Appendix B) used pathways to define the various means by which radionuclides could disperse in the environment (Ecologistics 1992). Pathways were used to illustrate the linkages between a source (i.e., a mine), a dose on an environmental receptor (e.g., VECs such as moose, fish and benthic invertebrates), and the contribution of all pathways to a total dose on the environment. Generally, radionuclides could be dispersed in the atmosphere, groundwater or surface water. Dispersal may continue through vegetation and soils, forage crops, wildlife, aquatic plants and animals and sediment. An example of one pathway amongst these possible interactions is: Mine à Surface Water à Aquatic Plants à Total Dose.

2.2.2 How Cumulative Effects Occur

Cumulative effects can occur in various ways:

- Physical-chemical transport: a physical or chemical constituent is transported away from the action under review where it then interacts with another action (e.g., air emissions, waste water effluent, sediment).
- Nibbling loss: the gradual disturbance and loss of land and habitat (e.g., clearing of land for a new sub-division and roads into a forested area). [This can include alienation of wildlife habitat due to sensory disturbances.]
- Spatial and temporal crowding: Cumulative effects can occur when too much is happening within too small an area and in too brief a period of time. A threshold may be exceeded and the environment may not be able to recover to pre-disturbance conditions. This can occur quickly or gradually over a long period of time before the effects become apparent. Spatial crowding results in an overlap of effects among actions (e.g., noise from a highway adjacent to an industrial site, confluence of stack emission plumes, close proximity of timber harvesting, wildlife habitat and recreational use in a park). Temporal crowding may occur if effects from different actions overlap or occur before the VEC has had time to recover.
- Growth-inducing potential: Each new action can induce further actions to occur. The effects of these "spin-off" actions (e.g., increased vehicle access into a previously unroaded hinterland area) may add to the cumulative effects already occurring in the vicinity of the proposed action, creating a "feedback" effect. Such actions may be considered as "reasonably-foreseeable actions" (Section 3.2.4).

Can Project-Specific CEAs Adequately Address Regional "Nibbling" Effects?

Regional "nibbling" effects usually cannot be adequately dealt with on a project-by-project review basis. Although broad changes in a landscape can often be quantified (e.g., total cleared land, fragmentation of wildlife habitat), it is more difficult to determine a significance to this change that is only attributable to the specific action under review. To properly address this type of cumulative effect, regional plans are required that clearly establish regional thresholds of change against which the specific actions may be compared (Section 4.2). Project applications can at least be compared to restrictions or requirements under any applicable land use plans or policies (e.g., Alberta's Integrated Resource Plans).

Careful Use of Terms

Ideally, cumulative effects should be assessed relative to a goal in which the effects are managed on a regional basis. Terms such as ecological carrying capacity, ecosystem integrity, long-term population viability and sustainable development are often cited as goals to be accomplished by CEAs. What these terms represent are important and their successful implementation would substantially improve the value of an assessment. They often appear in CEAs because they relate to relatively large landscape-level changes in a regional study area, and their broad application appears amenable to the objectives of future regional-based planning efforts.

However, expectations of what should be accomplished in CEA often exceed what is reasonably possible given our knowledge of natural ecosystems, available information, level of effort required to obtain more information, and the limits of analytical techniques in predicting the effects of actions on the environment. These terms should not be used in a CEA *unless* they are carefully defined; otherwise, the uncertainty associated with their meaning will

later bring into question the usefulness of the CEA during its interpretation by regulatory reviewers.

2.2.3 Improvements in the Evolving Practice of CEA

The growing body of CEA literature, the increasing number of assessments completed, and direction from reviewing agencies and Boards (or Panels) has raised expectations of what should be accomplished in CEAs. Each assessment creates a precedent for what *can* and *should* be done. The following identifies some aspects of CEA that require improvement:

- Better identification of and focus on those project-specific effects with the greatest potential to act in a cumulative fashion with other actions.
- Application of regional coordinated land use planning and practical measures of limits to growth.
- Results that compare the incremental contribution of an action to regional thresholds for various VECs and indicate to what degree a threshold is approached or exceeded.
- Conclusions relying on more quantitative analysis.
- Broadening of the number of proven analytical approaches.
- Finer breakdown of more specific interactions among various actions.
- Ability to better examine synergistic effects, particularly the potential interactions between contaminant releases and direct physical effects and the influence these effects may have when combined with natural perturbations.
- The influence of environmental cumulative effects on socio-economic systems, as well as the effects of cumulative socio-economic changes on the regional environment.
- Selection of management options for dealing effectively with significant cumulative effects.

APPENDIX 2B

Section 3.1 of CEAA CEA Practitioners Guide

Cumulative Effects Assessment Practitioners Guide

3.0 Key Tasks in Completing CEAs

3.0 Key Tasks in Completing CEAs

3.1 The Assessment Framework

CEAs build on what has been learned and applied in EIA practice for many years. However, assessment practitioners need to know in what ways assessing cumulative effects are different. This Chapter of the Guide identifies and discusses unique tasks in CEAs for each of the five steps in a basic EIA framework (from CEAA 1994): Scoping, Analysis, Mitigation, Significance and Follow-up [Mitigation may also be identified after significance is evaluated; however, the interpretation of significance changes (both approaches have been suggested in the EIA literature as valid). In the order shown in the Framework (mitigation before significance), significance reflects residual effects. This approach implies that mitigation must be identified regardless of whether there is a significant effect. However, this is not always an onerous task as many mitigation measures are "standard" practice and often expected to be recommended by regulators. In the reverse order (significance before mitigation), the significance reflects the "worst-case" situation before mitigation is applied, and therefore provides an understanding of what may happen if mitigation fails or is not as effective as predicted. In recent practice, the former approach is more common (mitigation before significance), largely to better

reflect the eventual outcome to decision makers under the assumption that mitigation is effective as described.] . This framework itemizes the typical steps followed by practitioners in completing EIAs. The information box below identifies each of the CEA tasks for these steps.

Frameworks

Assessment Framework

Basic EIA Steps	Tasks to complete for a CEA
1. Scoping	• Identify regional issues of concern • Select appropriate regional VECs • Identify spatial and temporal boundaries • Identify other actions that may affect the same VECs • Identify potential impacts due to actions and possible effects
2. Analysis of Effects	• Complete the collection of regional baseline data • Assess effects of proposed action on selected VECs • Assess effects of all selected actions on selected VECs
3. Identification of Mitigation	• Recommend mitigation measures
4. Evaluation of Significance	• Evaluate the significance of residual effects • Compare results against thresholds or land use objectives and trends
5. Follow-up	• Recommend regional monitoring and effect management

Ideally, all aspects of a CEA are done concurrently with the EIA, resulting in an assessment approach that makes no explicit distinction between the two "parts". In practice, however, the substantive work in a CEA is often done after the *initial* identification of effects have been completed in an EIA. In this way, the early identification of direct project effects "paves the way" for cumulative effects to be assessed. The Assessment Framework is suitable for assessing actions of any size. However, as discussed in Chapter 4, a scaled-down framework may be more suitable for assessing smaller actions (e.g., in screenings).

During the completion of a CEA, the five steps of the framework are usually completed in order. However, earlier steps may be repeated during an assessment if new information suggests that earlier assumptions and conclusions were incorrect. Also, it is possible that the results of post-project effects monitoring may indicate that further assessment is required. [Under CEAA, Responsible Authorities (RAs) do not have jurisdiction to conduct further assessments based on post-project monitoring.]

What a Project-Specific Cumulative Effects Assessment Fundamentally Needs to Do

A CEA, for a single project under regulatory review, should fundamentally do the following:

1. Determine if the project will have an effect on a VEC.
2. If such an effect can be demonstrated, determine if the incremental effect acts cumulatively with the effects of other actions, either past, existing or future.

3. Determine if the effect of the project, in combination with the other effects, may cause a significant change now or in the future in the characteristics of the VEC after the application of mitigation for that project.

With the exception of the consideration of future actions, the above are identical to the requirements of a good EIA (the consideration of the effects of other actions is not necessarily new to CEA, as the existing environmental setting of a project has typically recognized other actions at least within the EIA's study area).

A key task in accomplishing the above is examining the effect on the VEC until the incremental contribution of all actions, and of the project alone to the total cumulative effect, is understood. Keep in mind that an assessment of a single project (which is what almost all assessments do) must determine if *that* project is incrementally responsible for adversely affecting a VEC beyond an acceptable point (by whatever definition). Therefore, although the total cumulative effect on a VEC due to many actions must be identified, the CEA must *also* make clear to what degree the project under review is alone contributing to that total effect. Regulatory reviewers may consider both of these contributions in their deliberation on the project application.

