Consideration of Uncertainties in Environmental Protection Plans and Follow-up Programs in Canadian EIA

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A thesis

in

The Department

of

Geography, Planning and Environment

Presented in partial fulfillment of the requirements

For the degree Masters of Science (Geography, Urban and Environmental Studies) at

Concordia University

Montreal, Quebec, Canada

June 2014

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CONCORDIA UNIVERSITY

School of Graduate Studies

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Masters of Science (Geography, Urban & Environmental Studies)

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Abstract

The rationale for project-based environmental impact assessment (EIA) is to provide stakeholders and decision-makers with a complete understanding of a proposed project as well as a realistic representation of impacts on environmental processes. Environmental processes are known to be unstable, complex and sometimes hard to predict leading to the uncertainties about impacts. In project-based EIA, environmental processes tend to be simplified. Classifying uncertainties and evaluating their implications have been identified as an urgent need. Predictions about the kinds and severity of a project's impacts are often wrong and mitigation measures less effective than anticipated. This study aims to evaluate the extent to which uncertainty is considered and addressed in Canadian EIA practice. Environmental protection plans (EPPs) and follow-up programs present opportunities for proponents to disclose and address uncertainties raised during the environmental impact predictions. Twelve Canadian Environmental Impacts Statements (EISs), post the *Canadian Environment Assessment Act* in 1995 and prior to the 2012 Canadian environmental legislation Act, were reviewed. This study shows that in the EPPs and follow-up programs, uncertainty is never discussed in depth. There is a lack of suitable terminology and consistency in how uncertainty is disclosed reflecting the need for explicit guidance. When uncertainty is acknowledged, the authors took various approaches to address it. Seven kinds of approaches were identified in the reports. However, uncertainties were still never addressed in depth. This research clearly demonstrates that project-based Environmental Protection Plans and follow-up programs in Canadian EIA are not as transparent with respect to uncertainties as they should be, and that uncertainties generally need to be better considered and communicated to stakeholders and decision-makers.

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CEAA	**Canadian Environmental Assessment Agency**
CI	**Cumulative Impact**
CS	**Comprehensive Study**
CSR	**Comprehensive Study Report**
EEA	**European Environment Agency**
EIA	**Environmental Impact Assessment**
EIS	**Environmental Impact Statement**
EPP	**Environmental Protection Plan**
EU	**European Union**
RP	**Review Panel**
RPR	**Review Panel Report**
VEC	**Valued Ecosystem Component**
WBGU	**German Advisory Council on Global Change**

Chapter 1. Introduction

1.1. "Late Lessons from Early Warnings"

In the late 1920s, Thomas Midgley, a researcher working at General Motors, aimed to find a substitute for ammonia, methyl chloride and sulfur in refrigerators. These gases, useful refrigerants, have harmful and toxic properties and were not appropriate for home use. Thus, he invented dichlorofluoromethane (Freon 12). At an American Chemical Society meeting in 1930, Midgley demonstrated that the gas was non-flammable and had harmless properties. To prove this, he inhaled the "Freon 12" gas and blew out a candle with it. He performed this experiment to demonstrate that there was absolutely no risk involved in using this new gas: it was not toxic to humans (he could breathe it in) and it was not explosive (he could blow out a candle with it). So was the general consensus. Decades later, it turned out that the utilization of "Freon 12" gas had caused tremendous damages to the stratospheric ozone layer (Friedlander, 1989). This story, amongst many others, demonstrates the lack of consideration for ignorance of environmental effects in scientific and industrial research and decision-making (EEA, 2001). Ignorance involves a deep level of uncertainty to the extent that "we do even not know that we do not know" (Walker et al., 2003, p.13). The possibility of surprises should therefore be considered explicitly in environmental decision-making.

In many areas, human economic activities have resulted in irreversible impacts before actions were taken to stop further damages to the civil society and to the environment such as ozone holes (EEA, 2001). However, even though the lack of concern for ignorance and uncertainty in the application of scientific discoveries has been criticized because it has had tremendous environmental and human costs in the past. The European Environment Agency's (EEA's) report "Late Lessons from Early Warnings" (2013) shows that history tends to repeat in this regard. Even today, adequate consideration of preventive or responsive actions in environmental decision-making is often not done and the lack of these considerations weakens the protection of our vulnerable environment. Environmental Impact Assessment

(EIA) is step of the environmental decision-making process that creates an opportunity for preventive and responsive actions to be considered and implemented.

1.2. Importance of Uncertainties in Environmental Decision-Making

Environmental processes are known to be complex, variable, and sometimes unstable, and therefore hard to predict. In environmental decision-making, environmental processes are inevitably simplified leading to the creation of uncertainties (Geneletti et al., 2003). Internationally, uncertainty has been recognized as a necessary and significant aspect of environmental decision-making not only in science but also in politics and administration (Sigel et al. 2010). A recent study by Sigel et al. (2010) provides conceptual guidance for describing and dealing with uncertainty associated with environmental decision-making and specifically in regards to the EU Water Framework Directive (2010). However, in project-based EIAs, uncertainty has not been given enough attention (Wood, 2008).

Project-based EIA aims to identify, predict, evaluate and mitigate the negative impacts of a particular project (Noble, 2010). Empirical evidence shows that the information communicated in EIA is simplified and often incomplete (De Jongh, 1988; Tennoy et al., 2006; Duncan, 2008; Noble, 2010). This results in the proposal of environmental protection plans (EPPs) and contingency measures that are less efficient than anticipated (Buckley, 1992; Tennoy et al., 2006; Noble, 2010). Impacts on health, ecosystems or local communities can be tremendous and the economic cost of restoration is much heavier than the cost required for preventative measures (Wardekker et al., 2008).

Furthermore, environmental restoration capacity is often limited as environmental damages can be irreversible. This is the case for the loss or decline of keystones species or the permanent destruction of natural habitats. However, there is a major gap between the studies giving guidance on uncertainty identification and communication in EIA and the actual studies that looked at uncertainty in EIA. In Canada, no study was found on how uncertainties are considered and disclosed in EIA. This study aims to evaluate the extent to which uncertainty is considered and addressed in Canadian EIA practice. Its

purpose is to identify potential trends and good practices in order to help future EIA practitioners to better consider and disclose uncertainty.

1.3. Research Questions

In seeking to evaluate how uncertainties have been considered in Canadian Environmental Impact Assessment practice, this thesis focused on the EPPs and follow-up programs sections of EISs. Environmental Impact Statements (EISs) are presented to decision makers and the public to communicate about a project's potential impacts and proposed mitigation**.** Twelve Canadian EISs were selected in this study. The decision documents, i.e., Comprehensive Study reports and Review Panel reports were also reviewed. EPPs and follow-up programs sections were particularly relevant when looking at uncertainty disclosure in EIA. In Canada, the EIA process consists of seven steps: project description; screening; scoping; impact prediction and evaluation; EPPs, review and decision; and implementation and follow-up (Noble, 2010). Of particular interest was to analyse how EPPs addressed the uncertainties from the impact prediction section and how follow-up programs addressed uncertainties from both the impact prediction and EPPs sections. In addition, when uncertainty was discussed in any other section of an EIS, it was also considered.

This thesis seeks answers to the following research questions:

1. What kinds of uncertainties are expressed and how are these are expressed in environmental protection plans (EPPs) and follow-up programs?

This research question is aimed at gathering information on the types of uncertainties disclosed and on how well these were disclosed.

2. Which procedures are used to deal with uncertainties?

The purpose of this research question is to determine if the uncertainties identified were being addressed and if so, how these were being addressed.

Chapter 2. Literature Review

2.1. Terminologies and Concepts of Risk and Uncertainty

The literature review aimed to provide an overview of the English literature that has been published regarding uncertainty disclosure and communication in the field of EIA from the 1980s to present. Figure 1 is a detailed literature map. Literature review materials were identified by searching key words such as "uncertainty in EIA", "prediction" and "risk assessment" in online databases such as Science Direct, Web of Knowledge, Google Scholar, JSTOR and Academic Search Complete.

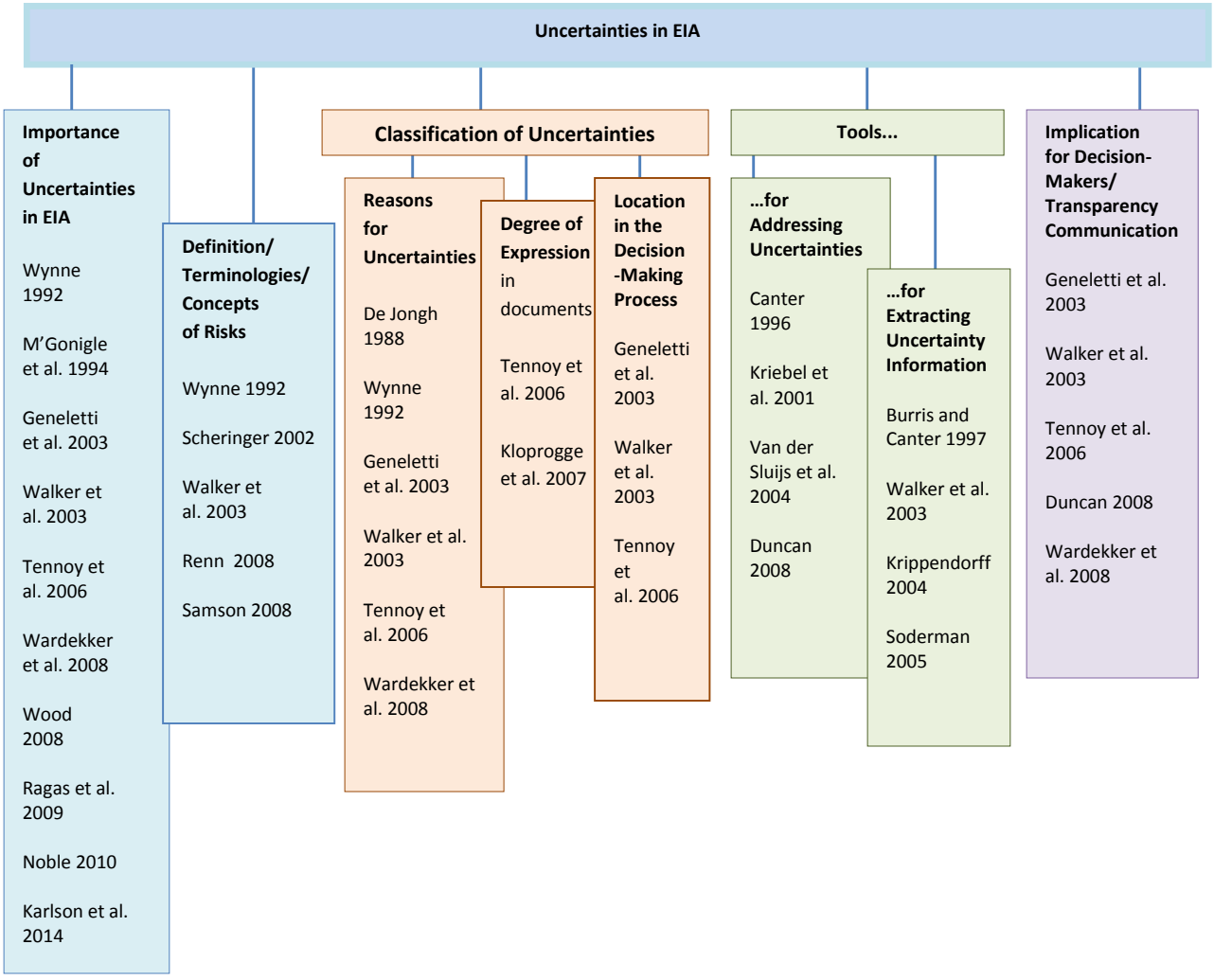

Figure 1: Literature map.

First, the literature review aimed to determine if risk and uncertainty should be considered as different concepts or dependent concepts. Throughout the literature, different views have been established on the relationship between the risk and uncertainty (Samson, 2008) (Fig. 2).

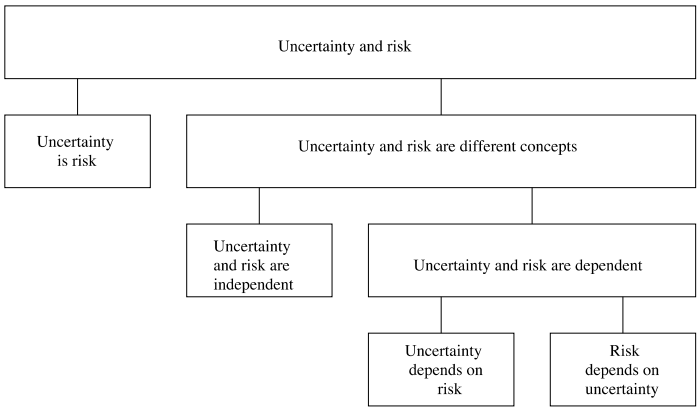

Figure 2: Various relationships between risk and uncertainty discussed in the literature (Samson, 2008).

The concept of "uncertainty" is closely related to the concept of "risk". Risk is defined by the magnitude of an unwanted damage multiplied by the probability of occurrence of that damage (Renn, 2008). Before and during the 1930s economic and financial crisis, economists such as Keynes and Knight traditionally differentiated the concept of risk from uncertainty (Globernance, 2012). Risk is quantifiable and can be given a monetary value, while uncertainty is not (Knight, 1921). In an article from 1937, Keynes considered that for example the next world war or the price of copper in twenty years did not relate to the concept of risk but to the concept of uncertainty (Keynes, 1937).

On the other hand, Renn (2008) uses the term "risk" in a wider sense. He includes the notion of uncertainty as an integral part of the concept of risk. He does so to take into account the complexity of environmental processes that are hard to estimate numerically. This relationship between the concept of risk and the concept of uncertainty was applied to the classification of risk given by the German Advisory Council on Global Change (WBGU). The council created a more sophisticated classification that provided a set of additional criteria to evaluate risk.

Six classes of risk (named after Greek mythology figures) were defined according to the nine criteria of the taxonomy: the extent of damage, the probability of occurrence of the damage, incertitude, ubiquity, persistence, reversibility, delay of the effect, violation equity, and potential mobilization of the public (Renn, 2008).

The first class of risk, named the *Sword of Damocles*, regroups risks that encompass a fatal event, a large amount of chance, a high damage and a low probability of occurrence (Fig. 3). This is the case for risks linked with nuclear energy or chemical facilities (Renn, 2008).

The class of risk defined as *Cyclops* describes risks with an unknown probability and a high extent of damage. For example, this would be the case of earthquakes or volcanic eruptions (Renn, 2008).

In the class of risk known as *Pythia,* probabilities are uncertain and the extent of the damage is potentially high but subject to variability. This is the case for human impacts on ecosystems (Renn, 2008).

The fourth class of risk, established as *Pandora's box* regroups risks with an unknown probability and a potentially high and persistent damage. For example, this would be the case of the risk caused by persistent organic pollutants (Renn, 2008).

The class of risk *Cassandra* regroups risks with a high probability of occurrence, a high extent of damage and an irrefutable manifestation. However, there is no public concern about the damages because of the uncertain occurrence of the damages. It is unclear when these potential negative effects will happen in the future. This is the case of the risks linked with sea-level rise (Renn, 2008) (Fig. 3).

The last class of risks, named *Medusa*, identifies a low probability and a low extent of damage. But because the outcomes cannot be proven, it encompasses high public mobilization (Renn, 2008). For example, this is the case of electromagnetic fields (Renn, 2008). Within the seven classes, the most important relationship that defines each type of risk is the one between the probability of occurrence of damage and the extent of the damage.

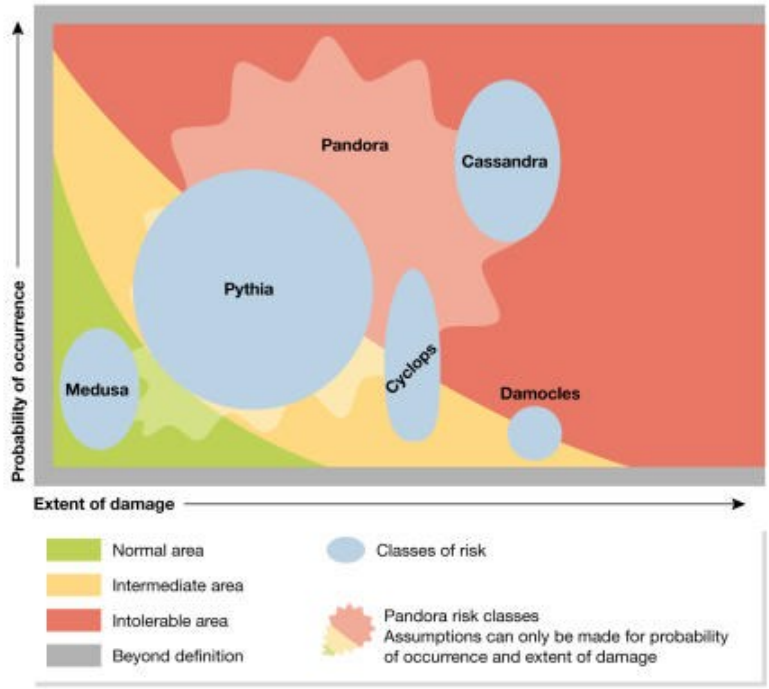

Figure 3: The six classes of risk according to WBGU (2000).

According to this classification, risk and uncertainty are two different concepts, which are in interaction with each other as the concept of uncertainty is viewed as an important component of the concept of risk (Fig. 2).

However, uncertainty can alternatively be understood as an overarching concept that regroups different kinds of uncertainty. Therefore, a distinction can be made between different kinds of uncertainty (in its wide sense) such as risk, uncertainty, ignorance and indeterminacy (Wynne, 1992) (Fig. 4).

- RISK – Know the odds.
- UNCERTAINTY – Don't know the odds: may know the main parameters. May reduce uncertainty but increase ignorance.
- IGNORANCE – Don't know what we don't know. Ignorance increases with increased commitments based on given knowledge.
- INDETERMINACY – Causal chains or networks open.

Figure 4: The different kinds of uncertainty according to Wynne (1992).

Similarly, Scheringer (2002) also compares risk, uncertainty and indeterminacy under the wide concept of uncertainty (Tab.1). In the situation of risk, both possible events and corresponding probabilities are known but the time of occurrence is unknown. For uncertainty, the possible events are known but the corresponding probabilities are not known. Indeterminacy is present when both the possible events and the corresponding probabilities are not known. Risk is still considered to be a kind of uncertainty (in its wide sense) but uncertainty (in its narrow sense) is not an integral part of risk any longer.

	Risk	Uncertainty	Indeterminacy
Possible Events	Known	Known	Not Known
Corresponding Probabilities	Known	Not Known	Not Known

Table 1: Concepts of Risk, Uncertainty and Indeterminacy (Scheringer, 2002).

Wynne's (1992) and Scheringer's (2002) classifications differ from the classification of the German Advisory Council on Global Change (WBGU), however not for the reason that they use a different classification system. Wynne's (1992) and Scheringer's (2002) classifications also discuss uncertainties in a general and objective manner, but giving no social dimension to risk. It is interesting to consider risk without a social dimension, but interdisciplinary or integrative approaches allow for the integration of different facets of risks and are more inclusive and representative of social reality. Interdisciplinary approaches consider the potential physical changes and the perceptions of the changes from both a social and psychological point of view.

Therefore, the classification of the German Advisory Council on Global Change (WBGU) remains the most complete and realistic classification system as it provides an interesting interdisciplinary approach to risk that include uncertainty as an integral part of the concept of risk. This approach to risk was the most suitable for EIA as it is more realistic and complete. Thus, when reviewing Environmental Impact

Statements (EISs), the concepts of risk and uncertainty were considered interconnected and therefore, the concept of risk was not excluded from the current study.

The concept of vulnerability and resilience are also related to the concept of risk. Vulnerability describes the probability of a damaging effect on the environment as a result of a risky situation and the incapacity of the environment to cope with that change. Resilience can be defined as the ability of the environment to overcome that change (Un-Habitat, 2007).

2.2. Uncertainty Classification

The literature review also aimed to gather information on uncertainty classification in order to conceptualise the potential types and sources of uncertainties in EISs. Even though the existence of uncertainties has been recognized in environmental decision-making, the scientific community lack of a common understanding regarding uncertainty features and degrees, including uncertainty typology and terminology (Walker et al., 2003). This results in a considerable confusion in terminology used in different publications and reports. De Jongh (1988) mentions various sources of uncertainties and identifies four sources in particular: *model errors* (resolution errors, process errors, functional errors and numerical errors), *changes in the project*, *errors in input data* (inaccurate data from data sampling and measurement including the data used in the calibration and application of models) and *bias* (both calculated and subjective considerations along the process).

De Jongh's model errors category can be further explained by the categories proposed by Walker et al. (2003). They identify three dimensions of uncertainty in the context of model-based decision support studies: the *location* of uncertainties, the *nature* of uncertainties and the *level* of uncertainties. The *location* of uncertainty describes where the uncertainty manifests itself in the model-based decision-making process. Walker et al. (2003) define four *locations* of uncertainties: *context uncertainties, model uncertainties, inputs uncertainties and parameter uncertainties.*

First, *context uncertainties* arise from the framing of the problem containing the technological, economic, social, political and ecological *system* boundaries including the stakeholder's subjective interpretation of the context. In EIA, the *system* is the project to be implemented and its environment as well as the project's potential environmental, social and economic effects.

Secondly, *model uncertainties* are associated with the lack of understanding of the current *system* behaviour and its evolution and therefore involve uncertainty about the relationships between variables (*model structure uncertainty*). *Model uncertainties* can also be associated with the technological implementation of the *model* such as software or hardware errors (*model technical uncertainty*).

Third*, inputs uncertainties* include the uncertainties about the data that are used. Data are entered to quantify relevant features in the *model* such as land-use maps or infrastructure information.

Fourth, *parameter uncertainties* are the uncertainties present in techniques or the data used to calibrate the *model* parameters. While some of the parameters are constants (*exact parameters* such as pi (π) or *fixed parameters* such as the acceleration of gravity (g)), some are established with uncertainties. This is the case of *a priori chosen parameters* estimated according to previous experiences and *calibrated parameters* that are established without the presence of previous experiences. *Model outcome uncertainties* are the accumulated uncertainties caused by all the others that decision-makers should be interested in (Walker et al., 2003).

For Walker et al. (2003), the *nature* of uncertainty differentiates uncertainties due to the imperfection of our understanding of processes (epistemic uncertainty) or is due to the stochastic variability in the environmental, societal and technological processes themselves (stochastic uncertainty). Finally, the *level* of uncertainty classifies uncertainties according to a spectrum that ranks from *determinism knowledge* to *ignorance*. Different levels of uncertainty are identified here: statistical uncertainty (e.g.: sampling errors, inaccuracy, scenario imprecision) which implies a wide range of plausible futures but none in particular, scenario uncertainty (possible outcomes are described instead of probabilities), recognized ignorance

(divided into reducible ignorance by further research and irreducible ignorance or indeterminacy) and total ignorance (we do not even know that we do not know) (Fig. 5)

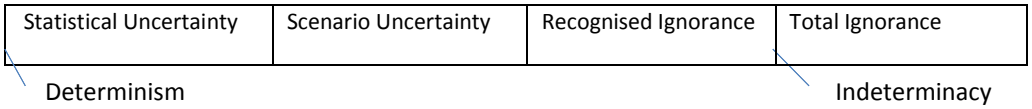

Figure 5: The levels of uncertainty represented by a range between determinism and total ignorance (modified after Walker et al., 2003).

Another dimension of uncertainty was found in the literature: the *disclosure* of uncertainty in the documentation (Tennoy et al., 2006). Uncertainty information in the documentation can be presented in various forms. It can be expressed in a graphic, numeric and linguistic way. Graphic and numeric expressions tend to be more specific than words and to present information in a more objective form. However, they tend to appear complex to the public and may require additional knowledge to extract information for untrained individuals and possibly for the decision-makers. Words can be understood in different ways, but tend to be more accessible to the public. They provide readers with a more simplistic approach to uncertainty information. Words also allow readers to locate and make use of uncertainty disclosure (Kloprogge et al., 2007).

In a previous study, linguistic information has been classified into four categories that describe the "degree to which uncertainty is expressed" (Tennoy et al., 2006) throughout the EIA process (Tab.2).

Category	Description
0	Uncertainty is not mentioned or suggested
X	Uncertainty is suggested, but not specifically referred to as uncertainty
XX	Uncertainty is indicated, sometimes estimated but not explained or discussed
XXX	Uncertainty is explained and/or discussed to some degree

Table 2: Categories describing the degree to which uncertainty is expressed in EIA documents (Tennoy et al., 2006).

De Jongh's (1988), Walker et al.'s (2003) and Tennoy et al.'s (2006) classifications seem useful to classify uncertainty information found in Canadian EISs.

2.4. Tools for Addressing and Extracting Uncertainty Information

2.4.1. Tools for addressing uncertainties in Environmental Impact Assessment

Several tools can be used to address uncertainties in Environmental Assessments. Van der Sluijs et al. (2004) propose a non-exhaustive list of tools that address different sorts and locations of uncertainty in Environmental Assessments: *Sensitivity Analysis*, *Error Propagation Equations, Monte Carlo Analysis, Expert Elicitation, NUSAP (Numeral Unit Spread Assessment Pedigree), Scenario Analysis, PRIMA (Pluralistic Framework of Integrated Uncertainty Management and Risk Analysis), Checklist for Model Quality Assistance and Critical Review of Assumptions in Models* (Van der Sluijs et al., 2004). Within the EIA process, Canter (1996) differentiates techniques to handle uncertainty in Input Data (e.g.: *Handling Uncertainty in Measurement and Analysis, Sensitivity Analysis)* and in Prediction (e.g.: *Scenario Approach, Monte Carlo Simulation)*. Van der Sluijs et al. (2004) also present a table about the correspondence of the tools with the different sorts and locations of uncertainty (Fig.6).

Type → / Location ↓			Level of uncertainty (*From determinism, through probability and possibility, to ignorance*)			Nature of uncertainty		Qualification of knowledge base (backing)	Value-ladenness of choices
			Statistical uncertainty (range+ probability)	Scenario-uncertainty ('what-if' option)	Recognized Ignorance	Knowledge related uncertainty	Variability related uncertainty		
Context	Ecological, technological, economic, social and political representation		SA *QA* EE	Sc *QA* *SI* EE	Sc MQC *QA* *SI* NUSAP/EP EE	NUSAP / EP MQC *QA* EE		NUSAP / EP MQC *QA* *PR* *EPR* EE	CRA, PRIMA Sc, *AA, SI,* EE *PR, EPR*
Data (in general sense)	Measurements+ Monitoring data; Survey data		SA, Tier 1 MCA EE	Sc EE	Sc *QA* NUSAP MQC *DV* *MV* EE	NUSAP MQC *DV* *QA* EE		NUSAP MQC *QA* *PR* *EPR* EE	CRA PRIMA Sc *PR* *EPR* *SI*
Model	Model Inputs	Measurements monitoring data; survey data							
	Model Structure	Parameters							
		Relations	SA, *MMS*, EE, MQC, *MC*	Sc, *MMS*	NUSAP, MQC, *MC, MV*	MQC, NUSAP, *QA*, EE		MQC, NUSAP, MC, *MV, PR, EPR,* EE	CRA, PRIMA, *MMS, PR, EPR, SI*
	Technical Model	Software& hardware-implement.	*QA* SA	*QA* SA	*QA* SA	*PR*		*PR*	SA *PR*
Expert Judgement		Narratives; storylines; advices	SA, *QA* EE	Sc, *QA, SI*, EE	Sc, MQC, *QA, SI,* NUSAP/EP, EE	NUSAP / EP MQC, *QA*, EE		NUSAP / EP, MQC, *QA, PR, EPR*, EE	CRA, PRIMA, Sc, *AA SI, PR, EPR*, EE
Outputs		(indicators; statements)	Sc, SA, Tier1, *MC*, EE	Sc, SA, EE	NUSAP, EE	NUSAP, MQC, *PR, EPR*, EE		NUSAP, MQC, QA, *PR, EPR*, EE	CRA, PRIMA, *PR, EPR*

AA	Actor Analysis
CRA	Critical Review of Assumptions
DV	Data Validation
EE	Expert Elicitation
EP	Extended Pedigree scheme
EPR	Extended Peer Review (review by stakeholders)
MC	Model Comparison
MCA	Tier 2 analysis / Monte Carlo Analysis
MMS	Multiple Model Simulation
MQC	Model Quality Checklist
MV	Model validation
NUSAP	NUSAP
PR	Peer Review
PRIMA	PRIMA
QA	Quality Assurance
SA	Sensitivity Analysis
Sc	Scenario Analysis
SI	Stakeholder Involvement
Tier 1	Tier 1 analysis (error propagation equation)

Figure 6: The correspondence of tools to address uncertainties with the sorts and locations of uncertainty according to Van der Sluijs et al. (2004).

While Van der Sluijs et al. (2004)'s tools to address uncertainties might be too technical to be explicitly mentioned in EISs, more approachable methods include the creation of pilot experiments (e.g. waste streams), the review of similar past projects, the evaluation of the effects of the most probable scenario, the most realistic scenario and the worst-case scenario (Canter, 1996). *Relative* uncertainties can also be presented according to impact categories. For example, uncertainty is known to be generally greater for detrimental (vs. beneficial), cumulative (vs. single project), irreversible (vs. reversible), long-term (vs. short-term), regional (vs. local), or indirect impacts (vs. direct or primary) (Canter, 1996). For these impacts with a greater level of uncertainty, a precautionary approach, monitoring and contingency planning are recommended (Canter, 1996). In particular, a precautionary approach implies that the burden of proof is shifted from the evidence of damage to the evidence of harmlessness (Wingspread statement on the Precautionary Principle, 1998). In EIA, the proponent should be responsible for all environmental damages resulting from the project's construction and operation. In addition, the proponent should anticipate the risk of these damages. That is why monitoring and contingency plans should be discussed in depth in the reports. In EIA, monitoring and contingency plans tend to be more confident than they should be (Wiklund, 2011). Finally, to better consider uncertainties and improve transparency in EIA, Karlson et al. (2014) recommends the establishment of "guidelines for spatial and temporal delimitation" as well as the implementation of "a quantitative framework including tools, methods and threshold values". These approaches are suitable to EIA and should be taken into account when reviewing EISs.

2.4.2. Tools for extracting uncertainty information from Environmental Impact Statements

The different methods proposed for classification indicate the challenges that one is facing when defining a typology and terminology for uncertainties. However, working with clear definitions and a consistent understanding of concepts is crucial in uncertainty communication in EIA to avoid confusion. Literature on uncertainties presented different techniques that are relevant to uncertainty identification, classification and communication in EIA. Some studies demonstrated the use of review questions to evaluate a particularly relevant aspect of EIA practice. For example, cumulative impacts and biodiversity issues have been evaluated according to pre-determined standards in the form of detailed questions (Burris and Canter, 1997; Soderman, 2005).

Burris and Canter (1997) reviewed 30 American EIAs in order to determine if cumulative impacts (CIs) were properly addressed. They used 17 review questions to assess CIs in EIA. For each review question, the rationale for its inclusion in the study was given. The review questions were divided into two sections: documentation of CIs and analyses of CIs.

Soderman (2005) reviewed 38 Finnish assessment reports in order to evaluate the extent to which biodiversity concerns are integrated into Biodiversity Impact Assessments. The study searched for best practices from the Finnish EIA Act and the Decree on Environmental Impact Assessment Procedure (1999). The reports selected were those that were likely to cause the most severe impacts on ecosystems. Forty-three review questions were used to evaluate the treatment of ecological and biodiversity issues. The criteria that were used to evaluate these questions were divided into three categories: if biodiversity concerns were addressed satisfactorily, partly satisfactorily, or not addressed. Review questions (Burris and Canter, 1997; Soderman, 2005) seem to be an effective tool to extract uncertainty information in EIS.

Other studies demonstrate the effective use of a classification table, a practice that is also recommended by the Netherlands Environmental Assessment Agency (formerly RIVM/MNP). Under the supervision of Peter Janssen and Jeroen van de Sluijs, the agency proposed guidance for Uncertainty

Assessment and Communication in decision-making (Nusap.net, 2012). The key guidance instrument of the panel is the so-called uncertainty matrix. The "uncertainty matrix" brings together the three first dimensions of uncertainty defined in section 2.3 (Uncertainty Classification): *location*, *level* and *nature*. This matrix aims to provide a framework for organizing and reporting uncertainties in policy-making fields such as EIA. The matrix also provides experts, decision-makers and stakeholders with a consistent understanding of the various aspects and terminologies of uncertainty, to help increase communication and transparency between these actors (Walker et al., 2003) (Fig. 7).

Location		**Level**			**Nature**	
		Statistical uncertainty	Scenario uncertainty	Recognised ignorance	Epistemic uncertainty	Variability uncertainty
Context	Natural, technological economic, social and political, representation					
Model	Model structure					
	Technical model					
Inputs	Driving forces					
	System data					
Parameters						
Model Outcomes						

Figure 7: The *Uncertainty Matrix* from Walker et al. (2003).

However, the Walker et al. (2003) uncertainty matrix is not applicable to EIA. Even though the matrix intend to provide experts, decision-makers and stakeholders with a consistent understanding and approach to the various aspects of uncertainty, it is impossible to use the matrix to gather uncertainty information from EISs. The matrix does not consider environmental effect sectors, what are the uncertainties generally about and what are the approaches used by the authors to address the uncertainty.

2.5. Reflection on Literature Review and Implications of Uncertainty Consideration for Practitioners and Decision-Makers

The literature review provided useful information on uncertainty types and on potential tools that can be used to extract uncertainty information in EIA. Uncertainty classifications used by De Jongh (1988), Walker et al. (2003) and Tennoy et al. (2006), appeared useful to gather uncertainty information from EISs. In addition, review questions (Burris and Canter, 1997; Soderman, 2005) seemed to be the most applicable tool to extract uncertainty information from EIS. Finally, Canter (1996) provided an overview of potential methods that could be used to address uncertainty disclosure. The literature review also confirmed that very few studies have considered uncertainties in EISs and that therefore, little guidance is available for practitioners in that matter. To address this issue, uncertainty terminology needs to be clarified and well organized. This would provide stakeholders with a consistent understanding of the different aspects of uncertainties, therefore, facilitating communication and increasing transparency between these actors (Walker et al., 2003). In EIA, stakeholders interact at different levels with the decision-making process (International Institute for Environment & Development, 2000). Three types of stakeholders are involved in the decision-making process: *Proponents*, *EIA regulators* and *Communities. Proponents* (companies or governmental organizations) develop the project (Morrison-Saunders, 2012). In most cases, proponents hire consultants to conduct the EIA. The larger companies are likely to conduct the EIA themselves (Edwards-Jones et al., 2009). *EIA regulators* (government authorities) make sure that the project complies with EIA guidelines. The community (public and NGOs) is kept informed of the process, communicate with proponents and EIA regulators, and can be involved in follow-up programs (Morrison-Saunders, 2012).

The current study aims to determine what Canadian EIA practitioners can bring to this area of study both in term of how to disclose and how to address uncertainty. In EISs, uncertainty classification and communication is also particularly relevant when decision-makers are accused of burying uncertainty to

their profit. While some scholars maintain that decision makers are neutral actors in EIA and are simply not aware of uncertainties (Tennoy et al., 2006), others argue that decision makers are aware of uncertainties and chose not to disclose them (Duncan, 2008). Tennoy et al. (2006) also described the consideration of uncertainties in impact prediction as the "black box" of EIA. The "black box" represents the importance of uncertainties in the EIA process but also the lack of transparency of the process (Tennoy et al., 2006). The current study aims to investigate if Tennoy et al.'s (2006) conclusions hold for Canada as well, and determine how well Canadian decision-makers are made aware of uncertainties.

Chapter 3. Uncertainty in Canadian Environmental Impact Assessment Environmental Protection Plans and Follow-up Programs

3.1. Introduction

3.1.1. Objectives and Limitations of Environmental Impact Assessment and the Importance of Uncertainties

Project-based environmental impact assessment (EIA) is *the* most important tool (Noble, 2010) for the identification, prediction, evaluation and mitigation of potential negative impacts on our natural environment, which can occur when developing a project (IAIA, 1999). Environmental impact assessment covers an ambitious range of potential natural environmental effects and examines impacts on water, air quality, soils, fauna and flora, among others. Ideally, the EIA process provides decision-makers with the best information and feasible alterations to a proposed project. The EIA process is ideally objectively conducted such that stakeholders and decision-makers are provided with a complete and specific understanding of the project as well as a realistic representation of natural environmental processes. However, environmental processes are known to be complex, vulnerable and sometimes unstable and therefore hard to predict. "Ecosystems not only are more complex than we think, but even more complex that we can think" (Geneletti et al., 2003, p.472). In impact prediction, these processes are inevitably simplified (Geneletti et al., 2003) and there will always be uncertainties in EIA (Arts et al., 2001; Walker et al. 2003).

Empirical evidence shows that the information communicated in EIA is often incomplete and that experts, decision-makers, and stakeholders are influenced by a number of factors that influence uncertainty perception (De Jongh, 1988; Tennoy et al., 2006; Duncan, 2008; Noble, 2010). These uncertainties, associated with environmental predictions and mitigation measures effectiveness, are not given enough attention during the EIA process (Wood, 2008). Therefore, academics have urged for better consideration of uncertainties in EIA as environmental predictions are often wrong and this results in the proposal of environmental protection plans (EPPs), and contingency measures that are often less efficient than anticipated (Buckley, 1992; Tennoy et al., 2006; Noble, 2010). Impacts on health, ecosystems or local

communities can be tremendous and the economic cost of restoration is much heavier than the cost required for preventative measures (Wardekker et al., 2008). Furthermore, environmental restoration is often limited as environmental damages can be irreversible. This is the case for the loss or decline of keystones species or the permanent destruction of natural habitats.

Therefore, decision-makers of a given project should never have limited access to information and potential natural environmental impacts should be communicated in a way that is as representative and specific as possible. Thus, uncertainty disclosure and communication in EISs promote the consideration and communication of the potential environmental risks triggered by areas of uncertainty, as well as the accountability of the proponent in that regard. Consideration for uncertainty also promotes transparency and openness throughout the whole environmental evaluation process (Tennoy et al., 2006; Wardekker et al., 2008).