The remainder of this Chapter discusses in detail each step of the Assessment Framework (the page heading shows which step you are in).

3.2 Step 1: Scoping

Scoping (or focussing) involves the identification of key issues of concern and VECs, thereby ensuring that the assessment remains focussed and the analysis remains manageable and practical. This assists in determining if the action under review has the potential to contribute to any cumulative effects. Professional judgement is required to achieve an optimum balance between the minimum required by legislation and ideal goals. This is referred to as best professional practice.

Scoping is a well established first step in good EIA practice, and is essential in establishing the assessment's Terms of Reference. Although scoping is not unique to CEA, the larger regional nature and complexity of assessing cumulative effects means that scoping must be more strictly applied to avoid assessing more than is necessary. A first step in this direction is to focus only on those effects to which the action under review may actually by contributing. For example, although continued reductions in wildlife habitat may be a regional concern, there may be no reason to investigate these effects if the action under review does not contribute to these long-term reductions (e.g., a single pipeline may cause a slight and temporary loss of habitat for some species, while a network of seismic lines or logging roads may cause more significant long-term changes).

The scoping of regional cumulative (i.e., indirect) effects is often completed after the scoping of local (i.e., direct) effects in an EIA. In this case, information and conclusions from the EIA may assist in scoping of the CEA, including: action description, environmental baseline, identification of issues and VECs, types of effects caused, conclusions about significance of effects, and mitigation measures.

Although local effects may not have been scoped in the EIA in as large a scale as required in a CEA, the results provide a useful starting point.

What is Done First in Scoping?

APPENDIX 2C

Sections 1 to 3 of 1994 FEARO Reference Guide on *Addressing Cumulative Effects*

Reference Guide: Addressing Cumulative Environmental Effects

1. Introduction

This reference guide describes an approach for addressing cumulative environmental effects under the *Canadian Environmental Assessment Act* (Act). It is one of several reference guides intended to provide the supporting documentation for the *Responsible Authority's Guide to the Canadian Environmental Assessment Act* prepared by the Federal Environmental Assessment Review Office (FEARO). All of the reference guides are complimentary to the *Responsible Authority's Guide to the Canadian Environmental Assessment Act* but go into more detail on individual issues. Specifically, this reference guide:

- reviews the concept of cumulative environmental effects;
- discusses the relevant requirements of the Act;
- outlines some general considerations;
- proposes a framework for addressing cumulative environment effects under the Act; and
- provides a list of key references on the subject.

As the practice of environmental assessment evolves, it will be necessary to update and revise both the *Responsible Authority's Guide to the Canadian Environmental Assessment Act* and the individual reference guides. These guides should be seen as evolving documents rather than as static textual materials. Any suggestions for updates or revisions should be directed to:

Director
Process Development
Policy and Regulatory Affairs
Federal Environmental Assessment Review Office
14th Floor, Fontaine Building
200 Sacré-Coeur Boulevard
Hull, Québec
KIA 0H3

2. The Concept of Cumulative Environmental Effects

The concept of cumulative environmental effects recognises that the environmental effects of individual human activities can combine and interact with each other to cause aggregate effects that may be different in nature or extent from the effects of the individual activities. Ecosystems cannot always cope with the combined effects of human activities without fundamental functional or structural changes.

Examples of cumulative environmental effects include the incremental loss of prairie wetlands caused by agricultural practices, the degradation of Great Lakes water quality by persistent toxic chemicals, global warming caused by the build-up of green house gases in the upper atmosphere, and loss of biodiversity.

For the purposes of this reference guide, cumulative environmental effects can be defined as:

> *The effect on the environment which results from effects of a project when combined with those of other past, existing and imminent projects and activities. These may occur over a certain period of time and distance.*

Over the last few years, the assessment and management of cumulative environmental effects has become a critical issue in Canadian environmental policy. Although the importance of cumulative environmental effects is undeniable, current assessment and management techniques do not always predict or control them adequately. Since cumulative environmental effects originate at the level of individual development projects, it makes sense to introduce the concept into environmental assessment.

Cumulative environmental effects should not be seen as a new type of environmental effect. The concept is simply a recognition of the complex ways in which the effects of individual projects and activities interact and combine with each other over time and distance. Thus, to address cumulative environmental effects in environmental assessments requires no more than *thinking cumulatively*. This means considering:

- The temporal and geographic boundaries of the assessment; and
- The interactions among the environmental effects of the project, and past and future projects and activities.

To a limited extent, federal and other environmental assessments already address cumulative environmental effects. For example, most examine the *baseline* environmental conditions, which include the cumulative environmental effects of past and existing projects and activities. However, consideration

should also be given to the cumulative environmental effects resulting from the interactions among the environmental effects of the proposed project with those of future projects and activities.

3. Cumulative Environmental Effects and the Canadian Environmental Assessment Act

Cumulative environmental effects, and a determination of the significance of such effects, are a key component of every environmental assessment conducted under the Act. Subsection 16(1) of the Act states:

> *"Every screening or comprehensive study of a project and every mediation or assessment by a review panel shall include a consideration of the following factors:*
>
> a. *the environmental effects of the project, including . . . and any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out;*
> b. *the significance of the effects referred to in paragraph (a)"*

Although the Act does not define cumulative environmental effects, it provides some guidance on what should be addressed. First, it is clear that only environmental effects, as defined in the Act, can be considered cumulatively. Subsection 2(1) of the Act defines "*environment*" as:

- *the components of the Earth, and includes*
  a. *land, water and air, including all layers of the atmosphere,*
  b. *all organic and inorganic matter and living organisms, and*
  c. *the interacting natural systems that include components referred to in paragraphs (a) and (b) above*
- and "*environmental effect*" as:
  a. *any change that the project may cause in the environment, including any effect of any such change on health and socio-economic 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, and*
  b. *any change to the project that may be caused by the environment,*

whether any such change occurs within or outside Canada.

Thus, the assessment of cumulative environmental effects must consider:

- changes in the environment caused by the project;
- the effects of any such changes on:
- health and socio-economic conditions;
- physical and cultural heritage;
- current use of lands and resources for traditional purposes by aboriginal persons; or
- any structure, site, or thing that is of historical, archaeological, paleontological, or architectural significance
- any change to the project caused by the environment.

For example, a socio-economic effect (such as job losses) could be considered as a cumulative environmental effect only when it is caused by a change in the environment, as defined in the Act (such as loss of fish habitat) caused by a project. If the job losses are caused by something else (such as a re-allocation

of funding caused by the project), they cannot be addressed as cumulative environmental effects.

Second, the Act states that environmental assessments must consider the cumulative environmental effects that are likely to result from the project in combination with other projects or activities. Thus, it is necessary to decide which projects and activities will be addressed. In this regard, the Act defines a "*project*" as:

a. *in relation to a physical work, any proposed construction, operation, modification, decommissioning, abandonment or other undertaking in relation to that physical work, or*
b. *any proposed physical activity not relating to a physical work that is prescribed or is within a class of physical activities that is prescribed pursuant to regulations made under paragraph 59(b)"* (subsection 2(1)).

"*Activities*", however, are not defined in the Act, but could include any human activity considered to be relevant to the assessment, for example, fishing or hunting near the project.

Third, the Act states *"in combination with"* other projects and activities. To be assessed, then, the effects must result, at least in part, from the project, and only

those environmental effects of other projects and activities that accumulate or interact with the environmental effects of the project in question should be included in the assessment. If the environmental effects of other past or future projects are not likely to act in combination then they should not be included in the cumulative environmental effects assessment of the project.

For example, if the construction of a bridge affects the fish population in the river it traverses, then other stressors on that same fish population, such as those from a nearby mill could be included in the project EA.

Fourth, the Act states that projects or activities that have been *or will be* carried out must be considered. As mentioned above, many environmental assessments already consider the cumulative environmental effects of the project in combination with those of past and existing projects. What is new is that the environmental effects of projects or activities *"that will be carried out"* must now be examined in combination with the environmental effects of the project being proposed. This implies that, at a minimum, (only) projects or activities that have already been approved must be taken into account. The environmental effects of uncertain or hypothetical projects or activities need not be considered. Nevertheless, it would be prudent to consider projects or activities that are in a government approvals process as well. Environmental assessments can take a long time to complete, and approvals for other projects and activities may be given during the assessment of the project in question.

Where projects and activities are not subject to a formal government approvals process but are relevant to the assessment (for example pesticide spraying), they should also be considered if there is a high level of certainty that they will occur. It should be noted that this interpretation of future projects and activities will, in most cases, preclude consideration of a project's growth inducing

potential.