In the literature, no study was found on how uncertainties are considered and disclosed in EIA in Canada. This study aims to evaluate the extent to which uncertainty is considered and addressed in Canadian EIA practice. Its purpose is to identify potential trends and good practices in order to help future EIA practitioners to better consider and disclose uncertainty. For many years, Canada has been a country highly regarded internationally as a standard of reference for its EIA practice. However, in 2012, Canada has witnessed significant cuts in its EIA legislation and overall environmental legislation (Gibson, 2012). This current study did not intend to review any legislative changes and therefore did not consider the new Canadian environmental legislation.

3.1.2. Research Questions

In Canada, the EIA process consists of seven steps: project description; screening; scoping; impact prediction and evaluation; impact management; review and decision; and implementation and follow-up (Noble, 2010). In seeking to evaluate how uncertainties have been considered in Canadian Environmental Impact Assessment practice, this study focused on the EPPs and follow-up programs sections of EISs.

These sections were particularly relevant when looking at uncertainty disclosure in EIA. Of particular interest was to analyse how EPPs addressed the uncertainties from the impact prediction section and how follow-up programs addressed uncertainties from both the impact prediction and EPPs sections. In addition, when uncertainty was discussed in any other section of an EIS, it was also considered.

This study seeks to answer to the following research questions:

1. What kinds of uncertainties are expressed and how are these expressed in environmental protection plans (EPPs) and follow-up programs?

This research question is aimed at gathering information on the types of uncertainties disclosed and on how well these were disclosed.

2. Which procedures are used to deal with uncertainties?

The purpose of this research question is to determine if the uncertainties identified were being addressed and if so, how these were being addressed.

3.2. Methodology

Two methodological aspects are addressed in this section. First, the procedure used to select EISs throughout Canada to use in this study is explained. Second, the method used to consider how uncertainty was disclosed and addressed in EPPs and in follow-up programs is described.

3.2.1. Selection of EISs

Environmental Impact Statements (EISs) are presented to decision makers and the public to communicate about a project's potential impacts and proposed mitigation**.** Twelve Canadian EISs were selected in this study. The decision documents, i.e., Comprehensive Study reports and Review Panel reports were also reviewed.

Only EISs completed since proclamation of the *Canadian Environment Assessment Act* in 1995 but prior to the 2012 act were taken into account because the current study did not consider and did not attend to review any legislative changes.

For a relatively representative distribution of EISs, two types of EIAs were taken into account: Comprehensive Studies (CSs) and Review Panels (RPs). Review Panels differ from Comprehensive Studies. For a Review Panel, the public or stakeholders trigger an independent review panel that conducts the EIA (Noble, 2010). Because three of these EISs were examined as case studies as part of the parent SSHRC research project entitled: "*Uncertainty Analysis and Communication in Canadian Environmental Assessment Practice and Decision-making"* (2012-2016)*,* they were automatically included in the selection: these were the Lower Churchill Hydro project in Newfoundland, the 407 East Transportation Corridor project in Ontario, and the Joslyn North Oil Sands Mine project in Alberta. These three projects were selected as case studies because they were complex projects with potential for significant impacts. In addition, they all issued participant funding to interest groups and indigenous communities. Finally, they all have been approved recently.

Since the aim was to select a sample of Canadian EISs that would be representative in terms of Provinces/Territories and project themes as much as possible. EISs were stratified according to: the type of EISs (Comprehensive Studies or Review Panels), the geographical location of EISs (Canadian provinces or territories) and EISs content. In total, fourteen content categories (development sectors) were identified (mining; road construction; gas facility; flood control; storage facility; treatment center; pipeline; power line; nuclear facility; decommission, decontamination and remediation; groundwater collector well; hydroelectricity; oil and gas development offshore; port and marine development; and ski development). The selection of EISs was intended to be as diverse as possible. The EISs were identified on the Canadian Environmental Assessment Agency's website in the *Environmental Assessments* section (CEAA, 2012) but accessed on the provincial websites or sent by government agents.

For a representative distribution of EISs across the country, approximately one project per province or territory should have been selected. However, in reality, EISs were unevenly distributed across Canada. For example, on the CEAA Website, no Review Panel or Comprehensive Study report was found for either

the Yukon or Nunavut. Similarly, no information on Review Panels for Manitoba was available. For Saskatchewan and Prince Edward Island, the EISs could be identified but not be accessed. In addition, the number of Comprehensive Studies was higher than the number of Review Panels. Finally, the EISs tended to be concentrated in a few provinces and territories, leaving others with few or, in some cases, no EISs. Where the distribution was more condensed, more EISs were selected. Table 1 provides the following information on the 12 EISs: The project location, the project title, the type (CSs or RPs EIA), the content, the sources and the provincial websites.

Location	**Project Title**	**Type**	**Content**	**Sources**	**Provincial Website**
AB	Joslyn North Mine project	RP	Storage/ Treatment/Water /Pipeline	-Deer Creek Energy, 2006. Section B Project Description and Section D Environmental Assessment -Total E&P Joslyn Ltd., 2011.Joslyn North Mine Project-Report of the Joint Review Panel	The Alberta Environment and Sustainable Resource Development: http://environment.alberta.ca
AB	Marmot Basin Ski Development project	CS	Ski Development	Iris Environmental Systems, 1999. A Proposal to Develop a Chairlift and Ski Runs on Eagle Ridge Marmot Basin Ski Area, Jasper National Park	The Alberta Environment and Sustainable Resource Development: http://environment.alberta.ca
BC	Prosperity Gold-Copper Mine project	RP	Mining	-Taseko Mines, 2009. Prosperity Gold-Copper Project Environmental Impact Statement/Application -Taseko Mines, 2010. Prosperity Gold-Copper Mine Project-Report of the Federal Review Panel	The British Columbia Environmental Assessment Office: http://www.eao.gov.bc.ca/
BC	Prince George Hart Water Supply project	CS	Water Diversion/Storage/ Treatment/ Pipeline	Golder Associates, 2003. Application for Environmental Assessment Certificate and Draft Comprehensive Study Report for the City of Prince George Island Collector Well	The British Columbia Environmental Assessment Office: http://www.eao.gov.bc.ca/
MB	Swan Valley Gasification project	CS	Gas/Gas Facility	Golder Associates, 2000. Environmental Impact Assessment for the Swan Valley Gasification Project	The Manitoba Conservation and Water Stewardship: http://www.gov.mb.ca/conservation/eal/index.html
NB	Liquefied Natural Gas Terminal and Multi-Purpose Pier project	CS	Port/Marine development	Irving, 2004. Liquefied Natural Gas Marine Terminal and Multi-Purpose Pier	The New Brunswick Environment and Local Government: http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/environmental_impactassessment.html
NL	Lower Churchill Hydro project	RP	Hydroelectricity	-Nalcor Energy, 2011. Lower Churchill Hydroelectric Generation Project-Report of the	The Government Newfoundland and Labrador: http://www.env.gov.nl.ca/env/en

				Joint Review Panel -Nalcor Energy, 2013. Lower Churchill Project-Project Wide Environmental Protection Plan Component 1 and 4b	v_assessment/index.html
NT	Mackenzie Gas project	RP	Gas/Gas Facility	-Imperial Oil Resources Ventures, ConocoPhillips, Shell, ExxonMobil and Aboriginal Pipeline Group, 2004. Environmental Impact Statement for the Mackenzie Gas Project -Joint Review Panel, 2009. Report of the Joint Review Panel for The Mackenzie Gas Project	The Government of the Nothwest Territories: http://www.gov.nt.ca
NS	Deep Panuke Offshore project	CS	Oil/Gas Development Offshore	-EnCana Energy Corporation, 2006. Deep Panuke Offshore Gas Development Plan-EIS -EnCana Energy Corporation, 2002. Deep Panuke Offshore Gas Development-Comprehensive Study Report.	The Government of Nova Scotia: http://novascotia.ca
ON	407 East Transportation Corridor project	CS	Roads	-Ministry of Transportation, 2009. 407 East Individual Environmental Assessment and Preliminary Design Study -Canadian Environmental Assessment Agency, 2011. 407 East Transportation Corridor-Comprehensive Study Report	The Ontario Ministry: http://www.ene.gov.on.ca/en/eaab/index.php
ON	Aquarius Gold Mine project	CS	Mining	AGRA Earth and Environmental, 1999. Comprehensive Study Report Environmental Assessment, Aquarius Project	The Ontario Ministry: http://www.ene.gov.on.ca/en/eaab/index.php
QC	Waskaganish Road project	CS	Roads	The Crees of the Waskaganish First Nation et l'Institut national de la recherche scientifique, 1998. Environmental and Social Impact Study	The Government of Quebec: http://www.bape.gouv.qc.ca/sections/rapports/themes/infrastructures.htm

Table 1: The selected EISs locations, titles, types, contents, and sources (see Appendix 1 for more information about the projects).

The process of accessing the EISs and their associated decision documents was difficult. When the EIS could not be found online, the recommended contacts on the CEAA website were contacted (e.g.: "*To obtain a copy of the comprehensive study report, or to obtain further information on the project, please contact*…"). The provincial contacts were eventually reached and so were the proponents to the project. One of the main problems was to get access to the Comprehensive Studies Reports (CSRs). Government agents were often unable to distinguish between CSRs and the entire EISs. In most cases, they sent or referred the researcher to the Comprehensive Studies report *summaries or reviews* instead of the

Comprehensive Study EIS itself. The process of accessing the EISs was also fraught with difficulties. For example, for *the Waskaganish Permanent Road project*, nothing was available on the CEAA Website. The first emails were sent in May 2013 to the contacts on the CEAA webpage and correspondence continued through September. The EIS was finally received on a CD at the end of October.

3.2.2. The consideration of uncertainties in EIA EPPs and follow-up programs

Generally, extracting uncertainty information from the EISs was based on *content analysis*. This systematic and replicable scientific method allows for the gathering of unstructured information into specific and predetermined categories (Krippendorff, 2004). Content analysis can and should be both quantitative and qualitative (Smith, 1975). Qualitative analysis addresses the form of the information collected (the what, how, when and where of something) while quantitative analysis records the incidences of the form of the information collected (the frequency of something) (Jackson, 1968; Smith, 1975; Dabbs 1982).

Follow-up programs are composed of three interconnected steps: monitoring, auditing and ex-post evaluation (Noble, 2010). In the context of uncertainty disclosure, monitoring is used to confirm anticipated outcomes and to alert managers of unanticipated outcomes *(progress monitoring)* (Noble, 2010). The second component, auditing, aims to determine if predicted environmental impacts correspond to actual environmental impacts *(project impact audit)* (Noble, 2010). The third step, ex-post evaluation uses the information collected from *progress monitoring* and *project impact audit* in order to make adjustments to the regulatory framework of the project or to the project development components. This approach is called adaptive management (Noble, 2010). However, adaptive management is only a partial solution when facing irreversible impacts. Therefore, authors might choose to address uncertainty using other approaches such as more research or precautionary approaches.

The review of uncertainty information from EISs consisted of two steps. First, uncertainty information was extracted from the EISs, specifically the EPPs and follow-up programs sections and organized into a

table (see Appendix 2). Next, the information from the EPPs and follow-up programs table was reorganised into twelve 'uncertainty categorization' tables; one per EIS (see Appendix 3).

Uncertainty information was extracted from the EPPs and follow-up programs based on a series of review questions. These questions were inspired by the ones used in the studies by Burris and Canter (1997) and Soderman (2005). In these studies, cumulative impacts (Burris and Canter, 1997) and biodiversity issues (Soderman, 2005) were evaluated according to pre-determined standards in the form of detailed questions. The review questions used to complete the EPPs and follow-up programs are presented in table 2. Not all of the review questions were answered for each EIS, as when uncertainty was not disclosed, some of the questions could not be answered.

EIS Section	Review Questions
EPPs	-Do mitigation measures directly disclose uncertainty? If so, what is uncertainty generally about (e.g., impact predictions - for a particular impact or in general -, effectiveness/planning/implementation of mitigation measures or contingency planning - for a particular impact or in general -, how the project will be designed, methods, and tools for assessment)? More specifically about what (e.g., *Context uncertainties, model uncertainties, input uncertainties, and parameter uncertainties)*? -Is uncertainty used as a criterion to determine the significance of the residual impacts? -How is uncertainty addressed in mitigation measures (e.g., mitigated, ignored, justified, addressed by more research, addressed with follow-up programs)? -Are uncertainties disclosed in depth in contingency plans? If so, what is the uncertainty generally about (e.g., impact predictions-for a particular impact or in general, mitigation measures or contingency planning-for a particular impact or in general, how the project will be designed, methods, tools for assessment)? More specifically about what (*e.g., context uncertainties, model uncertainties, input uncertainties and parameter uncertainties)*? -How is uncertainty addressed in contingency plans (e.g., mitigated, ignored, justified, addressed by more research, addressed with the disclosure risk scenarios with quantitative information: e.g. about the probability of occurrence of the damage, or the extent of the damage)?
Follow-up program	-Do follow-up programs address any particular uncertainties? If so, what is uncertainty generally about (see above)? More specifically about what (see above)? -If so, how well is monitoring/ auditing and adaptive management disclosed (e.g. schedule, budget, authority and for adaptive management thresholds, location and time)? -If uncertainty is a criterion to determine the significance of the residual impacts, are these significant impacts addressed with monitoring/auditing and adaptive management? If yes, how well are these disclosed (schedule, budget, authority)? -Are any other measures proposed to address that uncertainty (mitigated, ignored, justified, addressed with more research)? -Is there any other measure proposed in the case that adaptive management measures will fail? -Are follow-up programs concentrated on areas of importance to identify unexpected changes in the environmental information (for environmental impacts and mitigation measures)? If yes, how well are the follow-up programs disclosed (schedule, budget, authority)? -Will the results of the follow-up program be communicated to the public and shareholders?

Table 2. Review questions used to gather uncertainty information in the EPPs and follow-up programs table.

Once the uncertainty information was gathered in the EPPs and follow-up programs table, the information was further organised into categorization tables as mentioned above.

One categorization table was completed for each EIS, consisting of the following:

Environmental Sectors	Mitigation measures			Contingency Plans			Follow-up Programs		
	Uncertainty about	o/x/xx/xxx	Uncertainty addressed with	Uncertainty about	o/x/xx/xxx	Uncertainty addressed with	Uncertainty about	o/x/xx/xxx	Uncertainty addressed with

Table 3: Uncertainty categorization table.

The first sub-column *uncertainty about* aims to describe what the uncertainty is generally about. In the mitigation measures and follow-up programs sections uncertainty can be about cumulative impact predictions, residual impact predictions or about the failure of the mitigation measures or the follow-up programs themself. In the contingency plans sections, uncertainty can be about the risk of a failure, or about the effectiveness of the contingency plans.

In each of the three groups of the categorization table, the second sub-column (o/x/xx/xxx) aims to describe how uncertainty is disclosed. The categorization in this column was inspired by the classification (Table 4) by Tennoy et al. (2006).

Category	**Level of disclosure**	**Content**	**Description**
0	None	n/a	Uncertainty is not disclosed (neither suggested nor mentioned); Neither directly nor indirectly; The reference is not strong enough to associate it with any types of uncertainties.
x	Low	Implicit	Uncertainty is suggested implicitly and therefore not specifically referred to as uncertainty; It is not explained or discussed (the type of uncertainty is not identifiable).
		Explicit	Uncertainty is suggested explicitly and referred to as uncertainty but not explained or discussed (the type of uncertainty is not identifiable).
xx	Medium	Implicit	Uncertainty is explained and/or discussed to some degree but not referred to as uncertainty.
		Explicit	Uncertainty is explained and/or discussed explicitly to some degree and referred to as uncertainty.
xxx	High	Implicit	Uncertainty is explained and discussed in depth and appropriately but not referred to as uncertainty.
		Explicit	Uncertainty is explained and discussed in depth and appropriately and referred to as uncertainty.

Table 4*: The categories used in this study to describe the extent to which uncertainty is expressed (inspired by Tennoy et al., 2006).

*** In cases where the level of disclosure was between any two levels, the closest level was chosen.**

When uncertainty disclosure is medium or high, its type can be identified according to the classifications found in the literature. De Jongh (1988) mentions four sources of uncertainties: *Model errors*, *changes in the project*, *errors in input data* and *bias*. These sources of uncertainties can be further explained by Walker et al. (2003)'s classifications: the *location* of uncertainties, the *nature* of uncertainties, and the *level* of uncertainties. Walker et al. (2003) define four *locations* of uncertainties: *context uncertainties, model uncertainties, input uncertainties and parameter uncertainties.* First, *context uncertainties* arise from the framing of the problem containing the technological, economic, social, political and ecological *system* boundaries including the stakeholder's subjective interpretation of the context. Secondly, *model uncertainties* are associated with the lack of understanding of the current *system* behaviour and its evolution. Third*, inputs uncertainties* include the uncertainties about the data that are used to quantify relevant features in the *model* such as land-use maps or infrastructure information. Fourth, *parameter uncertainties* are the uncertainties present in techniques used to calibrate the model parameters.

For Walker et al. (2003), the *nature* of uncertainty differentiates uncertainties due to the imperfection of our understanding of processes (epistemic uncertainty) or is due to the inherent variability of environmental, societal and technological processes themselves (stochastic uncertainty). Finally, the *level* of uncertainty classifies uncertainties according to a spectrum that ranks from *determinism knowledge* to *ignorance*.

Different levels of uncertainty are identified here: statistical uncertainty which implies a wide range of plausible futures but none in particular, scenario uncertainty (possible outcomes are described), recognized ignorance and total ignorance (we do not even know that we do not know).

The third sub-column aims to describe how the uncertainty (previously disclosed) is addressed.

3.3. Results

The complete EPPs and follow-up Programs table is available in Appendix 2. It gives an overview of how uncertainty was expressed and addressed in the EPPs and follow-up programs sections and provides example quotes from the EIS reports. When uncertainty was not disclosed, some of the review questions were ignored to avoid unnecessary repetition in the table. Information from the EPPs and follow-up programs table was then reorganized into the Categorization Tables, available in Appendix 3.

Categorization tables quantified uncertainty information and help identify trends regarding how uncertainty was expressed and how it was addressed in EPPs and follow-up programs sections.

The results section will first cover how uncertainties were expressed and second how uncertainties were addressed in EPPs and follow-up programs sections.

3.3.1. How was uncertainty disclosed?

This section aims at identifying trends about uncertainty disclosure. Examples of cases where uncertainty was not disclosed (category 0), implicitly disclosed (category x and category xx), and explicitly disclosed (category x and category xx) are given. Uncertainties were never implicitly explained and/or discussed explicitly in depth (i.e., level of disclosure = xxx). Quantitative results are also presented in order to report on the level of disclosure of all the uncertainties and on what these uncertainties were generally about (e.g. cumulative impact predictions, residual impact predictions, the failure of the mitigation measures or the follow-up programs themselves).

In all reports examined, the expressions “may”, “could”, “probably”, “maybe” or “as soon as possible” were widely used. In these cases, the uncertainty was not disclosed (neither mentioned nor suggested). Table 5 gives a list of all the expressions used in circumstances where uncertainty was not disclosed. In the table, relevant terms and expressions are underlined and page numbers are given in brackets.

Category 0-None: Uncertainty was not disclosed, suggested nor mentioned and the reference was not strong enough to associate it with any types of uncertainties		
Terms	**Examples from the reports examined**	**Source**
Might/May	*"DCEL and CENRL will continue to discuss the timing and scheduling of activities to determine the future monitoring and subsequent mitigation that may be required."(4-15)*	Joslyn North Mine Project
Could/Can	*"The following is a summary of follow-up monitoring that could be done to ensure the long term sustainability of the soils resource."(10-30)*	Joslyn North Mine Project
Likely/Unlikely	*"The Panel finds that with an effective emergency response plan in place, it is unlikely that significant adverse environmental effects would occur as result of accidents or malfunctions associated with the project."(78)*	Joslyn North Mine Project
Potential/ Potentially	*"B.10.3.1 Progressive Project Management* *The Progressive Project Management approach used by DCEL will be applied in three stages. The first stage is implemented prior to development, and much of the documentation has been included in this application. During this stage, baseline environmental conditions are documented and potential environmental effects identified."(10-4)*	Joslyn North Mine Project
Probably	*"Absence of veteran trees, relative lack of arboreal lichens, low to moderate levels of downed and dead woody material, low to moderate dbh values and lack of complex debris structure indicated to the botanists that low elevation forests were probably not old aged."(267)*	Marmot Ski Area Project
Improbable	*"Although the scenarios are improbable, the effects of a LNG spill are presented here for consideration. The following locations are considered to be the most likely areas where a spill could occur" (157).*	LNG Project
Or	*"Implement one or a combination of, the following mitigation measures" (5-10 in Section 5: Contingency Plans).*	Mackenzie Gas Project
Relatively	*"This new wildlife mitigation plan should include measures such as the following:* *-Implementation of off-site offsets: The creation (preferred) or the protection of habitats suitable for species at risk in locations relatively near the project;" (45).*	Joslyn North Mine Project
Approximately	*"As such, the final configuration of Joslyn Creek will result in a net gain in area of available habitat of approximately 3.4 hectares excluding any potential habitat provided by End Pit Lakes."(3-26)*	Joslyn North Mine Project
It was assumed	*"For the purposes of mitigation planning, it is assumed that within the newly constructed sections of Joslyn Creek channel sinuosity will be maximized to 1.3:1, where technically feasible; and average channel width will be about 7-8 metres, approximating the natural pre-disturbed channel width."(3-26)*	Joslyn North Mine Project
As needed	*"Mine fleet haul routes will be optimized for operational efficiencies and to minimize fuel consumption, and will be adjusted as needed during the life of the project" (1-27)*	Joslyn North Mine Project
To the extent possible	*"Minimize the Project footprint to the extent possible" (*14-33).	Joslyn North Mine Project
Whenever possible	*"Integrate project developments with other existing and/or proposed land use activities in the area to minimize new disturbance and cumulative habitat loss, including the use of exiting access or utility corridors whenever possible"(14-33).*	Joslyn North Mine Project
Where possible	*"Use previously disturbed areas where possible to avoid disturbing sensitive vegetation and wetlands" (13-37).*	Joslyn North Mine Project
As much as possible	*"Designs to minimize footprint as much as possible" (11-32).*	Joslyn North Mine Project
As soon as possible	*"-Participate in the Regional Aquatics Monitoring Program* *-Assess effectiveness of fish habitat enhancements* *-Reclaim disturbed areas as soon as possible* *-Undertake additional erosion control measures in areas of high potential for erosion" (3-28).*	Joslyn North Mine Project
One possibility would be	*"One possibility would be to plan observation well(s) on one or more of the islands in the Athabasca River North-East of the DCEL lease. Further work will be conducted in the future in this regard". (4-16)*	Joslyn North Mine Project
When operationally feasible	*"When operationally feasible, direct placing mineral soil on reclaimed landscapes." (10-50).*	Joslyn North Mine Project
Where technically feasible	*"For the purposes of mitigation planning, it is assumed that within the newly constructed sections of Joslyn Creek channel sinuosity will be maximized to 1.3:1, where technically feasible; and average channel width will be about 7-8 metres, approximating the natural pre-disturbed channel width."(3-26)*	Joslyn North Mine Project
Where appropriate	*"Floating roofs on storage tanks, where appropriate" (1-27).*	Joslyn North Mine Project
Where economically feasible	*"Based on the results from these studies, the project will evaluate and, where economically feasible, implement changes in the way these facilities are operated or managed in order to reduce greenhouse gas emissions;"(1-28)*	Joslyn North Mine Project

Table 5: List of all the terms used in circumstances where uncertainty was not disclosed (category 0). Particularly relevant terms and expressions are underlined.

The expressions listed in table 5 were extensively used throughout each EIS and in all EISs examined. It shows how vague statements could be about predictions, mitigation measures, contingencies and follow-up programs. When these expressions were used, it was impossible to grasp if the authors were disclosing or hiding a gap in knowledge.

When uncertainty was implicitly disclosed, the disclosure could be low (x) or medium (xx). A low and implicit disclosure implies that uncertainty was suggested implicitly, but not explained nor discussed. The source of the uncertainty was therefore not identifiable. A medium and implicit disclosure implies that uncertainty was explained to some degree but not referred to as uncertainty. In that case, the source of the uncertainty was identifiable (e.g. data uncertainty, model uncertainty, context uncertainty). In the contingency planning sections, uncertainty was always generally implicitly taken into account because uncertainty is part of the definition of a contingency. When accidents, malfunctions, and unplanned events were mentioned, it was concluded that the disclosure of uncertainty was medium. In the mitigation measures and follow-up program sections of EISs, uncertainty was implicitly disclosed using the terms listed in Table 6.

Terms used in circumstances where uncertainty disclosure was implicit			
Terms	**Level of Disclosure**	**Examples from the reports examined**	**Source**
Unplanned	Low (x)	*"Identifying all unplanned repercussions and elaborating new measures to be taken, if applicable." (110)*	Waskaganish Permanent Road Project
Not a measurable parameter	Low (x)	*"Baseline harvest data is available for the region, but poaching incidence is not a measurable parameter (6-142).*	Prosperity Gold-Copper Project
Unexpected	Low (x)	*"During the pipeline construction, the failure of various control or mitigative measures can result from the occurrence of unexpected conditions, such as construction trough unstable soils or an unusually severe precipitation event." (154)*	Swan Valley Gasification Project
Unpredictability	Low (x)	*"However, given the unpredictability of mitigation measures related to wildlife road mortalities, any Project-related wildlife-vehicle collisions or near misses will be recorded, and reviewed to identify problem areas." (6-75)*	Prosperity Gold-Copper Project
Unknown	Low (x)	*" Examination of existing tree stumps in the kruppelholz zone shows an increased level of dead or dying ericaceous shrubs and little regeneration by ground layer herbs and forbs. The age of these cuts is unknown, however and it is expected that over time these areas will be revegetated by less shade-tolerant species."(266)*	Marmot Basin Ski Project
Available information/Accurate/Accuracy/	Low (x)	*"For a number of reasons that shall be described in this section, available information does not permit an accurate means to measure and assess the impact of skier traffic on highway wildlife mortality"(259).*	Marmot Basin Ski Project
Knowledge deficiencies	Low (x)	*"No critical knowledge deficiencies were identified during this process leading to the completion of the Comprehensive Study"(383).*	Marmot Basin Ski Project
Data gaps /No information/No data	Low (x)	*"Should deficiencies or data gaps be identified, the adaptive management framework will trigger a feedback mechanism to ensure deficiencies are addressed and compensation efforts continue moving toward the overall goal of achieving NNL."(9-94)* *"There is no information on the effects of industrial development on this group"(6-346).*	Prosperity Gold-Copper Project
Moderate reliability rating/ Not reliable	Low (x)	*"- Model used to predict/map the value and availability of seasonal feeding habitat in the mine site LSA and transmission line LSA has a moderate reliability rating* *-Model used to predict/map the value and availability of habitat in the RSA is not as reliable as that used for the mine site LSA and transmission line RSA."(6-128)*	Prosperity Gold-Copper Project
Confidence in prediction	Medium (xx)	*"**Confidence in Predictions*** *Project Effects* *Overall confidence in the project effects assessment for groundwater quantity is medium to high for the following reasons"(4-140)*	Prosperity Gold-Copper Project

Table 6: List of all the terms used in circumstances where uncertainty was suggested and therefore not specifically referred to as uncertainty (the content is implicit).

In Table 6, the first example ("*unplanned"*) represents a case where uncertainty disclosure was implicit and low: *"Identifying all unplanned repercussions and elaborating new measures to be taken, if applicable." (110)*

Uncertainty was not explicitly acknowledged nor explained and/or discussed to some degree. The source of the uncertainty was not identifiable. The last example (*Confidence in Prediction*) shows a case where uncertainty disclosure was medium and implicit. As mentioned before, when uncertainty disclosure was medium, its source could be identified (e.g. model uncertainty, context uncertainty, data uncertainty). In this case, uncertainty was implicitly explained to some degree in a separate section (*Confidence in Prediction).* Therefore, the source of uncertainty was easily identifiable and could be associated with the

complexity of the geology and the variability of the hydrology in the region, for example. Here, uncertainty is generally about impact prediction and is due to context and stochastic uncertainty.

When uncertainty disclosure was explicit, the disclosure could be low or medium. Table 7 gives examples where uncertainty disclosure was explicit.

Examples where uncertainty disclosure was explicit			
Terms	**Level of Disclosure**	**Examples from the reports examined**	**Source**
Uncertainty	Low (x)	*"Monitoring will also address any uncertainty distinguishing pre-closure logging and post-closure Project effects."(9-93)*	Prosperity Gold-Copper Project
		"Available information and understanding of the project components are used to predict the project's contribution to greenhouse gas emissions. As with all predictions of future conditions, the predictions in the impact assessment have a level of uncertainty. The prediction confidence in the effects related to greenhouse gas emissions is high because the likely emissions will be less than predicted. The potential contribution of the project to greenhouse gas emissions was calculated based on peak operations, with all equipment operating at full capacity. Actual operations will likely be at lower level and result in lower emissions." (2-107)	Mackenzie Gas Project
		"To verify the accuracy of the environmental assessment and determine the effectiveness of mitigation measures. In accordance with the requirements of the Act, a follow-up program is required for the Project. The program will focus on those environmental components where there is a relatively larger degree of uncertainty about the predicted effects. MTO will provide annual follow-up reports on vegetation (including wetlands), surface water, groundwater, wildlife, fish and fish habitat."(V)	407 East Transportation Corridor Project (CSR)
Uncertainty/ Certainty	Medium (xx)	*"DFO expressed its concern about the uncertainty of the predictive models. It stated that the models are based on limited data and a number of assumptions and cannot predict with certainty the success of fish habitat compensation. Therefore, DFO requires validation and monitoring to ensure accurate fish habitat impact predictions and the achievement of fish habitat compensation goals. DFO would require conditions in its authorization to TOTAL, including the use of adaptive management if new information clarifies the uncertainties."(65)*	Joslyn North Mine Project
		"To address uncertainty regarding responses of aquatic organisms in Wasp Lake to diversion of clean water during and after the life of the Project, monitoring of phytoplankton, zooplankton and benthic invertebrate, along with water and sediment will be required."(2-158)	Prosperity Gold-Copper Project
		"The Panel notes that there are uncertainties about the effects of industrial development on water quality in the lower Athabasca River and that these should be resolved through better monitoring programs."(102)	Joslyn North Mine (RPR)

Table 7: Examples where uncertainty was suggested explicitly and referred to as uncertainty.

In the first example of explicit and medium disclosure, uncertainties due to models were disclosed. These uncertainties prevented the authors from predicting with certainty the success of the fish habitat compensation plan for the Joslyn North Mine project:

> *"DFO expressed its concern about the uncertainty of the predictive models. It stated that the models are based on limited data and a number of assumptions and cannot predict with certainty the success of fish habitat compensation. Therefore, DFO requires validation and monitoring to ensure accurate fish habitat impact predictions and the achievement of fish habitat compensation goals. DFO would require conditions in its authorization to TOTAL, including the use of adaptive management if new information clarifies the uncertainties."(65)*

In this case, the source of the uncertainty was identifiable: uncertainty was due to data, model, recognized and stochastic uncertainty. In addition, uncertainty was generally about impact prediction

("*uncertainty of the predictive models*") and about the effectiveness of the mitigation measures ("*cannot predict with certainty the success of fish habitat compensation*").

In order to identify how uncertainties were the most disclosed, Table 8 summarizes the total number of times uncertainties were expressed in the EPPs and follow-up sections of all EISs; the number of uncertainties with a low or medium level of disclosure; and the number of uncertainties according to what they were generally about (impact predictions, cumulative impacts, residual impacts, mitigation measures, and follow-up programs). These numbers are based on the categorization tables available in Appendix 3.

Project Title	**Type**	**Total number of uncertainties**	**Low disclosure: Implicit (imp) Explicit (exp)**	**Medium disclosure: Implicit (imp) Explicit (exp)**	**Uncertainties about impact predictions**	**Uncertainties about cumulative impacts**	**Uncertainties about mitigation measures**	**Uncertainties about residual impacts**	**Uncertainties about the potential failure of follow-up programs**
1. Joslyn North Mine Project	**RP**	**35**	18 (imp)	17 (13 exp & 4 Imp)	14	11	3	7	0
2. Marmot Basin Project	CS	**4**	0	4 (imp)	4	0	0	0	0
3. Prosperity Gold-Copper Mine Project	**RP**	**47**	6 (5 imp & 1 exp)	41 (25 exp & 16 imp)	31	3	6	5	0
4. Prince George Hart Water Supply Project	CS	**0**	0	0	0	0	0	0	0
5. Swan Valley Gasification Project	CS	**1**	1 (imp)	0	1	0	0	0	0
6. Liquefied Natural Gas Terminal project	CS	**0**	0	0	0	0	0	0	0
7. Lower Churchill Hydroelectric Generation project	**RP**	**18**	9 (1 imp & 8 exp)	9 (7 exp & 2 imp)	10	1	7	0	2
8. Mackenzie Gas project	**RP**	**24**	7 (1 imp & 6 exp)	17 (5 exp & 12 imp)	22	0	2	0	0
9. Deep Panuke Offshore Gas Development project	CS	**6**	6 (imp)	0	0	0	0	6	0
10. 407 East Transportation Corridor project	CS	**6**	3 (2 imp & 1 exp)	3 (exp)	2	0	4	0	0
11. Aquarius Gold Mine project	CS	**10**	10 (5 imp & 5 exp)	0	5	0	5	0	0
12. Waskaganish Permanent Road project	CS	**0**	0	0	0	0	0	0	0
Total number of uncertainties			**61 (39 imp & 22 exp)**	**91 (53 exp & 38 imp)**	**89**	**15**	**27**	**18**	**2**

Table 8: Number of times uncertainties were expressed according to the level of disclosure (low or medium) and what the uncertainties were about (impact predictions, cumulative impacts, mitigation measures, residual impacts and follow-up programs). There was no high disclosure found in any report.

Based on Table 8, it is apparent that uncertainties disclosed about impact predictions were the most common ones in the EPPs and follow-up program sections of EISs, followed by uncertainties about mitigation measures, uncertainties about residual impacts, and those about cumulative impacts. Uncertainties about follow-up programs were rarely mentioned (only in the Lower Churchill Hydroelectric Generation project EIA). Three reports (the Prince George Hart Water Supply Project, the Liquefied Natural Gas Terminal and Multi-Purpose Pier project and Waskaganish Permanent Road project) did not disclose any uncertainty at all (i.e. level of disclosure=0). Uncertainties were more often mentioned in Review Panel EISs than in Comprehensive Study EISs. In the Review Panel EISs, the complexity and unpredictability of environmental processes were sometimes well acknowledged by the Review Panel. However, in the Review Panel report (not the EIS), uncertainties (on an individual basis) were never discussed in depth nor explained.

Table 8 also indicates that the reports were not consistent with respect to how they disclosed uncertainty. Uncertainty disclosure was not done (0), was low (x) or medium (xx), which means that sometimes the uncertainties were identifiable and sometimes it was not clear what the uncertainty was about. This was also true with explicit and implicit disclosures. No consistent pattern could be detected here. When uncertainties were identifiable, they were mainly about data, context, and model uncertainties. These included stochastic and epistemic uncertainties. Scenario uncertainty was taken into account, to some extent, through contingency scenarios but these were never discussed and addressed in depth. Finally, when uncertainties were mentioned (either explicitly or suggested implicitly), they were never expressed with in-depth scenarios or statistical information (probabilities).

3.3.2. How was uncertainty addressed?

When uncertainty was acknowledged (implicitly or explicitly) in the EPPs and follow-up programs, the authors took on various approaches to address it. Seven types of approaches have been identified and will be discussed in this section: Uncertainties were addressed with follow-up programs; Uncertainty levels were estimated but completely ignored; The neglect of uncertainty was justified; Uncertainties were addressed with sensitivity analysis or the use of conservative estimates; Uncertainties were addressed with more research; Uncertainties were addressed with precautionary approaches; and Uncertainty was discussed in a general way but no details were given. These approaches were sometimes combined, and sometimes not.

Uncertainties were addressed with follow-up programs

The most common way that authors chose to address that uncertainty was though follow-up programs. In that case, the authors promised that further information would be gathered using monitoring, auditing and subsequently adaptive management. However, follow-up programs were never disclosed in depth in the EIAs. The schedule, authority, budget and adaptive management thresholds, location and time were never discussed. Uncertainty was sometimes addressed with a partial follow-up program or complete follow-up program. A follow-up program was considered partial when adaptive management or auditing was not mentioned. Thus, it was unclear what would be done with the information gathered from the monitoring phase. This approach was used in all of the EISs.

For example, this is the case for the uncertainty regarding the impact of nitrogen deposition on vegetation in the Mackenzie Gas Project. Monitoring of the vegetation was recommended to determine if changes would occur. However, it was unclear what the information collected will be used for:

> *"Within the 8.4-ha isopleth, vegetation that is sensitive to nitrogen deposition could be affected if maximum nitrogen deposition occurs. The entire area within the isopleth is not likely to be affected. There is some uncertainty with this prediction. The WHO critical loads are based on European ecosystems and might not be accurate for the Canadian Arctic. Vegetation monitoring will be done to determine if changes in vegetation are occurring because of nitrogen deposition. The magnitude of effects is low. Vegetation affected throughout operations could take several years after to stabilize, so duration is long term. If nitrogen deposition affects nutrient cycling, the resulting mature vegetation type might be different from the original type." (9-151)*

In other cases, uncertainty was addressed with a complete follow-up program but it was not discussed in depth, either. In the Fish and Fish habitat section in the Joslyn North Mine project (Review Panel Report), the Department of Fisheries and Oceans "expressed its concern about the uncertainty of the predictive models" and therefore the accuracy of fish habitat impacts predictions and the success of the habitat compensation measures. DFO only implicitly mentioned auditing, but explicitly stated the need for adaptive management to address that uncertainty:

> *"DFO expressed its concern about the uncertainty of the predictive models. It stated that the models are based on limited data and a number of assumptions and cannot predict with certainty the success of fish habitat compensation. Therefore, DFO requires validation and monitoring to ensure accurate fish habitat impact predictions and the achievement of fish habitat compensation goals. DFO would require conditions in its authorization to TOTAL, including the use of adaptive management if new information clarifies the uncertainties."(65)*

Uncertainty levels were estimated but completely ignored

The second approach that authors used to address uncertainty was to estimate levels of uncertainties in a table and then completely ignore these uncertainties. For example, this was the case when the authors discussed the *level of confidence* in the residual, cumulative, or project impacts of the Joslyn North Mine project. In the Environmental Impact Assessment reports, and particularly in the Review Panel EIS, these impacts were sometimes given a "level of confidence" or "level of scientific uncertainty". However, no information was given on how these levels were defined. Moreover, in some cases, after acknowledging the gaps of knowledge in a table, the uncertainty then was quickly ignored. In the Joslyn North Mine project, each residual and cumulative environmental effect (air quality, groundwater, biodiversity etc.) was given a confidence rating. For example, Table 9 gives a summary of the Joslyn North Mine project impacts on air quality. In the table, residual, and cumulative impacts are given a level of confidence.