When there is insufficient information on future projects or activities to assess their cumulative environmental effects with the project being proposed, best professional

judgement should be used. It is not necessary to predict the environmental effects of future projects and activities in detail, but to the extent that is feasible and reasonable under the circumstances. For example, if a plan for a future project has been approved, but the design details and hence the environmental effects are not yet known, then, it is sufficient to give a general idea of the types of cumulative environmental effects that are anticipated.

Fifth, the Act recognises that not everything can be known about how the environmental effects of other projects or activities will combine with the environmental effects of the project. It says *"cumulative environmental effects that are likely"*. Only *likely* cumulative environmental effects need to be considered.

Finally, paragraph 16(1)(b) of the Act requires that every screening, comprehensive study, mediation and assessment by a review panel consider the significance of the

environmental effects including cumulative environmental effects. See the document entitled, *Determining Whether a Project is Likely to Cause Significant AdverseEnvironmental Effects, A Reference Guide for the Canadian Environmental Assessment Act* (available from FEARO).

These six points provide a basis for considering which cumulative environmental effects should be addressed in federal environmental assessments.

The Act also requires that a class screening report must be adjusted to take into account any cumulative environmental effects not otherwise addressed:

> *"Where a responsible authority uses or permits the use of a class screening report, it shall ensure that any adjustments are made to the report that are necessary to take into account local circumstances and any cumulative environmental effects that may result from the project in combination with other projects or activities that have been or will be carried out"* [subsection 19(5)].

When a class screening report is used for a particular project within the class, the report must be revised to address any cumulative environmental effects specific to that project.

4. General Considerations

4.1 Advice and Consultation

To assess cumulative environmental effects, relevant individuals, organisations and government departments and agencies should be consulted. The extent of advisory and consultation activities will depend on the nature of the project; however, the following points should be considered:

- expert departments, regional inter-departmental environmental assessment committees, and other similar committees could be used as a source of advice and information about past and future projects and activities and their cumulative environmental effects;

APPENDIX 2D

Section 3.2.4.1 of CEAA CEA Practitioners Guide

In recognition of spatial and temporal boundaries (Section 3.2.3), identify actions associated with the project that meet the criteria shown in Table 1. [It is often suggested that certain natural events, such as flooding and forest fires, be considered as an action in the same context as human-caused events. This Guide suggests that such natural events should be considered as one of the attributes that describes environmental baseline conditions.]

Table 1: Spatial and Temporal Criteria for Selection of Actions

Spatial criteria	Temporal criteria
Actions with footprints within the regional study area(s) that may affect the VECs being assessed. Footprints include associated components (e.g., access roads, powerlines), and include air or areas of land or water directly disturbed. Actions outside the regional study area if it is likely that any of their components may interact with other actions or VECs within that area.	**Past:** actions that are abandoned but still may cause effects of concern. **Existing:** currently active actions. **Future:** actions that may yet occur.

Past Actions

Past actions are no longer active yet continue to represent a disturbance to VECs (e.g., ongoing effects of an abandoned gravel pit on terrain, or a plume of solvents from an abandoned wood preserving factory on a nearby aquifer). It is possible that the effects may no longer be readily observable (e.g., review of maps or airphotos shows little evidence of the action). However, significant changes may remain to ecological processes and VECs. In practice, past actions often become part of the existing baseline conditions. It is important, however, to ensure that the effects of these actions are recognized.

Future Actions

Selection of future actions must consider the certainty of whether the action will actually proceed. Figure 1 lists criteria that may be used in the selection process. The figure categorizes actions into three types:

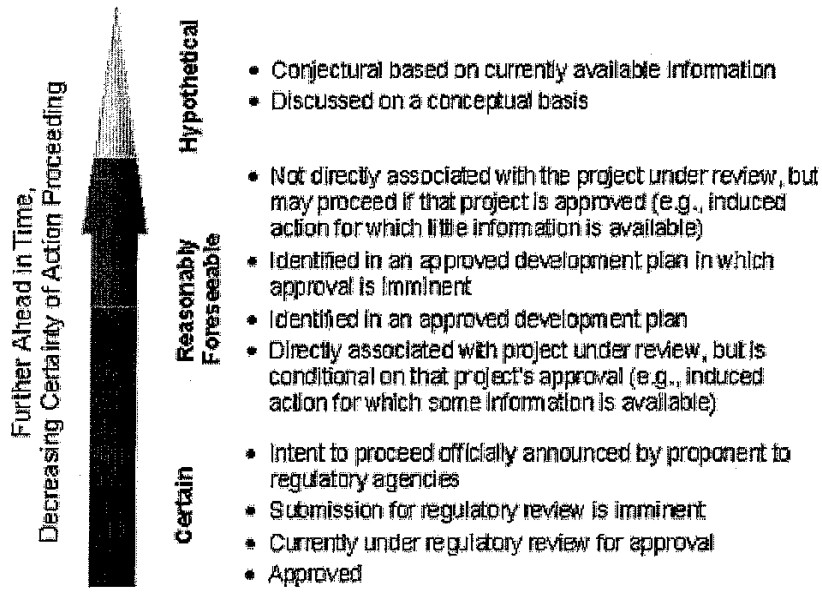
- *Certain*: The action will proceed or there is a high probability the action will proceed.
- *Reasonably Foreseeable*: The action may proceed, but there is some uncertainty about this conclusion (The Canadian Environmental Assessment Agency's Operational Policy Statement *Addressing Cumulative Environmental Effects under the Canadian Environmental Assessment Act* recommends that at least these types of projects be considered).
- *Hypothetical*: There is considerable uncertainty whether the action will ever proceed.

The selection of future actions to consider should at least reflect the certain scenario and at best the most likely future scenario. Rigid adherence to minimum regulatory requirement however is increasingly becoming

unacceptable to many stakeholders if there is reason to believe that at least some reasonably foreseeable projects could have a significant cumulative effect with the project under review (also, precedent setting court and panel decisions on project approvals will continue the evolution of change regarding what is and is not expected and acceptable practice). Practitioners are therefore encouraged to consider the opportunity to also include reasonably foreseeable actions. The final decision for the assessment is often at the practitioner's discretion or under the direction of the regulatory authority.

Figure 1: Options for Selecting Future Actions

As one proceeds upwards along the arrow, the certainty decreases of the action occurring.



The actions in Figure 1 lie on a continuum from most likely to least likely to occur. The practitioner will have to decide how far the proponent is obligated to go by statutory requirement, and by this obligation to demonstrate best practice. In the latter case, the reason for proceeding beyond statutory requirement (if defined) is to ensure that important future developments that may cause significant cumulative effects with the action under assessment have been adequately addressed. The practitioner will have to decide whether consideration of these future actions will be important to regulatory reviewers of the action. Furthermore, various regulatory agencies, due to their unique responsibilities, may modify or expand on what constitutes actions to be included. [For example, the Alberta Energy and Utilities Board considers the following as candidates for actions that will occur in the oil and gas industry: field study is underway, land base is leased, or resource delineation is favourable to future production.]

Although requiring interpretation on a case-by-case basis, the selection of future actions will be a compromise between under-representing the full extent of future change and identifying and assessing an unreasonably large number of actions. As with most matters facing practitioners, compromises are continually made between the minimum required by legislation and the professional obligations perceived by the practitioner.

A major criterion for selecting other actions is whether the action causes similar effects on the same VECs as the action under assessment. Focussing on

actions with similar effects is a good first step, and will ensure that the most appropriate actions are included in the assessment (i.e., those with the greatest likelihood of causing effects that interact). Such a criterion is attractive from a practical point of view, as it could significantly reduce the number of actions a practitioner may have to consider.

However, cumulative effects also occur solely due to the physical presence of an action as it occupies space in the landscape and contributes indirectly to other activities (such as road traffic). The presence of an action always leads to some degree of landscape fragmentation, representing a "nibbling" loss of land potential to support other uses (it is this type of cumulative effect that cannot always be easily addressed on a project-by-project review basis).

The criterion of similar effects may be too restrictive if such effects are interpreted only as a physical or chemical interaction between the actions. For example, if a pulp mill is the action under review and the major effluent is waste discharge into a river, then the only other actions selected on this basis would be other sources of effluent if the *major* issue of concern was water quality in the river. However, other types of actions may *also* contribute to air emissions, land clearing and sedimentation in waterways.

Induced Actions

Induced actions are projects and activities that may occur if the action under assessment is approved. Induced actions may not be officially announced or be part of any official plan. They usually have no direct relationship with the action under assessment, and represent the growth-inducing potential of an action. New roads leading from those constructed for a project, increased recreational activities (e.g., hunting, fishing), and construction of new service facilities are examples of induced actions. Increases in workforce and nearby communities contribute to this effect.

There may always be the potential for induced actions following any action. However, a practitioner usually can only conjecture as to what they may be, their extent and environmental implications. Must the practitioner nonetheless always consider the implications of induced actions? [This argument has especially been made in cases where no other specific future actions can be identified (e.g., in remote hinterland areas). When combined with highly successful mitigation measures, proponents may confidently claim that there are no cumulative effects. However, induced actions may represent the only source of important cumulative effects.]

Induced actions (e.g., public activities) rarely fall under the scrutiny of an approved process: they just happen, and one must examine the likelihood of this based on existing use, precedent and implications of the assessed action proceeding. Best practice suggests that effort should be made in identifying actions if there is reason to believe they may occur, yet are not overly hypothetical. As illustrated in Figure 1, consideration of induced actions may be more reasonable if there is sufficient information describing them to allow an adequate assessment of their effects.

Ultimately, because of the uncertainty and often dispersed nature of these actions (i.e., they may occur in many places within a region), induced actions are best considered as part of Regional Land Use Planning Studies involving regional administrative agencies.

Example Action List

The following is an example of the type of actions that may be considered for an action proposed in a forested area under "multiple-use" conditions.

APPENDIX 2E

FEARO Reference Guide:
Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects

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Reference Guide: Determining Whether A Project is Likely to Cause Significant Adverse Environmental Effects

Disclaimer: "Some electronic documents are currently available only in Adobe's Portable Document Format. For an alternative format, contact our publications department."

1. Introduction

This reference guide describes an approach for deciding whether a project is likely to cause significant environmental effects under the Canadian Environmental Assessment Act (Act). It is one of several reference guides intended to provide the supporting documentation for the Responsible Authority's Guide to the Canadian Environmental Assessment Act prepared by the Federal Environmental Assessment Review Office (FEARO). All of the reference guides are complimentary to the Responsible Authority's Guide to the Canadian Environmental Assessment Act but go into more detail on individual issues. Specifically, this reference guide:

- reviews the concept of significance;
- discusses the relevant requirements of the Act;
- proposes an approach for deciding whether a project is likely to cause significant adverse environmental effects under the Act;
- provides a list of key references on the subject.

As the practice of environmental assessment evolves, it will be necessary to update and revise both the Responsible Authority's Guide to the Canadian Environmental Assessment Act and the individual reference guides. These guides should be seen as evolving documents rather than as static textual materials. Any suggestions for updates or revisions should be directed to:

Director
Process Development
Policy and Regulatory Affairs
Federal Environmental Assessment Review Office
14th Floor, Fontaine Building
200 Sacré-Coeur Boulevard
Hull, Québec

K1A 0H3

This guide is intended primarily for responsible authorities (RAs) and the Minister of the Environment (the Minister), since under the Act, they are responsible for determining when a project is likely to cause significant adverse environmental effects.

2. The Concept of Significance

Deciding whether a project is likely to cause significant adverse environmental effects is central to the concept and practice of environmental assessment. Whateveradverse environmental effects are addressed and whatever methods are used, the focus of environmental assessment always narrows down to a decision about whether the project is likely to cause significant adverse environmental effects.

The concept of significance cannot be separated from the concepts of "adverse" and "likely." Environmental effects that are adverse, and significant adverse environmental effects that are likely, are referred to for convenience in this guide as "the related matters."

Deciding when a project is likely to cause significant adverse environmental effects is not new to environmental assessment (EA). This concept was included in the Environmental Assessment and Review Process (EARP) Guidelines Order and can be found in most EA legislation, procedural manuals, documents and the research literature. But there is little guidance available on what to consider when determining significance and the related matters and how this should be done.

3. The Requirements of the Canadian Environmental Assessment Act

The concept of significance is extremely important in the Act. One of the stated purposes of the Act is:

> to ensure that projects that are to be carried out in Canada or on federal lands do not cause significant adverse environmental effects outside the jurisdictions in which the projects are carried out" (section 4 (c)).

The central test in the Act is whether a project is likely to cause significant adverse environmental effects. This determination is an objective test from a legal standpoint, which means that all decisions about whether or not projects are likely to cause adverse environmental effects must be supported by findings based on the requirements set out in the Act.

The definitions of "environment" and "environmental effect" are the starting point for this test . The Act defines the environment as:

- the components of the Earth, and includes
  a. land, water and air, including all layers of the atmosphere,
  b. all organic and inorganic matter and living organisms, and
  c. the interacting natural systems that include components referred to in paragraphs (a) and (b) (section 2(1)).

Environmental effect means, in respect of a project,

a. any change that the project may cause in the environment; including·

any effect of any such change on health and socio-economic 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, and

b. any change to the project that may be caused by the environment, whether any such change occurs within or outside Canada (section 2 (1)).

Only environmental effects as defined in the Act can be considered in determinations of significance and the related matters. It follows that the determination of significance and the related matters can consider only:

- direct changes in the environment caused by the project;
- the effects of these environmental changes on:
  - health and socio-economic conditions,
  - physical and cultural heritage,
  - current use of lands and resources for traditional purposes by aboriginal persons,
  - any structure, site or thing that is of historical, archaeological, paleontological or architectural significance; or
- changes to the project caused by the environment.

For example, the socio-economic effects of a project may or may not be factors in determining significance and the related matters. If a socio-economic effect (such as job losses) is caused by a change in the environment (such as loss of fish habitat), which is in turn caused by the project, then the socio-economic effect is an environmental effect within the meaning of the Act and must be considered when determining significance and the related matters. If the socio-economic effect is not caused by a change in the environment, however, but by something else related to the project (for example, reallocation of funding as a result of the project), then the socio-economic effect is not an environmental effect within the meaning of the Act and cannot be considered in the determination of significance and the related matters.

Determinations of significance and the related matters must be made:

- following a screening;
- after a comprehensive study report has been completed;
- after a mediation or review panel report has been submitted.

Following a screening, the RA must decide whether or not the project is likely to cause significant adverse environmental effects, taking into account the implementation of mitigation measures (section 20(1)). If the RA decides that the project is not likely to cause significant adverse environmental effects, it may allow the project to proceed, while ensuring that any appropriate mitigation measures are implemented. If the RA decides that the project is likely to cause significant adverse environmental effects (taking into account the implementation of mitigation measures) and these effects cannot be justified in the circumstances, it must not do anything that would permit the project to proceed.

The RA must refer the project to the Minister for referral to a mediator or a review panel when:

- it is uncertain whether the project is likely to cause significant adverse environmental effects (taking into account the implementation of mitigation measures);
- it decides that the project is likely to cause significant adverse environmental effects that may be justifiable in the circumstances; or

- public concerns warrant a referral.

When a comprehensive study report is sent to the Minister and the Canadian Environmental Assessment Agency (the Agency) by an RA, the Minister is required to make a process decision about whether or not further review of the project is necessary, or whether a final decision can be made by the RA (section 23). This decision must be based on the comprehensive study report. If the Minister decides that the project, taking into account the implementation of mitigation measures, is not likely to cause significant adverse environmental effects or that it is likely to cause significant adverse environmental effects that cannot be justified in the circumstances, the Minister must refer the project back to the RA for appropriate action. If it is uncertain, however, whether the project is likely to cause any significant adverse environmental effects or that the project will cause significant adverse environmental effects that may be justified in the circumstances, the project must be referred to a mediator or a review panel. Public concerns may also warrant referring the project to a mediator or a review panel.

After a panel review or a mediation is completed, or when a comprehensive study report of a project is referred back to the RA by the Minister, the RA must make the final determination and decide whether the project is likely to cause significant adverse environmental effects (section 37(1)). If the project is not likely to cause significant adverse environmental effects, or if it is likely to cause significant adverse environmental effects (taking into account the implementation of mitigation measures) that can be justified in the circumstances, the RA is free to provide federal support to or participate in the project. If, on the other hand, the RA considers that the project is likely to cause significant adverse environmental effects that cannot be justified in thecircumstances, it must not do anything to permit the project to proceed.

Four points merit special attention. First, with the exception of transboundary boundary reviews, the RA makes the determination about whether the project is likely to cause significant adverse environmental effects. The Minister, however, does make a process determination of significance and the related matters following receipt of a comprehensive study report from an RA. After considering whether the project is likely to cause significant adverse environmental effects, as described in the comprehensive study report, the Minister must make a decision whether further study, through a panel review or mediation, is warranted.

Second, in all cases, significance and the related matters are determined only after taking into account any mitigation measures the RA considers appropriate. In other words, no final determination can be made about the significance of the likely adverse environmental effects or the related matters unless the implementation of any appropriate mitigation measures has been considered.