Table D.1.6.1 Summary of Impact Significance on Air Quality VECs

VEC	Nature of Potential Impact or Effect	Mitigation/ Protection Plan	Type of Impact or Effect	Geographical Extent of Impact or Effect[1]	Duration of Impact or Effect[2]	Frequency of Impact or Effect[3]	Ability for Recovery from Impact or Effect[4]	Magnitude of Impact or Effect[5]	Project Contribution[6]	Confidence Rating[7]	Probability of Impact or Effect Occurrence[8]	Significance[9]
1. Project Emissions												
	Project emits gases and particulate	See CR #1, Sections 1.2.1, 1.2.2, and 4.2.1	Project Residual	Local	Long	Continuous	Reversible in long term	Low	Negative	High	High	Insignificant
			Cumulative	Regional	Long	Continuous	Reversible in long term	High (>10% increase)	Negative	Moderate (uncertainty associated with Planned emissions)	High	Insignificant
2. NO_2 Concentration												
	Potential for odour perception	See CR #1, Sections 1.2.1, 1.2.2, and 4.2.1	Project Residual	Local	Long	Continuous	Reversible in long term	Low	Negative	High	High	Insignificant
			Cumulative	Regional	Long	Continuous	Reversible in long term	Low	Negative	Moderate	High	Insignificant
3. SO_2 Concentration												
		See CR #1, Sections 1.2.1, 1.2.2, and 4.2.1	Project Residual	Local	Long	Continuous	Reversible in long term		Negative			Insignificant
			Cumulative	Regional	Long	Continuous	Reversible in long term		Negative			Insignificant
4. $PM_{2.5}$ Concentration												
	Potential human health effects and visibility impairment	See CR #1, Sections 1.2.1, 1.2.2, and 4.2.1	Project Residual	Local	Long	Continuous	Reversible in long term	Low	Negative	Moderate (greater uncertainty in PM emissions)	High	Insignificant
			Cumulative	Regional	Long	Continuous	Reversible in long term	High (>10% increase)	Negative	Low	High	Insignificant
5. CO Concentration												
	Potential human health effects		Project Residual	Local	Long	Continuous	Reversible in long term	High (>10% increase)	Negative	High	High	Insignificant
			Cumulative	Regional	Long	Continuous	Reversible in long term	High (>10% increase)	Negative	Moderate	High	Insignificant

1. Local, Regional, Provincial, National, Global
2. Short, Long, Extended, Residual
3. Continuous, Isolated, Periodic, Occasional, Accidental, Seasonal
4. Reversible in short term, Reversible in long term, Irreversible-rare
5. Nil, Low, Moderate, High
6. Neutral, Positive, Negative
7. Low, Moderate, High
8. Low, Medium, High

Table 9: Summary of the Joslyn North Mine project impacts on air quality showing that uncertainty is disclosed but not addressed.

In the table, it was not clear why the confidence rating was sometimes explained (disclosure is medium) and sometimes not further discussed (disclosure is low). Nothing was done to reduce the uncertainties. Tables were used to communicate about uncertainties in four of the EISs reports: in the Joslyn North Mine Project, in the Prosperity Gold-Copper Mine Project (only for vegetation and wetland ecosystems), in the Liquefied Natural Gas Terminal Project, and in the Deep Panuke Offshore Gas Project.

The neglect of uncertainty was justified

The third approach that was used by the authors to address uncertainty was to justify the neglect of uncertainty by the small scale of the project, the abundance of the environment in the area, or the non-significance of the anticipated impacts. The neglect of uncertainty was justified behind the small scale of the project in the case of the Marmot Basin Ski Project. Even though uncertainty exists, the environmental impact was predicted to remain negligible because of the small scale of the project. In the vegetation section, uncertainty about the loss of old-growth forest in the area was explicitly recognized: "Parks Canada has expressed concerns regarding loss of old forest ecosystems to development, including ski areas" (266), and it was clear that there are uncertainties about the presence of old forest ecosystems in the area:

> *"Tree-coring and measurements, such as diameter at breast height (dbh) and tree height for the purposes of estimating tree age, were not undertaken as part of this study."(266)*
> *"Definition of old growth near tree line has yet to be developed (Peterson et al. 1995), thus age in Kruppelholz is difficult to determine. The tree size (height and diameter) there does not necessarily reflect the age of these trees."(268)*

Data uncertainty seems to be high here even if uncertainty was not clearly mentioned or suggested. However, these aspects were not addressed:

> *"Most of the area proposed for ski runs is unforested or sparsely treed especially on ski run B; however some tree removal is unavoidable (…) no mitigation strategies have been suggested to compensate for loss of these trees, other than minimizing the width of ski runs."(305)*
> *"Construction of the lower terminal, and to a much lesser extent the lift line, will require the removal of some mature Engelmann spruce and subalpine fir trees. These species are common in the Marmot Basin Ski Area and in Jasper National Park in Lower and Upper Subalpine regions. No mitigations are proposed and loss of these trees will not affect wildlife status."(302)*

The lack of uncertainty disclosure was also linked to another issue that was not addressed in that section: the lack of consideration of the impacts of earlier and future projects on old forest in the area. The project

seemed to be too small and of a local scale for the authors to consider any cumulative impacts on the old growth forest ecosystem, whether it was past projects:

> *"Areas of vegetation up to two or three meters across will be removed, leaving bare or sparsely vegetated ground that then becomes exposed to higher insolation rates and potentially lowered soil moisture levels. Examination of existing tree stumps in the kruppelholz zone shows an increased level of dead or dying ericaceous shrubs and little regeneration by ground layer herbs and forbs. The age of these cuts is unknown, however and it is expected that over time these areas will be revegetated by less shade-tolerant species."(266)*

Or future projects:

> *"Most of the area proposed for ski run development occurs in Engelmann spruce subalpine forests. These forests are abundant and widely distributed in the Canadian Rockies at higher elevations. The removal of a small number of these tree species for ski run development within a confined area is not anticipated to have anything more than a localized impact."(268)*

In addition, the residual impacts on vegetation section stated: *"of trees that will be removed, 702 are lodgepole pine, 1920 spruce and 930 subalpine firs" (315)*. It was therefore very well possible that removed trees were old growth. The authors did not exclude this possibility. The magnitude of such an impact was vaguely stated:

> *"Most shrub and tree removal (74%) will involve lodgepole pine and Engelmann spruce. These species comprise the dominant tree cover in most of the Lower Subalpine and Upper Subalpine areas and are very common in the Marmot Basin Ski Area and in Jasper National Park. " (315)*

Here, it seems that, again, the impact was ignored because of the abundance of these tree species in the area.

The neglect of uncertainty can also be justified by the supposedly strong resilience of the environment at stake or its relative abundance in the area. This was the case for wetlands in the Aquarius Gold Mine Project, where the wetland's natural resilience was expected to compensate for a possible failure of the mitigation measures:

> *"No environmental effects are anticipated in the event of restoration failure as natural succession would continue, with the result that wetland habitats will develop on their own, but simply over a greater time period." (487)*

This approach was used in three EISs: the Marmot Basin Project, the Prosperity Gold-Copper Mine Project and the Aquarius Gold Mine project.

Uncertainties were addressed with sensitivity analysis or the use of conservative estimates

The fourth approach used by the authors to address uncertainty was the use of sensitivity analysis or conservative estimates. The use of conservative estimates allowed the authors to not consider

uncertainty any further, as there was a high degree of confidence that emissions were over-estimated. For example, this was the case in the atmospheric impact section for the Prosperity Gold-Copper Project. The report stated:

> *"Emission rates for PM used in the modeling were estimated based on a combination of emission factors, engineering estimates, manufacturer's specifications and maximum emission limits. In reality, actual emissions vary from hour-to-hour and day-to-day. Because of the nature of this approach, there is a high degree of confidence that emissions are being over-estimated. As such, the rating of prediction confidence is high for the Project based on quality of baseline data, emissions data, and confidence in the conservative nature of analytical techniques applied in this assessment." (2-48)*

For Groundwater effects in the Prosperity Gold-Copper Project impact assessment, the difficulty to accurately predict changes in groundwater flows due to context uncertainty (hydrology is highly variable) was addressed by using sensitivity analyses:

> *"Similarly, average climate normal are used to estimate evapotranspiration and infiltration rates to the groundwater model. As discussed in Section 4.2, the hydrology of the project area is highly variable, and groundwater infiltration rates differ substantially from sub-catchment to sub-catchment. It is therefore difficult to accurately predict changes in groundwater flows, specifically groundwater discharge as baseflow, on more than an average annual basis. Six-month stress periods were used to simulate average summer and winter conditions in the groundwater flow model. Large variability in predicted average groundwater discharge, as baseflow should therefore be anticipated on monthly, weekly and daily bases within these stress periods. Where possible, ranges of model input values are provided, and sufficient data and explanation are presented to permit an independent assessment of the suitability of a parameter value for a given application. Sensitivity analyses were then conducted to evaluate variability in model responses to different input parameters."(4-140)*

> *"However, based on the results of the sensitivity analyses, confidence is medium to high that a conservative assessment of the potential range of solute concentrations and migration times has been considered in the environmental assessment. Similarly, the results of the modeling indicate that seepage potential from the western tailings embankment towards the Big Onion Lake sub- catchment will not likely exist until about Year 8, and therefore confidence is high that if the proposed monitoring measures are implemented, there will be adequate time and hydrogeologic data available to permit the design and installation of secondary mitigation measures (e.g., seepage recycle wells) should conditions warrant this measure during the project lifetime."(4-140)*

Sensitivity analyses were used in the Prosperity Gold-Copper Project only and were used in order to determine that a conservative assessment was considered. Therefore, for the purpose of the current study, sensitivity analyses and conservative estimates were combined.

Conservative estimates were also used in the Mackenzie Gas Project for the uncertainties about air quality and noise impact predictions. Confidence that impacts will be less than predicted was rated high because conservative estimates were used to address data and model uncertainties. For air predictions, the report states:

> *"In all cases, there is a high degree of confidence that effects will be less than predicted because, where data is uncertain, a conservative approach has been applied in developing the effect assessment"* (2-92).

For greenhouse emissions and noise level predictions, the report states:

> *"Available information and understanding of the project components are used to predict the project's contribution to greenhouse gas emissions. As with all predictions of future conditions, the predictions in the impact assessment have a level of uncertainty. The prediction confidence in the effects related to greenhouse gas emissions is high because the likely emissions will be less than predicted. The potential contribution of the project to greenhouse gas emissions was calculated based on peak operations, with all equipment operating at full capacity. Actual operations will likely be at lower level and result in lower emissions."* (2-107)

Even though environmental residual effects were estimated from peak operations, all residual effects were rated as not significant. It seems that peak operations were always used as the standard of reference and that peak operations did not address any uncertainties in particular. Therefore, other effects that had lower magnitude than the peak operations were simply not taken into account. This was the case for the noise effects associated with construction activities:

> "*Construction noise is usually exempt from environmental noise impact assessments. Construction noise can be high magnitude, but it is often short duration. For this reason, construction noise is exempt from most noise impact assessment guidelines"* (3-10)

This approach was used in the Joslyn North Mine Project, the Prosperity Gold-Copper Mine Project, the Mackenzie Gas project and the Aquarius Gold Mine project.

Uncertainties were addressed with more research

The fifth approach used to address uncertainty was with more research. This approach was specifically used in review panels where parties to the panel acknowledge uncertainty and recommend more research to compensate for the absence of data about a particular environmental effect or about the effectiveness of a particular mitigation measure. However, the additional research was not disclosed in the review panel reports. For example, this was the case for wildlife mitigation measures in the Joslyn North Mine Project. In the mitigation and monitoring sections, the panel recognized uncertainty explicitly regarding wildlife corridor establishment. The panel recommended further research in the matter, but no clear commitments were made before the start of the project. The panel also recommended a precautionary approach, but the authors did not mention what this would entail:

> *"The Panel notes that TOTAL's evidence concluded that the project's footprint would limit the movement of bear and moose in the local study area. The Panel is of the view that wildlife corridors are important to maintain habitat connectivity for wildlife in the region. The Panel notes that there is uncertainty about an appropriate mine development setback from the Ells River to allow a wildlife corridor around the project and that there is uncertainty with using the Ells River valley as a wildlife corridor. The Panel agrees with EC that the need for a wildlife travel corridor may become more important over time as development of the area intensifies. The Panel notes that any existing studies on wildlife corridors in the mineable oil sands area or in other areas may help identify what the appropriate width of the corridor along the Ells River valley should be. The Panel concludes that more studies of the local study area and the regional study area are needed before a final conclusion can be drawn."(45)*

This approach was used in the Joslyn North Mine Project, the Lower Churchill Hydroelectric Generation project, and the 407 East Transportation Corridor project.

Uncertainties were addressed with precautionary approaches

The *precautionary principle* or a *precautionary approach* is sometimes recommended by the authors to address uncertainty. For example, this was the case for the Mackenzie Gasification Project. Uncertainty was disclosed about the effects of the subsidence from reservoir depletion at Niglintgak and Taglu. To address that uncertainty, a precautionary approach was applied. While no details are given in that regard, only general guidance on the precautionary principle was disclosed:

> *"Confidence in predictions of the effects of Niglintgak and Taglu development is moderate, whereas prediction confidence for the Parsons Lake field is high. Uncertainty about the effects of subsidence from reservoir depletion at Niglintgak and Taglu and its resulting effect on habitats used by freshwater and brackish water species in the future results in a moderate level of certainty about the expected effects. Provided that proposed mitigation measures are implemented, there is a relatively high degree of confidence that effects will be less than predicted because where data is uncertain, the precautionary principle has been applied in developing the effects assessment (see Volume 1, Section 2, Assessment Method). As a result, there is a high degree of confidence in the determination of significance" (7-187)*

The precautionary principle was defined as:

> *"A precautionary principle was applied to ensure that the EIS does not under-report potential effects. The precautionary approach requires that where there are threats of serious or irreversible damage, lack of full scientific certainty will not be used as a reason for postponing cost-effective measures to prevent environmental degradation (Government of Canada 2001). Examples include:*
> *-Where it is uncertain if an effect will occur, it is assumed likely to happen. For example, if features in the area affected by the project indicate that a channel is suitable for spawning by any of the VECs; it is assumed that spawning habitat could be affected.*
> *-Any value that exceeds guideline levels is assumed to have a high effect, even though guidelines can be highly protective of the environment and a receptor might not necessarily be affected. For example, infrequent values exceeding water quality criteria for fish are unlikely to adversely affect fish but are viewed as a high effect. In response to uncertainties in the prediction of project effects, programs will be established throughout all stages of the project to monitor effects and to provide a basis for adjusting environmental management actions." (7-187 and 7-188)*

In this case, the shift of the burden of proof from the evidence of damage to the evidence of harmlessness (Wingspread statement on the Precautionary Principle, 1998) was not mentioned. Here, vague references were made such as: "Examples include" and "In response to uncertainties in the prediction of project effects, programs will be established throughout all stages of the project to monitor effects and to provide a basis for adjusting environmental management actions". However, these programs were not disclosed in the EIS. This approach was used in the Mackenzie Gas project, the Joslyn North Mine Project, the Lower Churchill Hydroelectric Generation project and the Swan Valley Gasification

Project

Uncertainty was discussed in a general way

Last but not least, the authors discussed uncertainty in a general way but no uncertainty was specifically addressed. The reports stated that uncertainty should be addressed with follow-up programs and/or precautionary measures, but nothing was done concretely. Guidance was only given on how to address uncertainty in general, but no uncertainties were clearly identified from the EPPs or follow-up program sections.

This approach was mostly used in the Mackenzie Gas Project. In the Review Panel report, uncertainty was discussed in a separate section. The role of the precautionary principle was recognized and uncertainty was explicitly mentioned regarding the project development. Particularly, uncertainty was recommended to be considered as a factor in significance determination:

> *"The Panel accepts that a precautionary approach requires that: uncertainty is an explicit factor in significance determination; the implications of uncertainties for decision making are explicitly considered; and greater emphasis on monitoring and adaptive management is required. As noted above, the Panel has applied this approach in view of the largely conceptual nature of the Project at the stage in which it was reviewed."(95)*

The panel also acknowledged the lack of disclosure of uncertainty in impact mitigation and monitoring in the Mackenzie EIS. In particular, even though the EIS proposed an audition of the predictions and of the monitoring programs, the panel criticized the weaknesses of the disclosure of these programs: They "*were ill-defined, highly conceptual and process-driven":*

> "*Several participants expressed the view that the Proponents' approach placed a heavy reliance on their proposed monitoring programs to determine the accuracy of impact predictions and the effectiveness of mitigation, when the monitoring programs themselves were ill-defined, highly conceptual and process- driven."(96)*

The panel also debated on adaptive management as a method to address uncertainty:

> *"Adaptive management has been widely advocated as an appropriate, even necessary, response to such uncertainties in the implementation of plans and projects. Proposals for its use in the MGP have been submitted by the Proponents and many other participants in the hearings. The Panel notes, however, that the advocacy and critiques of adaptive management reflect different definitions of and approaches to adaptive management. Many of the questions about its effectiveness were dependent on how it was understood." (96)*

The panel differentiated two types of adaptive management. *Adaptive management in response to impact prediction uncertainties*: this approach entails a monitoring that targets a particular prediction, a

comparison with the actual impacts, and an adjustment in accordance of the mitigation measures (96). *Adaptive management in response to ill-defined possibilities and surprise:* Monitoring should be concentrated on areas of importance to identify unexpected changes (uncertainty in a broader sense, surprises). The main principles to deal with these uncertainties are to adopt an *adaptive project design and adaptive governance capacity*. These designs should be based on *flexibility, reversibility and fall-back options* (97). Thus, The panel recognized the unavoidable presence of uncertainties in the Mackenzie Gas project. However, no uncertainties were disclosed nor addressed in particular. In addition, the extent to which the proponent will implement these measures and recommendations is unknown.

Table 10 summarizes how often uncertainties were addressed taking the approaches described above. These approaches were sometimes combined in the reports. Thus, the number of uncertainties listed in the table does not reflect the total number of incidences where uncertainties were disclosed. When uncertainty was discussed only in a general way, no uncertainties were clearly identifiable. Therefore, this approach was not considered in the table. Regarding uncertainties addressed with follow-up programs, this approach was also not considered in the table. It was not possible to quantify the exact amount of uncertainties addressed with these programs. Indeed, follow-up programs were always mentioned in the reports. In many cases, it was impossible to determinate if the programs mentioned aimed to address the uncertainties disclosed. This is because follow-up programs aim to verify impact predictions and the effectiveness of mitigation measures and to make adjustments in accordance. Their role is to address uncertainty. However, follow-up programs were never discussed in depth in the reports. Therefore, even if they theoretically aimed to address uncertainties; in practice, they failed to provide a solution. Moreover, as mentioned before, uncertainties about the follow-up programs themselves were poorly considered (in one report only). This proves the poor quality of disclosure of these programs in the reports.

In Table 10, the cases where uncertainty was acknowledged but then completely ignored were considered "*not addressed"*. Uncertainties in the category "*not addressed"* also included uncertainties in that were *"not addressed and this was justified".* These two categories ("*not addressed*" and "*not addressed and this was justified")* were presented separately in Table 10. In addition, "*not addressed"* uncertainties were not clearly, directly or explicitly addressed with follow-up programs (monitoring and/or auditing and/or adaptive management). Finally, the Prince George Hart Water Supply Project, the Liquefied Natural Gas Terminal and Multi-Purpose Pier, and the Waskaganish Permanent Road project were not included in the table because uncertainties were not disclosed at all in these reports.

Project Title	**Type**	**Number of uncertainties that are…**				
		…Not addressed and this was justified	**...Addressed with sensitivity analysis or the use of conservative estimates**	**…Addressed with more research**	**…Addressed with precautionary approaches**	**…Not addressed**
1. Joslyn North Mine Project	**RP**	**0**	**4**	**1**	**1**	**23**
2. Marmot Basin Project	CS	1	0	0	0	4
3. Prosperity Gold-Copper Mine Project	**RP**	**3**	**6**	**0**	**0**	**18**
5. Swan Valley Gasification Project	CS	0	0	0	1	0
7. Lower Churchill Hydroelectric Generation project	**RP**	**0**	**0**	**1**	**1**	**5**
8. Mackenzie Gas project	**RP**	**0**	**8**	**0**	**5**	**8**
9. Deep Panuke Offshore Gas Development project	CS	0	0	0	0	6
10. 407 East Transportation Corridor project	CS	0	0	3	0	1
11. Aquarius Gold Mine project	CS	7	1	0	0	8

Table 10: Number of uncertainties addressed according to the different approaches.

Sensitivity analyses or conservative estimates approaches were more often used to address uncertainties than precautionary approaches. The quality of these approaches, as mentioned before, was extremely weak. More research was proposed to address uncertainties in only four cases. Most uncertainties remained unaddressed.

3.4 Discussion and Conclusion

3.4.1. Uncertainty disclosure

Regarding the classifications by De Jongh (1988) and Walker et al. (2003), the current study demonstrates that context, input and model uncertainties are the most often disclosed. However, these uncertainties were never discussed in depth. These uncertainties were more acknowledged than the ones related to the determination of significance of environmental impacts (bias uncertainties). Environmental effects uncertainty relates to the change caused by the project to the environment (e.g. data, model or context uncertainty), while the uncertainty is related to the determination of significance of environmental impacts and is highly qualitative (Noble, 2010). There is also a lack of consideration for change in project uncertainties and statistical uncertainties. Scenario uncertainties were taken into account to some degree, through contingency scenarios, but these were never discussed quantitatively in depth and addressed in accordance. Uncertainties about impact predictions were the most frequently identified (89 uncertainties). Uncertainties about mitigation measures were disclosed in only half of the reports (27 uncertainties). Uncertainties for cumulative impacts and residual impacts were less often disclosed. Cumulative impacts uncertainties (15 uncertainties) were discussed in only three of the reports, while residual impact uncertainties were discussed in four of the reports (18 uncertainties). Clearly, these uncertainties were not considered sufficiently in the reports. In this study, uncertainties regarding the same impact prediction, mitigation measure, cumulative impact and residual impact were never counted twice when reviewing the reports. Disclosing uncertainty only once, explicitly and in depth would be

enough for each environmental impact prediction, mitigation measure, cumulative impact and residual impact.

In addition, the authors of the EISs raised the potential failure of follow-up programs in one report only (see Table 8, section 3.3.1), but the failure of follow-up programs was not addressed later on in the report. This demonstrates the authors' lack of anticipation of the future and their overconfidence in mitigation measures, contingency plans and follow-up programs.

This study found that the reports lacked in consistency regarding uncertainty disclosure. No clear patterns could be identified. Uncertainties exhibited inconsistently a low or medium level of disclosure throughout a report and between different reports: i.e., sometimes uncertainties were identifiable and sometimes it was not clear what the uncertainties were about. This was also true with the difference between explicit and implicit disclosure: Sometimes, uncertainty was suggested implicitly and not specifically referred to as uncertainty and sometimes uncertainty was expressed explicitly. The term "confidence" seemed to be used quite often to describe uncertainty. In half of the reports, uncertainty was expressed using the term "confidence", but generally authors appeared to be very inconsistent in expressing uncertainty explicitly or implicitly. For the authors, it seemed to be a matter of wording.

Therefore, explicit disclosure should not generally be ranked higher than implicit disclosure, weakening Tennoy's et al. (2006) classification. Indeed, Tennoy's original categories gave a higher "*degree to which uncertainty is expressed*" to uncertainties that were "*suggested, but not specifically referred to as uncertainty*" than to uncertainties that were "*indicated, sometimes estimated, but not explained or discussed*". The fact that uncertainty is not consistently expressed explicitly or implicitly also shows that these categories in themselves are insufficient in classifying how uncertainty is currently expressed in EIA. Finally, the authors' inconsistency regarding uncertainty disclosure reflects the lack of guidance that is provided to them regarding uncertainty disclosure. The authors seem to not know how to write about uncertainties and what terminology to use. This was also expressed though the widespread use of vague

words such as: “may”, “could”, “probably”, “maybe” or “as soon as possible” in the reports. The use of vague words was one of the reasons the classifications by De Jongh (1988) and Walker et al. (2003) lacked practical applicability to EIA. When these vague words were used, no uncertainty could be identified. These classifications were also limited because they did not aim to understand how uncertainty was considered in EIA, or more specifically, how uncertainty was disclosed and addressed. In addition, these classifications did not consider what uncertainties were generally about, be it impact predictions, residual impacts, cumulative impacts, mitigation measures and follow-up programs

3.4.2. Good and poor practices found in the reports

Uncertainty was expressed and addressed very differently in the reports. The highest level of disclosure found in the EPPs and follow-up programs was medium (uncertainty is explained, discussed to some degree and therefore identifiable). Uncertainties were never discussed in depth. Some relatively good practices could be identified, mainly two approaches. In some cases, environmental impacts were given a “level of confidence” or a “level of certainty” in a separate table (see example in Section 3.3.2), and in other cases, uncertainties were acknowledged and discussed in separate sections for each environmental sector.

Tables were used in four of the reports: for the Joslyn North Mine Project, for the Prosperity Gold-Copper Mine Project (only for vegetation and wetland ecosystems), for the Liquefied Natural Gas Terminal Project, and for the Deep Panuke Offshore Gas Project (see example in section 3.3.2 and the EPPs and follow-up program table in Appendix 2). Uncertainties were discussed in separate sections in only three of the 12 reports: for the Aquarius Gold Mine Project, for the Mackenzie Gas Project, and for the Gold-Copper Mine Project (see EPPs and follow-up program table in Appendix 2). These two approaches were never used in the same report. The only exception was for vegetation and wetland ecosystems for the Gold-Copper Mine Project. It is not clear why the two approaches were not used for other environmental effects in the Gold-Copper Mine Project.

However, these two approaches are complementary and should be used together. Using a table is a suitable tool to quantify uncertainty information and gather it in one place. It is an easy way to disclose and communicate uncertainty throughout the environmental impact assessment process. It also makes it easier for decision-makers to review uncertain impacts before taking a decision. However, in the table, the methods used for determining "levels of confidence" or "levels of certainty" should be clearly defined and uncertainty should be explicitly addressed in the cases where the level of confidence is "low" or "medium". In reality, however, when tables were used, uncertainties were rarely explained, discussed, nor addressed in the tables. Uncertainty was acknowledged and rated, but subsequently completely ignored (see Section 3.3.2). This is the reason why using tables should always be combined with discussing uncertainties in separate sections. When uncertainties were discussed in separate sections, in most cases, the level of uncertainty disclosure was ranked medium. One exception was the Aquarius Gold Mine project where uncertainties were mentioned in separate sections but were never explained (level of disclosure was low). In the other reports where uncertainties were discussed in separate sections (the Mackenzie Gas Project and the Gold-Copper Mine Project), uncertainties were explained and discussed to some degree.

Uncertainties were mostly addressed using follow-up programs. However, it was unclear in many cases if these programs aimed at directly addressing the uncertainties that were disclosed. These programs were never discussed in depth. Potential weaknesses and failures of follow-up programs were never discussed (mentioned in only one report) and were never addressed. Mitigation measures and contingency plans were never discussed in depth either. Therefore, it was difficult to assess uncertainty disclosure for these programs (see the EPPs and follow-up program table in Appendix 2). The cases where uncertainties were not addressed remained higher in number than the cases where uncertainties were addressed (see Section 3.3.2). The rest of the uncertainties were addressed with conservative estimates

or sensitivity analysis, precautionary approaches, and more research. The quality of these approaches was poor and uncertainties were never addressed in depth.

It is unclear if the authors of the reports were willingly hiding uncertainty behind these approaches or if they thought it was too difficult or not worth the effort to disclose uncertainties to the public and to decision makers. In any case, there is a lack of tools for consistently dealing with uncertainties. Moreover, the authors relied too much on the anticipated success of mitigation measures and on contingency plans that were not disclosed in depth or on follow-up programs. Environmental impacts that were uncertain were rarely rated as significant. Even when impacts were rated as significant, they were not addressed. This was the case for the Joslyn North Mine Project. Cumulative impacts due to the reduction in minimum flows due to water withdrawals were rated as significant and a moderate confidence rating was given for these impacts. However, this issue was not explained nor addressed (see EPPs and follow-up programs table in Appendix 2).

Overall, the current study illustrates that the information communicated in EIA is simplified and incomplete (De Jongh, 1988; Tennoy et al. 2006; Duncan, 2008; Noble, 2010). This study also confirms previous evidence from Sweden that the effectiveness of mitigation measures, contingency plans, and follow-up programs are presented more confidently than they should be (Wiklund, 2011). Moreover, the lack of in depth consideration for uncertainty can be likened to Tennoy et al. (2006)'s *black box* and illustrate the lack of transparency and accountability toward the public and decision makers. The *black box* represents the importance of uncertainties in the EIA process but also the lack of transparency of the process in Norway (Tennoy et al., 2006). In Canada, uncertainties were never discussed in depth but they were somehow acknowledged in the reports, which confirmed the unavoidable presence of uncertainties in EIA as described in studies conducted in the Netherlands (Arts et al., 2001; Walker et al., 2003), the US (Canter, 1996) and Northern Italy (Geneletti et al., 2003). However, the fact that uncertainties were not disclosed consistently and not addressed with thorough approaches confirms that how and where to

address uncertainty information is a challenging task in EIA (El-Sayed, 1996). It also reflects the lack of guidance in that matter.

3.4.3. Implications for decision-makers

The current study results are more or less in accordance with the study by Tennoy et al. (2006) that concluded that decision-makers are not made aware of uncertainties in EIA in Norway. Indeed, decision-makers in Canada are somewhat made aware of uncertainties but in a way that is not sufficient for them to further examine the uncertainties and discuss what these uncertainties imply. In the EISs reports, when uncertainties can be identified, the efforts to address these uncertainties were weak, inconsistent, and not discussed in depth. Uncertainty identification was also not consistent within and between reports. Therefore, not enough valuable information is transmitted to decision makers. They are not able to fully understand what the uncertainties imply (and what alternatives to consider) and to assess if the way these uncertainties were addressed was sufficient or not.

In addition, uncertainties were rarely discussed in separate sections or in tables, which would make it easier for decision-makers to consider, discuss, and address them systematically and in depth. Instead, in Review Panel (RP) reports, decision-makers seemed to be made aware that uncertainty was present, but no particular uncertainties were identified from the EIS impact prediction or mitigation measures sections. In the RP reports, the authors tend to discuss uncertainty as a general concept but not specifically for any impacts or for any mitigation measures, with the only exemption of the Lower Churchill Hydroelectric Project (see EPPs and follow-up program table in Appendix 2).

In the RP reports, it seems that decision-makers do not refer to the uncertainties in justifying their decisions, and accordingly, they were poorly acknowledged in the EIS reports. This confirms that decision-makers are made aware of uncertainties (to some extent) and chose not to disclose them further (Duncan, 2008). Review panel decision-makers should request more information about the uncertainties found in the EIS (their sources and implications) especially if the information communicated is generally

vague and incomplete. Decision-makers in the RP reports can use uncertainty information as a "basis for the need to fund additional monitoring, experimentation, or information acquisition" (Reckhow, 1994, p.161). This would allow decision-makers to make more informed decisions (Geneletti et al., 2003) and promote prudent strategies (Reckhow, 1994). In addition, by considering uncertainties more thoroughly, review panel members would impact the overall quality of the EIA (Tennoy et al., 2006; Duncan, 2008; and Ragas et al., 2009). The EIA would then better evaluate the potential environmental effects of the project.

3.4.4 Room for improvement in EIA practice

Environmental Impact Statements and specifically EPPs and follow-up programs in EISs should better reflect the complexity of environmental processes, the incompleteness of knowledge and the uncertain aspects of the future. For the EISs to be as accurate as possible, uncertainties should be closely considered. Uncertainties should be discussed and addressed in a consistent manner, in a way that is understood in the report so that stakeholders, the public, and decision makers feel confident and comfortable in using and discussing uncertainty information.

Within EIAs, Mackenzie's *certainty trough* theory proposes that experts close to knowledge production tend to attribute a high level of uncertainty to their work, while the public (often opposed to the project) will perceive an even higher amount of uncertainty than the experts. Project proponents and decision-makers tend to only be aware of a rather low level of uncertainty (Duncan, 2008). Therefore, disclosing uncertainty would lead to an improvement in terms of the public's confidence and trust in the project. Uncertainty disclosure and consideration would help clarify issues that are unclear and distrusting for the public. In addition, it would strengthen the quality of mitigation and contingency measures. This would reassure the public. Thus, this study agrees with Budescu et al. (2012) who recommend that uncertainty information should be well-documented in a way that can be easily and effectively transmitted to decision-makers, the public, and other stakeholders

The use of separate sections or tables are helpful and appropriate approaches, but uncertainties also need to be discussed in depth and more explicitly addressed. This should be the case for each steps of the EIA. Table 11 aims to give some preliminary guidance in that regard.

Steps of EIA (Noble, 2010)	**How uncertainty disclosure can be improved**
Screening Screening triggers the assessment and the extent of that assessment (Noble, 2010)	Uncertainty guidelines should be communicated to the proponents and consultants of the project. General uncertainty information should be made available to the public as well. Uncertainty typology and terminology should be clarified for all parties. The public's early concerns and perceived uncertainties related to the project should be communicated.
Scoping Scoping aims to identify the key issues that should be considered in the assessment (Noble, 2010)	Uncertainty disclosure should be clearly present in the Terms of References. However, uncertainty disclosure should always be taken into account regardless of if it is required in the Terms of References or not. Consultants should disclose uncertainty, as it is their responsibility to provide decision-makers with the right type of information about the project. They should not ignore uncertainty disclosure if this is not required by the Terms of References. Early identification of uncertainties should be done thoroughly when considering the alternatives to the projects, baseline data, public concerns and major issues to the projects. These uncertainties should be addressed right away.
Impact prediction and evaluation; Impact management	Uncertainty should be discussed in separate sections for each environmental sector and for each environmental impact, residual and cumulative impact, mitigation measure, contingency plan and follow-up program. Consultants should define and disclose in depth the approaches taken to deal with uncertainties that can not be reduced (e.g. data uncertainty). The budget, schedule and authority should be disclosed for mitigation measures, contingency plans and follow-up programs. Uncertainty should be a criterion of significance determination. Consultants should make a difference between the uncertainty found in the measurement of an effect and the uncertainty found in the importance of the impact (subjective uncertainty).
Review and Decision	Identification and review of all uncertainties found in the EISs. Providing social NGOs and the public with information on how the remaining uncertainties will be dealt with. Economic stakeholders and experts should discuss the remaining uncertainties and the risk that they entail in term of environmental, social and economic costs.
Implementation and Follow-up	Proponents should disclose the implementation of follow-up programs. If unexpected information is gathered, changes to the project implementation should be put in place. The monitoring, auditing and adaptive management plans should also be made public so that consultants are able to use that information for future EISs. Past experience on how to address inaccuracies, miscalculations, data gaps and misinterpretations should be made available for future projects. Uncertainties would be better dealt with if experience on the treatment of uncertainty from previous EIAs and their follow-up programs was shared. This would allow consultants to compare EIAs and identify the mistakes made in the past. This would also reduce the cases of ignorance that involve a deep level of uncertainty to the extent that “we do even not know that we do not know” (Walker et al., 2003, p.13).

Table 11: Preliminary guidelines on how uncertainty disclosure can be improved at each steps of EIA

The current study was not able to identify any consistent uncertainty terminology from Canadian EISs, and more research is required in that matter. This study aligns with the scientific community lack of a common understanding regarding uncertainty features and degrees, including uncertainty typology and terminology (Walker et al., 2003). Some helpful approaches were identified in the EISs such as the use of conservative estimates or sensitivity analysis, precautionary approaches, and more research. However, more guidance on how to use these approaches in a more consistent and thorough manner is needed. Generally, this study agrees with the conclusion that more guidance is needed for both practitioners and decision-makers to better consider uncertainties in EIA (Leung et al., accepted.).

In addition, discussing the potential weaknesses of contingencies plans, mitigation measures and follow-up programs would force the authors of the reports to discuss these programs in depth, while in reality; the EPPs and follow-up programs were never discussed in depth and quantitatively in the reports. In the contingency plans sections, uncertainty was never addressed with the disclosure of risk scenarios and quantitative information. This could be done with the authors discussing in depth the probability of occurrence of a particular environmental damage, the extent of the damage, and how the damage would be addressed. This would also help practitioners anticipate the drawbacks of uncertainties instead of implicitly relying on the effectiveness of mitigation measures, contingencies plans and follow-up programs. Therefore, the current study illustrates the overconfidence of EPPs and follow-up programs in EIA reports in Canada and therefore agrees with the studies conducted in Norway (Tennoy et al., 2006), Australia (Duncan, 2008) and Sweden (Wiklund, 2011).

This study also agrees with the studies by Burris and Canter (1997), Soderman (2005), Wood (2008) and Karlson et al. (2014) that concluded that cumulative impacts (Burris and Canter, 1997), biodiversity impacts (Soderman, 2005), residual impacts (Wood, 2008) and ecological impacts (Karlson et al., 2014) are not properly assessed and addressed in EIA.

These studies called for more guidelines and quantitative methods to assess and address residual impacts, ecological impacts, biodiversity impacts and cumulative impacts. Wood suggested "definitive regulatory thresholds or criteria" (Wood, 2008, p.25) to assess residual impact significance in UK EIA projects. He also recommended to "improve the treatment of uncertainty and fully identify assessment limitations" in the evaluation of impact significance. To improve the assessment of ecological impacts in EISs from Sweden and the UK, Karlson et al. recommended "improved guidelines for spatial and temporal delimitation, and the establishment of a quantitative framework including tools, methods and threshold values" (Karlson et al. 2014, p.10). This would "enhance transparency and improve handling of uncertainties" (Karlson et al. 2014, p.17). To better consider biodiversity impacts in Finnish EIA, guidelines for biodiversity assessment were prepared by the Finnish Environment Institute (Soderman, 2005). In particular, these guidelines aimed to "encourage decision makers to demand that biodiversity issues are presented understandably in the reports" (Soderman, 2005, p.96). Similarly, Burris and Canter (1997) called for a better analysis of American cumulative impacts that must be "more thorough and documented" (Burris and Canter, 1997, p.18). The current study approves and is in line with all of the recommendations suggested in these studies conducted within the EIA process in UK, Sweden, Finland and the US, as it calls for more thorough, organized, consistent, and quantitative uncertainty information in EISs.

3.4.5 Recommendations for future research

It was challenging to gather and assess uncertainty disclosure and that is because uncertainty information in EIAs is usually both highly qualitative and implicit. A word search function was not used for the current study because the authors of the reports could have used many different types of wording to describe uncertainty and as mentioned before, in many cases, uncertainty information was implicit.

In addition, the length of the EIS reports was not considered as a criterion for considering uncertainty information as it was determined that an EIS could be long but its content not as relevant as a shorter and more detail-oriented report.

The EISs reports were hard to access and that is because federal agencies are not obligated to keep the entire EISs available after disclosing them to the public at the time of the EIA process. The EIA process is also a continuing process. The EIA process at the federal level includes a constant exchange of documents, suggestions, comments and questions between the proponent and the federal agency. Sometimes, in a document, a section can be missing in the first version. Therefore, the current study was limited as when extra information was requested by the federal agencies, that information was not made available on the federal or provincial websites. This also applies to the final contingency plans, mitigation plans or follow-up programs that could have been communicated later in the process but were not made available online. This is because there is no legal obligation for the proponent to disclosure the EIA documents after the EIA is done and the project approved. Therefore, to better understand the author's consideration of uncertainty in EISs, future research studies would benefit from interviews with practitioners and stakeholders to the projects. A difference should be made between prospective approaches (that support the acceptance project) and predictive ones (that aim to predict environmental impacts without necessarily supporting the project).

In addition, because it was the researcher's intent to include EISs from all provinces in the study, the sample used was too small to compare the EISs according to their location or content. All EISs were selected from one country only, making a comparison with other countries impossible. Further research is needed including more EISs and EISs from different countries. While no other studies explicitly recommend more research, the current study's suggestion for more research is in accordance with the literature review by Leung et al. (accepted) that confirmed that very few studies have considered uncertainties in EISs.

Finally, it might of have been useful to investigate concepts and aspects related to uncertainty disclosure in more depth. For example, the concepts of vulnerability and resilience of natural processes and their relation to uncertainty in regard of the quality of EPPs and follow-up programs could be studied. Another aspect that could be investigated in more depth would be uncertainty disclosure in regard to the definition of environmental effects (changes in the state of the environment) versus environmental impacts (linked with issues at stake).

Chapter 4. Overall Conclusion

This study illustrates the challenges that arise for researchers and practitioners when attempting to analyse and classify the information pertaining to uncertainty in EISs (El-Sayed, 1996). This is because no guidelines have been provided for practitioners by the current literature on uncertainty disclosure and accordingly, no consistent methodology has been used in the reviewed EIA reports. Nevertheless, this study revealed a few key findings about the current practice of uncertainty disclosure in Canadian EIA.

First, uncertainty information is generally acknowledged in more detail in Canadian Review Panels EIA than in Canadian Comprehensive Studies EIA. Review Panel EIAs are more complex and generally deal with larger, more controversial projects than Comprehensive Studies EIA. This may lead to more uncertainty in the results and may inspire authors of the EISs to take uncertainty more seriously into account. The Review Panel hearing process is also an opportunity for stakeholders and decision-makers to identify and discuss the weaknesses of the EIS including the uncertainties. However, because of the inconsistency and superficiality of the methods used in the EIS to consider uncertainties, these were not discussed in depth and not fully acknowledged in the Review Panel reports.

Secondly, in cases where uncertainties were mentioned, the level of their disclosure varied significantly from one report to another. Some reports covered uncertainties and did so explicitly, whereas other reports paid little attention to uncertainties and did not describe them in detail. In addition

to the variable amount of uncertainty disclosure, the approaches taken to deal with these uncertainties were weak, vague, and also inconsistent. This reflects an urgent need for the creation of uncertainty guidelines, both on how to appropriately disclose uncertainty and how to appropriately address uncertainty in EIA. The authors of the reports seemed to be aware of the need to acknowledge uncertainty to some degree, but they did not do it well. This is demonstrated by the fact that uncertainty disclosure was never high (uncertainty was never discussed and addressed in depth) and by the presence of terms such as “may”, “could”, “probably”, “maybe”, “as soon as possible” that were seen everywhere in the reports.

Thirdly, the implications of these uncertainties were never thought through and presented in any useful and practically relevant way. Therefore, Canadian decision-makers are not provided with the right type of information about uncertainties. Even when uncertainties were acknowledged, decision-makers were not made aware of the complexity and implications of these uncertainties. In other words, this study confirms that decision-makers are not made aware of how the uncertainty was determined and the potential risks that they imply (Tennoy et al., 2006). As a consequence, it is impossible for Canadian decision-makers to determine if the uncertainties were evaluated in a sufficient way or not. This is reinforced and illustrated by the consistent overconfidence of the success of EPPs and follow-up programs as described in the studies by Tennoy et al. (2006), Duncan (2008) and Wiklund (2011). The current study also demonstrates that decision-makers tend to avoid uncertainties (Duncan, 2008). Decision-makers should be more active in term of uncertainty disclosure and request additional information about uncertainties (their sources and implications). This would allow Canadian decision-makers to make more informed decisions (Geneletti et al., 2003) and to increase the overall quality of the EIA (Tennoy et al., 2006; Ragas et al., 2009).

Fourthly and more broadly, this study exposes some flaws in Canadian EIA practice. The current study shows that Canadian EIA process is no different from other EIA process in other countries and lacks

transparency (De Jongh, 1988; Tennoy et al. 2006; Duncan, 2008), and Canadian EIA reports lack accessibility. This pertains to both reviewing uncertainty information in the EISs and to the accessibility of the EIA documents. Only some EISs were available online and some of them were particularly difficult to access. In addition, because EIA is a continuing process, not all the components of the EIAs were made available online. Therefore, when the mitigation plans, contingency plans, and the follow-up plans were not disclosed in the EIS, it was impossible to know the extent to which these were communicated to decision-makers or implemented. In addition, EISs lacked clarity. In terms of uncertainty disclosure, uncertainty information should be discussed in a separate section and in a table so that it is easily debated, understood and communicated throughout the whole process. This should be done for each environmental impact, mitigation measure, contingency plan, and follow-up program.

Finally, this study acknowledged the fact that there will always be a certain amount of uncertainty in environmental impact predictions, environmental protection plans and follow-up programs (Arts et al., 2001). However, this study confirms that not all predictions are equally uncertain (Budescu et al. 2012) and that in some cases uncertainty can be reduced. This is the case of data uncertainties that can often easily be reduced by more research, but the results of that research should be done and disclosed prior to the decision-making. In addition, uncertainties that cannot be reduced such as context uncertainties (e.g. uncertainties due to the instability of environmental processes) can be better recognized through the use of a better classification for uncertainty identification suitable to EIA, better tools for uncertainty communication, and better techniques to address these uncertainties. Strong legislation and administrative backing should also support these reforms.

In addition, risk scenarios should be discussed in depth. For each scenario, uncertainty levels and thresholds should be closely defined and disclosed. For regulatory thresholds to be in place, knowledge must be available. While this is not always the case, this should be promoted and supported as much as possible. The best scenario should be chosen and in the case of too much uncertainty the project should

be reconsidered or aborted. Using a reactive approach (relying on mitigation, contingency plans and adaptive management) to deal with uncertainty is not enough. It is known that the lack of consideration of uncertainties has led to tremendous negative environmental effects. The damage to the environment can sometimes be irreversible (e.g. loss of habitats or extermination of species). This is why uncertainty consideration should be carried out in advance of project approval.

In EISs, more attention should be given to precautionary approaches, conservative estimates or sensitivity analyses. In addition, more research would help to compensate for the absence of data about a particular environmental effect or about the effectiveness of a particular mitigation measure. These measures (more research, precautionary measures, conservative estimates or sensitivity analysis) are suitable approaches that were mentioned in Canadian EISs but they should be discussed, defined and applied in depth for the uncertainties about each environmental impact prediction, cumulative impact, residual impact, mitigation measure, contingency plan and follow-up program. This should be done in separate sections and tables so that the information is easily transmitted to decision-makers. Decision-makers should review and discuss uncertainty information before taking a decision. More guidance is needed for both practitioners and decision-makers to better consider uncertainties in EIA (Leung et al, accepted.). Overall, this study confirms that uncertainties are not given enough attention in EIA (Tennoy et al., 2006; Wood, 2008).

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Appendices-Appendix 1: EIS database

Type	Content	Project Title	Website CEAA	Project Description	Proposed Development Location	Availability (EIS, CSR and RPR)
RP	Water Diversion/Storage/ Treatment/ Water Supply Well/Pipeline	Joslyn North Mine project, Townships 94-96, Ranges 11-13 West of 4th Meridian	http://www.ceaa.gc.ca/052/details-eng.cfm?pid=37519	In February 2006, Deer Creek Energy Ltd (DCEL), owned by Total, applied to ERCB (Alberta Energy Resources Conservation) and to Alberta Environment. The project includes an oil sands open pit mine as well as bitumen extraction facilities.	About 70 kilometers North of Fort McMurray.	EIS: On the provincial website: https://external.sp.environment.gov.ab.ca/DocArc/EIA/Pages/default.aspx; RPR: On the CEAA website: http://www.ceaa.gc.ca/052/document-eng.cfm?did=48613
CS	Ski Development	Marmot Basin (Eagle Ridge) Ski Development project	http://www.ceaa.gc.ca/default.asp?lang=En&n=B82562B0-1	Ski Marmot Basin Ltd. has submitted a proposal to install and operate a new quad chairlift.	In Eagle Ridge within the Marmot Basin Ski Area in Jasper National Park.	CSR: Chapman,Steve [CEAA] send me a hard copy <Steve.Chapman@ceaa-acee.gc.ca>
RP	Gold/Copper/Nickel/Cobalt/Diamonds /Coal/Gravel/Uranium Mining	Prosperity Gold-Copper Mine project	http://www.ceaa-acee.gc.ca/050/details-eng.cfm?evaluation=44811	Taseko Mines Ltd. proposes the development of a high volume open pit gold-copper mine.	125 km southwest of Williams Lake.	http://www.ceaa-acee.gc.ca/050/document-eng.cfm?document=32276
CS	Water Diversion/Storage/Treatment/Water Supply Well/Pipeline	Prince George Hart Water Supply Improvements project	http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=15C3D394-1	The City of Prince George has submitted a proposal to construct and operate a groundwater collector well, two water transmission pipelines, access roads and ancillary works.	Prince George.	On the provincial website: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_209_15598.html
CS	Gas/Gas Facility	Swan Valley Gasification project	http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=00EB1599-1	The Many Island Pipe Lines Canada Ltd. and Swan Valley Gas Corporation have submitted a proposalto construct and operate a natural gas pipeline system to service Swan Valley in the southern part of the province.	The pipeline system would originate in Norquay, Saskatchewan and extend to Swan River and Minitonas.	Contacted Provincial Website-tania.steele@gov.mb.ca and Bruce Webb <Bruce.Webb@gov.mb.ca> sent me a hard copy
CS	Port/Marine development	Liquefied Natural Gas Terminal and Multi-Purpose Pier project	http://www.ceaa-acee.gc.ca/default.asp?lang=En&xml=C44D41EB-266E-490B-8B69-C8C16F33789C#archived	Irving Oil Limited has submitted a proposal to construct and operate a liquefied natural gas receiving, storage and processing facility. The proposed facility would be located at an existing deepwater oil terminal (Irving Canaport) near Saint John, New Brunswick	Near Saint John.	CSR was available on CEAA website: http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=E6679DCE-1
RP	Hydroelectricity	Lower Churchill Hydroelectric Generation project	http://www.ceaa-acee.gc.ca/052/details-eng.cfm?pid=26178#report	Nalcor Energy proposes to to construct and operate two hydroelectric power generating facilities.	On the lower section of the Churchill River at Gull Island and Muskrat Falls in Labrador.	EIS was available on the provincial website: http://www.env.gov.nl.ca/env/env_assessment/projects/Y2010/1305/
RP	Gas/Gas Facility	Mackenzie Gas project	http://www.ceaa.gc.ca/default.asp?lang=En&n=71B5E4CF-1	Imperial Oil Resources Ventures Limited, Shell Canada Limited, ConocoPhillips Canada (North) Limited, ExxonMobil, and the Aboriginal Pipeline Group propose to develop natural gas, gathering lines, processing facilities and a pipeline to transport gas south through the Mackenzie Valley to northern Alberta.	In the Mackenzie River Delta in the Northwest Territories.	http://www.mackenziegasproject.com/theProject/regulatoryProcess/applicationSubmission/Applicationscope/EIS.html
CS	Oil/Gas Development Offshore	Deep Panuke Offshore Gas Development project	http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=68D50708-1	EnCana Corporation has submitted a proposa to develop the Deep Panuke natural gas field	Offshore on the Scotian Shelf, approximately 175 kilometres southeast of Goldboro.	http://www.encana.com/pdf/communities/canada/atlantic/v4eamainreport.pdf

CS	Roads	407 East Transportation Corridor project	http://www.ceaa-acee.gc.ca/052/details-eng.cfm?pid=39781	The Ontario Ministry of Transportation is proposing to construct an easterly extension of the 407 Transportation Corridor (highway/transitway).The approximate length of the undertaking is 70kms.	Extension of the 407 mainline from its current terminus at Brock Road to Highway 35/115 and two north-south links connecting Highway 401 to the proposed extension of Highway 407.	Found on a CD from Dr. Jaeger
CS	Gold/Copper/Nickel/Cobalt/Diamonds /Coal/Gravel/Uranium Mining	Aquarius Gold Mine project	http://www.ceaa.gc.ca/default.asp?lang=En&n=8F145283-1	Echo Bay Mines Ltd. has submitted a proposal to develop an open-pit gold mine and ore processing facility on its Aquarius property in northern Ontario.	The property is in Macklem Township just east of Night Hawk Lake, 40 km east of Timmins.	Fisheries and Oceans sent me a CD from Kristopher Pelletier <Kristopher.Pelletier@dfo-mpo.gc.ca>
CS	Roads	Waskaganish Permanent Road project	http://www.ceaa.gc.ca/default.asp?lang=En&n=62C9ED8B-1	The Waskaganish Band Council has submitted a proposal to construct a permanent road to link the Indian Reserve of Waskaganish to the Matagami-LG2 road.	in the northern part of the province on James Bay.	Kelly Le Blanc <kleblanc@gcc.ca>sent me a CD

Appendix 2: EPPs/Follow-up Programs Table

Abbreviations used

AENV	Alberta Environment
ASRD	Alberta Sustainable Resource Development
BATEA	Best Available Technology Economically Achievable
BGC	BGC Engineering Inc.
BWS	Basal Water Sands
CAC	Criteria Air Contaminant
CAPP	The Canadian Association of Petroleum Producers
CEMA	Cumulative Environmental Management Association
CNRL	Canada Natural Resources Ltd
DCEL	Deer Creek Energy Ltd
DFO	Department of Fisheries and Ocean
DOC	Dissolved Organic Carbon
EC	Environment Canada
EPA	Environmental Protection Agency (US)
GBPU	Grizzly Bear Population Unit
GHG	Greenhouse Gas
ISO	International Organization for Standardization
JNMP	Joslyn North Mine Project
KP	Knight Piésold
LSA	Local Study Area
MMER	Metal Mining Effluent Regulations
MPB	Mountain Pine Beetle
NEB	National Energy Board
NNL	No Net Loss
RAMP	Regional Aquatic Monitoring Program
RSA	Regional Study Area
SAGD	Steam Assisted Gravity Drainage
SRK	SRK Consulting Ltd.
TDS	Total Dissolved Solids
TSF	Tailings Storage Facility
TEEM	Terrestrial Environmental Effects
VEC	Valued Ecosystem Component
VOC	Volatile Organic Compound
WQG	Water Quality Guidelines
WSC	Water Survey of Canada

Project	Uncertainty in EPPs	Uncertainty in Follow up-Programs Monitoring, Auditing, Adaptive Management	Notes
1. Joslyn North Mine Project	Environmental management is discussed in the section B.10 Environmental, health, and safety management (10-1). Uncertainty is not explicitly nor implicitly disclosed in that section. In that section, the authors state that the plans will be prepared but nothing is disclosed in the report. This is how the report addresses safety concerns: *"The Company is committed to a safe and compliant work place. In combination with environmental and health management, safety and well being of all workers is a top priority. Significant effort will go into preparation of procedures and practices which will become the guiding principles of how the Joslyn North Mine Project will be run and how work gets done."(10-1)* Here, the procedures and practices should be disclosed but they are not. The Environmental Protection Program is described on pages 10-2 and 10-3. None of the environmental plans are disclosed in the EIS. Regarding the possibility of a chemical spill, the report states: *"A Spill Prevention and Contingency Plan will be developed prior to construction which will describe the procedures to reduce the potential for a spill, as well as the procedures required in the event of a spill."(10-3)* The Spill prevention and Contingency Plan should be disclosed in the report. It is therefore impossible to assess uncertainty disclosure in that plan. In the Substance Release Controls and Monitoring section (B.10.6), the contingency plans are also not disclosed: *"Contingency plans will be developed and implemented to minimize local, regional and trans-boundary effects to people or the environment. Regional environmental management initiatives will be reviewed and incorporated into DCEL management practices when they are deemed applicable and show a real positive cost effective impact to existing practices."(10.6)* It is therefore impossible to assess uncertainty disclosure in these plans. Generally in that section (B.10 Environmental, health, and safety management) risk scenarios are not clearly disclosed. No accidents or malfunctions are can be clearly identified neither can the consequences associated with them. Uncertainty is not disclosed at all. Mitigation measures and monitoring are discussed in the impact prediction sections for each VEC (Section D). Air For air emissions, the mitigation measures are general. The budget, schedule and authority are not disclosed. Uncertainty is not mentioned. More details should be given on certain aspects, for example: *"Mine fleet haul routes will be optimized for operational efficiencies and to minimize fuel consumption, and will be adjusted as needed during the life of the project." (1-27)* Here, more details should be given on how these routes will be optimized: *"Dust from haul routes will be managed by applying water or approved dust suppressants during dry periods" (1-27)* Here, more details should be given on what	Air Monitoring does not address any uncertainty in particular. In the monitoring section, the authors state that "DCEL will contribute to regional monitoring through support of the TEEM air monitoring program" (1-28) but nothing is said about the kind of support it will provide nor the aims of the monitoring program. Adaptive management and auditing is implicitly mentioned for methane emissions and fugitive emissions but its implementation lack details in term planning and expenditure. No uncertainties are identified in that section: *"The project will implement a program of monitoring and measuring methane emissions from the mine face, tailings pond and dump areas. Based on the results from these studies, the project will evaluate and, where economically feasible, implement changes in the way these facilities are operated or managed in order to reduce greenhouse gas emissions; The project will implement a program of monitoring and measuring fugitive emissions. Based on the results from these studies, the project will evaluate and, where economically feasible, implement changes in the way these facilities are operated or managed in order to reduce greenhouse gas emissions."(1-28)* In the RP report, more information is given on monitoring, auditing and adaptive management (implicitly). Air Emissions-RP Uncertainty and adaptive management are not considered in that section. *"The Panel concludes that the project is not likely to result in significant adverse environmental effects to air quality, provided that the mitigation measures and the Panel's recommendations are implemented."(71)* Risk scenarios are mentioned in the panel report. It seems that more information was given than what was disclosed in the EIS. However, contingency plans are still not disclosed: *"The Panel notes that TOTAL has the responsibility to ensure that it is fully prepared and capable of responding to any type of emergency arising from the project."(77)* *"The Panel acknowledges that TOTAL has committed to developing, in consultation with relevant stakeholders, a comprehensive emergency response plan that identifies, describes, and evaluates the potential impact of all project-related accidents and malfunctions and identifies procedures to ensure prompt response, notification, and cleanup in the event of a hazardous substance spill or a threat of release. The Panel notes that TOTAL has committed to providing a copy of the plan to relevant stakeholders and any other interested parties."(77)* *"The Panel expects TOTAL to meet this commitment and develop a comprehensive response plan consistent with ERCB Directive 071: Emergency Preparedness and Response Requirements for the Petroleum Industry. The Panel finds that with an effective emergency response plan in place, it is unlikely that significant adverse environmental effects would occur as result of accidents or malfunctions associated with the project."(78)*	Uncertainty is definitely more acknowledged in the RP than in the EIS but only for certain impacts. However, all residual impacts are rated as non-significant even though EPPs are not completely disclosed. This is the case for all of the reports. Confidence is mentioned for each residual environmental impact but it is never discussed in depth. It is not clear why confidence rating is sometimes given a *source of uncertainty* (note: my own words here) and why sometimes it is being ignored. Either way it is neither discussed in depth nor addressed. Uncertainty is rather ignored. At the end, the final conclusions on residual impacts are suspiciously too confident. In addition in the EIS, none of the EPPs are discussed in depth. Therefore, in the EIS, it is impossible to evaluate if uncertainty is disclosed in these plans. Finally, the Report of the Joint Review Panel that was published on January 27, 2011, concludes that the project has no significant adverse environmental effects even in the absence of the complete disclosure of EPPs and in the presence of uncertainty.

	the authors defined as "dry periods". *"The use of process designs that reduce VOC emissions" (1-27).* Details should be given on the type of process designs that will actually be used and how these will be used. *"Floating roofs on storage tanks, where appropriate" (1-27).* The term "where appropriate" is a vague. The information should be specified if possible. If not possible, uncertainty should be disclosed. For all residual impacts: "Impact significance should be explained in terms of direction, magnitude, frequency, duration, seasonal timing, reversibility, geographic extent and uncertainty"(1-4). For each VEC, a table summarises the environmental impact ratings including project residual effects. In the table, potential impacts or effects (e.g.: for air emissions, the different types of emission concentration) are given a confidence rating and a probability of impact or effect occurrence. For air quality, all of these impacts are assessed not significant. Confidence rating is not explained. It can be high, moderate or low. It is not clear why confidence rating is sometimes given a *source of uncertainty* (note: my own words here) and why sometimes it is being ignored. Uncertainty disclosure is low and (uncertainty is suggested, but not identifiable) or medium (it is briefly explained). The location of uncertainty is identifiable for the project cumulative impact emissions, the project residual human health effects and visibility impairment, the project impacts, cumulative and residual impacts from potential acidification of sensitive soils, water bodies and vegetation, the project residual ozone concentration and its potential damage to vegetation and finally the project cumulative potential human health effects. However, these uncertainties are not addressed. Here, thresholds should of have been put in place as well as their respective responsive actions. Fish and Fish habitat In the mitigation measures for fish habitat, no uncertainties are disclosed. In addition, no risk scenarios are clearly disclosed. The report states: *"Update exiting Emergency Response Plan to incorporate actions to take in case of a release due to mine activities"(3-22).* Here, it is not clear what the authors mean by "release" and which "mine activities" they refer too. No budget, authority nor planning is provided for the Fish Habitat Enhancement plan. Words such "where technically feasible", "approximately" and "will be about" are used but the references are not strong enough to be considered as uncertainty disclosure. *"For the purposes of mitigation planning, it is assumed that within the newly constructed sections of Joslyn Creek channel sinuosity will be maximized to 1.3:1, where technically feasible; and average channel width will be about 7-8 metres, approximating the natural pre-disturbed channel width. As such, the final configuration of Joslyn Creek will result in a net*	Fish and fish habitat-RP In that section, the department of fisheries and ocean expressed its concern about the uncertainty of the predictive models and explicitly recommended monitoring, adaptive management to address that uncertainty (implicit auditing): *"DFO expressed its concern about the uncertainty of the predictive models. It stated that the models are based on limited data and a number of assumptions and cannot predict with certainty the success of fish habitat compensation. Therefore, DFO requires validation and monitoring to ensure accurate fish habitat impact predictions and the achievement of fish habitat compensation goals. DFO would require conditions in its authorization to TOTAL, including the use of adaptive management if new information clarifies the uncertainties."(65)* In addition: *"DFO noted that it does not monitor water quality in compensation lakes for contaminants from air emissions. It noted that if the lake does not satisfy the "no-net-loss" of fish habitat, it would investigate to find out the cause.* *DFO recommended that TOTAL implement a detailed "no-net-loss" plan that would provide, at minimum, a 2:1 ratio of fish habitat compensation based on habitat units; develop and implement, in consultation with DFO, a plan to compensate for potential impacts of river water intake on fish habitat once all the necessary river water intake details have been compiled; develop and implement a monitoring program, to the satisfaction of DFO, to validate models and verify predictions about quality and quantity of fish habitat in the pre-disturbed habitat and in the proposed fish habitat compensation structures; and develop and implement a monitoring program, to the satisfaction of DFO, to verify compliance with commitments in the "no-net-loss" plan and with all conditions of any authorization."(66)* Later the report states: *"TOTAL will develop and implement a monitoring program, to the satisfaction of DFO, aimed at validating models and verifying predictions related to quality and quantity of fish habitat in the pre disturbance habitat and the proposed fish habitat compensation structures, and that addresses the uncertainties associated with modeling the productive capacity of fish habitat compensation."(163)* Here, uncertainty is explicitly disclosed (data and model uncertainty, recognized and stochastic) and explicitly addressed with adaptive management and monitoring for both the impact prediction and the mitigation measures. Auditing is implicitly there but not disclosed as monitoring. No thresholds, budget, nor schedule are disclosed. The panel agrees with these recommendations and states: *"The Panel is of the view that, given the compensation plan proposed by TOTAL and the need for its approval by DFO, the project is unlikely to have significant adverse effects on fish and fish habitat. The proposed mitigation measures include a fish habitat compensation plan that would replace habitat at a ratio of 2:1. The Panel is confident that since DFO has final approval of any compensation plan, it would ensure that the effects on fish and fish habitat are appropriately mitigated. The Panel agrees with DFO's proposed*	

	gain in area of available habitat of approximately 3.4 hectares excluding any potential habitat provided by End Pit Lakes. Reconstructed sections of Joslyn Creek will be enhanced by the incorporation of approximately 205 Class 1 pool habitat and 20% riffle habitat. The remainder of the creek will consist of run habitat. To further enhance the replacement habitat, woody debris cover structures, such as root wads and submerged trees, will be incorporated into the reconstructed creek."(3-26) Here, more information should be given on the Regional Aquatics Monitoring Program and how the proponent will participate in such program (funding, planning, responsible authority). Auditing is implicitly mentioned in "assess effectiveness of fish habitat enhancements" but it is not mentioned how the information will be gathered and which adjustments will be made after assessing the effectiveness of fish habitat enhancement. All impacts on fish habitat are rated as insignificant in the EIA. Confidence is indicated as high for all impacts on fisheries resources and their mitigation plan. The probability of impact or effect occurrence is rated low for all impacts on fisheries resources. No uncertainties are disclosed. Groundwater Mitigation measures are poorly disclosed. It seems that they were not prepared for the EIS. The report states: *"DCEL and CENRL will continue to discuss the timing and scheduling of activities to determine the future monitoring and subsequent mitigation that may be required. Both companies are working cooperatively to develop plans to deal with depressurization of the SAGD reservoir should they occur as a result of the Horizon Project. DCEL is also working independently on contingency plans in the event that depressurization at the Joslyn North Mine Project spreads west to their SAGD. These mutual and independent plans include the following: planning of monitoring networks to give warming of impending problems; and remedial measures, such as water curtains, to cut off the effects of hydraulic head decline in the BWS (Basal Water Sands).* *The BWS water has high TDS in the Northeast portion of the lease. In order to minimize the amount of saline water entering the end pit lakes, DCEL will: continue to dewater these wells until the water level in the lakes is of sufficient elevation to minimize inflow into the lakes; and pump water from the Athabasca river to the East Lake to accelerate filling and minimize the BWS dewatering"(4-15)* No risk scenario can be clearly identified here. Residual and cumulative effects on groundwater are rated insignificant (4-17). For effects on groundwater, confidence rating is low for cumulative impact from the flow in BWS from the Athabasca River. It is moderate for the project impact on the flow in BWS from the Athabasca River. It is also moderate for the project and residual impact from groundwater contamination. Confidence is rated as "none" for residual impact from flow in BWS from Athabasca River and for the	*recommendations (Section 6.4.2). If the project is authorized, the Panel understands that DFO's proposed recommendations would be among its conditions of approval. The Panel expects TOTAL to continue working with DFO to ensure that it meets all of the recommendations to DFO's satisfaction."(66)* Groundwater In the monitoring section (D.4.6.2. Monitoring) words such as "unlikely", "may", "one possibility would be" and "further work will be conducted in the future" are used: *"Monitoring systems for the interaction of injection to or withdrawal from the BWS (Basal Water Sands) is problematic with the Athabasca River. Direct effects within the river are unlikely to be observable within the context of flow volumes and chemistry. There may also be injection of water by CNRL to the north along the river. One possibility would be to plan observation well(s) on one or more of the islands in the Athabasca River northeast of the DCEL lease. Further work will be conducted in the future in this regard"(4-16)* The possibility of "depressurization" is briefly mentioned. For that effect, monitoring (*"planning of monitoring networks to give warming of impending problems")* and adaptive management is implicitly and generally mentioned *("remedial measures, such as water curtains"*). They do not address any uncertainties from the impact prediction section or from the mitigation measures. The impact of depressurization is not disclosed. No thresholds are established, nor budget, authority and schedule of the remedial measures. Here, the impacts on the Athabasca River are completely ignored. Water including groundwater-RP Adaptive management and auditing are implicitly mentioned (it does not address any uncertainties in particular) but nothing substantial is disclosed. *"The Panel recognizes the importance of monitoring programs to assess project impacts, validate and adjust models, and mitigate problems. The Panel understands that TOTAL would be submitting further information to AENV as part of its Environment Protection and Enhancement Act applications for its groundwater-monitoring program. The Panel is confident that this would ensure that a suitable groundwater monitoring program is in place and that it would satisfy the interveners' and NRCan's concerns."(*62) Hydrology Adaptive management and auditing are ignored. The monitoring programs are general. No thresholds are established. No uncertainties from the impact predictions are disclosed. It is not clear what will be done if monitoring data do not confirm that diversion ditches are operating as designed and if runoff from the disturbed areas is entering natural streams. *"D.7.6.2 Monitoring* *Stream flows and sediment concentrations in both Joslyn Creek and Ells River will be monitored routinely by DCEL, likely through participation in the Regional Aquatics Monitoring Program (RAMP); Flow monitoring of the Athabasca River is presently carried out by and is available on a real time basis; and diversion ditches will be monitored and maintained to ensure they are operating as designed and that runoff from the disturbed areas*	

	cumulative impact from groundwater contamination. The classification of confidence rating is not explained. It is not clear what it is meant by "none". All potential impacts are rated as insignificant. In the table, mitigation measures in the Protection Plans sections for impacts on Groundwater are not existent ("none"). Hydrology In the mitigation measures section, no uncertainties are disclosed from the impact prediction sections. No budget, authority nor schedule is disclosed. The mitigation measures are general and vague. Here are examples from that section: *"The Tributary 4 channel will be modified to avoid increase erosion due to higher flows."(7-20)* Here a threshold to address the potentiality of higher flows should be put in place. It is not clear how Tributary 4 channel will be modified. *"Disturbed areas will be reclaimed as soon as possible."(7-20)* Here the words 'as soon as possible" show how vague the mitigation measure is. All impacts on hydrology are rated as insignificant. Only cumulative impacts due to the reduction in minimum flows due to water withdrawals are rated as significant. Moderate confidence rating for the project impacts and cumulative changes in channel geometry and sediment due to flow changes and excavations is not explained nor addressed. Surface Water Quality Mitigation measures are extremely vague. The "sediment control measures"(11-30), the "company emergency response plan that establishes procedures"(11-30), the "emergency situations"(11-30), the "designs to minimize footprint as much as possible"(11-30) or the "measures that will be taken to minimize acidifying emissions including the use of low NOx burners and ultra-low sulphur diesel"(11-30) are not disclosed. No risk scenario can be identified. Uncertainty is not considered. For monitoring and mitigation plans, the budget, responsive authority and schedule are not disclosed. Water Quality-RP cumulative impacts Uncertainty is explicitly disclosed about the effects of industrial development on water quality in the lower Athabasca River (context uncertainty, epistemic and recognized). To address these uncertainties, the panel suggests a better monitoring program. No information is given on that monitoring program: *"The Panel notes that there are uncertainties about the effects of industrial development on water quality in the lower Athabasca River and that these should be resolved through better monitoring programs."(102)* Auditing is also considered to assess uncertainty about the water quality in the oil sands region (model uncertainty, stochastic and recognized). The responsible authority is disclosed: *"The Panel acknowledges that both the federal*	*is not entering the natural streams."(7-20)* Water Quantity-RP cumulative impacts Adaptive management is explicitly mentioned to address the uncertainty in cumulative impacts from water withdrawal from the Athabasca River. *"DFO noted that the successive elimination of watercourses and cumulative water withdrawals from the lower Athabasca River watershed would affect regional fish habitat quantity and quality. DFO further indicated that disturbing large numbers of small channels may change temperature regimes, peak flow hydrology, sediment supply and routing, the timing of organic matter inputs, and reduce habitat availability. DFO noted that there was uncertainty about how regional impacts would affect the productivity of the lower Athabasca River watershed"(97).* *"The Panel understands that Phase II's progressive implementation will commence in January 2011 and be fully operational in January 2016. The Panel considers that the proposed Phase II Water Management Framework and subsequent adaptive management measures would address potential issues related to water withdrawals during low flow conditions. The Panel understands that since the mid-1970s, the Athabasca River's average flow has been dropping and that it is one of the concerns that is part of the analysis completed by DFO and AENV during the development of the Phase II Water Management Framework. The Panel notes that DFO and AENV will monitor the proposed ecosystem base flow and will incorporate required adjustments to the Water Management Framework.* *The Panel acknowledges that TOTAL has committed to adhere to the intentions of the Phase II Water Management Framework and all adaptive management, including no water withdrawals from the Athabasca River during low flow conditions; support the development of and participate in a monitoring program focusing on cumulative effects assessment of water withdrawals from the Athabasca River; support a water management framework that would be implemented with ongoing review and monitoring to improve the understanding of the effects of water withdrawals and incorporate these understandings into a system aimed at protecting the fish and fish habitat of the lower Athabasca River. The Panel expects TOTAL to implement the above commitments if the project proceeds."(98)* Adaptive management measures are poorly disclosed. Soil and Terrain In that section, the monitoring programs are not disclosed. Only a summary is available: *"The following is a summary of follow-up monitoring that could be done to ensure the long term sustainability of the soils resource."(10-30)* Here "could" is used but this reference is not strong enough for uncertainty to be considered. In that summary the measures are vague. Here are some examples: "*Monitor soil replacement activities to ensure potential for compaction is minimized." (10-30)* Here soil replacement activities should be disclosed and they are not. "*Monitor reclaimed areas to ensure erosion is kept to a minimum."(10-30)* Here the minimum should be disclosed. *"Undertake ongoing assessment and management of reclaimed areas until reclamation certification is achieved."(10-30)*	

	and provincial governments have recently put in place independent advisory panels to better understand the water quality of the lower Athabasca River. The federal panel was to report back to the federal Minister of the Environment on the current state of environmental research and monitoring in the oil sands region and make recommendations to ensure that state-of-the-art monitoring and best practices are implemented. The focus of the provincial committee of experts was to examine the monitoring data and methodology of both government and academic research findings. These experts will also investigate whether data are consistent with historical values in the region and explain the relevance of any differences and gaps that may exist. The Panel is of the view that the work of these two independent panels will help address the concerns and uncertainty about water quality in the oil sands region. While evidence provided by EC suggested that there may be some detectable cumulative effects downstream from mineable oil sands operations, the Panel finds, on the basis of the RAMP data, no reason to believe that these effects are significant."(102) No adaptive management is considered. Noise Mitigation and monitoring plans for noise impacts are not disclosed: "*D.8.5 Mitigation and Monitoring* *D.8.5.1 Mitigation* *Prior to 2019 DCEL will engage in discussions with the owner of the trappers Cabin to conduct a noise survey or to determined the appropriate noise mitigation measures."(8-10)* Monitoring is not disclosed. *"D.8.5.2 Monitoring* *DCEL will initiate a noise monitoring program in consultation with the community of Fort McKay and the owner of the Trappers Cabin."(8-10)* Uncertainty is not disclosed. Auditing and adaptive management are ignored. All impacts are insignificant. Confidence is high for all impacts (no explanations are given in that regard). Soil and Terrain Soil and terrain mitigation procedures are not prepared for the EIS. The report states: *"The effect of surface mining is the complete disruption of the natural terrain and the natural soil landscape. The key mitigation strategy is the utilization of appropriate conservation and reclamation techniques to create new terrain and new soil landscapes for the intended end land use. Such procedures will include: Salvaging surface soil prior to sequential mine development; When operationally feasible, direct placing mineral soil on reclaimed landscapes; Replacing coversoil with minimal levelling resulting in soil with low bulk density and excellent porosity. These rough surfaces will catch and hold snow, reduce the risk of erosion and provide a greater diversity of microsites; Revegetating soil stockpiles and reclaimed areas as soon as possible; Establishing nurse crops on areas with moderate potential for soil erosion; Alternate erosion control measures will be used in areas of high potential for soil erosion."(10-50)*	Here, more details should be given on reclamation certification. Adaptive management is implicitly taken into account but auditing is not considered and the reference remains extremely weak. No thresholds are established that could trigger adaptive measures (no disclosure of the adaptive measures). *"Utilize information gained by CEMA and other regional monitoring initiatives that have established monitoring sites to periodically sample soils and vegetation in areas of high sensitivity to acid deposition. Response to any adverse findings and incorporate appropriate mitigation strategies."(10-50)* No schedule, authority, or budget are given. Uncertainty is not disclosed. Surface Water Quality Auditing and adaptive management are ignored. The report mentions monitoring and environmental quality guidelines: "*DCEL will conduct water quality monitoring, sediment quality monitoring, and benthic invertebrate community monitoring at specific locations in specific drainages to assess how these VECs conditions are changing with JNMP implementation and to ensure environmental quality guidelines are being met."(11-32)* Here, no adaptive measures are disclosed in the case where environmental quality guidelines are not being met. Vegetation and Wetland Adaptive management and auditing are not considered. It is unclear of what the goal of the monitoring program is. Uncertainty is not disclosed. Information is missing. For example: *"Determination through consultation with CEMA the appropriate measures to take to reduce impact on rare vascular plant species."(13-37)* This should have been done prior for the EIS and disclosed in the EIS. Vegetation and Wetlands-RP Auditing is implicitly considered for the success of reclaimed wetlands. However, nothing substantial is disclosed: *"The Panel also considered TOTAL's commitment to identify opportunities for on-site pilot studies on peat-accumulating wetlands establishment. The Panel is of the view that experimentation and research on the reclamation of wetlands—and in particular peat-accumulating wetlands—is necessary to contribute to the scientific knowledge of, and ultimately to the long-term environmental management of, the surface mineable oil sands region. The Panel agrees with EC that given the 40-plus years proposed for the project, there is an opportunity to advance the scientific knowledge and operational practice for peat-accumulating wetlands that should be shared with the public and other operators in the mineable oil sands area. Should the project proceed, the Panel recommends that TOTAL develop and submit a detailed plan to AENV, in consultation with EC as appropriate, and to SRD for review and approval, outlining its explicit plans to experiment with peat land and reclaim wetland before the project begins. AENV should also require that TOTAL develop a follow-up and monitoring program in consultation with SRD and EC, as appropriate, to determine the success of reclaimed wetlands."(51)*	