Third, public input into the determination of significant adverse environmental effects must limit itself to questions related to scientific analysis and interpretation. The public, for example, could provide new evidence, offer a different interpretation of the facts, or question the credibility of the conclusions. Issues that are not directly linked to the scientific (including traditional ecological knowledge) analysis of environmental effects, such as long-term unemployment in a community or fundamental personal values, cannot be introduced into the determination at this step. Such public concerns and values are given prominence elsewhere in the EA process. Under the Act, serious public concerns can warrant referral of the project to a public review through either mediation or a public panel review. That is, public concerns -- that may or may not have to do with scientific issues -- can prompt the EA process to take a closer look at the project.

Fourth, if there is a determination that the project, taking into account the implementation of appropriate mitigation measures, is likely to cause significant adverse environmental effects, then the RA must also determine whether or not such effects can be justified under the circumstances. The Act is clear that the project may be allowed to proceed if any likely significant adverse environmental effects can be justified in the circumstances. This is the final "test" in the Act. The RA can decide that likely significant adverse environmental effects are not justified after a screening, comprehensive study report, or a public review. It can decide that they are justified, however, only after a public review in the form of mediation or a panel review.

The central question for the RA or the Minister in the process decision following submission of a comprehensive study report, remains: "Is the project likely to cause any significant adverse environmental effects?" Thus, only environmental effects that are both likely and adverse can be considered in determinations of significance. Environmental effects that are unlikely or are not adverse cannot be considered in significance decisions. It is important to note that the test is not of "significantly adverse" effects, but of adverse effects that are significant. The "likely" applies to the environmental effects of the project that are both adverse and significant.

4. A Framework

This section provides a framework for guiding RAs in determining whether environmental effects are adverse, significant, and likely within the context of the Act.

The framework consists of three general steps:

- Step 1: Deciding Whether the Environmental Effects are Adverse
- Step 2: Deciding Whether the Adverse Environmental Effects are Significant
- Step 3: Deciding Whether the Significant Adverse Environmental Effects are Likely

Each step consists of a set of criteria that RAs and the Minister should use to address these three questions, as well as examples of methods and approaches that can be applied. To apply the criteria, the RA and the Minister must rely on information provided by the proponent. Thus, the RA or the Minister should ensure that the proponent provides the necessary information (section 18(2)), by specifying the types of information required to determine significance and the related matters when the scope of the project is defined by the RA or the Minister.

4.1 Step 1: Deciding Whether the Environmental Effects are Adverse

In making this decision, it may be helpful to separate the effects on people from the effects on the environment, recognizing of course that people are integral to most ecosystems. It is important to remember that only "environmental effects" as defined in the Act can be considered.

Table 1 lists the major factors that should be used to determine whether environmental effects are adverse. Obviously, the importance of individual characteristics will be different in different EAs. To assist the RA and the Minister in deciding whether the environmental effects are adverse, the proponent should be required to submit information on these factors.

The most common way of determining whether a project's environmental

effects are adverse is to compare the quality of the existing environment with the predicted quality of the environment once the project is in place, using some or all of the criteria shown in Table 1 as variables. This method implies a need for environmental monitoring information collected over time and/or distance before the project is in place. It also assumes normal baseline environmental conditions, although this may not always bethe case (e.g., fluctuating water levels in a river). It is the proponent's responsibility to ensure that such information is put before the RA. In most cases, the proponent should be expected to collect and synthesize the available information on baseline environmental quality. In some cases where there are gaps in information, the proponent can be requested to collect new information, depending on the size and nature of the project and the proponent's resources.

Occasionally, information from other situations may be helpful in determining whether the environmental effects are adverse. For example, if there are similar or identical projects already in place in similar ecosystems, it may be helpful for the proponent to provide information on their environmental effects.

4.2 Step 2: Deciding Whether the Adverse Environmental Effects are Significant

There are several criteria that should be taken into account in deciding whether the adverse environmental effects are significant. These are briefly discussed below:

Magnitude of the adverse environmental effect

Magnitude refers to the severity of the adverse environmental effects. Minor or inconsequential effects may not be significant. On the other hand, if the effects are major or catastrophic, the adverse environmental effects will be significant. When using this criterion, it is important to consider the extent to which the project could trigger or contribute to any cumulative environmental effects.

Table 1: Factors in determining adverse environmental effects

Changes in the Environment	Effects on People Resulting from Environmental Changes
Negative effects on the health of biota including plants, animals, and fish;	Negative effects on human health, well-being, or quality of life;
Threat to rare or endangered species	Increase in unemployment or shrinkage in the economy;
Reductions in species diversity or disruption of food webs;	Reduction of the quality or quantity of recreational opportunities or amenities;
Loss of or damage to habitats, including habitat fragmentation;	Detrimental change in the current use of lands and resources for traditional purposes by aboriginal persons;
Discharges or release of persistent and/or toxic chemicals, microbiological agents, nutrients (e.g., nitrogen, phosphorus), radiation, or thermal energy (e.g., cooling wastewater);	Negative effects on historical, archaeological, paleontological, or architectural resources;
Population declines, particularly in top visual amenities (e.g., views);	Decreased aesthetic appeal or changes in predator, large, or long-lived species;
Loss of or damage to commercial species	

The removal of resource materials (e.g., or resources; peat, coal) from the environment;	Foreclosure of future resource use or production;
Transformation of natural landscapes;	
Obstruction of migration or passage of wildlife;	
Negative effects on the quality and/or quantity of the biophysical environment (e.g., surface water, groundwater, soil, land, and air).	

Geographic extent of the adverse environmental effects

Localized adverse environmental effects may not be significant. Alternatively, widespread effects may be significant. When considering this criterion, it will be important to take into account the extent to which adverse environmental effects caused by the project may occur in areas far removed from it (e.g., acid rain and the long-range transportation of atmospheric pollutants), as well as contribute to any cumulative environmental effects.

Duration and frequency of the adverse environmental effects

Long term and/or frequent adverse environmental effects may be significant. Future adverse environmental effects should also be taken into account. For example, many human cancers associated with exposure to ionizing radiation have long latency periods of up to 30 years. Obviously, when considering future adverse environmental effects, the question of their likelihood becomes very important.

Degree to which the adverse environmental effects are reversible or irreversible

Reversible adverse environmental effects may be less significant than adverse environmental effects that are irreversible. In practice, it can be difficult to know whether the adverse environmental effects of a project will be irreversible or not. It will be important to consider any planned decommissioning activities that may influence the degree to which the adverse environmental effects are reversible or irreversible.

Ecological context

The adverse environmental effects of projects may be significant if they occur in areas or regions that:

- have already been adversely affected by human activities; and/or
- are ecologically fragile and have little resilience to imposed stresses.

To assist the RA and the Minister in deciding significance, proponents should always be required to submit information on these criteria. All of them should be considered in deciding whether the adverse environmental effects are significant or not. Different criteria will be important in different EAs and the extent to which an individual criterion will influence the overall determination of significance will vary between assessments.

The most common method of determining whether the adverse environmental effects of a project are significant is to use environmental standards,

guidelines, or objectives. If the level of an adverse environmental effect is less than the standard, guideline, or objective, it may be insignificant. If, on the other hand, it exceeds the standard,guideline, or objective, it may be significant.

Environmental standards, guidelines and objectives have been established by federal, provincial, and in some cases municipal departments, ministries, and agencies. They often define either maximum levels of emissions or discharges of specific hazardous agents into the environment or maximum acceptable levels of specific hazardous agents in the environment. They are usually based on the results of studies in the field and with laboratory animals, available technology, and/or prevailing attitudes and values.

However, environmental standards, guidelines and objectives have been established only for a relatively small number of hazardous agents, such as some chemicals, radiation, and physical parameters including acidity and acceptable levels of particulates or suspended solids. Since there are no standards, guidelines, or objectives for most environmental effects, they cannot be used to determine the significance of many adverse environmental effects, nor do they necessarily protect ecological health. In addition, standards, guidelines, or objectives are set on the basis of individual hazardous agents and do not allow for any interactions that may occur (i.e., cumulative environmental effects).

Another method of determining significance is quantitative risk assessment, which is often used to determine the significance of the risks to human health from ionizing radiation and carcinogenic chemicals. Its use is restricted to agents that have predictable dose-response (or exposure-effect) relationships. Often derived from experiments using laboratory animals, these relationships usually approximate straight lines (see below).

dose /

exposure

response / effect/ risk

The response, effect, or risk is often measured in terms of increased cancer incidence per million people exposed. In quantitative risk assessment, an "acceptable" level of risk is determined. Conventional levels for "acceptable risk" to the public are an increased incidence of between one in 10 thousand to 1 in 10 million. By using the dose-response relationship, it can be determined whether or not the dose/exposurewould result in an unacceptable level of risk. In other words, significance is determined on the basis of an "acceptable level" of a specified risk, often cancer incidence.

This approach assumes that there is an "acceptable" level of risk. In practice, occupational health and safety standards allow for a greater degree of risk than public exposure standards. The Delaney Clause in the U.S. Food and Drugs Act establishes zero as the acceptable or significant increased cancer risk associated with food additives. It is important to be clear on who determines acceptable risk levels as well as how they are determined when quantitative risk assessments are included in EAs. As well as determining significance, quantitative risk assessment can also be used to determine the probability of occurrence of significant environmental effects, i.e., likelihood.

If there are no relevant environmental standards, guidelines, or objectives and quantitative risk assessment is not possible, other methods and approaches must be used. In larger EAs, such as panel reviews, it may be possible to develop methods and approaches for determining significance for individual projects. In others, it will be necessary for the RA or the Minister to use a

qualitative approach based on their best professional judgement.

When a project's adverse environmental effects are being compared to the adverse environmental effects of an alternative means of carrying out the project, weighting and ranking methods can assist in deciding whether the adverse environmental effects are significant. Generally, quantitative methods are used to weight or rank the individual adverse environmental effects of different alternatives which are then added to produce a total effect "score." These methods can be helpful in summarizing and comparing the effects of alternatives, but they can also hide the assumptions inherent in the weighting or ranking system. As well, weighting and ranking methods compare total effects, so that a locally significant individual effect may appear unimportant in the overall scheme. In other words, there is a loss of specificity. These problems can be at least partially resolved by ensuring that weighting and ranking exercises are conducted by those with a wide variety of experience and expertise.

Whatever methods are used to determine significance, they should be based on the criteria outlined above.

Cost-benefit analysis cannot be used to determine significance in federal EAs, because it compares the estimated environmental costs and benefits of a project, whereas the Act clearly states that only adverse environmental effects are to be considered in determining significance and likelihood. Although cost-benefit analysis could be used to justify proceeding with a project that is likely to cause significance adverse environmental effects, this justification can take place only after the likelihood of the significant adverse environmental effects has been determined.

4.3 Step 3: Deciding Whether the Significant Adverse Environmental Effects Are Likely

When deciding the likelihood of significant adverse environmental effects, there are two criteria to consider:

Probability of occurrence

If there is a high probability that the identified significant adverse environmental effects will occur, obviously they are likely. Conversely, if there is a low probability of occurrence, the significant adverse environmental effects are unlikely.

Scientific uncertainty

There will always be some scientific uncertainty associated with the information and methods used in EAs. This is often termed the "confidence limits". If the confidence limits are high, there is a low degree of uncertainty that the conclusions are accurate and that the significant adverse environmental effects are likely or not. If the confidence limits are low, there is a high degree of uncertainty about the accuracy of the conclusion. In this case, it will be difficult to decide whether the significant adverse environmental effects are likely or not. If low scientific uncertainty can lead to an unambiguous conclusion of likelihood or unlikelihood, conversely high uncertainty cannot be a basis for a clear conclusion about likelihood. In this case, only the probability of occurrence criterion should be used to determine likelihood.

To assist the RA or the Minister in deciding likelihood, proponents should be required to submit information on these criteria.

The use of confidence limits has already been mentioned as a method of determining likelihood based on scientific certainty or uncertainty. Others include a range of statistical methods that are used to determine "statistical significance," which is usually defined as the low probability of error. Although statistical methods themselves are not discussed in this paper, it is useful to note the two commonly encountered types of statistical errors. Type 1 is a false positive, that is, a false conclusion that there will be a significant adverse environmental effect. Type 2 is a false negative, that is, a false conclusion that there will not be a significant adverse environmental effect. Statistical results provided by proponents should always be required to state the probabilities of making both types of errors.

Another method used to determine the probability of occurrence is quantitative risk assessment. (See section 4.2 above.)

RAs and the Minister should require proponents to use statistical methods to determine statistical significance, whenever possible. These methods will facilitate a determination of likelihood by the RA or the Minister. In EAs where numerical methods cannot be used or are not feasible, the RA or the Minister must use a qualitative approach to determining likelihood, based on their best professional judgement.

5. Further Reading

Allelt, E.J. 1986. EIA and Decision Analysis. Journal of the Operational Research Society 37: 901-10.

Ames, G. 1978. An Approach to the Determination of Significance in the Preparation of Environmental Assessments In: Environmental Assessment: Approaching Maturity, edited by Bendix and Graham, 25-33. Ann Arbor Science Publishers Inc. Ann Arbor, Michigan.

Bacow, L.S. 1980. The Technical and Judgemental Dimensions of Impact Assessment. Environmental Impact Assessment Review 1(2): 109-24.

Bakus, G., W. Stillwell, S. Latter and M. Wallerstein. 1982. Decision Making: With Applications for Environmental Management. 6(6): 493-504.

Caldwell, L.K. 1987. The Contextual Basis for Environmental Decisionmaking: Assumptions are Predeterminants of Choice. The Environmental Professional 9: 302-08.

Duinker, P.N., and G.E. Beanlands. 1986. The Significance of Environmental Impacts: An Exploration of the Concept. Environmental Management 10(1): 1-10.

Economic Commission for Europe. 1989. Criteria for Determining the Environmental Significance of Projects. Meetings of Experts on Environmental Impact Assessment, The Hague, Netherlands, November 27-28. United Nations Economic Commission for Europe. Netherlands.

Haug, P.T., R.W. Burwell, A. Stein, and B.L. Bandurski. 1984. Determining the Significance of Environmental Issues Under NEPA. Journal of Environmental Management 18: 15-24.

Hollick, M. 1981. The Role of Qualitative Decision Making Methods in EIA. Journal of Environmental Management 12(1): 65-78.

Hundloe, T., G.T. McDonald, J. Ware, and L. Wilks. 1990. Cost Benefit

Analysis and Environmental Impact Assessment. Environmental Impact Assessment Review 10(1/2): 55-68.

Matthews, W.H. 1975. Objective and Subjective Judgements in Environmental Impact Analysis. Environmental Conservation 2(2): 121-31.

Rodericks, J.V., S.M. Brett, and G.C. Wrenn. 1987. Significant Risk Decisions inFederal Regulatory Agencies. Regulatory Toxicology and Pharmacology 7(3): 307-20.

Rucklehaus, W.D. 1983. Risk and Public Policy. Science 221: 1026-28.

Sharma, R.K., J.D. Buffington, and J.T. McFadden. 1976. The Biological Significance of Environmental Impacts. Proceedings of a Conference on June 4-6, 1975 at the University of Michigan. NR-Conf 002. U.S. Nuclear Regulatory Commission. Washington, D.C.

Slovic, P. 1987. Perceptions of Risk. Science 236: 280-85.

Thompson, M.A. 1990. Determining Impact Significance in Environmental Impact Assessments. A Review of 24 Methodologies. Journal of Environmental Management 30: 235-50.

Travis, C.C., and H.A. Hattemer-Frey. 1988. Determining an Acceptable Level of Risk. Environmental Science and Technology 22(8): 873-76.

U.S. Army Corps of Engineers, Seattle District. 1983. A Guide to the Analysis of Significance. U.S. Army Corps of Engineers. Seattle, Washington.

Wolf, P.G. 1982. User's Guide to Defining Significant Impacts under the Federal EARP. Federal Environmental Assessment Review Office. Hull, Quebec.

Reference Guide: Assessing Environmental Effects on Physical and Cultural Heritage Resources [PDF - 469 kb]

Reference Guide for the Federal Coordination Regulations

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Last Updated: 2003-10-28 ▲ Important Notices

APPENDIX 2F

Section 3.5 of CEAA CEA Practitioners Guide

3.5 Step 4: Evaluation of Significance

3.5.1 Approaches to Determining Significance

Determining the significance of residual effects (i.e., effects after mitigation) is probably the most important and challenging step in EIA. The determination of significance for CEAs is fundamentally the same; however, it may be more complex due to the broader nature of what is being examined. A cumulative effects approach requires determining how much further effects can be sustained by a VEC before suffering changes in condition or state that cannot be reversed.

Significance

Deciding Whether Effects are Likely

The *Canadian Environmental Assessment Act* states that "any cumulative environmental effects that are likely to result..." must be considered. According to guidance provided by CEAA (1992), the following questions should be asked:

1. Are the environmental effects adverse?
2. Are the adverse environmental effects significant?
3. Are the significant adverse affects likely?