	Here, general assumptions are made such as "when operationally feasible", "reclaimed areas as soon as possible" and "on areas with moderate potential for soil erosion". These are vague and imprecise. These show how poorly mitigation measures for disturbance on soil and terrain are disclosed. Here, uncertainty should be disclosed and discussed instead of using the terms "moderate potential". Both in the mitigation and monitoring sections, no schedule, authority nor budget are disclosed. Uncertainty is not disclosed at all. Vegetation and Wetland For impacts on vegetation and wetland, the mitigation measures disclosed are weak and general. No budget, schedule nor responsible authority is disclosed. The report states: *"Several methods will be used to minimize or eliminate impacts resulting from the Joslyn North Mine Project in vegetation and wetland resources. The following measures will be implemented. "(13-37)* But these remain vague and incomplete: *"Use previously disturbed areas where possible to avoid disturbing sensitive vegetation and wetlands."(13-37)* Here, more details should be given on what "where possible" means. *"Control non-native/invasive species infestations using a combination of mechanical and chemical methods."(13-37)* Here, mechanical and chemical methods should be further discussed. Accidental scenarios and their impact on vegetation and wetlands are not considered. Wildlife Mitigation measures are vague. Here are some examples that illustrate the vague aspects of these measures: *"minimize the Project footprint to the extent possible"(14-33), "integrate project developments with other existing and/or proposed land use activities in the area to minimize new disturbance and cumulative habitat loss, including the use of existing access or utility corridors whenever possible"(14-33), "avoid sensitive wildlife habitats to the extent possible"(14-34)* and *"implement dust control measures on access roads as needed"(14-34).* It is not clear if uncertainty is present here. However, if the authors are uncertain about their commitments then they should disclose and address these uncertainties. In addition, dust control measures should be disclosed in the EIS but they are not. This is also the case for the following: *"implement appropriate erosion control measures" (14-34)* and *"use vegetation control measures to avoid attracting wildlife to tailings ponds" (14-34)*. Accidental events that might impact wildlife are not disclosed here. The report states that DCEL will *"create fuel and chemical spill contingency and response plan" (14-34)*. In the summary of project and cumulative effects impacts on Wildlife Resources (14-37), confidence ratings for habitat availability varies from low to high. Sometimes, additional information is given on the pages above the table on a particular confidence rating. Wildlife-RP Uncertainty is explicitly disclosed for wildlife	Wildlife In the monitoring section (D.14.6.2) adaptive management is explicitly (implicit auditing) mentioned but poorly disclosed. The report states: *"Monitoring of wildlife is planned to assess the effectiveness of mitigation measures, and to ensure that the scale of impacts do not exceed that predicted by the assessment. The mitigation and monitoring program will operate using an adaptive management approach, whereby additional mitigation measures will be implemented or exiting mitigation measures adjusted, as necessary, to ensure that Project impacts are minimized. A specific monitoring program will be developed after the Project has been approved. This monitoring program will be developed based on consultation with ASRD, other stakeholders, and possibly other operators in the region."(14-35)* Wildlife-RP The panel conclusions and recommendations for wildlife mitigation measures include more research, auditing of the mitigation measures and adaptive management (addresses uncertainty about wildlife repopulation): "*The Panel notes that conducting research in and of itself is not a mitigation measure but is carried out to better understand the ecology of species at risk in order to develop mitigation measures and implement them using adaptive management practices. The Panel notes that in order for the wildlife mitigation plan to achieve no net significant adverse effects on species at risk, an optimal combination of mitigation measures, such as those listed above, needs to be identified. As an evaluation of the proposed plan requires the expertise of SRD and EC, the Panel recommends that prior to any authorization of the project, SRD consult with EC as appropriate, and work with TOTAL to ensure that additional mitigation, such as using off-site offsets, avoiding high quality habitat, and conducting research, be identified to ensure that the project would not cause significant adverse effects to species at risk. These additional measures should be provided to AENV for inclusion in any Environmental Protection and Enhancement Act approval it may issue."(45)* *"The Panel is of the view that proper follow-up monitoring is required so that TOTAL can determine the effectiveness of reclamation and if species are re-establishing themselves in the local study area. If wildlife that currently resides in the local study area do not return to the site in a timely manner, then further adaptive management measures would be required to ensure the area is not only reclaimed, but also functions as wildlife habitat. The Panel recommends that AENV and SRD, with advice from EC as appropriate, determine what combination of monitoring and follow-up measures TOTAL or CEMA should conduct and, based on the results of such work, implement adaptive management measures as are necessary."(46)* However, no thresholds are disclosed. Monitoring, auditing and adaptive management are not clearly disclosed (no budget, schedule). Wildlife and Wildlife habitat -Cumulative Environmental Effects-RP Here, adaptive management is implicitly considered. Thresholds are not disclosed but they are mentioned; however, uncertainty is not disclosed:	

	corridor establishment. The panel recognizes the need for further research in the matter but no clear commitments are made before the start of the project. A precautionary approach is recommended but no details are given. *"The Panel notes that TOTAL's evidence concluded that the project's footprint would limit the movement of bear and moose in the local study area. The Panel is of the view that wildlife corridors are important to maintain habitat connectivity for wildlife in the region. The Panel notes that there is uncertainty about an appropriate mine development setback from the Ells River to allow a wildlife corridor around the project and that there is uncertainty with using the Ells River valley as a wildlife corridor. The Panel agrees with EC that the need for a wildlife travel corridor may become more important over time as development of the area intensifies. The Panel notes that any existing studies on wildlife corridors in the mineable oil sands area or in other areas may help identify what the appropriate width of the corridor along the Ells River valley should be. The Panel concludes that more studies of the local study area and the regional study area are needed before a final conclusion can be drawn; however, a precautionary approach should be adopted in the establishment of wildlife corridors until such studies can be conducted and evaluated."(45)* Wildlife-RP In the mitigation and monitoring sections the panel recognize uncertainty explicitly regarding the wildlife repopulation of the area while reclamation is incomplete. To address that uncertainty the panel recommends the use of *"reclamation practices that will contribute to reducing the impact on species at risk and wildlife in general in the very long term" (42).* *"The Panel concludes that the effects to species at risk within the local study area are significant because: High quality habitat of species at risk, which contain residences and individuals, would be directly affected; Habitat would be lost for decades; Uncertainty exists as to whether some wildlife, including species at risk, would be able to repopulate the local study area once reclamation is complete; and it is highly likely that these effects would occur since it is evident that most wildlife habitat within the local study area would be destroyed if the project proceeds.* *For greater certainty, the Panel encourages good reclamation practices that will contribute to reducing the impact on species at risk and wildlife in general in the very long term. However, given the measures the governments of Alberta and Canada have taken to protect species at risk, the Panel cannot accept that the impacts of the project on species at risk over the next several decades are anything but significant. However, pursuant to Section 16 of the Canadian Environmental Assessment Act, the Panel is obliged to consider "measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project." Such measures were presented during the hearing and the Panel is satisfied that some*	"*The Panel notes that the Terrestrial Ecosystem Management Framework recommends that specific thresholds trigger management responses for specific environmental indicators (e.g., index of native fish integrity, woodland caribou, moose, fisher, old growth birds, black bear, and area of old-growth forest)."(91)* Biodiversity Auditing is implicitly mentioned for the reclamation program, but no adaptive management and thresholds are disclosed. *"The following will be part of the DCEL monitoring program: Assessment of reclaimed areas to assess the effectiveness of the reclamation program; Assessing both reclaimed and disturbed areas for erosion and presence of invasive weed species." (15-20)* The goal of the monitoring of erosion and presence of invasive weed species is not disclosed.	

	combination of these measures can be used to make the impacts to species at risk less than significant. If it's not possible to mitigate these impacts, the Panel would construe this outcome as a serious indicator that the project would not be in the public interest."(42) The Panel will recommend monitoring, auditing (implicit) and adaptive management of reclamation practices. Biodiversity Mitigation measures for biodiversity are vague and missing information about them. Here are some examples: *"-Reduce footprint whenever possible" (15-20).* More information should be given on what "whenever possible" means. "*-Mimic natural soil conditions and create a micro-hummocky surface that enhances moisture by using rough mounded coversoil replacement techniques to unevenly spread coversoil on the recontoured surfaces;* *-Enhancing biodiversity through the use of special reclamation procedures during all phases of the reclamation process" (15-20).* Here, coversoil replacement techniques and special reclamation procedures should be disclosed. Here adaptive management is ignored. For monitoring and mitigation plans, no budget, neither schedule nor responsible authorities are mentioned. For certain impacts, confidence is given a value in the impact rating summary table (15-23)		
2. Marmot Basin (Eagle Ridge) Ski Project	Uncertainty is not disclosed explicitly. No details are given in regard to contingency plans (only half a page). No clear risk scenarios are evaluated in depth. Only three types of risks are disclosed: for accidents due to weather, fuel spills, and fire prevention: "*Using tidy tanks and spill pans will mitigate the risk of fuel spills."* (379) *"Fire prevention and response will be provided through the ski area's existing fire protection system. No measures are required beyond those already in place."(379)* No quantitative information is given. In addition, an environmental surveillance officer will be designated. He has the authority to *"stop work orders, or to modify field procedure to protect natural resources or assure public safety" (379).* These directions are not specific enough. The effectiveness of mitigation measures are overly confident*:* *"The net, or residual impacts will reflect the degree to which the proponent has been rigorous in applying mitigations and implementing the Environmental Protection Design presented in Chapter 1 (page 3) of this report. Effect design and prudent location of facilities can ensure that the development will avoid impacts to resources such as soils, groundwater and vegetation species. Impact avoidance may be more challenging for dynamic resources such as wildlife, where mitigations that can reduce the risk of potential impacts must be prudently conceived and rigorously implemented."(293)* Mitigation measures for environmental effects are weak. Climate and Air Quality *"No mitigation is proposed for impacts on*	Monitoring is not used to address uncertain aspects in particular. The report states: *"No critical knowledge deficiencies were identified during the completion of the Comprehensive Study" (383).* In addition, for the acknowledged minor areas of *"knowledge deficiency"* such as the accuracy of the stream flow data for Marmot Creek within the Marmot Basin Ski Area and the lack of data for air quality: *"No data on air quality is available for the ski area" (383).* The report states: "Neither of these knowledge deficiencies are recommended for further research or monitoring at this time, but the ski area would be interested in participating in co-operative studies with Parks Canada on these subjects"(383) Regular monitoring is general and broad (381): *"A series of projects to monitor changes to vegetation communities will be established in consultation with Parks Canada for sites representing plant communities deemed at risk."(381)* *"Monitoring will take place annually or bi-annually for at least 10 years after development. The precise details of the monitoring program will be developed on a species and site-specific basis in consultation with Parks Canada representatives." (381)* Terrain Implicit adaptive management *"-The impact of skiing, grooming and tree removal on vegetation communities that have been recorded to included exiting rare plant species. Density counts and an assessment of vigor and reproductive potential would be appropriate*	The authors implicitly disclose uncertainty but choose to not address it. Nothing is planned to evaluate the accuracy of the prediction (no actual auditing or adaptive management). It seems that the small size of the project is used as an excuse for rating all impacts as negligible and also to ignore areas of uncertainty. The effectiveness of mitigation measures is rated too confidently.

	climate and air quality other than ensuring that all equipment is in excellent running condition in order to minimize vehicle exhaust emissions." (310) No uncertainty is disclosed (particularly failure of mitigation measures). Here, it is not clear if the authors are hiding a gap of knowledge or not. Aquatic and Hydrological No uncertainty disclosure. Here is an example of how vaguely the contingency measures are mentioned: "*During the construction program, care will be required to ensure that fuels or other contaminants are not released into the environment through malfunction or accident." (309)* Aquatic Resources *"No specific mitigations required. The magnitude of impact on aquatic resources is rated as negligible." (301)* Soil and landforms Uncertainty is not disclosed. Mitigation measures remain vague. "*Procedures for free and debris removal are outlined in Chapter 1." (309)* And again at the end: "*the magnitude of impacts on soils and landforms is rated to be negligible." (309)* Vegetation -Uncertainty about the loss of old-growth forest in the area (265-272). Even though *"Parks Canada has expressed concerns regarding loss of old forest ecosystems to development, including ski areas"(266)*, it is clear that there are uncertainties about the presence of old forest ecosystems in the area: *"Tree-coring and measurements, such as diameter at breast height (dbh) and tree height for the purposes of estimating tree age, were not undertaken as part of this study."(266)* *"Definition of old growth near tree line has yet to be developed (Peterson et al. 1995), thus age in Kruppelholz is difficult to determine. The tree size (height and diameter) there does not necessarily reflect the age of these trees."(268)* *"There are many Engelmann spruce-subalpine fir kruppelholz communities (...) some within the Marmot Basin Ski Area may be old growth."(268)* Data uncertainty seems to be high here even if uncertainty is not clearly mentioned or suggested. These aspects are not addressed though precautionary, mitigation or monitoring measures and no further studies were done to reduce that uncertainty: *"Most of the area proposed for ski runs is un-forested or sparsely trees especially on ski run B; however some tree removal is unavoidable (…) no mitigation strategies have been suggested to compensate for loss of these trees, other than minimizing the width of ski runs."(305)* *"At the currently forested proposed development area encompassing the lower terminal, maze and road re-alignment, where considerable mature subalpine fir and Engelmann spruce will be removed, construction of most of the lift is expected to require minimal tree removal."(263)*	*methods.* *-The impact of skiing, grooming and maintenance mowing on convex slopes and hummocky terrain that is prone to scalping and shearing so that appropriated action can be taken to prevent further damage when required". (381)* *-"The establishment and long term success of any transplanted and/or re-seeded rare plant species.* *-The success of re-vegetation efforts surrounding tower pads and terminals using plant density and/or cover techniques" (381).* For the other monitored impacts, no indication is given on the purpose of the monitoring. Change in vegetation *"Projects will monitor: The impact of skiing, grooming (using permanent photo plots and/or quadrat sampling) and tree removal on sensitive vegetation including the terrestrial lichen dominated communities and in seepages. The viability of reindeer lichen mats in particular will be monitored in the long term to determine the effects of increased insolation levels and increased skiing and grooming activities. If permanent sampling plots are set up before development of the runs, a baseline could be established to compare any subsequent changes in vegetation."(381)* Auditing is implicitly considered for changes in vegetation but no explicit commitments are made: *"a baseline could be established to compare any subsequent changes in vegetation" (381)*. The schedule is vague. No budget is disclosed. Uncertainty is not disclosed.	

	"Construction of the lower terminal, and to a much lesser extent the lift line, will require the removal of some mature Engelmann spruce and subalpine fir trees. These species are common in the Marmot Basin Ski Area and in Jasper National Park in Lower and Upper Subalpine regions. No mitigations are proposed and loss of these trees will not affect wildlife status." (302) The lack of uncertainty disclosure is also linked to another issue that is not addressed in that section: the lack of consideration of the impact of old and future projects on old forest in the area. The project seems to be too small and of a local scale for the authors to consider any cumulative impacts on the loss of old forest ecosystem whether it is a past project: *"Areas of vegetation up to two or three meters across will be removed, leaving bare or sparsely vegetated ground that then becomes exposed to higher insolation rates and potentially lowered soil moisture levels. Examination of existing tree stumps in the kruppelholz zone shows an increased level of dead or dying ericaceous shrubs and little regeneration by ground layer herbs and forbs. The age of these cuts is unknown, however and it is expected that over time these areas will be re-vegetated by less shade-tolerant species."(266)* Or a future project: *"Most of the area proposed for ski run development occurs in Engelmann spruce subalpine forests. These forests are abundant and widely distributed in the Canadian Rockies at higher elevations. The removal of a small number of these tree species for ski run development within a confined area is not anticipated to have anything more than a localized impact."(268)* In addition the residual impacts on vegetation section states: "*Of trees that will be removed, 702 are lodgepole pine, 1920 spruce and 930 subalpine fir."(315)* It is therefore very well possible that removed trees are old growth. The authors can clearly not exclude this possibility. The proportion of such an impact is vague: *"Most shrub and tree removal (74%) will involve lodgepole pine and Engelmann spruce. These species comprise the dominant tree cover in most of the Lower Subalpine and Upper Subalpine areas and are very common in the Marmot Basin Ski Area and in Jasper National Park "(*315) Here, the 74% that represent tree removal is not well evaluated. It seems that, again, the impact is ignored because of the ordinary and abundant presence of these tree species in the area. Overall, the authors do not even consider the impact on old-growth forest independently and propose no mitigation measures in that matter. Uncertainty is not considered as part as any of the any attributes given to describe the impacts. Residual impacts defined as impacts that "can no be avoided or fully mitigated" (p 325) from the removal of trees are not addressed either: *"Loss of biomass and organic materials for soil and nutrient building; Loss of food source for wood eating insects and the animals that feed*		

	on them; and increased erosion potential where mineral soil is exposed, and prior to establishment of re-vegetation cover" (316) Even in the section "14. Knowledge deficiencies" (383) the authors indicate that: *"No critical knowledge deficiencies were identified during this process leading to the completion of the Comprehensive Study"(383)* In that section the authors also state: *"Forestry assessment for areas to be gladed was on dbh size and species diversity. Age classes were not determined. Given the relatively small number of larger diameter trees that will be removed during glading, selecting trees to be representative of size classes and species diversity is recommended"(383)* Thus, no thorough research on old-growth forest is planned. Highway Traffic Mortality "No specific mitigations required. The magnitude of impact on highway traffic mortality is rated as negligible"(302) -Uncertainty about highway traffic mortality (258-262) *"For a number of reasons that shall be described in this section, available information does not permit an accurate means to measure and assess the impact of skier traffic on highway wildlife mortality"(259)* *"There is no way to accurately define the proportion of highway wildlife mortality that can be attributed to skiers, nor of the potential increased impact that would result from the development of Eagle Ridge"(259)* *"A significant problem in this regard is the ability to determine the percentage of all highway traffic that can be attributed to skiers. This is an area for more detailed, subsequent study and assessment"(260)* Here, data uncertainty is clearly recognized by an absence of study in the area. It is epistemic as it is due to the imperfection the understanding of highway traffic. Uncertainty is suggested, but not specifically referred to as uncertainty. For the impact of highway traffic mortality, no specific mitigations measures are demanded. Overall "the magnitude of the impact of highway traffic mortality is rated as negligible and no specific mitigations are required" (301) even though the level of uncertainty in that matter is high. Overall, it seems that the authors ignore completely the uncertain aspect of that impact. In my opinion, the present uncertainty could be easily reduced by more research to assess the impact of the project on wildlife road kills. In addition, precautionary, monitoring and mitigation measures should be implemented in that matter. Wildlife No mitigations measures for wolves, wolverine, lynx (298) and small mammals (300). For example: "*No specific mitigations required. The magnitude of impact on lynx is rated as negligible" (398)*. Or: *"The magnitude of impact on small mammals is rated as negligible" (300).* Generally for wildlife, mitigation measures are poorly disclosed and vague. They do not address any uncertainty of the impacts in particular.		

	Residual impacts on Wildlife: *"Long-term reduction in crowberry production may occur on 6.71 ha. of forested land that will be cleared or partially cleared for ski runs and glades. This may impact bear foraging patterns within the ski area." (315)* Birds Mitigation measures are vague. No uncertainty is disclosed.		
3. Prosperity Gold-Copper Mine Project	Accidents and malfunctions are discussed in a separate Volume (9): *"Six potential accidents and malfunctions scenarios are assessed: 1) fuel spill on land and in rivers; 2) failure or major leakage from tailings or the reclaim pipeline; 3) concentrate haul spill on land and in rivers; 4) road culvert failure causing increased sedimentation release into Fish Creek or Taseko Rivers; 5) excessive water in TSF resulting from the failure of dam construction to keeping up with rising water; and 6) the loss of power to TSF seepage recovery resulting in tailings seepage overflowing into the emergency settling pond open pit. The assessment explains the reason for the selection of these scenarios as representative of the types of events that could potentially take place, the potential consequences; and the Project's capabilities, resources, equipment and plans for responding."(1-4)* In that volume risk scenarios are well identified. However uncertainty is not mentioned. EMPs are also not disclosed in depth. For residual Environmental Effects: uncertainty is not one of the parameters. "Confidence in predictions" is discussed for each environmental impact. Air contaminants Management practices are vague and expressed in a table. E.g.: *"Implement management practices to reduce smoke during brush burning" (2-47).* Here the management practices are not disclosed *"Incorporate BATEA into project design wherever possible" (2-47)* Confidence in prediction is discussed on page 2-48: In that section uncertainty is not discussed. Once again it seems that because conservative estimated are used uncertainty is not considered. The report states a high degree of confidence that "emissions are being over-estimated": *"The quantitative evaluation of potential changes in atmospheric environment depends primarily upon air dispersion models. These complex models are used to predict the change in expected ambient air concentrations. Among the available regulatory models developed by the US EPA, the CALPUFF model employed in this exercise is the best suited to treat the source types, terrain, and meteorology of this region. Confidence in the model, the approach taken and the execution in this instance are judged to be high. Emission rates for PM used in the modelling were estimated based on a combination of emission factors, engineering estimates, manufacturer's specifications and maximum emission limits. In reality, actual emissions vary from hour-to-hour and day-to-day. Because of the nature of this approach, there is a high degree of*	In the EMPs section, auditing is implicitly mentioned and adaptive management is explicitly mentioned for all environmental impacts predictions and for the mitigation measures. However, their implementation remains vague: *"an outline of the follow-up and monitoring" (8-66).* They do not address any uncertainty and the limits of the adaptive management programs themselves are not discussed. *"8.6.1 Follow-up Monitoring and Adaptive Management* *With respect to mitigation and compensation measures, a compliance-monitoring program verifies the proper implementation of all such measures whereas a follow-up program is used to determine the accuracy of EA conclusions and the efficacy of the required mitigation measures. CEAA defines follow-up as "a program for verifying the accuracy of the environmental assessment of a project, and determining the effectiveness of any measures taken to mitigate the adverse environmental effects of the project". An outline of the follow-up and monitoring for each element is provided in Section 8.4. A defined follow-up, monitoring and adaptive management plan will be developed for each of the elements in support of making applications for authorizations, permits and other approvals. The follow-up programs will be designed to support or verify the predictions made concerning the likelihood of "no significant environmental effects"; aid in the detection of unanticipated environmental effects; and provide an assessment of the success of management programs and the possible need for adjustments through adaptive management should the results indicate the need. These plans will follow appropriate provincial and federal legislation, policies and programs, including the CEAA Operational Policy Statement: Follow-up Programs under the Canadian Environmental Assessment Act (CEAA 2007), and policy direction under the British Columbia* *Environmental Assessment Act. Compliance monitoring programs will also be developed and implemented to meet applicable provincial and federal permits, licences and approvals. Adaptive management as part of the development of the compensation elements will provide a management tool to adjust the elements as required, ensuring goals are met and habitats are functioning within specified timelines. Ongoing monitoring of compensation planning activities, including collection of baseline data, will provide information, which will be measured against established targets, and timeframes for individual compensation plans. Should deficiencies or data gaps be identified, the adaptive management framework will trigger a feedback mechanism to ensure deficiencies are addressed and Compensation efforts continue moving toward the overall goal of achieving No Net Loss. The adaptive management process for this Project will incorporate contingency planning, management*	Once again, EMPs are not fully disclosed but all impacts are rated non-significant. The authors make an effort to discuss the *"confidence in prediction in a separate section".* In the RP the authors define the precautionary principle as: *"Precautionary Principle" means the application of prudent foresight, the recognition of uncertainty, and, when decisions must be taken, to err on the side of caution;" (appendix 1).* Even though guidance on uncertainty disclosure and the precautionary principle is given in the RP, no uncertainties are clearly acknowledged in that report. Scientific certainty is not defined at all in the EIS. In the RP report, the authors define scientific uncertainty as: *"Scientific uncertainty - this involves determining confidence levels based on statistical methods or best professional judgement" (25).*

	confidence that emissions are being over-estimated. As such, the rating of prediction confidence is high for the Project based on quality of baseline data, emissions data, and confidence in the conservative nature of analytical techniques applied in this assessment. Cumulative Effects- As previously discussed, there are no cumulative effects related to CACs associated with the Project." (2-48) The air quality and dust control management plan has not been developed for the project. No thresholds, auditing and adaptive management are disclosed. Uncertainty is not disclosed. <u>Greenhouse gases</u> Mitigation measures are vague; Impacts are rated as insignificant even if clearly the proponent has a lack of technological knowledge to evaluate GHG effects of the project (that lack of knowledge is recognized by Environment Canada and the CEAA). -Uncertainty is taken into account implicitly but not investigated in depth: *"There are no residual GHG effects, as was detailed in Section 2.1.1.1 Environment Canada (2007) and the CEAA (2003) consider that it is not possible to attribute potential effects (be they local, regional, or global) to the emissions from any specific project. Therefore, there are also no residual or cumulative effects attributable to GHG emissions."(2-57)* <u>Water Quality (in the EMPs)</u> -Model uncertainty is recognized about the prediction of the pit water quality. It is subjectively addressed who the authors who assure that the technology available will be able to address any excess of the water quality guidelines adequately: *"Taseko recognizes there is uncertainty inherent in the mass balance model used to predict pit water quality, but is confident that both the opportunity and the technology are available to address any exceedances of water quality guidelines adequately." (9-51)* -Uncertainty is explicitly mentioned about the current prediction about metal loads generated by the different waste sources. It will be dealt in the monitoring programs: *"Data from these monitoring programs will remove a large amount of uncertainty contained in the current prediction about metal loads generated by the different waste sources." (9-53)* -Uncertainty is explicitly mentioned about prediction pit discharge concentration. It is addressed by more mitigation (Water Quality Guidelines); However, these are not disclosed: *"Taseko will deal with uncertainty about predicted versus actual pit discharge concentrations by committing to meet generic or site-specific WQG that may be developed for the Project during the permitting stage. Additional mitigations, such as treatment of groundwater than contains porewater seeping through the western embankment and moving toward Big Onion Lake, would need to be assessed based on monitoring programs and implemented if actual groundwater quality is not as good as the conservative predictions made."(9-53)* -Uncertainty is mentioned but is justified:	*objectives, ongoing monitoring and the proponent's commitment for achieving benchmark goals along specified timelines with regard to fish and fish habitat compensation plans." (8-66)* Moreover, the RP states: *"18.1: Incorporate adaptive management processes for this Project including contingency planning, management objectives, ongoing monitoring, and the proponent's commitment for achieving benchmark goals within specified timelines.* *18.2: Implement corrective measures should unforeseen adverse effects arise during the life of the Project. Measures will be taken to correct these effects and prevent them from occurring in the future. The EMS is then updated and associated training programs enhanced to improve the level of environmental protection based on the results of these programs."(Appendix 4)* In the review panel: *"Mr. Sean Nixon, legal counsel for the Tsilhqot'in National Government, commented in his closing remarks that adaptive management was not mitigation, and that "where it would not be appropriate to use adaptive management is where there is uncertainty about significant adverse environmental effects." (235)* However, this was not discussed furthermore. <u>Atmospheric Environment</u> In the EIS, for all atmospheric environments: Auditing is implicit for all atmospheric Environments but adaptive management is not mentioned. They do not address any uncertain aspects. It is not clear what will be put in place if the EA is not accurate and measures to mitigate adverse environmental effects are not effective. *"2.4.3 Follow-up and Monitoring for Atmospheric Environment* *To verify the accuracy of the environmental assessment and to determine the effectiveness of the measures taken to mitigate the adverse environmental effects of the project follow-up and monitoring is recommended."(2-57)* -Uncertainty (explicit) about weather patterns brought about by climate changes. These also question the efficiency of mitigation measures (water management plan). These uncertainties would be addressed with adaptive management (not disclosed). In the RP, the authors state: *"With respect to climate change, the Panel has examined the effects of extreme precipitation events in Section 6.2 and has concluded that Taseko's water management plan includes provision for various scenarios. Climate change and its effects are widely known to introduce variable changes to weather patterns that are often difficult to predict. The Panel finds that while uncertainties with regard to variations in weather patterns brought about by climate change would make the implementation of mitigation measures more challenging, the mitigation measures and commitments to adaptive management proposed by Taseko would be sufficient to ensure that effects of climate change on the Project would be minimal."*(228) <u>For fish and fish habitat:</u> -Gap of knowledge (implicit uncertainty) regarding fish and fish habitat compensation plans is addressed with adaptive management (and implicit auditing):	

	"To estimate the uncertainty in the estimate of tonset, a second set of constants was used ("worst case")."(7-93) It seems that uncertainty was addressed with conservative estimates. Aquatic ecosystem (in the EMPs) -Uncertainty about impact predictions is mentioned. That uncertainty is addressed with monitoring: *"Monitoring will also address any uncertainty distinguishing pre-closure logging and post-closure Project effects."(9-93)* Surface Water Hydrology and Hydrogeology (EIS) -Uncertainty regarding baseline condition of surface water hydrology is mentioned (data uncertainty: uncertainty in the actual quantities of the reduction/increase in stream flow due to the variability of the hydrology). That uncertainty is not addressed: *"The baseline conditions presented for the LSA for the Project are best estimates, and there is inherent uncertainty associated with their determination. But given the extensive stream flow data collection in Fish Creek, there is a higher level of confidence in the predicted effects, that surface water stream flow, during operations, in Fish Creek will be reduced and stream flow in Beece Creek will slightly increase due to the diversion of additional water from the Upper Fish Creek catchment. There is moderate uncertainty with the actual quantities of the reduction/increases in stream flow due to the hydrology of the Project area being highly variable. Groundwater infiltration rates differ greatly from sub-basin to sub-basin and even within sub-basins, resulting in a very large range of observed flows. Consequently, it is very difficult to accurately estimate flows. Caution is required when using the baseline values, or when developing additional estimates on the basis of these values, without a full appreciation of the hydro meteorological characteristics of the Project area."(3-103)* -Uncertainty about the numerical models used to predict the cumulative effects on surface water stream flow. Because cumulative effects are *"likely to be short-term (10-15 years)"*, uncertainty is ignored. *"The magnitude of the cumulative effects of MPB on surface water stream flow in the Project area is not very well understood due to the uncertainty associated with the numerical models used to predict the effects. However, the cumulative effects are likely to be short-term (10–15 years) and not considered a significant cumulative effect."(4-103)* Groundwater Quantity In the mitigation measures and the characterization of residual impacts sections, uncertainty is not disclosed. Overall confidence in the project effects assessment for groundwater quantity is medium to high for the following reasons: -Uncertainty (implicit) regarding the change in groundwater elevation (model and data uncertainty due to hydrogeological conditions) is addressed with implicit auditing but nothing is disclosed in regard to what will be done with the information gathered. *"In a suitably calibrated groundwater flow model, these simplifications generally permit*	*"Adaptive management as part of the development of the compensation elements will provide a management tool to adjust the elements as required, ensuring goals are met and habitats are functioning within specified timelines. Ongoing monitoring of compensation planning activities, including collection of baseline data, will provide information, which will be measured against established targets, and timeframes for individual compensation plans. Should deficiencies or data gaps be identified, the adaptive management framework will trigger a feedback mechanism to ensure deficiencies are addressed and compensation efforts continue moving toward the overall goal of achieving NNL.* *The adaptive management process for this Project will incorporate contingency planning, management objectives, ongoing monitoring and the proponent's commitment for achieving benchmark goals along specified timelines with regard to fish and fish habitat compensation plans."(9-94)* For the fish and fish habitat compensation plan, uncertainty is also recognized by the RP that states: *"If the potential future mine life extension from 20 to 33 years to allow the extraction of the entire mineral resource were to occur, the Panel concluded it would further affect the proposed fish and fish habitat compensation plan and increase the risks and uncertainties associated with the plan; Due to the high level of risk and uncertainty associated with the proposed fish and fish habitat compensation, the level of distrust between First Nations and Taseko and the First Nations strong opposition to the destruction of Teztan Biny (Fish Lake), the Panel cannot recommend any measures that would mitigate the significant adverse effects of the Project on fish and fish habitat in the Teztan Yeqox (Fish Creek) watershed;"(244)* However, the panel makes no strong recommendations. Water Quality-Altered water chemistry Follow-up is mentioned to "verify quality prediction"(implicit auditing) but no adaptive management is discussed. Groundwater Quantity No mention of uncertainty in the follow-up and monitoring section. Wetland ecosystems-Access Road No follow-up program: *"No specific follow-up and monitoring is recommended for wetland ecosystems in the mine site RSA, aside from the monitoring activities implemented as part of the reclamation plan"(5-99).* Water Quality-Altered water chemistry Monitoring is suggested and implicit auditing but no adaptive management and no mention of uncertainty: *"Additional information about groundwater pathways between the Fish Lake and Big Onion Lake watersheds will be helpful in more accurately predicting the potential for groundwater seepage into Big Onion Lake. It is anticipated that before the TSF is built, additional monitoring wells will need to be installed in the area between the watersheds to better define baseline conditions and monitor conditions during the life of the Project. Also, the wells will need to be monitored*	

	reasonably good predictions of project effects on a regional scale; However substantial variability on a local scale will occur where local hydrogeological conditions differ to a great degree from the best estimate, generalized case. Ongoing monitoring of the change in groundwater elevations and comparison against predicted conditions both within the project area and in potentially affected adjacent watersheds will therefore be of critical importance in the ongoing assessment of project effects as part of compliance monitoring for the project."(4-140) *"Locations for monitoring installations that will be retained from the existing well network (where possible based on project construction requirements), and proposed locations for new monitoring installations that would be established during pre-construction, construction and commission phases of the project will be established in the permitting phase of the project. Ongoing monitoring of the change in groundwater elevations and comparison against predicted conditions both within the project area and in potentially affected adjacent watersheds will therefore be of critical importance in the ongoing assessment of project effects as part of compliance monitoring for the project"(4-140).* -The difficulty accurately predicting changes in groundwater flows due to context, results in model and data uncertainty (hydrology is highly variable). To address that uncertainty, sensitivity analyses were completed: *"Similarly, average climate normal are used to estimate evapotranspiration and infiltration rates to the groundwater model. As discussed in Section 4.2, the hydrology of the project area is highly variable, and groundwater infiltration rates differ substantially from sub-catchment to sub-catchment. It is therefore difficult to accurately predict changes in groundwater flows, specifically groundwater discharge as baseflow, on more than an average annual basis. Six-month stress periods were used to simulate average summer and winter conditions in the groundwater flow model. Large variability in predicted average groundwater discharge, as baseflow should therefore be anticipated on monthly, weekly and daily bases within these stress periods. Where possible, ranges of model input values are provided, and sufficient data and explanation are presented to permit an independent assessment of the suitability of a parameter value for a given application. Sensitivity analyses were then conducted to evaluate variability in model responses to different input parameters. "(4-140)* Ground Water Quality No uncertainty disclosure in the mitigation measures and characterization of residual impact sections. -Uncertainty about groundwater quality baseline conditions is implicitly mentioned. It is addressed by mentioning various assessments and evaluations by various experts. Adaptive management is also mentioned but remains extremely vague. *"Groundwater infiltration rates and subsurface stratigraphy differs substantially from sub-basin to sub-basin and even within sub-basins, resulting in a very large range of observed*	*during operations, closure and post-closure to verify the predictions." (2-78)* Wildlife: The follow-up program and monitoring remains extremely vague in how to address uncertainty (implicit) about the project related wildlife vehicle collisions. -Direct Mortality for Mule Deer and for Moose Implicit auditing and adaptive management (not disclosed) address uncertainty that is implicitly disclosed. Areas of low and medium confidence are recognized here (data uncertainty about both mitigation measures and impact predictions), but not really addressed: *"However, given the unpredictability of mitigation measures related to wildlife road mortalities, any Project-related wildlife-vehicle collisions or near misses will be recorded, and reviewed to identify problem areas"* (6-75). -For Black Bear, Great Blue Heron, Mallard, Barrow's Goldeneye, Sandhill Crane and Long-billed Curlew Implicit auditing but no follow-up program*:* *"Follow-up and Monitoring for Direct Mortality Risk for Black Bear. No species-specific follow-up or monitoring programs are proposed for black bear mortality risk; however, given the unpredictability of mitigation measures related to wildlife road mortalities, any Project-related wildlife-vehicle collisions or near misses will be recorded, and reviewed to identify problem areas."(*6-146) -For Grizzly Bear, Black Bear, Great Blue Heron, Mallard, Barrow's Goldeneye, Sand hill Crane and Long-billed Curlew Data uncertainty. Implicit uncertainty about impact predictions on road kills: E.g.: *"no local information on incidence of grizzly bear road kills" (6-128)* and *"there is no baseline (mortality) data" (6-261).* -For Grizzly Bear The follow-up program seems to be well directed to address the uncertainty about the loss of habitat for Grizzly Bear (implicit uncertainty) and human-caused grizzly bear mortalities. However, in section 6.3.4.8 only a summary of the program is given. Moreover, no research is suggested prior to the construction of the project: *"Follow-up and Monitoring for Direct Mortality Risk for Grizzly Bear* *Given its threatened status, any human-caused grizzly bear mortalities that occur in the South Chilcotin Ranges GBPU are a serious concern. Therefore, a follow-up program is proposed—that is, a "Grizzly Bear Mortality Investigation Program", implemented under the direction of the BC Ministry of Environment. This program is described in more detail in Section 6.3.4.8."*(6-128) Biodiversity In the RP, adaptive management (vague and auditing is not mentioned) is used to address uncertainty about the status (genetically distinct) of the Rainbow trout in Fish Lake. However, overall, uncertainty seems to be ignored considering that the specie is common in the region: *"In reaching its conclusions on biodiversity, the Panel considered the following factors to be particularly relevant: there was uncertainty regarding the genetic distinctiveness of the*	

	groundwater flow and quality. Consequently, it is very difficult to accurately estimate flows. Caution is required when using the baseline values, or when developing additional estimates on the basis of these values, without a full appreciation of the hydrogeologic conditions in the vicinity of the Project area. *Various investigation and assessment components were relied upon to make predictions related to groundwater quality. These components include:* *-A baseline water quality assessment completed by Knight Piésold, which included various tasks such as installation of monitoring wells, collection and chemical analysis of groundwater samples, and interpretation and discussion of analytical results. This assessment contains minor intrinsic error (associated with the analysis of groundwater samples) and thus provides a high confidence in the results of the assessment.* *-A tailings pore-water quality assessment completed by SRK Consulting Ltd., which is based on on-going test work, among other inputs.* *-A numerical hydrogeologic evaluation completed by BGC Engineering Inc. (Appendix 4-4-C), the confidence of which is discussed in Section 4.3.2.3, above.* *-A mass balance evaluation of groundwater quality completed by KP, which included collection of flow rate and water quality data provided by the above assessments and calculations using a simple mass balance equation. There is low intrinsic error associated with this evaluation (associated with the assumptions about water mixing) and thus provides a high confidence in the results of the evaluation. Based on the assumption of confidence in the relied-upon predictions, we are confident with our assessment of effects on groundwater quality. Furthermore, we are confident in the calculations used to make this assessment and the methods proposed for mitigation of these effects.* *As a result, the cumulative confidence in the predictions discussed herein is deemed to be moderately high. However, if and when new information is acquired that may change the conclusions of any of the above-listed information this assessment should be revised to address such changes."(4-164)* Water Quality-Altered water chemistry -Data uncertainty is implicitly considered which is due to the complexity of natural watershed processed. That uncertainty is not addressed as the prediction remains within "water quality guideline". This is not further explained. Uncertainty is being ignored: *"Although the prediction of little altered water chemistry in lower Fish Creek and no change in the Taseko River from construction through closure can be made with confidence, results have been modeled using existing data. Additional factors, such as natural watershed processes that occur between the mine site and the mouth of Fish Creek, may affect water quality, as currently occur within the system. These processes could result in water chemistry other than has been predicted, but still within WQG (water quality guideline)."* (2-56) -Uncertainty is recognized explicitly about parameter estimates used in the model. To	*rainbow trout in Teztan Biny (Fish Lake); rainbow trout were reported to be a common species in the Cariboo-Chilcotin region; there was disagreement on the potential effects of the Project on wildlife species, including those considered threatened, such as the grizzly bear; Taseko concluded that habitat fragmentation and disturbance at the mine site would be considerable; however, at the regional level, biodiversity would not be substantially affected; Taseko concluded that the effects of the project on most selected key indicator species would likely be negligible following post-closure reclamation; and Taseko recognized the potential effects to the endangered moss S. heterophyllum and proposed to relocate the boulders hosting populations to suitable sites outside the mine footprint."(224)* *"Nevertheless, the Panel notes that rainbow trout are a common species in the Cariboo-Chilcotin region and a loss of the Teztan Biny population would not have an overall significant adverse effect on the biodiversity in the region." (225)* *"If the Project proceeds, the Panel recommends that Taseko commit to monitoring the transplanted Schistidium heterophyllum populations and the implementation of appropriate adaptive management measures to ensure its survival."(225)*	

	address that uncertainty a sensitivity analysis was used and worst case scenarios established. This resulted in a high degree of confidence. *"Sensitivity of the predictions of solute migration rate and concentration in groundwater discharging to Big Onion Lake due to uncertainty in parameter estimates used in the model (e.g., saturated hydraulic conductivity) can be described by re-evaluating the model using different estimates of these parameters. The sensitivity analysis for these physical processes can be considered somewhat like establishing error bars on a calculation, but it does not take into account conservative assumptions used to derive pore water quality, which is likely to be better than predicted."(2-76)* -Confidence in predictions of no altered water chemistry in Big Onion Lake from construction through post-closure is high because worst-case assumptions were used. However, there is implicit uncertainty about the predictions made further into the future after year 100 (model uncertainty). This is addressed with mitigation strategies. However these mitigation measures are not disclosed. *"The limitation of modelling only to Year 100, because of increasing lack of confidence in predictions made further into the future, will need to be addressed with mitigation strategies should groundwater monitoring indicate pore water contributions are higher than 5%."(2-77)* *"Although the Project has been designed to contain seepage, and the prediction of no altered water chemistry in Big Onion Lake from construction through post-closure can be made with confidence, results have been modeled using existing data and reasonable worst-case assumptions. The altered groundwater paths and resulting groundwater quality containing porewater will need to be monitored to provide site-specific information. However, given the conservative approach taken, there is a high degree of confidence that porewater and groundwater chemistry will be no worse than predicted (and likely be better); lake water chemistry may be other than has been predicted, but still within WQG. The limitation of modelling only to Year 100, because of increasing lack of confidence in predictions made further into the future, will need to be addressed with mitigation strategies should groundwater monitoring indicate pore water contributions are higher than 5%. If necessary and appropriate, secondary mitigation measures (e.g., reactive barriers, seepage recycle wells) can be implemented to mitigate the potential for TSF seepage impacted groundwater to reach Big Onion Lake."(2-78)* -Mitigation measures uncertainty (explicit): About the underlying geochemical laboratory test work and actual site conditions after mine construction (data and context uncertainty). It is addressed with reasonable but conservative inputs have been made at all steps in the modeling process, resulting in predictions of discharge concentrations of parameters that are likely to be higher than the actual discharge concentrations. *"A conservative, mass balance model was used*		

	to develop the pit water quality predictions. This model assumes no losses to the sediment of a 495 m deep pit through commonly observed processes related to solubility and precipitation of metals. A reasonable worst-case model for prediction of water quality was used because of technical and legislative requirements to address uncertainty about the underlying geochemical laboratory test work and actual site conditions after mine construction. Reasonable but conservative inputs have been made at all steps in the modeling process, resulting in predictions of discharge concentrations of parameters that are likely to be higher than the actual discharge concentrations. The conservative approach is discussed in Section 2.3.1.2."(2-107) -Uncertainty (explicit) inherent in predictions of pit water quality. It is addressed with the opportunity and the technology that is available to address any exceedances adequately but these are not disclosed. *"Taseko recognizes there is uncertainty inherent in predictions of pit water quality but is confident that both the opportunity and the technology are available to address any exceedances adequately. Natural attenuation processes in the pit (precipitation of metals to the sediment) that cannot be accounted for in the mass balance model, and are not easily modelled, will reduce metals levels below those predicted. In addition, there are treatment options available that are feasible using current technology."(2-107)* -Uncertainty about the current predictions about metal loads generated by the different waste sources. This is addressed through monitoring programs during operations and closure to assess the actual geochemical performance of the Project and implicit auditing ("*assess the actual geochemical performance of the project"*), adaptive management is implicit but well explained; but not disclosed in depth: *"The need for treatment will be assessed through monitoring programs during operations and closure to assess the actual geochemical performance of the Project (to calibrate the water quality prediction to site data) and during the 27 years required for the pit to fill. Data from these monitoring programs will remove a large amount of uncertainty contained in the current prediction about metal loads generated by the different waste sources."(2-108)* *"Should monitoring indicate the need for water treatment, there are current technologies capable of achieving the necessary load reductions to meet existing provincial and federal WQG (or site specific WQG for parameters with elevated baseline levels). These can be applied at the source or in the pit, or a treatment plant can be built at the pit outlet. Summaries of some full-scale water treatment operations currently removing selenium and cadmium from mine discharge are discussed in Appendix 5-2-C (SRK Memo on Mine Discharge Determination). These include use of iron co-precipitation, biological reduction in ponds and wetlands, and membrane filtration for selenium and sulphide*		

	precipitation for cadmium."(2-108) -Uncertainty about predicted versus actual pit discharge concentrations will be addressed by the development of generic or site-specific Water Quality Guidelines for the Project during the permitting stage. This data uncertainty is therefore addressed with new mitigation measures though WQG (water quality guidelines). Thresholds are disclosed "relevant considerations include the list of existing generic WQG in Table 2-9 and establishment of site-specific WQG for the following parameters, some of which are discussed in more detail below" but the measures remain vague: *"It is anticipated that the uncertainty about predicted versus actual pit discharge concentrations will be addressed by the development of generic or site-specific WQG for the Project during the permitting stage. As discharge will not occur for decades, Taseko is not applying for a permit to discharge at this time. However, relevant considerations include the list of existing generic WQG in Table 2-9 and establishment of site-specific WQG for the following parameters, some of which are discussed in more detail below: Sulphate, given the precedent at other mines, the difficulty confirming historic toxicity test results for an aquatic moss (the most sensitive species used to develop the BC WQG), and the role of hardness and other site-specific characteristics in ameliorating sulphate toxicity; Dissolved aluminum, given the elevated levels in the Taseko River baseline data and the role of site-specific characteristics such as DOC in complexing with aluminum to reduce toxicity; Cadmium, considering characteristics that reduce toxicity (e.g., hardness, and the role of DOC in complexing with cadmium); Dissolved and particulate iron considering the elevated baseline levels in both the Taseko River and Fish Creek (related to glacial silt in the former and groundwater and freshet silt in the latter)" (2-108)* For water quality, once again because worst case estimates were used the prediction results in a high degree of confidence: *"The uncertainty in water quality predictions and use of a reasonable worst case model, discussed in the mitigation section, results in high confidence that water quality will be no worse than predicted, but does not define how much better than predicted the pit discharge water will be. Given that Taseko anticipates developing and meeting sitespecific WQG, a second modeling exercise was done, using the lower of water quality guidelines or predicted post-closure water quality in the pit."(2-108)* Sediment Quality -Uncertainty about impact prediction (explicit): due to a complex aquatic system: uncertainty is addressed with monitoring only. No details are given on adaptive management (auditing is implicit): *"There is always some degree of uncertainty when predicting effects in a complex aquatic system, particularly several years post-closure. Given that the extent of geochemical interactions of dissolved metals and sediment can be only be roughly estimated, it will be*		

	important to consider monitoring during post-closure discharges to verify the prediction. *Follow-up sediment surveys will be helpful in reducing variability in baseline data at sites W8 and W3 in Fish Creek prior to construction and again prior to post-closure discharges to ensure there are accurate measurements of sediment metal levels. Post closure monitoring will likely be done as part of MMER Environmental Effects Monitoring programs and to assess whether there are substantial water-sediment interactions that result in sedimentation of dissolved metals." (2-143)* Aquatic Ecology Uncertainty regarding impact prediction regarding the responses of aquatic organism (context uncertainty, stochastic and recognized) in aquatic ecology. Monitoring is used explicitly to address that uncertainty but there is no auditing, no adaptive management: *"To address uncertainty regarding responses of aquatic organisms in Wasp Lake to diversion of clean water during and after the life of the Project, monitoring of phytoplankton, zooplankton and benthic invertebrate, along with water and sediment will be required."(2-158)* Noise Here is a typical example where there is overconfidence in mitigation measures that are not completely disclosed. Uncertainty is not disclosed and overall residual impacts are insignificant. In the prediction confidence section, because conservative estimates are used confidence is rated as high. *"Additionally, the ISO 9613 model also produces results representative of conservative meteorological conditions favoring sound propagation (e.g., downwind and temperature inversion conditions). These meteorological conditions have been described in detail in Section 3.2.3.2 and includes downwind and temperature inverse conditions. The temperature (10°C) and relative humidity (70%) values were conservatively selected as per ISO 9613 publication (ISO 1993) because these two conditions minimize atmospheric absorption of sound energy thereby enhancing sound propagation. As these conditions do not occur all the time, so the model predictions are conservative, and actual sound levels during other climate conditions are expected to be less than indicated for much of the time. Based on these factors, confidence is high that the model has not under-predicted noise levels."(3-27)* Terrain and Soils-Terrain -Uncertainty is present about impact predictions regarding the extent to which groundwater influence terrain stability. This data uncertainty is addressed with a follow-up program: *"However, as there is uncertainty in the prediction, follow-up and monitoring will need to be undertaken to determine the extent, if any, to which groundwater changes influence terrain stability. Given the geographic isolation of the project from other activities and Projects with effects on terrain stability, it was concluded that the Project will not result in cumulative effects on terrain in the region" (4-47).*		

	Soils -Uncertainty is implicitly considered regarding spatial information regarding soil metal exceedance. The analysis was not conducted so the confidence in the predictions of metal data exceedance is considered to be moderate. This data uncertainty is ignored; nothing is done to reduce/address it: *"A spatial analysis of the aerial extent of soil metal exceedance was not conducted. Therefore, the confidence in the predictions of metal data exceedance is considered to be moderate." (4-120)* -Implicit data uncertainty about soil fertility changes and reclamation activities (both uncertainty about impact predictions and mitigation measures). The report states: *"With respect to soil fertility changes, there is a moderate degree of confidence, as total changes cannot be measured until reclamation activities commence at Project closure." (4-120)* *"The goal of the monitoring program is to determine the need for further action and, if necessary, to set remediation objectives at Project closure."(4-120)* Implicit adaptive management that is not discussed in depth. Vegetation-Old forest -Uncertainty about the recovery of the mine site and transmission line due to data and context uncertainty: reforestation mitigation measure uncertainty due to the *"influence of natural disturbance and commercial forest harvesting activities"*: uncertainty due to time required for forest recovery, environmental processes (climate change) and economic climate: *"However, as discussed for the mine site, there is some uncertainty about the likelihood of old forest recovery in the transmission line corridor due to the long time periods required and the influence of climate change, natural disturbance and commercial forest harvesting activities."(5-69)* The report states*:* *"Reclamation monitoring will be sufficient to ensure that reforestation mitigation measures are implemented successfully and no incremental follow-up and monitoring is required."(5-62*) Two tables 5-73/5-74 and 5-75 summarize the project and residual environmental effects for old forest. Confidence ratings are high/medium/low but not explain nor addressed. The table states: *"Prediction Confidence: Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation: Low level of confidence; Moderate level of confidence; High level of confidence" (5-63)* The level of confidence is high for all impacts. Only the levels of confidence for cumulative effects for old forest loss due to the mountain pine beetle infestation are rated as medium-high. The medium level of confidence is ignored. In the residual environmental effects table, scientific certainty is rated as high for old forest.		

	Wetland ecosystems-Access Road -The confidence in predictions for residual and cumulative environmental effects is rated as moderate: Uncertainty is explicitly recognized regarding legislative context (forest licenses) and environmental context (pine beetle infestation, interaction with climate change or fire): data and context uncertainty. That uncertainty is not addressed but is being ignored. *"The prediction confidence for cumulative environmental effects and significance prediction is moderate as the actions of forest licensees are governed by operational guidelines and, while these are commonly adhered to, there is some potential for small wetland losses to occur in isolated cases. Also, the environmental effects of forest canopy reduction resulting from pine beetle infestation (i.e., reduced snow interception, higher snowpack, larger peak flows), while not expected to result in wetland loss, may interact with other factors (e.g., fire, climate change), thereby introducing some uncertainty into these predictions.'*(5-99) For the impact on Wetland Ecosystem-Transmission Line -The prediction confidence for the significance of project environmental effects is rated as moderate (implicit uncertainty) because of the quality of the detailed sensitive ecosystem inventory mapping (5-109). That uncertainty is ignored. -Certainty is medium in the potential residual environmental effects assessment matrix ("scientific certainty") for maximum footprint on the changes in plant structure and composition. It is not addressed (5-109). Riparian Ecosystem -Prediction confidence is rated as medium for changes in Riparian Ecosystem community structure and composition during the construction of the transmission line: that uncertainty is ignored. -Scientific certainty is rated medium for the maximum footprint regarding the changes in riparian ecosystem structure and composition. It is not addressed (there is monitoring planned but not clearly aimed at uncertainty). Grassland -Prediction confidence is rated medium for Grassland Ecosystem Loss during construction of the transmission line but it is not addressed. Scientific certainty is rated high for all (5-173) Rare Plants -Uncertainty about certain rare plants-but not explicitly recognized and not addressed (ignored) Potential effect on rare plant loss has a low level of confidence in the table- Assessments of Environmental Effects to Rare Plants. The level of prediction is not explained nor addressed (we can assume it is because of the lack of information mentioned before. In addition, the residual effects on vegetation loss have a low scientific certainty. *"In spite of the lack of information on other rare plant populations within the mine site RSA, the following general mitigation measures can be implemented to protect other potential rare plant locations*."(5-187)		

	Monitoring is recommended in that section but no adaptive management and no auditing: "*rare plant surveys outside mine footprint to determine population size and spatial distribution of rare species. Follow wetland ecosystem mitigations."(*5-196) Grizzly Bear and Black Bear -Implicit uncertainty about impact prediction is mentioned regarding the model used to predict the availability of seasonal feeding habitat (not addressed). *"Model used to predict/map the value and availability of seasonal feeding habitat in the mine site LSA and transmission line LSA has a moderate reliability rating; Model used to predict/map the value and availability of habitat in the RSA is not as reliable as that used for the mine site LSA and transmission line RSA"(6-128).* -RP: Uncertainty about impact prediction for Grizzly Bear; the small nature of the project and the abundance of the species in the region is used to justify that uncertainty: *"The Panel notes that there was some uncertainty about the Project's effects on grizzly bears and has concluded that the effects of the Project in combination with other past, present and reasonably foreseeable future forestry harvesting activities would result in a significant adverse cumulative effect on the South Chilcotin grizzly population. However, the Panel also notes that at a broader regional scale, the total affected area would be relatively small. Further, the Panel notes that while the South Chilcotin grizzly population is nearing the endangered level, the population of grizzly bears at the provincial level is more stable. Consequently, the Panel finds that the overall effects on biodiversity due to a possible further reduction in the South Chilcotin grizzly bear population would not be considered significant."(225)* For Grizzly Bear, Black Bear, Fisher, Townsend's Big-eared Bat, Great Blue Heron, Mallard, Barrow's Goldeneye, Sandhill Crane, Long-billed Curlew, Lewis's Woodpecker, Yellow-breasted Chat, Sagebrush Brewer's Sparrow, Sharp-tailed Grouse, Owls and Amphibians -Implicit uncertainty is acknowledged in impact prediction about the model used to predict the availability and loss of habitat: *"The availability and loss of habitat was determined using quantitative models with a moderate reliability rating." (6-161.* That uncertainty is not addressed. For Yellow-breasted Chat, Sagebrush Brewer's Sparrow, Sharp-tailed Grouse, Owls, and Amphibians -Data uncertainty about impact prediction regarding the abundance of the species in the area. E.g.: *"Presence/relative abundance of chats in the study area is supported by limited field data and other information available for the region" (6-276).* *"Limited baseline data is available for the region (e.g., grouse distribution and habitat use)" (*6-294). That uncertainty is not addressed.		

	Reptiles In the table page 6-343, prediction confidence is rated as medium for potential residual environmental effects on amphibians. It is neither being explained nor addressed. For Terrestrial Invertebrates -Data uncertainty about impact prediction on terrestrial invertebrates; but that uncertainty is ignored. *"There is no information on the effects of industrial development on this group" (6-346).* *"There is very little information available on the abundance, distribution, and ecology of terrestrial invertebrates in the Cariboo-Chilcotin, and essentially no information on the effects of industrial development on this group. For these reasons, no attempt was made to characterize Project effects. However, habitat loss or alteration is the most likely potential Project effect. There is also the potential for direct mortality if construction intersects seasonal population concentrations (e.g., breeding sites). Mitigation measures directed at minimizing or eliminating effects on wildlife in general (Section 6.4.1) will also protect terrestrial invertebrates."(6-346)*		
4. Prince George Hart Water Supply Project	Accidents, malfunctions and adverse conditions are discussed in section "12.0 accidents, malfunctions and adverse conditions". Uncertainty is not explicitly disclosed but is implicitly considered: the authors consider the potentiality for unexpected situations *"In this section, potential accidents, malfunctions, and adverse conditions that might occur during the construction and operation phases of the Hart Water Supply Improvement Project are reviewed, and preventative measures that would need to be taken to minimize the risk of accidents and malfunctions occurring are identified."(114)* For the construction phase, four scenarios are briefly identified: Spills or release of fuels, hydrocarbons, or antifreeze; Damage to other facilities; Accidents involving the public and Leak or rupture along the water transmission main resulting in a *potential* release of chlorinated water. Disclosure of uncertainty is medium and implicit. No quantitative information is given. Environmental management plans that will minimize the likelihood of these accidents and malfunctions are not disclosed in the EIA. For the operation phase: Uncertainty is not disclosed but implicitly considered: "*During the operation phase of the Fishtrap Island Collector Well, the potential risk for accidents and malfunctions will be minimal (…) the likelihood of an accidental release of disinfection compound is considered minimal, recognizing that the City has strict safety requirements for the storage and handling of chlorine in accordance with the Workplace Hazardous Materials Information Systems (WHMIS) and Workers Compensation Board (WCB) Regulation"(118).* Here, the safety requirements should be disclosed. No adaptive management. The environmental management plans and contingency measures are generally described on pages 120-130. The disclosure of these	Monitoring and auditing (implicit) are used to reduce uncertainties from the environmental predictions and mitigation measures but this is done only implicitly and generally disclosed. No particular uncertainties are disclosed: *"As required by CEAA, the purpose of this section of the environmental assessment report is to outline the City's proposed approach to evaluating and reporting progress of the project, and specifically, occurrences of both forecasted and unforeseen environmental effects, success of mitigation measures, and compliance with regulatory requirements. To achieve effective implementation of the above-recommended environmental mitigation measures, the City will retain qualified, independent environmental resource monitors. The roles, responsibilities, and general duties of the Environmental Monitor are summarized below.* *14.7.1 Environmental Monitoring* *The role of the Environmental Monitor will be to inspect, evaluate, and report on the performance of construction activities, and effectiveness of environmental control strategies and mitigation measures with respect to regulatory permits, approvals, and authorizations, environmental legislation, and BMPs (Best Management Practices). Other responsibilities of the Environmental Monitor typically include […]* *· Providing recommendations for modifying and/or improving environmental mitigation measures, as necessary;* *[…]* *· Suspending construction activities that are causing, or potentially causing, risk of environmental damage; and* *· Preparing factual environmental monitoring summary reports throughout the duration of construction, to summarize activities and actions taken to minimize impacts during each of the construction activities."(130-131)* *"Environmental monitoring by qualified personnel will also reduce the likelihood of activities, whether accidental or intentional, which contravene environmental legislation and regulations. During construction, the City's Environmental Monitor will have the primary*	Emergency and contingency plans are not disclosed. The authors promise the preparation or implementation of these plans. Instead they should be disclosed directly in the report.

	plans is of poor quality. Uncertainty is not part of the attributes used to determinate the significance of residual impacts. However, it is explicitly disclosed in that same section (section 3.3 *Evaluation criteria and determination of significant adverse environmental effects*-page 15) *"In some cases the level of scientific uncertainty is sufficiently high that an estimate of environmental consequence cannot be made with a sufficient degree of confidence. Undetermined ratings are accompanied by recommendations for research or monitoring to provide more data in the future. Note, that not all of the above - referenced evaluation criteria will necessarily be applicable to residual impacts for each environmental component; however, it is anticipated that in most instances magnitude, duration, and geographical extent will be relevant. In addition, it should be noted that the above-referenced evaluation criteria used to derive "significance" of adverse residual impacts are specific to this project. Since the EA predicts future conditions of characteristics that are, by their very nature, continuously changing and dynamic, there is frequently a level of scientific uncertainty related to the prediction. In some cases, the level of uncertainty associated with an impact prediction has required that a subjective assessment be provided about an impact, and the requirement for ongoing monitoring has been identified. These evaluation criteria are applied to the residual potential environmental effects, both before and after mitigation, in Section 15.0 of this Application/Comprehensive Study Report and are summarized in a matrix format to determine significance of the residual effects of the project, following implementation of the mitigation measures"(18)* Here, more research or monitoring is suggested in the case of data uncertainty. Uncertainties about specific environmental effects are not mentioned. Mitigation measures are not disclosed in the report and have not been prepared for the EIS. While possible failure of mitigation measures are considered (see follow-up section), these are not discussed in depth. No uncertainty is clearly identified: *"14.7 Environmental Construction Monitoring and Management Plan.This section provides information regarding. Preparation of the framework for an Environmental Management Plan (EMP), the details of which would be provided during the detailed design of the project. The approved EMP would be included in the contract documents provided to the contractor(s) selected for construction of the Fishtrap Island Collector Well Project."(131)*	*responsibility to confirm that the environmental management measures, controls, and specifications are properly implemented as per the terms and conditions of the Environmental Assessment Certificate, and/or other regulatory permits and approvals" (130-131)* Here, uncertainty is implicitly disclosed using the word "accidental". Post-Construction Environmental Monitoring: The city of Prince George will report on the success rate, survivability, and general health of existing vegetated and newly planted areas. We can assume that uncertainty about the survivability of these vegetated areas might have triggered the post-construction monitoring but nothing is disclosed. Adaptive management (implicit) is used to address the potential death of this vegetated area: *"14.8 Post-Construction Environmental Monitoring Following completion of the construction phase of the project, the City of Prince George will evaluate the effectiveness of site restoration and reclamation works and compliance with site enhancement initiatives outlined in this Application for an Environmental Assessment Certificate/Comprehensive Study Report."(133)* *"The City of Prince George will evaluate and report on the success rate, survivability, and general health of existing vegetated and newly planted areas on an annual basis over a minimum period of 3 years to achieve an 80% plant survival rate, or as otherwise specified in any permits, approvals, or authorizations to be issued by the regulatory agencies for this project. Copies of post-construction annual monitoring reports will be filed with the City and made available to the public and agencies having jurisdiction upon request."(133)* *"Typically, the post-construction monitoring program will include regular maintenance of newly planted trees and shrubs, including watering, fertilizing, pruning if necessary, and removal of invasive non-native weed species. The maintenance schedule will be determined by the City of Prince George, but will likely be a minimum of twice annually. Qualified municipal personnel will conduct monitoring of the survivability of the re-vegetation. The post-construction monitoring program will examine all of the restored areas, documenting failures in re-seeding and/or plant mortalities. If any noxious weeds are observed during the 3 years of post-construction monitoring efforts, they will be controlled by physical/ mechanical means by the City. Typically, plant survival should achieve a minimum 80% or greater survival rate after the period of three years during operation of the well. If an overall survival rate of 80% of re-vegetation efforts has not been achieved by the end of the third year, the City of Prince George will continue annual inspections and replanting until such time that 80% survival rate has been achieved." (133)*	
5. Swan Valley Gazification Project	Mitigation measures do not address any uncertain aspects that were clearly disclosed in the impact prediction sections. Generally, mitigation measures are not disclosed in the EIS and their description is general. The programs are not disclosed in the report. In addition, no thresholds are clearly identified and adaptive management is not disclosed. It is the same for the emergency measures: "*The company will prepare an Emergency Response Plan to address the potential*	There is uncertainty about the failure of various control or mitigative measures. However, the mitigative measures are not disclosed. More research and additional precautions are proposed to identify unstable soils but not disclosed as part of the report. Monitoring is used to address unusually severe precipitation event but information about it is not disclosed. Auditing and adaptive management are not proposed.	Uncertainty is implicitly taken into account to some extent: auditing and adaptive management is implicitly considered for re-vegetation and erosion control

	hazards associated with operating the pipeline." (29) "*Possible malfunction of operational systems" is considered: "Should a pipeline rupture, automatic line sensors immediately close the upstream and downstream valves to isolate the section in which the failure has occurred. An alarm system is in place to alert operation personnel and the Emergency Response Plan is implemented for the valve section in question. The major component of natural gas, methane, is not directly toxic to plant or animal life and is rapidly dispersed in the atmosphere. In the atmosphere, methane is naturally oxidized to carbon dioxide and water. Because it is highly combustible, the principal danger from an uncontrolled escape of natural gas is ignition. Should this occur, any equipment or individuals at the immediate site of the rupture would be at serious risk of damage or injury. Once the line section has been isolated, the discharge of gas from a rupture is relatively rapid and has no long-term negative impacts. In an aquatic environment, the natural gas would bubble to the surface of the watercourse and disperse into the atmosphere. Methane is not toxic or harmful aquatic life. Long-term impacts resulting from a rupture in a aquatic ecosystem would be negligible."(155)* In my opinion, here, it is unclear in which quantities exactly methane will affect plants, animals and human life: "*Immediate repair may be necessary for serious leaks. In certain instance, the landowner may not receive prior notification of the repair if the leak is an immediate threat to the health and safety of the general public and environment. However, all pertinent procedures for repair, environmental protection, and owner compensation would be followed. During emergencies, some disruption to wildlife may occur. This disruption and damage will be kept to a minimum and restoration will commence as soon as possible." (29)* Impact predictions are over confident. This is the case for all environmental impacts. Vague assumptions (*to the extent possible*, *measures will be discussed, to the extent feasible, may occur, likely, could, potential etc.*.) are extensively used by the authors. Water Quality Another example of how overconfident the predictions are is disclosed here. Uncertainty is clearly not addressed: *"Water quality impacts due to chemical release from sediments during in-stream construction activities are predicted to be minimal. Although site-specific data are not available, sediment quality at the watercourse crossing can be expected to be good, as the watercourses are generally uncontaminated by anthropogenic activities."(112)* Fisheries Resources The main uncertain aspect found in this project concerns the sensitivity of the eight Swan River tributaries that the pipeline crosses: *"Each of the watercourses which have potential to provide fish habitat on a permanent or seasonal basis were surveyed and the CAPP fisheries habitat screening*	In the section "Possible Malfunction of Mitigative Systems during construction" (154) the authors state: *"During the pipeline construction, the failure of various control or mitigative measures can result from the occurrence of unexpected conditions, such as construction trough unstable soils or an unusually severe precipitation event. Soil type mapping will be examined to identify potentially unstable soils. In those areas, additional precautions must be taken during trenching. Furthermore, severe rainfall events will be anticipated by the Environmental Monitor as early as possible during the proposed construction by regular and frequent consultation with local meteorological station staff." (154)* Vegetation and erosion Auditing (implicit) and adaptive management (extremely implicit) are considered (no uncertainties are disclosed: "*A post construction environmental survey will be conducted after one complete growing season following construction to assess the effectiveness of mitigation measures. In particular, the effectiveness of revegetation programs and slope erosion prevention measures will be examined. In the event that areas of concern are noted during the inspection, appropriate measures (e.g., stabilization and/ or reseeding) will be implemented to correct the problem."(30)* Ex-post evaluation measures are implicitly considered for vegetation, river crossing and erosion but these do not address any particular uncertainties "*The company will provide an on-site Environmental Monitoring for the crossings of the following areas: crown lands, native vegetation areas, and crossing of the Spruse Creek, Deer Creek, Bear Head Creek, Roaring River, Favel River and Eat Favel River."(155)* *"In addition, the monitor will be involved in determining area requiring erosion control, and the appropriate control measures in these areas. These decisions will be made in conjunction with the Company Chief Inspector. Terms of reference for the monitor will be consistent with those developed for other pipeline projects constructed by the Company."(155)* Ex-post evaluation is generally considered for cumulative and residual effects *"To provide post-construction assessment of cumulative and residual effects, the Company will monitor the effects of pipeline construction on the lands that have been disturbed by construction within one year of completion of the reclamation work. The monitoring will culminate in the filing of post-construction monitoring report with the NEB and provincial agencies. The detailed monitoring practices will ensure that both direct and cumulative impacts that results from pipeline construction are adequately dealt with and that all lands disturbed by construction activities are appropriately reclaimed." (155)* Here it seems that the post-construction assessment will only assess if the predicted impacts are mitigated. Uncertainty is not considered. Implicit auditing is also mentioned for erosion control later in the report: *"In addition, the monitor will be involved in determining area*	only, but these plans remains general. No thorough adaptive management of EMPs and contingency measures is disclosed. Uncertainty is not disclosed for any aspect of impacts prediction. No residual impacts are discussed.

	procedure was conducted to discern the sensitivity of the watercourse. Three of the crossings were identified as sensitive and consequently these crossings will be completed using a directional drill method that avoids in-stream work"(110) "*The remaining watercourses traversed by the route were categorized as non-sensitive due to their intermittent nature and/or lack of fisheries habitat potential near the crossing." (110)* *"To determine the potential for impact to the watercourses as a result of pipeline construction, an assessment of the fish and fish habitat was completed at all the crossing locations prior to construction. The primary objective of the assessment was to determine the level of impact that could be expected from crossing construction and to identify techniques that may be used to install the pipeline efficiently and safely while ensuring that the fish community and supporting habitat is protected." (109)* In the assessment in appendix IV, the authors indicate that "unknown aspects" are present in their sensitivity. They address these uncertain aspects by assigning it a number value to determine if the watercourse is sensitive or if it is non-sensitive and if a screening is necessary. The authors evaluate these aspects through a series of question such as: *"Are there known to be spawning or nursery habitats for warmwater fish within 100m, upstream or downstream of crossing?"(109)* Generally if the answer is positive, the answer is assigned the value of 2 or 3, if the answer is negative, the answer is assigned the value of 0, and if the answer is unknown it is assigned the value of 1. If the level scoring result is superior to 8, the watercourse is sensitive. If the scoring is below 3, the watercourse is non-sensitive. If the scoring was above or equal to 3 but below 8, the company proceeded with the screening procedure. Here, uncertainty is taken into account by performing more screening to reduce that uncertainty. In one case, however, the watercourse *Keillor Creek* is declared as non-sensitive even though the answer to the question "*Are fish known to migrate upstream or downstream of crossing?"* is unknown. In my opinion, uncertainty should be given a higher value than a positive response, as opposed to being less weighted as it is at present. This would assure that uncertainties are fully investigated in all cases. The report states: *"Impacts on fisheries resources will be minimized by adhering to the sediment control plans developed jointly by the company and the provincial regulatory authorities" (114) and "no net loss of fisheries habitat is predicted following the completion of the project" (115).* Hydrological features Same as above. The report states: *"Impacts on hydrological features resulting from pipeline construction will be successfully mitigated with the procedures outlined. Therefore, no residual effects are predicted" (98)* Noise quality and Noise pollution The report states: *"This equipment will adhere*	*requiring erosion control, and the appropriate control measures in these areas. These decisions will be made in conjunction with the Company Chief Inspector. Terms of reference for the monitor will be consistent with those developed for other pipeline projects constructed by the Company."(155)* However, erosion control measures are not disclosed and they do not address any uncertainties. Monitoring is implicitly taken account to address uncertainty found in the potentiality of pipeline leaks: *"Gas pipelines are routinely surveyed to identify potential pipeline leaks or other concerns along the ROW. In addition to lost pressure readings and third party notification, natural gas leaks may be indicated by color changes in the vegetation or active bubble formation in standing water over the line. These changes will be noted and the site inspected for potential leaks."(29)* There is no clear indication of when the gas pipelines will be surveyed and no detailed risk scenario is disclosed.	