The determination of likelihood is based on two criteria: 1) probability of occurrence and 2) scientific certainty. In practice, likelihood as an attribute of significance (*Cold Lake Oil Sands Project: Significance Attributes* for examples of other attributes) is often rated on a scale: e.g., None (no effect will occur), Low (<25% or minimal chance of occurring), Moderate (a 25% to 75% or some chance of occurring), and High (>75% or most likely a chance of occurring).

Query for Evaluating Significance

Significance conclusions in assessments should be defensible through some form of explanation of how the conclusions were reached. The following is an example of one approach (Duval and Vonk 1994). A series of questions are structured so as to guide the practitioner through a series of steps, eventually leading to a significance conclusion. The questions follow a basic line of inquiry as follows:

- Is there an increase in the action's direct effect in combination with effects of other actions?
- Is the resulting effect unacceptable?
- Is the effect permanent?
- If not permanent, how long before recovery from the effect?

In more detail, these questions appear below, specifically to address the nature of two different types of VECs.

Biological Species VECs

- How much of the population may have their reproductive capacity and/or survival of individuals affected? Or, for habitat, how much of the productive capacity of their habitat may be affected (e.g., <1%, 1-10%, >10%)?
- How much recovery of the population or habitat could occur, even with mitigation (e.g., Complete, Partial, None)?
- How soon could restoration occur to acceptable conditions (e.g., <1

year or 1 generation, 1-10 years or 1 generation, >10 years or >1 generation)?

Physical-chemical VECs

- How much could changes in the VEC exceed that associated with natural variability in the region?
- How much recovery of the VEC could occur, even with mitigation?
- How soon could restoration occur to acceptable conditions?

Case Study
Cold Lake Oil Sands Project: Significance Attributes

Determining the significance of effects associated with the Cold Lake Oil Sands project was, in part, based on conclusions reached for seven "Significance Attributes" (IORL 1997a). These attributes have generally gained common acceptance amongst EIA practitioners (although the definitions may vary) as a means of identifying and measuring various aspects of an effect that collectively assist in the evaluation of significance.

Attribute	Options	Definition
Direction	Positive	Beneficial effect on VEC
	Neutral	No change to VEC
	Negative	Adverse effect on VEC
Scope	Site	Effect restricted to a small site
	Local	Effect restricted to the project footprint
	Sub-regional	Effect extends to area within a few kilometres of the project footprint
	Regional	Effect extends throughout regional assessment area
Duration	Short-term	Effects are significant for <1 year before recovery returns conditions to the pre-project level; or, for species, for less than one generation
	Medium-term	Effects are significant for 1-10 years; or, for species, for one generation
	Long-term	Effects are significant for >10 years; or, for species, for more than one generation
Frequency	Once	Occurs once only
	Continuous	Occurs on a regular basis and regular intervals
	Sporadic	Occurs rarely and at irregular intervals
Magnitude	Low	Minimal or no impairment of component's function or process (e.g., for wildlife, a species' reproductive capacity, survival or habitat suitability; or, for soil, ability of organic soil to fix nitrogen)
	Moderate	Measurable change in component's function or process in the short and medium duration; however, recovery is expected at pre-project level
	High	Measurable change in component's function or process during the life of the project or beyond (e.g., for wildlife, serious impairment to species productivity or habitat suitability)
Significance	Insignificant Significant Unknown	Based on the analysis, use of Significance Query, and best professional judgment, is the effect on the VEC significant?

Confidence	Low Moderate High	In general, what is the confidence level in the conclusion?

3.5.2 Factors that Influence Interpretation of Significance

A cumulative effect on a VEC may be significant even though each individual project-specific assessment of that same VEC concludes that the effects are insignificant. This is a fundamental principle in the understanding of cumulative effects. Project-specific assessments, that focus on the incremental contribution of the project being assessed, can assist in making such conclusions as they must consider the implications of other actions also affecting the VECs. However, this inclusion (and sometimes the analytical approach used) requires the consideration of various factors that may influence the determination of significance (some which have not always been an issue in earlier assessments without a cumulative effects component). These factors include the:

- exceedance of a threshold;
- effectiveness of mitigation;
- size of study area;
- incremental contribution of effects from action under review;
- relative contribution of effects of other actions;
- relative rarity of species;
- significance of local effects;
- magnitude of change relative to natural background variability;
- creation of induced actions; and
- degree of existing disturbance.

Each of these points are discussed below in detail.

- *Significance may increase if a threshold is exceeded*: If the magnitude of an effect exceeds a threshold for a VEC, and the effect is not brief in duration, then the effect is usually considered significant.
- *Significance may increase as the effectiveness of mitigation measures decreases*: Determination of the significance of *residual* effects on a VEC is the most important outcome of an assessment. The effectiveness of recommended mitigation measures should, therefore, be acknowledged in the assessment (mitigation that is 100% effective will result in no residual effects).
- *Significance may appear to decrease as the study area size increases*: An assessment approach used in many CEAs involves comparing increases in area covered by successive actions in a region. The assessor can determine how much the action under review has contributed to the incremental historical and existing land uses. In such assessments, the study area against which the comparison is made is usually fixed, resulting in comparison against the same reference point. Therefore, the larger the study area, the smaller the apparent contribution of each action to change. In this way, the incremental contribution of even a large action may appear to be insignificant (e.g., <1%) if the study area is sufficiently large. To avoid misleading conclusions, the practitioner should also demonstrate how much change is attributable to the action under review when compared to other actions in the study area (as opposed to the study area itself).

Case Study
Eagle Terrace Sub-division: Comparing Incremental Effects of a Project

In the Eagle Terrace assessment (Eagle Terrace 1996), the loss of songbird

(Swainson's Thrush) habitat was calculated in two ways. It was first determined that existing developments caused a 38% loss of moderate quality habitat, reasonably foreseeable actions would cause a further loss of 7.2%, and the proposed Eagle Terrace project would cause a further incremental loss of only 0.1%. These numbers were based on a comparison to a fixed area: the regional study area.

However, the percentages were then re-calculated and compared to the land *remaining* undisturbed after each scenario (which becomes progressively smaller). In this case, the loss of habitat changed to 47%, 17% and 0.2% respectively. Although the contribution of the proposed project would double, it remained considerably less than 1% (usually a value of change considered insignificant in assessment practice). The contribution of all other actions, however, would more than double to considerably more than 10% (a value usually considered significant).

- *Significance may decrease as the relative contribution of an action decreases*: It can be argued that if the effects of an action within a regional study area are quite small relative to the effects of other actions in that same area, then the cumulative effects of that action are likely to be negligible. For example, if a forest cutblock of 4 ha is proposed within a region in which there are already 300 ha of clearcut areas, then the proposed action contributes an incremental loss of potential wildlife habitat of only 1.3%. The validity of this argument depends somewhat on the size of the study area (the larger the regional study area, the smaller the percentage becomes). The argument may not hold true in all cases, especially if that 4 ha supports plant species that are regionally rare, provides particularly important habitat for wildlife (e.g. salt licks for ungulates) or has a unique topographical feature. Furthermore, the argument may not hold if that further loss of 4 ha causes a threshold to be exceeded for a certain VEC, beyond which the VEC can not recover. However, applying this "straw-that-breaks-the-camels-back" view of the implications of adding one more action are often handicapped by the lack of clearly defined thresholds.
- *Significance may decrease as the significance of nearby larger actions increase*: For an action proposed in close proximity to larger existing actions, its relative contribution to cumulative effects may be minimal. Although this does not mean that a CEA is not required, it *does* suggest that the effects of the other action(s) should be adequately understood.
- *Significance may increase as a species becomes increasingly rare or threatened*: The significance of effects on a species' population may have to consider the rarity of the species at larger scales (e.g., regional, provincial or global). To illustrate for biological organisms, consider a population of 200 animals or plants living within the "footprint" of a proposed action. Such a population might be severely affected. The importance, however, that is attributed to such an effect will almost certainly depend on whether the population is part of a local, regional or global population of 200, 2000 or 200 million. In addition, it must also be considered if *that* remaining population itself is rare or threatened.
- *Significance may decrease as the significance of local effects decrease*: It has been argued that if the conclusions of an EIA indicate that none of the residual direct effects are significant, then there will be no cumulative effects (as therefore there are no effects remaining to act cumulatively with other actions). While this may be true for some types of effects, this may not always be the case: *an insignificant local effect may still contribute to a significant cumulative effect!*
- The argument of insignificance may be true, for example, if mitigation eliminates or substantially reduces the transport of a constituent elsewhere (e.g., a contaminant discharged into a waterway) or the emanation of a sensory disturbance (e.g., noise). In these cases, the potential for cumulative effects with other actions will be reduced.
- However, the argument may be false if, on a regional scale, there nonetheless remains an important *indirect* effect that results in a

regionally important loss of a VEC (e.g., loss of 10% of the population of a rare plant species with the study area) or of a resource on which the VEC depends (e.g., fragmentation of wildlife habitat). This indirect effect most commonly occurs as a result of the clearing of land which, although perhaps not significant at a local scale, may have important regional implications (i.e., the nibbling effect). In these cases, the practitioner must recognize this possibility and, while determining significance, consider the relative scarcity of what is being affected.