	to the appropriate regulatory agency emission standards. Therefore, the ambient air quality objectives will be achieved, and no residual impacts are predicted." (96) Uncertainty is clearly not taken into account. The report add:*" no residual impacts are expected with respect to air quality and noise during construction." (96)* Terrain No residual impacts are mentioned. No uncertainty disclosure. Soils Same as above (no uncertainty, residual impacts are rated not significant) Vegetation Auditing is mentioned (see follow-up programs) but no uncertainty disclosure; (no uncertainty, residual impacts are rated not significant) Sensitive Listed Plants Same as above (no uncertainty, residual impacts are rated not significant) Wildlife Same as above		
6. Liquefied Natural Gas Terminal Project	Poor disclosure of mitigation and contingencies measures. These are highly conceptual. Uncertainty is not disclosed nor addressed. Scientific certainty is used for the rating of residual adverse environmental effects, which are rated for each VEC in a table named *"environmental residual effects summary" (352).* Uncertainty is not part of the criteria that define significance (magnitude, geographic extent, duration frequency, reversibility, ecological/socio-economic context) but is used to assess the likelihood of the residual environmental effects (positive or adverse) for all phases of the project (construction and decommissioning operation; decommissioning and abandonment; accidents, malfunctions and unplanned events; and project overall). In the table the following components are assessed: *"-The likelihood of the residual environmental effect that is composed of:* *The probability of Occurrence based on professional judgment* *1=Low Probability of Occurrence; 2=Medium Probability of Occurrence; 3=High Probability of Occurrence,* *Scientific Certainty based on scientific information and statistical analysis or professional judgment:* *1=Low level of confidence; 2=Medium level of confidence; 3=High level of confidence,* *-The global level of confidence in the residual adverse environmental effect rating that is independently evaluated and rated on a scale of 1-3: 1=Low level of confidence; 2=Medium level of confidence; 3=High level of confidence"(352).* Generally, uncertainty is assessed for all residual adverse environmental effects in all stages of the project, however, certainty is never medium or low for these impacts and the source of these uncertainties is not identified. In addition, more details should be given on how the components of the	Atmospheric Impact Adaptive management is generally mentioned for the management of greenhouse gas emissions but no information about it is disclosed. Uncertainty is not disclosed and cumulative impacts are ignored. But overall, the emissions of greenhouse gas are ignored. *"The Project-related greenhouse gas emissions presented in Sections 2 with the exiting emissions of greenhouse gases from industry in the Assessment Area are small compared to the emissions from industry in the Assessment Area (…), and barely discernible in comparison with New Brunswick and Canadian total greenhouse gas emissions. The addition of these small amounts of greenhouse gases to the atmosphere is not expected to cause a substantive or measurable change in temperature, precipitation, wind, or sea level. While these climate parameters may be influenced by increases in the concentrations of greenhouse gases in the atmosphere, the climate science cannot demonstrate cause-and-effect relationship for emissions from specific projects such as the proposed Project. Adaptive management approaches will be employed for management of greenhouse gas emissions. Therefore, it is anticipated that the Project will not result in any substantive interaction with Atmospheric Environment (Climate) in a way that would result in discernible changes to regional, national, or global climate patterns."(307)* Commercial Fisheries Auditing is suggested for commercial fisheries impacts only (does not address uncertainties): *"Irving will make available to fishers all project information that may relate to fishing on the Irving waterlot for each phase of the Project. If a Fisheries Act authorization is required, follow up monitoring with local fishers may be required. Annual reporting by Irving of project-related claims to damaged fishing gear outside of exclusion zones and vessel traffic lanes may also be required by the Agency. The Canadian Environmental Assessment Act may also require*	Poor disclosure of uncertainty. Uncertainty is not disclosed for any impacts. It is only explicitly disclosed for accident and malfunctions. Follow-up programs are mentioned for all impacts but not disclosed.

	likelihood of the effect (probability of occurrence and scientific certainty) were determined. The authors should specifically disclose what differentiates a low probability of occurrence vs. a medium probability of occurrence vs. a high probability of occurrence. For scientific certainty, the authors state that it is based on scientific information and statistical analysis or professional judgment but it is not further discussed explained. Atmospheric impacts For the atmospheric environmental effects, all residual adverse environmental effects for construction and commissioning operation, decommissioning and abandonment and project overall are rated as non-significant. The level of confidence in these ratings is high. In addition, the likelihood in these non-significant effects has a high level of certainty and a high probability of occurrence. For accidents, malfunctions, and unplanned events, residual adverse environmental effects' rating is significant and the likelihood has a low level of confidence and low probability of occurrence. However, for accidents, malfunctions, and unplanned events the overall level of confidence remains high. For accidents, malfunctions and unplanned events, thresholds and monitoring should be put in place especially when accidental scenarios are known (e.g.: air quality to prevent ignition (307), depletion of oxygen and the sound quality impacts on workers (310). A list of all the accidents, malfunctions and unplanned events that could impact the atmospheric environment is provided in a table with the appropriate mitigation measures that are, as mentioned before, highly conceptual and do not address any uncertainties in particular (340). Groundwater In the residual environmental effects summary table, the residual adverse environmental effects are rated as non-significant for all phases of the projects and the level of confidence is high. For the likelihood of such impacts, the probability of occurrence is indicated as low and scientific certainty as high. Only for the likelihood of accidents, malfunctions and unplanned events, scientific certainty is assigned a medium level of confidence. This medium level of confidence is then completely ignored as scientific certainty is rated as high for the project for overall residual adverse environmental effect rating (non-significant). Marine Environment In the residual environmental effects summary table (437), the low level of confidence and the medium level of certainty in the likelihood of the significant adverse environmental effects on marine resources during accidents, malfunctions and unplanned events are once again ignored. At the end, the residual effects are rated as non-significant for the project overall. Freshwater Fish and Fish Habitat The fish and fish habitat residual environmental effects summary table shows a	*monitoring to confirm predictions of the environmental assessment"(573).* Groundwater Auditing is implicitly mentioned for groundwater quality: "*Where several wells are present within the 500m blast monitoring radius, selected representative proximity wells will be inspected, sampled, and closely monitored during the construction phase. Those wells within the Harbourview and Debly Subdivisions within the 500m blast monitoring radius will be surveyed in order to establish a baseline prior to construction." (377)* It is not clear what the monitoring information will be used for. Auditing is implicitly mentioned for the potential of erosion control failures: *"All construction activities will require inspection and monitoring to ensure that erosion and control structure are appropriately installed, maintained and removed. A one-site monitor (environmental inspector) will be present during construction of all pipeline watercourse crossings and realignment of the Canaport pond outlet creek to ensure that the EPP and Conditions of Approval detailed in the Watercourse and Wetland Alteration Permits are met.* *Follow up is requirement under CEAA. To that end, watercourse crossing and the realigned stream channel will be inspected routinely during the first year of operation to ensure that permanent erosion and sedimentation control measures are successful."(473)* Nothing is disclosed for the case where sedimentation control measures are not successful. Terrestrial and Wetland Environments Adaptive management is also implicitly considered for impacts on wetlands: results of the follow-up plan for wetlands for the Orimulsion pipeline could lead to*"possible changes to construction practices, if the planned techniques, identical to those planned for the natural gas pipeline installation, did not work" (512).* Generally for all impacts A follow-up program is mentioned for both impact prediction and mitigation measures. The follow-up program is not disclosed: *"Irving will provide the finalized Follow-up Program plan […] 60 days before the start of the construction."(944)*	

	low level of confidence for accidents, malfunctions and unplanned events effects and a medium level of certainty for the likelihood of these effects. The probability of occurrence is indicated as low for these effects. Uncertainty is ignored. Terrestrial and Wetland Environments The residual environmental effects summary table shows that all residual adverse effects are rated as non-significant. The level of confidence is high for all phases of the project and the likelihood is low with a high level of certainty. Migratory Birds The residual environmental effects summary table shows a medium level of confidence for accidents, malfunctions and unplanned events effects and a medium level of certainty for the likelihood of these effects that are rated as significant. The project's overall residual environmental effects on migratory birds are rated as non-significant. Commercial fisheries The residual environmental effects summary table shows a medium level of confidence for accidents, malfunctions and unplanned events effects, and a medium level of certainty for the likelihood of these effects that are rated as significant. The project's overall residual environmental effects on commercial fisheries are rated as non-significant.		
7. Lower Churchill Hydro electric Generation Project	In contingency plans, uncertainty is expressed using the term "unplanned occurrences". *"Contingency plans to address unplanned occurrences and emergency situations are provided in the following sections. The following unplanned occurrences and emergencies have been addressed under contingency plans: Fuel and Hazardous Material Spills (Master Spill Response Plan); Wildlife Encounters (including nesting and denning sites); Historic and Archaeological Resources and Forest Fires (ERP)" (171).* *"In case of a fuel or hazardous material spill project staff shall refer to the Master Spill response Plan for detailed contingency measures" (172).* The Master Spill Response Plan is not disclosed. The same is true for the case of forest fire: *"In case of a forest fire project personnel shall refer to the Emergency Response Plan for detailed contingency measures*"(174). The Emergency Response Plan is not disclosed. Environmental Protection Plans are not disclosed. E.g.: for air quality:*"Nalcor's proposed mitigation measures and monitoring related to air quality included the following: incorporate in an Environmental Protection Plan measures to reduce dust and vehicle emissions from construction activities. Implement measures equivalent to those contained in "Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities", as recommended by Environment Canada; and monitor ambient air quality and deposition of dust at the edge of buffer zones with annual reporting, if required by government regulators."(50)* Atmospheric impact-Climate Change -Uncertainty is mentioned regarding Climate	Atmospheric impacts: Monitoring, follow-up and adaptive management are specifically used to address uncertainty about the extent of the effects and the effectiveness of mitigation measures (auditing is ignored): "*While the atmospheric effects of the Project, such as effects on air quality, greenhouse gas emissions, and noise are not likely to be significant, the environmental assessment raised a number of important issues that require ongoing monitoring. Furthermore, there is still some uncertainty about the extent of the effects and the effectiveness of mitigation measures. The Panel has therefore considered the need for ongoing monitoring, reporting, follow-up and adaptive management with respect to atmospheric issues." (59)* Aquatic environment-Fish habitat Monitoring, follow up and adaptive management for the aquatic environment is discussed. These are not disclosed in the report. They do not address any uncertainties. However, the authors questioned the effectiveness of the adaptive management measures regarding the fish habitat compensation work. *"Nalcor reiterated that long-term monitoring was crucial to assessing the accuracy of its predictions and to aid in mitigation and adaptive management planning. Nalcor emphasized that the monitoring and follow-up programs proposed during the Panel review process were still at a preliminary stage. Once a decision was made to proceed with the Project, Nalcor would incorporate input from the environmental assessment process into its detailed Project plans." (90)* *"A number of participants questioned whether effective monitoring and adaptive management was feasible and how habitat compensation works could be monitored on such a large scale. They*	Uncertainty is mentioned for many aspects: failures of mitigation measures and even adaptive management. Other measures were proposed: more research, pilot experiment, and precautionary measures to deal with uncertainty.

	Change. This is addressed with monitoring only. *"Given the uncertainty around the scale of climate change effects, the outcome is difficult to predict, thus reinforcing the need for ongoing monitoring"(*93). Fisheries-Mercury effects on fish health -Uncertainty is implicitly recognized by the panel in term of the effectiveness of the mitigation measure of removing soil in the drawdown zone to mitigate mercury effects. To address that uncertainty the panel recommends a pilot study to audit the effectiveness of mitigation measures. Here all these recommendation remain extremely vague. Also the panel recommends a precautionary approach (89) because "no feasible adaptive management measures have been identified to reverse either long-term adverse ecological changes or mercury contamination of renewable resources"(89) *"The Panel recognizes that there appears to be no clear evidence that predicted levels of mercury would adversely affect fish health but questions how much research has been carried out on the effects of mercury on fish health in conjunction with other stresses imposed by reservoir creation projects, and also why Nalcor initially confined its measure of fish health to mercury effects."(71)* *"The Panel concludes that consumption advisories transfer part of the cost of generating hydroelectricity to local populations and it is therefore important to find better approaches to reducing methylmercury in reservoirs. Therefore the Panel believes that Natural Resources Canada should move ahead with testing the mitigative approach of removing soil in the drawdown zone, including determining how to avoid or minimize environmental impacts, and ways to make beneficial use of the materials removed."(71)* *"RECOMMENDATION 6.5 Pilot study for methylmercury mitigation through soil removal. The Panel recommends that Natural Resources Canada, in consultation with Nalcor and, if possible, other hydroelectricity developers in Canada, carry out a pilot study to determine (a) the technical, economic and environmental feasibility of mitigating the production of methylmercury in reservoirs by removing vegetation and soils in the drawdown zone, and (b) the effectiveness of this mitigation measure. The pilot study should take place in a location where the relevant parameters can be effectively controlled (i.e. not in the Lower Churchill watershed) and every effort should be made to complete the pilot before sanction decisions are made for Gull Island. If the results of the pilot study are positive, Nalcor should undertake to employ this mitigation measure in Gull Island to the extent possible and monitor the results."(72)* Terrestrial ecosystem and geomorphological issues -In the proposed mitigation measures and monitoring section, uncertainty is expressed using the word "unexpected". Adaptive management is implicitly disclosed for control measures on the north spur: *"Nalcor's proposed mitigation measures and monitoring related to terrestrial habitats and also questioned what adaptive management measures were realistically available if new habitats did not function as planned." (91)* While the panel recommendation regarding the monitoring program are pertinent (the panel mentions the use of appropriate thresholds and schedule), nothing is disclosed: *"The Panel observes that the main challenges with Nalcor's proposed monitoring program would likely include: Adequacy of the baseline data on which it would be based (noting that Fisheries and Oceans Canada has called for an extensive effort to collect better baseline information in Advance of and during the construction period); Level of effort that would be applied; Setting appropriate thresholds to trigger adaptive management (assuming that measures are available) or compensation; Determining how long monitoring must be carried out, and Maintaining effective oversight- both regulatory and community-based - over many years." (91)* Habitat quality-Water Quality effects Adaptive management is explicitly recommended but not disclosed. The panel explicitly mentions uncertainty about how the ecosystem would respond during the transitional period and how long stabilization would take. The panel also recommends an erosion and sedimentation prevention strategy. *"The Panel concludes that, because of the extent of the change resulting from creation of the two reservoirs and the length of time that water quality would be affected; there is uncertainty about how the ecosystem would respond during the transitional period and how long stabilization would take. This is compounded by the fact that Nalcor has been unable to identify viable adaptive measures to address excessive turbidity or nutrients, with the exception of possibly stabilizing sections of eroding shoreline which the Panel believes would have limited application."(68)* *"The Panel recommends that, if the Project is approved, Nalcor be required to prepare an erosion and sedimentation prevention strategy including the use of 15-metre vegetated buffer areas during reservoir preparation, best practices at all construction and cleared areas, and specified adaptive management measures to be applied should these mitigation measures fail'. (69)* -Change in fish distribution and abundance Adaptive management (explicit but not disclosed) is used to address data uncertainty (implicit) about whether the changed environment, from river to reservoir, in the vicinity of the dams would be likely to affect random fish movements in the area and therefore of potential entrainment. The panel recommends more research (additional samplings to verify both juvenile and adult fish movements) and compensation measures. *"The Panel also notes that turbine-related fish damage contributes to bioaccumulation of methylmercury and to the transfer of methylmercury effects downstream. Evidence was not provided as to whether the changed environment, from river to reservoir, in the vicinity of the dams would be likely to affect random fish movements in the area and therefore of potential entrainment. While adaptive management measures were mentioned, the feasibility of these measures was not discussed. The Panel acknowledges that entrainment losses are not likely to be a serious concern at Muskrat Falls but*	

	geomorphological issues included the following: Conduct additional field investigations to design a seepage control measure on the north spur and revise this measure as necessary; Develop formal draw down procedures for various operating conditions to ensure safe operation of the Project; Regularly inspect and maintain the spur stabilization measures and examine the area for unexpected seepage, piping, ground cracking and any indications of ground instability; Monitor bank recession rates along the lower Churchill River downstream of Muskrat Falls; Conduct stability analysis once the Project is at the detailed geotechnical design phase; Monitor bank erosion within the new reservoirs using remote sensing, direct measurements and real time weather/wave measurements."(95) Habitat quality -The panel expresses uncertainty about the impact prediction regarding the timing of restabilization and its consequences for bank erosion and loss of habitat. However, It is not addressed. *"Participants also expressed concerns about bank erosion and how the resulting loss of habitat would affect wildlife. Fisheries and Oceans Canada stated that because Nalcor used literature values and estimates for the slope stability study rather than using actual soils and overburden data from the Project area, predictions related to the timing of re-stabilization were uncertain, and in other reservoirs bank stabilization had taken up to 30 or 40 years. Other participants expressed concerns that wildlife would be displaced from shoreline habitat during the period of stabilization, possibly to areas where unoccupied habitat might not be available, resulting in population reductions."* (95) The panel concludes in light of the scale of terrestrial habitat that would be inundated by the Project and the permanence of the effect, that the overall loss of terrestrial habitat is significant (96). *"The Panel concludes in light of the scale of terrestrial habitat that would be inundated by the Project and the permanence of the effect, that the overall loss of terrestrial habitat is significant. The Panel concludes that as a result, habitat biodiversity and the overall integrity of terrestrial ecosystems would be affected by the Project, particularly when considered in combination with other developments that have already taken place, the likelihood that there will be further resource extraction development in the area in the future, and the stress imposed on the terrestrial environment as a result of the shifting climate patterns resulting from climate change. The overall loss of terrestrial habitat cannot be mitigated. At best, there are opportunities to ensure that some of the most important services provided by the habitat to be lost would be replaced in the surrounding area."(*96) Riparian and Wetland Habitat -The panel recognized the uncertainty associated with the success of the habitat compensation plans: "The scale of the habitat compensation effort required and the uncertainty associated with	*risks would be higher at Gull Island. Given the depth of the turbine intake species that could be entrained would likely include lake trout, adult brook trout, whitefish and suckers. (…) The Panel recommends that, if the Project is approved, Fisheries and Oceans Canada require Nalcor to take the following steps before receiving a Section 35(2) authorization with respect to potential entrainment losses: (a) carry out further baseline sampling at Gull Island to verify both juvenile and adult fish movements in this area; and (b) prepare a mitigation and adaptive management strategy that establishes thresholds for further action, and identifies what adaptive measures would be taken when, and for what species. The strategy should also address compensation measures should it become apparent that high losses of a specific species are inevitable." (71)* -Change in fish health (fish loss, alteration and compensation) -Adaptive management is mentioned (explicitly but not disclosed) to address the uncertainty (explicit) in the mitigation measures. The panel states that because of these uncertainties the project would result in a potentially irreversible, significant adverse environmental effect to fish habitat and the final fish assemblage in both reservoirs. "*While recognizing the comprehensive nature of Nalcor's compensation plan, the Panel concludes that there is considerable risk that compensation measures would not be as effective as needed for the following reasons: The Project would create a heavy dependency on the success of an ambitious habitat compensation plan; there are considerable uncertainties associated with Nalcor's ability to establish new, stabilized habitats in an environment that would be fundamentally unstable due to ongoing erosion for at least 15 years; New, low velocity, engineered habitats in the main stem would not easily provide the variety of niche habitats that have developed over long periods of time in the existing river and tributaries; Habitat replacement plans did not take into consideration the complex interactions of species and this could lead to unintended and deleterious effects, and adaptive management, should monitoring show that the new habitat was not working effectively, might not be possible." (80)* *"The Panel concludes that because of uncertainty about the effects on fish and fish populations caused by the number and scale of changes in the aquatic environment as a result of reservoir creation, the uncertainty about the effectiveness of habitat compensation, and the risk that at least some of the fish habitat lost would not be effectively re-created, the Project would result in a potentially irreversible, significant adverse environmental effect to fish habitat and the final fish assemblage in both reservoirs."* (*83)* Effects of mercury downstream Adaptive management is also suggested to address uncertainty (explicit) about potential ecological and mercury effects downstream but the panel also recommends to take a precautionary approach to compensate for the failure of adaptive management (implicit). The panel recommends more research too. *"Take a precautionary approach to reduce the uncertainty regarding both the potential ecological and mercury effects downstream."(89)* "*The Panel believes that this emphasizes the need*	

	its success" (99) Basically the panel recommends the development of a detailed wetland and riparian compensation plan (97). This proves that these plans are not explicitly disclosed in the report. To conclude: "*The Panel concludes that the residual adverse effect of the Project on wetlands and riparian habitats, even with appropriate mitigation, is significant." (100)* Rare plants-Environmental Development Plan is not disclosed -Data uncertainty is explicitly expressed and is addressed with careful monitoring: *"In reaching its conclusions on the effects of the Project on rare plants, the Panel considered the following factors to be particularly relevant: The limited information available on the presence of potentially rare plant species; The prediction that climate change will likely gradually extend the northern range of plant species; The presence of species of concern identified by the Department of Environment and Conservation, including rare plants; and the presence of a number of species of particular importance to local Aboriginal and non Aboriginal residents, including Canada yew, berries and sweet grass, amongst other harvested plants. Marsh horsetail and hidden bladderwort should be included in the Environmental Protection Plan as recommended by the Department of Environment and Conservation. The Panel concludes that with appropriate mitigation the adverse environmental effects of the Project on rare plant species are not likely to be significant. Given the somewhat limited information available on rare plants in the Labrador region and the resulting uncertainty in the predictions made about the presence of rare plants in the Project area, the accuracy of the prediction made by Nalcor that rare plants would not be significantly impacted would have to be carefully monitored during the reservoir preparation stage if the Project were to proceed." (102)* Wildlife Mitigation and monitoring measures are vague. Some key information is missing and it is clear that the entire measures are not disclosed. For example, this is one of the mitigation measures: *"Develop protocols to mitigate for disturbance and incidental take and outline how construction would minimize these effects;"(106)* Some of the baseline information seems to be missing too: *"Determine habitat availability and quality outside the Project area for species at risk and the distribution and abundance of species at risk in the Project area;"(106)* The panel recognizes the absence of the mitigation strategies: *"It clearly would have been desirable for all recovery strategies and critical habitat identification to have been completed before the start of the hearing, regardless of when they are required under federal or provincial legislation. Unfortunately, this did not happen. Only the recovery strategies for the harlequin duck and the Red Wine Mountain caribou herd were provided to the Panel. A number of the*	*for a precautionary approach, particularly because no feasible adaptive management measures have been identified to reverse either long-term adverse ecological changes or mercury contamination of renewable resources."(89)* *"The Panel recommends that, if the Project is approved and before Nalcor is permitted to begin impoundment, Fisheries and Oceans Canada require Nalcor to carry out a comprehensive assessment of downstream effects including: Identifying all possible pathways for mercury throughout the food web, and incorporating lessons learned from the Churchill Falls project; Baseline mercury data collection in water, sediments and biota, (revised modeling taking into account additional pathways, and particularly mercury accumulation in the benthos) to predict the fate of mercury in the downstream environment; Quantification of the likely changes to the estuarine environment associated with reduction of sediment and nutrient inputs and temperature changes; and Identification of any additional mitigation or adaptive management measures. The results of this assessment should be reviewed by Fisheries and Oceans Canada and by an independent third-party expert or experts, and the revised predictions and review comments discussed at a forum to include participation by Aboriginal groups and stakeholders, in order to provide advice to Fisheries and Oceans Canada on next steps."(89)* Riparian and Wetland Habitat Implicit auditing for the creation and natural wetland and riparian habitat: "Evaluates their effectiveness", but no information is given on what to implement if that measure is not effective. Uncertainty is not disclosed. Rare Plants For yew plants: adaptive management (explicit) as "appropriate" to address uncertainty that is explicitly expressed: *"limited information resulting in uncertainty in the prediction" (102)*. It shows how vague adaptive management is disclosed. Monitoring is also suggested but vaguely. Birds Auditing is implicitly mentioned for deciduous habitat creation efforts (these are not disclosed), for ashkui formation post-inundation and for mercury level. It is not clear what will be done if these efforts are not successful. *"Monitor deciduous habitat creation efforts to evaluate success and use of such sites by ruffed grouse;"(120)* *"Conduct aerial surveys of the lower Churchill River and surrounding locations to verify ashkui formation post-inundation;"(120)* *"Collect additional baseline data on osprey and otter mercury levels to evaluate impacts post-inundation and evaluate mercury levels before and after Project construction;"(120)* For all terrestrial impacts: Monitoring, follow up and adaptive management are discussed in a separate section for terrestrial impacts to address uncertainty that is explicitly disclosed about the extent of the effects and the effectiveness of mitigation measures: *"The Project, if it should proceed, would result in a range of effects on the terrestrial environment. These effects raise a number of important issues that require ongoing monitoring. Furthermore,*	

	strategies, including those for the common nighthawk, olive sided flycatcher and rusty blackbird, are not required to be completed until after the conclusion of this environmental assessment. The absence of these recovery strategies makes it more difficult for the Panel to assess the impact of the Project on the recovery of these listed species."(109) The panel also recommend a precautionary approach but the text remains vague: *"Should it not be possible to complete recovery strategies and identify critical habitat not required by law before making a project decision, decision-makers should take a precautionary approach. This means decision-makers should err on the side of overestimating the Project's impact on listed species and should assume, unless there is clear evidence to the contrary, that the assessment area includes critical habitat and is otherwise essential to the recovery of the species."(109)* -Uncertainty about the scale of the impacts on the Red Wine Mountain Caribou herd especially in the factors that might be threatening the specie ("highway, habitat fragmentation, climate changes among other ") and that are important for its recovery *"The status of the provincial recovery strategy, and particularly its failure to identify the location of critical habitat, adds to the uncertainty surrounding the possible scale of the impact of the Project on the Red Wine Mountain caribou herd. Based on the imperiled status of the Red Wine Mountain caribou herd and the uncertainty and disagreement over the range of factors that might be important for its recovery, the Panel concludes that any adverse effects of the Project on individual animals within the Red Wine Mountain caribou herd would be significant. Nalcor correctly pointed out that there is sufficient primary habitat outside the area directly affected by the Project. It is nevertheless clear that the Project, if it were to proceed, would pose a variety of risks to members of the herd, including possible displacement, possible increase in animal predation resulting from changes in the predator-prey dynamics and possible road kills from increased traffic, among others. The Panel concludes that in light of the current state of the herd and the cumulative effects on its recovery, the Project would cause a significant adverse environmental effect on the Red Wine Mountain caribou herd."(*117) *"The Panel recommends that, if the Project is approved, the provincial Department of Environment and Conservation ensure that adequate resources are available so that all reasonable efforts to ensure the recovery of the Red Wine Mountain caribou herd are taken. In addition, the Department should require Nalcor to play an enhanced role in the recovery process for the Red Wine Mountain caribou herd by putting resources into the process for research and recovery efforts and to participate actively in the overall effort to ensure the recovery of the caribou herd."(118)* Nothing is disclosed regarding the Red Wine Mountain Caribou Herb mitigation measures. -Uncertainty regarding the George River Caribou: *".The Panel concludes that the effect of the*	*<u>there is some uncertainty about the extent of the effects and the effectiveness of mitigation measures</u>. The Panel has therefore considered the need for ongoing monitoring, reporting, follow-up and adaptive management with respect to terrestrial issues."(126)* Moreover, the report states: *"Develop a detailed mitigation and monitoring plan for all listed species for approval by the provincial Department of Environment and Conservation;"(125)* That proves again that a detailed mitigation and monitoring planning have not been developed for the project. <u>Wildlife</u> Adaptive management is vague (not disclosed) and uncertainty is not disclosed (106).	

	Project on the George River caribou herd in isolation is not likely to be significant. The Panel is not in a position to make a cumulative significance determination because a proper cumulative effects assessment for the George River herd was not carried out and information on the recent decline came too late in the process to allow for proper consideration of its implications for this environmental assessment."(118) No data for cumulative significance determination. Implicit data uncertainty, recognized and epistemic, that is subsequently being ignored. Birds Mitigation and monitoring for impacts on birds are general. They lack specificity. E.g.: "Develop an avifauna management plan with Environment Canada for all species;"(120) The avifauna management plans have not been prepared and best management practices are not disclosed. However, the panel rates the effects on birds as not significant. -Uncertainty about interaction between the project and bird species (explicit). Monitoring and adaptive management (explicit) are recommended but not disclosed: *"The effect of the Project on listed bird species will have to be confirmed once recovery strategies are completed and critical habitat is identified. In any event, there does appear to be sufficient uncertainty about the exact interaction between the Project and these listed species that a careful monitoring program, along the lines of what was proposed by the provincial Department of Environment and Conservation, would be warranted if the Project were to proceed. Given the threatened status of these species, an active adaptive management approach would also be warranted."(123)* -Uncertainty is also mentioned regarding the fact that ashkui will form: This uncertainty is implicitly addressed by disclosing the wost case scenario in which case ashkui will not form. However, theses impacts are ignored: *"the loss of ashkui on terrestrial species is not likely to be significant given the abundance of alternate habitat"(123).* *"The Panel concludes that it is uncertain that ashkui (area of open water) will form as predicted by Nalcor. If ashkui do not re-form as productive habitat, the Panel concludes that it will be a loss in habitat for waterfowl. The impact of the loss of ashkui on terrestrial species is not likely to be significant given the abundance of alternate habitat."(123)* Auditing is also implicitly mentioned. Vegetation management -Uncertainty over long-term effects of exposure of vegetation to herbicides is disclosed (124). To address that uncertainty the panel states that the use of herbicides should be limited to situations where, in the judgment of provincial regulators, there is no reasonable alternative vegetation control method available. Here the provincial regulators are not named and the alternative vegetation control methods are not disclosed. *"The Panel concludes that the use of herbicides should be limited to situations where, in the judgment of provincial regulators, there is no*		

	reasonable alternative vegetation control method available."(124-125) *"The Panel recommends that, if the Project is approved, Nalcor be required to restrict the use of chemical herbicides to areas where alternative vegetation control is not reasonably possible. Approval of the use of herbicides should only be granted after Nalcor has submitted an overall vegetation control plan to the provincial Department of Environment and Conservation, demonstrating that all alternatives have been adequately explored and the use of non-chemical approaches maximized."(125)* Noise No uncertainty disclosure. All impacts are rated as non-significant.		
8. Mackenzie Gas Project	In volume 7 of the EIS, promising guarantees are made in regard to uncertainty consideration. The volume includes: Environmental Management Plans, an Environmental Protection Plan, Contingency Plans and an Environmental Compliance and Effects Monitoring Plan. Generally in these sections, the authors guarantee that measures to address uncertainty disclosure will be established in the future. However, these measures should have been disclosed in the EIS. More research should have been done prior to the EIS in that matter. This is the case for example for the disclosure of: the worst-case scenario for wildlife management in the Inuvialuit settlement region, remediation plans to restore tundra, the emergency reporting protocol for emissions and the environmental effects monitoring program. In all of these cases, a guarantee is made that these programs or plans will be designed only in the future: *"It is expected worst case scenarios will be developed that include each of the three anchor fields and the gathering pipelines located within the Inuvialuit Settlement Region. A description of each scenario, the rationale for its selection and assumptions, and alternatives considered, will be documented." (3-56)* Here, worst-case scenarios should be disclosed for wildlife management in the Inuvialuit settlement region but are not. The authors anticipate that it would be developed, documented and disclosed for the Joint Review Panel. It is not understood why the worst-case scenarios are not directly disclosed in the EIS. Moreover, it is not clear why worst-case scenarios are only considered for wildlife management when environmental management plans have also been prepared for: emissions, water, waste, hazardous materials, transportation and logistics, reclamation and operations. *"The proponents will develop remediation plans to repair tundra if unanticipated damage occurs because of project activities. Representatives of the proponents including reclamation specialists will develop these plans." (5-10)* *"Project facilities will include an emergency reporting protocol within the scope of their emission-monitoring program. This will ensure proper reporting and tracking of uncontrolled*	The Panel Report's recommendations explicitly define methods to address uncertainty. The panel differentiates different types of monitoring: -Compliance monitoring (regular monitoring) -Project impact monitoring (to verify impact predictions and the effectiveness of mitigation measures) -Cumulative impact monitoring (continuous process to determine cumulative impacts) Here we are particularly interested in project impact monitoring that *"must be able to address uncertainty and surprise to much greater extent than compliance monitoring"* (553). However, the panel does not address any particular uncertainties from the impact prediction sections. In the EIS: The Mackenzie Gas Project monitoring program is anticipated but not disclosed: "*An environmental effects monitoring program will be designed to meet the following objectives:* *-Complying with the conditions in permits, authorizations and approvals, which are related to environmental effects* *-Confirming the effectiveness of approved mitigation measures* *-Verifying the accuracy of impact predictions made in the Environmental Impact Statement* *-Identifying any effects not predicted in the Environmental Impact Statement" (6-14 in Section 6: Environmental Compliance and Effects Monitoring Plan)".* While uncertainty is not a criterion that defines significance; according to the panel it should be and therefore uncertainty could possibly be taken into account indirectly thought the monitoring of areas of concern: *" The Panel observes that disagreement amongst the participants arose from uncertainties relating to: Limited information about the nature and location of reasonably anticipated development beyond the Project as Filed; The reliability of predicted impacts of the Project, especially cumulative impacts; The effectiveness of proposed mitigation measures; and the adequacy of monitoring and adaptive management plans. The Panel has approached the issue of uncertainty and the application of a precautionary approach mindful of the following considerations in determining whether the Project could result in serious or irreversible damage and in the consideration of tradeoffs between positive and negative impacts:*	In the EIS, using conservative estimates especially when addressing data uncertainty is a good approach but more details are needed in that matter (how conservative estimates were determined, how often were they used?) It seems that the use of conservative estimates throughout the report is respected. However, it seems that this is used as an excuse for not disclosing other potential effects. At the end, effects are overestimated and the effect is expected to be lower. The effects that might be less than these peak estimates are ignored. The overestimation is still used as a worst-case scenario but is not addressed in any way. At the end all the effects are not significant and even when the worst case scenario is considered for the significance of all effects, they are still non-significant

	emission released during normal facility operations, as specified in regulatory permits." (3-5) Here, the remediation plans and the emergency reporting protocol should be disclosed, but they are not. It is understood that the objectives of the environmental effect-monitoring program can only be reached in the future: *"An environmental effects monitoring program will be designed to meet the following objectives:* *-Complying with the conditions in permits, authorizations and approvals, which are related to environmental effects* *-Confirming the effectiveness of approved mitigation measures* *-Verifying the accuracy of impact predictions made in the Environmental Impact Statement* *-Identifying any effects not predicted in the Environmental Impact Statement" (6-14).* *"Monitoring environmental effects allows for the testing of impact predictions and hypotheses, which can be used when conducting future assessments and developing environmental protection plans." (6-14)* *"The environmental effects monitoring program will use knowledge gained through the environmental assessment process. This knowledge is based on traditional knowledge and baseline information collected from the project area." (14 in Section 6: Environmental Compliance and Effects Monitoring Plan)* *"Valued components and key indicators have been selected and will be used in the design of the effects monitoring program. The results of the impact assessment will be used to:* *-Identify environmental effects that have the potential to be significant* *-Identify effects for which there is a high degree of uncertainty.* *Environmental effects monitoring will also identify effects that may not have been predicted in the EIS." (6-16)* *"A database will be put in place to track the status of issues addressed during post-construction monitoring."(6-15)* In that section: "Unforeseen" is used to express uncertainty. If completed correctly, the environmental effects monitoring effects will be able to identify the uncertain aspects of the environmental predictions and directly address them. It will also reduce uncertainty in future projects and reinforce future environmental protection plans. Here, uncertainty is disclosed and recognized but only in a general way. No uncertainties are clearly identified. In addition, the design of the environmental effects monitoring program (e.g. how long and costly it will be) should be disclosed in the EIS. Overall, the authors should simply disclose: "*The valued components and key indicators, the environmental effects that have the potential to be significant and the effects for which there is a high degree of uncertainty"(6-16)*. But this is not done, even though the EIS was completed and that the necessary information is available. The environmental effects monitoring program is highly	*• The novelty of Project interaction in the receiving environment, and the proven or likely effectiveness of the Proponents' designs, management plans and mitigations in that environment;* *• The degree of uncertainty about potential positive and negative impacts;* *• The magnitude and duration of potential impacts and the extent to which they might be irreversible; and* *• The extent and scale at which potential impacts could impair biological productivity, ecosystem health, local and regional capacities and community well being.* *The Panel accepts that a precautionary approach requires that:* *• Uncertainty is an explicit factor in significance determination;* *• The implications of uncertainties for decision making are explicitly considered; and* *• Greater emphasis on monitoring and adaptive management is required."(95)* The Mackenzie Gas Project planned to have an auditing program but it is not disclosed in depth in the EIS. The objectives of such program is to comply with: *"The conditions in permits, authorizations and approvals, which are related to environmental effects, conforming the effectiveness of approved mitigation measures, verifying the accuracy of impact predictions made in the Environmental Impact Statement and identifying and effects not predicted in the Environmental Impact Statement" (6.3.4.1).* *"A database will be put in place to track the status of issues addressed during post-construction monitoring"(6-15 in Section 6: Environmental Compliance and Effects Monitoring Plan).* The Review Panel report of the Mackenzie Gas project describes on page 97 the components to adaptive management. The Report of the Review Panel describes adaptive measures to address uncertainty extremely well. However, in the Review Panel report uncertainties in impact prediction are still not identified but are discussed as s general concept. Great guidance but lack of implementation.	