- *Significance may decrease if effects are within natural background variability*: If a *direct* effect causes no detectable change in a VEC, then the effect would usually be considered insignificant. If the change caused by the effect is detectable but within the magnitude of naturally fluctuating conditions (e.g., annual water temperatures and flows, percentage dissolved oxygen, seasonal wildlife population size), then the effect would also usually be considered insignificant. However, these arguments may not remain true if a number of individual actions each contribute small incremental changes, each below natural variability, which eventually causes a detectable change and exceedance of natural background conditions. For example, the effects of a series of placer mines or pulp mills along the same river may individually be considered insignificant due to adequately applied mitigation (e.g., the sediment or pollutants are diluted below background levels). However, their cumulative downstream effects may exceed even worst-case natural conditions (e.g., during periods of drought). Furthermore, there is often considerable uncertainty associated with identifying natural variability; its use for comparison purposes must therefore be approached with caution.
- *Significance may increase as the number of induced actions increase*: A proposed action may induce new actions to occur in the region. Although considering these spin-off actions in the CEA implies some certainty that they will occur, greater significance may be borne by the effects of the action under assessment.
- *Significance may decrease if the surrounding environment is already heavily disturbed*: An action proposed in a region already heavily disturbed due to existing actions may not be significant if environmental components are already compromised (e.g., thresholds have been exceeded). For example, a pipeline could be proposed in an area already crossed by numerous other rights-of-way (e.g., access roads), in which case the pipeline itself would not necessarily be an important contributing cause to a possible collapse of a wildlife population.

3.5.3 Using Thresholds

Thresholds are limits beyond which cumulative change becomes a concern, such as extensive disturbance to a habitat resulting in the rapid collapse of a fish population, or when contaminants in soil suddenly appear in potable water supplies. Thresholds may be expressed in terms of goals or targets, standards and guidelines, carrying capacity, or limits of acceptable change, each term reflecting different combinations of scientific data and societal values. For example, a threshold can be a maximum concentration of a certain pollutant beyond which health may be adversely affected, a maximum number of hectares of land cleared from its existing natural state before visual impacts become unacceptable, or a maximum number of deer lost from a valley habitat before the viability of the population is threatened.

Making useful conclusions about cumulative effects requires some limit of change to which incremental effects of an action may be compared. Theoretically, if the combined effects of all actions within a region do not exceed a certain limit or threshold, the cumulative effects of an action are considered acceptable. In practice, however, the assessment of cumulative effects is often hindered by a lack of such thresholds. This is particularly true for terrestrial components of ecosystems. Contaminants affecting human health

and constituents in air and water are usually regulated; therefore, thresholds useful for assessment purposes are defined by regulation or available in guidelines (e.g., Health Canada's drinking water quality guidelines). [Consideration of human health is often implicit is some assessments of biophysical components (e.g., air quality).]

There is not, therefore, always an objective technique to determine appropriate thresholds, and professional judgment must usually be relied upon. When an actual capacity level cannot be determined, analysis of trends can assist in determining whether goals are likely to be achieved or patterns of degradation are likely to persist.

In the absence of defined thresholds, the practitioner can either: 1) suggest an appropriate threshold; 2) consult various stakeholders, government agencies and technical experts (best done through an interactive process such as workshops); or 3) acknowledge that there is no threshold, determine the residual effect and its significance, and let the reviewing authority decide if a threshold is being exceeded.

Thresholds

Carrying Capacity and Limits of Acceptable Change

Carrying capacity is the maximum level of use or activity that a system can sustain without undesirable consequences. This is very much a subjective determination, which depends on the values and context involved. Ecological carrying capacity reflects biophysical limits, while social or recreational carrying capacity may be determined largely by user perception and levels of satisfaction associated with a specific activity.

The concept of "limits of acceptable change" shifts the focus from identifying appropriate levels of use to describing environmental conditions that are deemed acceptable. The advantage of this approach is that once acceptable conditions have been described, the appropriate combination of levels of use and maintenance interventions required to sustain those conditions can be determined (Stankey *et al.* 1985, Wight 1994).

Case Study
Placer Mining in the Yukon: Stream Sedimentation Thresholds

The Yukon Placer Authorization (GOC 1993) specifies maximum acceptable sediment discharge concentrations, based on acceptable effects on fish, for five different classes of streams. For example, the maximum concentration of sediment levels above natural background levels for Type III streams is 200mg/L (the type is based on fish bearing and harvesting attributes). Furthermore, some streams are uniquely classified on a series of mapsheets covering much of the southern Yukon. The cumulative effects implication of this Authorization is that any number of actions (i.e., placer mines) may occur on a single stream until the sedimentation limit is reached. This approach, therefore, provides a stream threshold that can assist in future decision making for actions affecting stream sedimentation.

Case Study
Highwood River: Instream Flow Needs

The Alberta Government proposed to divert some of the peak flow volume of the Highwood River to supplement water supplies to a proposed reservoir. Concerns were raised about possible effects of water withdrawals on riparian vegetation and fish. A study (Yarranton and Rowell 1991) investigated how to

determine minimum instream flow needs and what the flows should be. These flows represented a threshold, below which the survival of the VECs would be threatened. The flow was determined, based on best professional judgement, as the minimum flow requirements for various stream-related factors (e.g., vegetation regeneration, geomorphological changes, fish survivorship). The final threshold was selected as the highest volume flow required in each season for any one of those factors.

Case Study
Banff National Park: Human Use and Grizzly Bear Thresholds

In a recent cumulative effects study by the Banff-Bow Valley Task Force, increased human use in Banff National Park was identified as causing a significant effect on the park's environment (BBVS 1996). In assessing these effects, a GIS was used to map levels of human use in the park on a 6-point scale, ranging from 10 persons per month to 1 million persons per month (each increment represented an increase in use by a factor of 10). As expected, backcountry trails experienced the least amount of use, while popular tourist areas, highways and townsites received the highest level of use.

Research in the park on grizzly bear-human interaction suggested that a limit of 100 persons per month (i.e., the second lowest level of use) would not exceed a threshold of tolerance for the bears during the summer (Gibeau *et al.* 1996). Since bears are not active in winter, the winter threshold of 1000 person per month was based on observed responses of wolves to human disturbances and activities (Paquet *et al.* 1996). These thresholds of use were then recommended to assist in future park management efforts in the park's backcountry. In the frontcountry (i.e., in highly developed areas), the thresholds obviously could not be applied; however, efforts were made in those areas to provide movement corridors so that large mammals (e.g., elk, wolf and bear) could effectively move into more suitable habitat.

In an assessment of the effects of expansion of the Trans Canada Highway in the park (Parks Canada 1994), it was suggested that habitat effectiveness of only 70 to 80% (compared to existing capability) could exceed the threshold of disturbance for grizzly bear. Another study in Yellowstone National Park provides a grizzly bear threshold based on a maximum tolerance of road density (Mattson 1993). The study suggests that road densities of greater than 0.4 km/km2 in a region would greatly increase the likelihood that bears would be permanently alienated from the region.

3.5.4 Handling Uncertainty

Uncertainty in predicting effects and determining significance can arise due to variations in natural systems, a lack of information, knowledge or scientific agreement regarding cause-effect relationships, or the inability of predictive models to accurately represent complex systems. The degree of uncertainty in addressing cumulative effects is greater than for conventional EIAs because of a longer time horizon and larger study area.

It is recommended that the rules-of-thumb described below be considered when dealing with uncertainty.

Considerations when Handling Uncertainty

- Make conservative conclusions (i.e., assume that an effect is more rather than less adverse). This is referred to as the Precautionary Principle. [Other definitions exist of this term.]
- Provide a record or audit trail of all assumptions, data gaps, and confidence in data quality and analysis to justify conclusions.

- Recommend mitigation measures to reduce adverse effects and monitoring, followed by evaluation and management of effects, to ensure effectiveness of these measures.
- Implement mechanisms to evaluate the results of the monitoring and provide for subsequent mitigation or project modification, as necessary.