	conceptual. The contingency plans sound promising. They describe procedures to be implemented in the case of unforeseen events during construction, drilling and operations. The authors also foresee to modify contingency plans in case of new evidence: *"If during the Design and Construction Phase, the proponents learn of additional concerns, they will either modify an existing contingency plan or develop a new plan, as required." (5-1)* In the EIS: only general contingency plans have been developed for the report (no details on the budgets, quantity of substances released in the environment etc.) 9 contingencies are described. Similarly to the other reports, the contingency plans are not disclosed in depth. For example: *"If a spill of a substance occurs, the first person on the scene will:* *-Do an initial assessment to identify imminent danger* *-Identify the material spilled and verify the nature of the hazard using Material Safety Data Sheets, and implement applicable safety procedures" (5-2 in Section 5: Contingency Plans)* *"When notified of a spill, the proponents' representative will immediately ensure that:* *-Action is taken to control danger to human life and the environment" (5-2).* Here, the vague references "initial assessment", "applicable safety procedures" and "action is taken" are good example of what "conceptual" means here. No specifications are given. This is the same for mitigation measures. In the Review Panel Report, mitigation measures still need to be developed prior to the start of the project. For e.g. For the Air Quality and Emission Management Plan, the report sates: *" The Air Quality and Emissions Management Plan should include, but not be limited to: a description of the best available technology to be implemented at each facility or, if best available technology is not proposed, evidence that a different technology standard will in fact enable the Mackenzie Gas Project to meet comparable goals; a description of the best management practices to be implemented at each facility and the Proponents' proposed continuous improvement efforts, including plans or strategies to prevent unnecessary vehicle idling and mitigate dust within and outside communities; an emissions tracking and monitoring system, including emissions reporting that is legally required (e.g. the National Pollutant Release Inventory); a commitment to reassess environmental impacts, in consultation with Environment Canada and the Government of the Northwest Territories, should significant changes occur to quality and quantity of existing facility emissions sources and new sources to be added to the Mackenzie Gas Project; an ambient Air Quality Monitoring Program including, but not necessarily limited to, passive nitrogen dioxide monitoring; and procedures for publicly available annual reporting."(204)* After Volume 7, uncertainty is mostly likely to		

	be found in the Environmental Assessment Method Section (Volume 1 section 2). The section describes the general assessment method used to predict the potential effects of the project on biophysical and socio-economic environments. *Factors Affecting Prediction Certainty* are listed page 2-29 of the section: *"The description of effects provided in the EIS is based on available information and the current understanding of natural and social processes to predict future events. As with all predictions, those in the EIS are associated with a level of certainty. Certainty can be related to several factors, including:* *-Degree of understanding of project activities and other human activities, such as: How well do we understand when, where and how project activities will occur? ; When, where and how did, or will, other human activities occur? ; How will these activities interact with the project's activities?* *-Quality of data about the environment, i.e., how accurate is the data used in the analysis?* *-Variability of the data, i.e., how consistent is the data?* *-Degree of errors in handling data, i.e., what is the potential for generating errors?* *-Capability of models to predict, i.e., how accurately does the model predict effects?* *-Degree of understanding of ecological processes, i.e., how well do we understand what is happening to the valued component?* *-Success of proposed mitigation and optimization, i.e., how effective will the proposed mitigation be?* *Prediction certainty influences the possibility of error in the effects prediction, and is addressed in the EIS by taking a precautionary approach" (2-29).* Here, the authors distinguish the different aspects of uncertainty. Epistemic uncertainty (due to the imperfection of our understanding of processes) is expressed by the *degree of understanding of project activities and other human activities, the degree of errors in handling data, the capability of models to predict* and the *degree of understanding of ecological processes.* Stochastic uncertainty (due to the environmental, societal, and technological processes themselves) is expressed by the *quality of the data about the environment,* the *quality and variability of the data about the environment.* The *success of proposed mitigation and optimization* can be considered to be both epistemic and stochastic. Here, we can also distinguish context uncertainty: *degree of understanding of project activities and other human activities* and the *degree of understanding of ecological process;* model uncertainty: the *capability of models to predict,* data uncertainty: the *quality and variability of the data about the environment* and the *degree of errors in handling data.* Finally, bias uncertainty can be found in: the *degree of errors in handling data,* the *degree of understanding of project activities and other human activities,* the *degree of understanding of ecological process* and the *success of proposed mitigation and optimization.* Here the degree of disclose of uncertainty is high. Uncertainty is explained and/or discussed to some degree. Theoretically,		

	uncertainty in the impact prediction sections will be addressed using a precautionary approach (their approach does not consider the burden of the proof). *"To ensure that the EIS does not under-predict effects, a precautionary approach was applied. The precautionary approach requires that where threats of serious or irreversible damage exist, lack of full scientific certainty will not be used as a reason for postponing cost-effective measures to prevent environmental degradation (Government of Canada 2001). For example:* *-Even though an effect might be uncertain, it is still assumed likely to occur. For example, in the wildlife impact assessment, noise is assumed to affect wildlife, even though wildlife might tolerate the noise or habituate to it. Wildlife monitoring programs will consider noise as a potential effect (see Volume 7, Environmental Management).* *-Values that exceed guideline levels are assumed to have a high effect, even though receptors might not be affected. For example, infrequent values of short duration that exceed water quality guidelines are unlikely to affect environmental receptors, but are still classified as a high-magnitude effect. Because of uncertainties in predicting project effects, programs will be established throughout all stages of the project, to monitor for effects and provide a basis for adjustments to environmental management actions." (2-30)* In Volume 1 section 2, worst-case scenarios are also quickly mentioned: *"The EIS addressed the effects on the biophysical and socio-economic environment that might result from potential project incidents and malfunctions, including reasonable worst-case scenarios. Examples of incidents and malfunctions that could occur include: Hazardous material spills on land, ice and water; Fires; Transportation incidents; Rupture or failure of a pipeline; Failure of components at a compression or conditioning facility; See Volume 7, Environmental Management for the contingency or response measures for incidents."* (2-35) However, worst-case scenarios are not disclosed in Volume 7. Here, the challenge is to verify the extent to which uncertainty is disclosed and addressed the impact prediction sections. Because factors affecting prediction certainty are given, it is expected that these will be discussed in more details in the impact prediction sections and that uncertainty will be addressed by implementing precautionary measures. Uncertainty is not part of the attribute that determinate the significance of the residual impacts. For each environmental impact, uncertainty is explicitly generally recognized and prediction confidence is discussed in a separate section for each environmental sectors. Air Quality and Noise -Uncertainty about air quality and noise impact predictions-Confidence is high because conservative estimates were used to address data and model uncertainties. The authors guarantee that the level of confidence in the impact prediction is high and that the effects will be less than predicted. Uncertainty is		

	generally discussed in the "prediction confidence" sections (2-92, 2-107, 3-65 and 3-66). *"Available information and understanding of air quality are used to provide predictions of the effects of the project on air quality. As with all predictions of future conditions, the predictions in the impact assessment have a level of uncertainty"* (2-92). *"In all cases, there is a high degree of confidence that effects will be less than predicted because, where data is uncertain, a conservative approach has been applied in developing the effect assessment"* (2-92) *"The high degree of confidence in the air predictions is because: 12 months of ambient monitoring data collected outside Inuvik and in Norman Wells confirmed earlier expectations of low background air concentrations in the production area and along the pipeline corridor; Modeling used three comprehensive five-year meteorological datasets, ensuring the range of meteorological conditions over the project area was represented; Emission values used in the models were calculated based on peak operations with all equipment operating at maximum capability. This conservative assumption ensures that actual emissions and expected would not be underestimated; and dispersion modeling used the CALPUFF model to predict the parameters presented in the assessment. This model provides accurate predictions of ground-level concentrations and deposition values"* (2-92). -Same for greenhouse emissions: *"Available information and understanding of the project components are used to predict the project's contribution to greenhouse gas emissions. As with all predictions of future conditions, the predictions in the impact assessment have a level of uncertainty. The prediction confidence in the effects related to greenhouse gas emissions is high because the likely emissions will be less than predicted. The potential contribution of the project to greenhouse gas emissions was calculated based on peak operations, with all equipment operating at full capacity. Actual operations will likely be at lower level and result in lower emissions."* (2-107) -And noise level: *"Available information and understanding of noise are used to predict effects of the project on noise levels. As with all predictions of future conditions, the predictions in the impact assessment have a level of uncertainty. The conservative computer noise models used in the analysis attempt to account for meteorological conditions, including downwind propagation and the effects of a mild temperature inversion, which contribute to worst-case noise propagation. These conditions would not occur often. The models have a published accuracy of ± dBA over the source-receiver distances in question, which is considered excellent accuracy for an environmental noise model over such a large distance. The models depend on the accuracy of sound level data used in the analysis. Standard sound emission data was used wherever possible. Conservative estimates were applied when specific data was not*		

	available. Because of the conservative approach used to predict sound levels, there is a high degree of confidence in the assessment of effect significance."(3-65 and 3-66) Environmental residual effects are fixed from peak operations; all effects are rated as not significant. These peak operations do not address any uncertain aspects in particular. In addition, it seems that peak operations are always the standard of reference and that therefore other effects that have a lower magnitude than the peak operations are simply not taken into account. This is the case for the air and noise effects associated with construction activities: *"The air quality assessment focused on effects from project emissions at peak operations. Effects associated with construction activities are not addressed in this assessment because they: Will be lower magnitude that those of peak operations; Will be localized; Will occur over a brief period." (2-3 and 2-4)* *"The air emissions during construction were not quantified or assessed because they were determined to be small compared with the emissions during peak operations. The primary constructions emissions will be dust generated from borrow sites, pipeline construction and vehicle movements along unpaved roadways. Such emissions are intermittent and likely to have effects that will be highly localized, short duration and low magnitude."(2-22)* *"Potential effects of activities such as vehicle movement and operation camps, including waste incineration, are likely minor compared with potential effects of operating facilities are therefore not assessed. This included the construction camps that will be potential sources of air emissions from space heating and from the incinerators used to manage wastes. Air effects from these sources would be limited to the immediate vicinity of the camps and of lower magnitude than effects during peak operations" (2-83).* *"Greenhouse gas emissions from construction would be minor compared with the GHG emissions from peak operations and were not carried through the assessment" (2-95).* *"Construction noise is usually exempt from environmental noise impact assessments. Construction noise can be high magnitude, but it is often short duration. For this reason, construction noise is exempt from most noise impact assessment guidelines." (3-10)* Fisheries -Uncertainty about the effects of subsidence from reservoir depletion at Niglintgak and Taglu and its resulting effect on habitats used by freshwater and brackish water species in the future results in a moderate level of certainty about the expected effects. To address that uncertainty a precautionary approach was applied. While no details are given in that regard. General guidance on the precautionary principle is given. *"Available information and an understanding of fish species, their habitat requirements and their expected responses to project-related activities are used to predict the effects of the project on VCs. As with all predictions of future conditions, the predictions in the impact assessment have a level of uncertainty. Prediction confidence for effects of the*		

	gathering system and pipeline corridor and infrastructure is high. The effects of these project components are low magnitude and short term, and a variety of mitigation measures are available. Confidence in predictions of the effects of Niglintgak and Taglu development is moderate, whereas prediction confidence for the Parsons Lake field is high. Uncertainty about the effects of subsidence from reservoir depletion at Niglintgak and Taglu and its resulting effect on habitats used by freshwater and brackish water species in the future results in a moderate level of certainty about the expected effects. Provided that proposed mitigation measures are implemented, there is a relatively high degree of confidence that effects will be less than predicted because where data is uncertain, the precautionary principle has been applied in developing the effects assessment (see Volume 1, Section 2, Assessment Method). As a result, there is a high degree of confidence in the determination of significance." (7-187) The Precautionary Principle is defined. However, the burden of the proof is not mentioned. *"A precautionary principle was applied to ensure that the EIS does not under-report potential effects. The precautionary approach requires that where there are threats of serious or irreversible damage, lack of full scientific certainty will not be used as a reason for postponing cost-effective measures to prevent environmental degradation (Government of Canada 2001). Examples include: Where it is uncertain if an effect will occur, it is assumed likely to happen. For example, if features in the area affected by the project indicate that a channel is suitable for spawning by any of the VECs; it is assumed that spawning habitat could be affected; and any value that exceeds guideline levels is assumed to have a high effect, even though guidelines can be highly protective of the environment and a receptor might not necessarily be affected. For example, infrequent values exceeding water quality criteria for fish are unlikely to adversely affect fish but are viewed as a high effect. In response to uncertainties in the prediction of project effects, programs will be established throughout all stages of the project to monitor effects and to provide a basis for adjusting environmental management actions" (7-187 and 7-188)* Here vague references include: "*Examples include", "In response to uncertainties in the prediction of project effects, programs will be established throughout all stages of the project to monitor effects and to provide a basis for adjusting environmental management actions*" Hydrology, Groundwater and Water-Groundwater - Uncertainty is explicitly recognized for the distribution of karst systems force. No efforts are made to reduce or address that uncertainty. *"Available information and an understanding of hydrogeological processes were used to predict effects of the project on groundwater. As with all predictions of future conditions, the*		

	predictions in the impact assessment have a level of uncertainty. The prediction confidence for effects on groundwater associated with the production area, gathering system and production area infrastructure is high. The effects associated with project components in these areas are local in extent and sufficient mitigation measures are available to ensure the effect magnitudes remain low. The prediction confidence for effects associated with project components in the pipeline corridor and pipeline infrastructure is moderate. Although the interaction between karst systems and project components is expected to be low because the project includes only surface structures or shallow disturbances, uncertainties related to the distribution of karst systems force a moderate rating on prediction confidence for effects in these areas."(4-61) Hydrology Prediction Confidence is discussed for different aspects in the hydrology section: -For the significance of effects of runoff, drainage pattern and water level and velocity: confidence is high as conservative estimates were used however the fact that the hydrologic data is "sparse" is not addressed. Nothing is done to address that data uncertainty (implicit) *"The prediction of significance of effects on runoff, drainage pattern and water level and velocity is based on an assessment of the quality of available data, degree of conservatism in modeling assumptions, understanding of the processes and effectiveness of mitigation measures. Hydrologic data for flow and water level, available for use in the impact assessment, though sparse, was of good quality. The regional analysis, based on the available data, provided a reasonable characterization of the hydrology of basins affected by the project. The effect assessment on runoff was based on conservative estimates of runoff coefficients for disturbed lands. The diminishing impact on runoff as disturbed lands stabilize and are reclaimed over time was not accounted for in the effect assessment and hence the assessment is conservative. Effects that would likely be considered non detectable to minimal were classified as low, in keeping with the precautionary principle. Mitigation measures being considered for reducing the effects of the project on runoff and drainage pattern are common in engineering practice and are known to be effective. The degree of confidence in the conclusion that effects on runoff and drainage pattern are not significant is therefore high." (5-99)* Mitigation measures are not disclosed directly and are "*common in engineering practice and are known to be effective*". The precautionary principle is mentioned but no precautionary measures are disclosed specifically. -Uncertainty (implicit) about impact prediction about effects on water velocity in the delta regarding the delta area (complex environment and lack of data on channel geometry)-Implicit. At the end, confidence is rated as moderate. Again, the precautionary principle is generally mentioned but no measures are specifically disclosed. At the		

	end, uncertainty (overall confidence in the conclusion that effects on water velocity in the delta are not significant is moderate) is not addressed. *"The effect assessment on water levels in delta channels and on flood levels on land in the delta, resulting from land subsidence associated with resource extraction, was based on a qualitative review of the hydrologic and geomorphic processes operating in the area. Historical data on channel geometry, though sparse, was also examined. The delta is known to be an area with high flow and sediment throughput, where noticeable changes in channel geometry occur annually. Changes in long-term water levels resulting from gradual land subsidence in such a complex and dynamic environment can be difficult to detect. Morphologic changes in the delta, such as channel creation and abandonment, take place over shorter time spans, perhaps decades, in such an environment compared with much longer time spans in mature and nondeltaic river systems. Nevertheless, the effects resulting from the project were qualitatively rated low to moderate in keeping with the precautionary principle. Therefore, the degree of confidence in the conclusion that effects on water level and velocity in the delta are not significant is moderate" (5-99).* -Data uncertainty (implicit) about the impact prediction is addressed here by using conservative estimates but this is not discussed in depth. Also more details on mitigation measures should be disclosed. At the end, moderate to high degree of confidence in the conclusion that the effects on sediment concentration are not significant. This is not addressed. *"The prediction of significance of effects on sediment concentration in waterbodies is based on an assessment of the quality of available data, degree of conservatism in modelling assumptions, understanding of the processes and effectiveness of mitigation measures. Only a limited amount of information on sediment concentration and its regional variability in waterbodies was available for use in the effect assessment." (5-143)* *"Therefore, the assessment was based on conservative estimates of erosion rates and sediment delivery factors to calculate sediment yield from disturbed land. These estimates were based on literature values from regions receiving higher precipitation amounts. The diminishing impact on sediment yield as disturbed lands stabilize and are reclaimed over time was not accounted for in the effect assessment and hence the assessment is conservative. Effects that would be considered non detectable to minimal were classified as low to moderate magnitude in keeping with the precautionary principle. The mitigation measures under consideration for reducing the effects of the project on sediment yield, and ultimately on sediment concentration, are common in engineering practice and are known to be effective. The degree of confidence in the conclusion that the effects on sediment concentration are not significant is therefore moderate to high." (5-143)*		

	-Uncertainty (implicit) about impact prediction significance of effects on channel morphology: Uncertainty about impact prediction regarding information on hydraulics and sediment transport (baseline information on hydraulics and sediment transport in delta channel is limited or lacking). Qualitative assessment was used that result in moderate confidence for these effects. Uncertainty is not addressed. "*The prediction of significance of effects on channel morphology is based on an assessment of the quality of available data, degree of conservatism in modeling assumptions, understanding of the processes and effectiveness of mitigation measures, changes in stream flow, water level and velocity, and sediment concentration will have an effect on channel morphology. The assessment of effects on these key indicators (KIs) concludes that the effects are not considered significant. The degree of confidence in these predictions ranges from moderate to high. The degree of confidence in significance determination for the KIs tends to be higher for streams along the pipeline route, where the assessment was more quantitative, and moderate for effects in the delta where the assessment was of a more qualitative nature. The magnitude of effects of the project on channel morphology for streams along the pipeline route was rated as low. Changes in channel and lake morphology resulting from gradual land subsidence, increasing erosion of channel banks and modifying lake shorelines in the complex and dynamic environment of the delta can be difficult to detect. Baseline information on hydraulics and sediment transport in delta channels is limited or lacking, which makes a quantitative evaluation of morphologic processes difficult. The assessment was therefore necessarily qualitative."(5-161)* Water Quality -Uncertainty is generally discussed in the prediction confidence section. The authors take a conservative approach to uncertainty. Data uncertainty (explicit) can be identified for historical baseline data, lake hydrology data and the calculation of critical loads. *"As with all predictions of future conditions, predictions in the impact assessment have a level of uncertainty. Prediction confidence is a function of several factors: Available information on details of the project; Data availability and data quality; Understanding of chemical and biological processes that operate in the study area and the effects of stressors on the environment; Level of conservationism applied in the assessment; Effectiveness of mitigation measures to be applied during the project. The assessment addressed uncertainty by being more conservative in predicting effect attribute as uncertainty increased, and by specifying measures to ensure that effect attribute would not be worse than predicted. Provided that proposed mitigation measures are implemented, there is a relatively high degree of confidence that impacts will not be greater than predicted Project details regarding air emissions were sufficient for quantitative modelling of acid deposition rates. The understanding of the chemical process associated with acid deposition is well known. Although the historical baseline data is*		

	of low spatial resolution and unknown quality in some cases, the data summarized for 122 lakes and field water quality data collected along the pipeline yielded information that is consistent and indicates a low level of acid sensitivity in the production area and along the pipeline corridor. There is uncertainty in lake hydrology data used to calculate critical loads of acidity and the calculation of critical loads is subject to uncertainty. However, both acid deposition modelling and the calculation of critical loads were based on conservative assumptions to account for this uncertainty. Therefore, the confidence in the prediction of no significant effects on water quality from acid deposition is high. Confidence in predictions of the effects of wastewater discharges is based on the ability to manage effects on water quality through selection of appropriate treatment methods and receiving waterbodies. The effectiveness of various wastewater treatment methods is known and can be controlled through design. Effects of the types of wastewater that could reach surface waters are known and can be characterized using established methods. Once project details are available, detailed assessments can be conducted to ensure the receiving waterbodies are appropriate and effects on water quality are no greater than predicted. Therefore, based on the ability to manage effects from wastewater releases, the confidence in the prediction of no significant effects from wastewater releases on water quality is high."(6-66 and 6-67) -Uncertainty about the overall significance of effects on water quality from sediment releases (moderate confidence): not addressed. *"Effects on water quality related to sediment releases from land disturbance, potential dredging, barge traffic and watercourse crossings were predicted based on conservative predictions of TSS and understanding of chemical processes associated with sediment releases. Predictions of sediment inputs to water bodies were based on modeling using conservative assumptions and accounted for the known effectiveness of mitigation measures to be applied during project-related activities. Effect magnitudes were assigned based on current understanding of chemical processes associated with sediment inputs to water bodies. Therefore, the confidence in the prediction of no significant effects on water quality from sediment releases is moderate." (6-66 and 6-67)* Soil and Terrain Soils, Landforms and Permafrost -Uncertainties are disclosed about impact prediction related to soil conditions is addressed with precautionary measures and conservative estimates. *"Available information and understanding of landforms were used to provide an assessment of significance of the effects of the project on ground stability and uncommon landforms. Predictions of future conditions, in the impact assessment have an associated level of uncertainty. Prediction confidence for significance related to ground stability and uncommon landforms is high, mainly because*		

	the precautionary principle has been applied in developing the effects assessment (see Volume 1, Section 2, Assessment Method). Where available data and uncertainty about the locations of some project facilities existed, conservative parameters and conditions were used to assess the significance of expected effects. Similarly, simplified models used in the assessment relied on conservative assumptions and were applied to ranges of parameters to determine the accuracy of the assessment. Confidence in the effectiveness of mitigation, especially related to the effects on permafrost, is high, based on using proven techniques in other locations under similar conditions" (p.8-78) *"Available information and understanding of soil quality were used to provide an assessment of the significance of the effects of the project on soil quality. Predictions of future conditions in the impact assessment have an associated level of uncertainty.* *Prediction confidence for significance related to soil quality is high, mainly because the precautionary principle has been applied in developing the effects assessment (see Volume 1, Section 2, Assessment Method).* *Where available data and uncertainty about locations of some project facilities existed, conservative parameters and conditions were used to assess the significance of expected effects. Similarly, simplified models used in the assessment relied on conservative assumptions and were applied to ranges of parameters to determine accuracy of the assessment." (8-145)* Vegetation and Wetland -Data uncertainty about rare plants and vegetation communities in the prediction confidence sections. Mitigation measures uncertainty about the reestablishment techniques for specific rare plants. These uncertainties are addressed with a precautionary approach but no details are given on its implementation. *"Available information and an understanding of vegetation is used to provide predictions of project effects on vegetation types of concern, vegetation communities of concern, rare plants, and traditionally used species and collecting sites. As with all predictions of future conditions, the predictions in the impact assessment have an associated level of uncertainty.* *Prediction confidence varies from moderate to low. The assessment is conservative and effects are likely to be less than predicted where data is uncertain. To address uncertainty, the precautionary principle has been applied in developing the effects assessment (see Volume 1, Overview and Impact Summary). As a result, there is a high degree of confidence that effects will be less than predicted. Prediction confidence is affected by: Incomplete vegetation mapping in LSAs; Lack of information about rare plants and vegetation communities of concern in the Northwest Territories; Quality of available mapping; Lack of information about traditionally used plants and collecting areas. Confidence in mitigation effectiveness is moderate to high with the exception of rare plants. There is very limited information on re-establishment techniques for specific rare*		

	plants. Because the precautionary approach has been used to develop effects attributes, there is a high level of confidence in the significance determination." (9-120) -Uncertainty is mentioned regarding nitrogen deposition; vegetation is sensitive to nitrogen; monitoring of vegetation is recommended. *"Nitrogen deposition is expected to exceed critical loads at the Little Chicago compressor station. Nitrogen deposition can lead to: Changes in species composition; Decline in plant species diversity; Loss of rare and uncommon species; Sensitive vegetation might be affected in a small area southwest of the compressor station (see Figure 9-10 and Table 9-42, shown previously).* *Table 9-42 presents two critical loads for nitrogen deposition, the WHO estimate, which is a maximum load and depends on the sensitivity of each vegetation type, and the UNEP estimate, which is an aerial load averaged over a 40,000-ha area. The aerial load indicates that nitrogen levels are low in the air quality LSA. Nitrogen deposition will, however, exceed the WHO critical loads. Within the 8.4-ha isopleth, vegetation that is sensitive to nitrogen deposition could be affected if maximum nitrogen deposition occurs. The entire area within the isopleth is not likely to be affected. There is some uncertainty with this prediction. The WHO critical loads are based on European ecosystems and might not be accurate for the Canadian Arctic. Vegetation monitoring will be done to determine if changes in vegetation are occurring because of nitrogen deposition.* *The magnitude of effects is low. Vegetation affected throughout operations could take several years after to stabilize, so duration is long term. If nitrogen deposition affects nutrient cycling, the resulting mature vegetation type might be different from the original type." (9-151)* Wildlife -Uncertainty about mortality rates: *"The question of habitat availability has the strongest foundation of quantifiable data. Hence, prediction confidence can be better evaluated than in the questions on movement and mortality. As to movement, some large scale movements and migrations of wildlife VCs are known and effects of the project on them are predicted based on past industry experience in similar environments. <u>However, detailed knowledge on local movements is currently limited, affecting the strength of the predictions. As information on local mortality rates is low, mortality impacts can only be inferred from regional information and past industry experience</u>" (10-36)* -Uncertainty about wildlife movement; monitoring will be used to verify the predictions *"Confidence in predictions of the effects of industrial activities on wildlife movements is founded on three elements: The use of habitat by wildlife; Information on actual movements; Knowledge about wildlife responses to industrial activities. The confidence in predictions about wildlife habitat use was addressed under Section 10.3.10.8, Prediction Confidence, and was rated as relatively high.*		

	Information on actual movements is more problematic. The most accurate information currently available for the study area involves the movements of radio-collared barren-ground caribou (Nagy 2004). Several peer-reviewed studies are available to help understand how individual caribou and caribou populations might respond to industrial development. The prediction about the effects on caribou movements is therefore relatively high. Movements of most other VCs in the study area are not well known. Predictions are largely based on wildlife habitat use and inferences about how animals might move between patches of preferred habitat. A relatively large body of information on wildlife responses to industrial activities is used to support the predictions and the confidence in predicting responses of wildlife movement to the activities of the project is moderate. Actual effects on wildlife movements must be monitored to verify the predictions."(10-265) -Uncertainty about wildlife distribution and population changes resulting from mortality: monitoring and verification (implicit auditing) of mitigation effectiveness are essential in reducing mortality and ensuring that predicted sources of mortality remain at or below the predicted levels: *"Predictions about VC mortality caused by the project are almost exclusively based on experience from previous industrial activities, information from which is presented in Section 10.5.1, Effect Pathways. Little baseline information on mortality is available for the local study area because no studies have measured how many animals die in that area at baseline. Therefore, prediction confidence for effects on wildlife distribution and population changes resulting from mortality is low for mortality rates. However, considering a coarse level of prediction, such as whether the level of mortality will likely not exceed the predicted maximum of moderate and last through construction, the confidence in the prediction is moderate to high based on previous industry experience. This is because the project description and the intended mitigation measures are well understood and can be compared with other projects. Monitoring and verification of mitigation effectiveness are essential in reducing mortality and ensuring that predicted sources of mortality remain at or below the predicted levels."(10-350)* -Uncertainty (implicit) about the bird habitat modelling results is not addressed (monitoring) and uncertainty (implicit) about the effectiveness of mitigation measures: climate change changing the conditions of reclamations measures addressed by monitoring and adaptive management (implicit) *"The confidence in predictions on habitat alterations is based on: The strength of baseline measurements and existing information; Knowledge on how wildlife responds to habitat change. The approach to establishing the baseline for this EIS was to measure both the distribution of habitat types, each of which is composed of several vegetation types, and the use of those habitat*		

	types by the selected VCs. Baseline field studies conducted for this project (see Volume 3, Section 10, Wildlife) in combination with the understanding obtained from existing information in reports and publications provides a high level of confidence in predicting habitat use by mammals. The habitat models were developed based on existing information about the VCs in the study areas, including information obtained through personal communications with resource managers. Where a statistical comparison between field data and model output was possible, i.e., for those VCs covered in the winter track count survey: barren-ground caribou, woodland caribou, moose, marten and lynx, presence or absence of the following was found to depend on habitat as predicted by the models: Woodland caribou, where G=27.35, n=366 and p<0.05; Moose, where G=898.85, n=435 and p<0.05; Marten, where G=7.54, n=509 and p<0.05. Grizzly bear dens were also found more often in the modelled denning habitat than in habitat that was low or unsuitable for denning: density of dens in effective habitat = 6.0 dens/100 km2 and in non-effective habitat = 2.5 dens/100 km2, x2 = 14.4, p<0.05. The confidence in the mapping of habitat types and the predicted habitat use by these VCs is high. However, barren-ground caribou, where G=2.82, n=142 and p>0.05, and lynx, where G=4.14, n=509 and p>0.05, track density was independent of habitat quality as predicted by the models, but these results might be because of a small number of tracks observed. Nonetheless, a visual comparison of barren-ground caribou model output and a spatial aggregation of telemetry data points provided by RWED (Nagy 2004) indicates a correspondence between model and measured field distribution. The assessment of the potential effects of the project on the populations of bird VC species is based primarily on original fieldwork conducted for this project, the project description, previous studies of bird populations in the area, published studies of effects, and professional judgement. The models used to quantify bird habitat values in the study areas were based entirely on published literature sources, most of which were studies conducted elsewhere, although some were in geographically similar areas, such as Alaska. Confidence in the bird habitat modelling results is low primarily because few ground-truthing surveys were conducted to provide input or to validate the modelling results. Less consideration was given to the quantitative habitat modelling results for birds because we have low confidence in those. Nevertheless, our confidence in the qualitative predictions of effects, versus quantitative measures of habitat change, is moderate to high. Confidence varies somewhat with the level of detail provided in the project description. Confidence in the predictions of effects on wildlife responses and the zones of influence are based on lessons learned from previous industrial developments. The current knowledge of the biology of each species and its sensitivity to disturbance varies between the selected wildlife VCs. Species can either habituate to disturbance or learn to avoid disturbance, and can change the response to disturbance over time. Finally, animals that have the option to		

	move to an alternative area with equivalent resources will avoid disturbance without a heavy energetic and mortality cost (Gill et al. 2001), so their distribution might be locally altered while their viability remains unaffected. These factors influence the interpretation of how habitat alteration relates to wildlife habitat use. The confidence in predicting wildlife responses to habitat change is considered moderate. Monitoring of actual effects is required to verify the predictions. Aspects of pipeline construction related to matters such as permafrost subsidence and reclamation in arctic landscapes will affect the outcome of operational and post-decommissioning effects. Moreover, the climate might change over the life of the project, changing the conditions for reclamation and, potentially, wildlife distribution. Prediction confidence in outcomes in later stages of operations and decommissioning and abandonment is low and requires monitoring and environmental management that will be responsive to unexpected changes in the environment."(10-250) Biodiversity Uncertainty is not mentioned. Monitoring programs and environmental management techniques are not disclosed here and the reader is referred to Volume 7, Environmental Management. E.g.:" *Impacts to vegetation communities will be reduced through implementation of environmental management techniques such as avoidance, drainage control or restoration, reclamation, and seasonal restrictions on use (see Volume 7, Section 3, Environmental Management Plans)." (13-18)*		
9. Deep Panuke Offshore Gas Project	In the EIS, the EPPs plans are general and vague. Uncertainty is not disclosed. Contingency plans and EMPs (volume 2) "will be developed" or "will be designed" or "will be prepared". Risk scenarios are listed but not discussed in details. Follow-up and monitoring are recommended for each environmental impact (with implicit auditing) but no uncertainties are disclosed. A level of confidence is given for each residual environmental effect. It is neither explained nor discussed. Scientific uncertainty is also assessed in a "summary of residual effects" table for each impact. Uncertainty is never explained not discussed in depth. Uncertainty is rated as n/a when the effect is not predicted to be significant. This is not further explained nor discussed. Air -Residual effects regarding localized reduction in air quality-medium level of confidence (2)-not addressed - Residual effects regarding severe reduction in air quality- medium level of confidence (2)-not addressed -Residual effects regarding potential flaring of H_2S or SO_2 and reduction of air quality - medium level of confidence (2)-this is not addressed. -Residual effects regarding potential venting of CH_4 and reduction of air quality- medium level of confidence (2)-this is not addressed.	In the CSR, uncertainty is not disclosed in the follow-up programs sections. Follow-up is poorly disclosed: just an "overview" and has not been developed for the EIA. Implicit auditing and explicit adaptive management. *"The Environmental Effects Monitoring Plan (EEMP) for EnCana's Deep Panuke Project will be developed during the detailed engineering phase of the Project. The following information provides an overview of the EEMP. As detailed engineering and the regulatory process (and conditions of approval) have not yet been completed, it is premature to propose a complete EEMP to address potential impacts from the Deep Panuke Project. However, a sample table of contents has been provided to assist in the regulatory review process."(D-13)* *"EEM is conducted to test hypotheses built on effects predictions in the Environmental Impact Statement (EIS) and CSR and to verify the models used. EEM is also used to: Assess the effectiveness of implemented mitigation measures; Provide an early warning of changes in the environment; Improve understanding of environmental cause and effect relationships; and Prompt corrective action.* *Through adaptive management, the EEM will detect and assess Project-induced changes in the environment, providing essential feedback to operational managers who can effect any necessary modifications to Project activities."(D-13)* *"As part of its commitment to adaptive management, EnCana will develop a follow-up*	Uncertainties are only considered for residual impacts only though the "summary of residual effect tables". These are not discussed nor addressed.

	-Scientific uncertainty is mentioned for residual environmental effects on air quality resulting of malfunction or accident (medium level of confidence)- not addressed. Scientific uncertainty is rated "n/a" for the other phases: construction, operations and decommissioning. Marine Water Quality -Residual effects regarding localized water quality reduction- medium level of confidence (2)-not addressed Scientific uncertainty in rated n/a because each effect "is not predicted to be significant". Marine Benthos and Fish Residual effects have a high level of confidence and scientific uncertainty is rated n/a (each effect is not predicted to be significant). Marine Mammals and Turtles -Residual effects regarding malfunctions and accidents impacts :oiling of species--medium level of confidence (2). This is not addressed. Scientific uncertainty in rated n/a because each effect "is not predicted to be significant". Marine Related Birds Residual effects have a high level of confidence and scientific uncertainty is rated n/a (each effect is not predicted to be significant). Onshore Environment Residual effects have a high level of confidence and scientific uncertainty is rated n/a (each effect is not predicted to be significant). In the CSR, uncertainty is not considered in the EPPs. In fact, these have not been developed for the report: *"EnCana is currently in the process of updating its Spill Response Plan for its exploration activities offshore Nova Scotia. This document will soon be forwarded to the CNSOPB and other applicable regulatory authorities for review and approval. EnCana intends to update this Spill Response Plan to ensure alignment with the Deep Panuke Project. The following information is an excerpt from this draft exploration Spill Response Plan."(D-26)* Even though the mitigation and contingency plans are not disclosed all residual adverse environmental effects are rated as non-significant. The only effect that is rated as significant is for malfunctions and accidents effects on air quality. For residual adverse environmental effects scientific uncertainty is also evaluated for each residual environmental effects summary in a table but no details are given on which uncertainty, how is it determine and how it will be addressed. *"Scientific Uncertainty: Based on scientific information and statistical analysis or professional judgement; 1 = Low level of confidence; 2 = Medium level of confidence; 3 = High level of confidence; N/A = Not applicable (effect is not predicted to be significant)" (6-87).* No uncertainty is clearly identifiable. It is always N/A. Only in one case, scientific uncertainty is given a value. Uncertainty is	*program to be carried out over the life of the Project that takes into account impact predictions in the CSR, their review of the draft CSR, DPA documents and Addendum 1. These issues to be addressed by EnCana include, but are not limited to: Development of follow-up program principles; Refining the EEMP with updated information on marine birds; Management of spills and impacts on marine birds; Influence of lighting and flaring on birds; The development of a program to monitor Project impacts on the Roseate Terns; Development of a program to discourage all-terrain vehicle traffic on the pipeline RoW; Verification of the absence of species of special concern; Verification of the impacts of drilling muds and cuttings; Applicability of the National Pollutant Release Inventory; Verification of the impacts of produced water discharges; and Consideration of resident organisms in the vicinity of the Project and contaminant transport. Specific programs to address these issues will be developed in consultation with the relevant regulatory authorities. It is anticipated that this planning process will be managed by the CNSOPB."(4-3)* The follow-up programs are not disclosed to address all these issues. It does not address any uncertainty is particular. In addition, no information is given on what will happen if the process fails (both if the predictions are wrong and if adaptive measures fail), on oongoing findings of the EEM program, mitigation measures adopted, and emerging issues that may arise.	

	rated 3 (high level of confidence) for malfunctions and accidents in air quality residual environmental effects summary. This is not discussed furthermore. The authors state: *"Potential adverse residual environmental effects on air quality are predicted to be not significant for Construction and operation phases. Significant adverse effects on air quality could occur as a result of an accidental release of large amounts of raw gas or acid gas through a blowout or pipe break; however, Such an event would be temporary and is considered extremely unlikely."(6-83)* How can all residual impacts be non-significant when the mitigation plans and contingency planning have not been developed for the report? The only effect rated as significant is for air quality (malfunctions and accidents). The report states: *"A detailed outline of the following Plans, including purpose, scope, objectives, requirements and responsibilities, is provided in Appendix D […] Details of these plans can only be finalized once the Project design is finalized. These plans will be develop in consultation with various regulators to ensure their concerns are addressed in the planning process. Full versions of these plans will be provided to appropriate regulators for review prior to Project start-up" (4-1).*		
10. 407 East Transportation Corridor Project	In the EIS report monitoring and mitigation measure are disclosed in chapter 9. In that chapter, the report states: *"A monitoring strategy and schedule was developed based on the impact assessments carried out for the Recommended Design to ensure the following: That the predicted net negative effects are not exceeded; That the unexpected negative effects are addressed; and that the predicted benefits are realized"(9-1).* Environmental Management Plans are not disclosed in the chapter: *"Environmental Management Plans (EMPs) will be prepared following EA Act approval of the Recommended Design. The EMPs will detail the preceding commitments, monitoring requirements, and approval conditions associated with each of the construction contracts for the Recommended Design. The EMPs will include any Minister Conditions of Approval. The EMPs will act as a reference document for use by MTO and/or their agent during the construction of the Recommended Design."(9-1)* The monitoring requirements from the EIA sections are summarized in a table: *"Exhibit 9.1: Summary of Monitoring Requirements Associated with the Recommended Design"* (9-2). Uncertainty is not disclosed. Effects of Accidents and Malfunctions are disclosed on page 85. However no clear risk scenario can be identified. Terms such as "unlikely", "usually", "could" are used. The references are not strong enough for uncertainty to be considered. The preventive measures and contingency planning is not disclosed but "will be developed" by MTO: "*Spills of petroleum products such as gasoline, oils or lubricants can occur during construction or during machinery refuelling, or as the result*	Hydrology Adaptive management is implicitly considered for groundwater quality but no evidence on how the information will be gathered and evaluated is given. Uncertainty is not disclosed: *"To minimize reductions in groundwater quality, the MTO Road Salt Management Plan should be followed over the entire section. Runoff must be collected in the storm water management system and consideration should be given to drainage alternatives. If long-term impacts do occur, homeowners could be compensated by providing an alternative water supply on a case-by-case basis."(8-33)* Terrestrial Impacts Adaptive management is only implicitly mentioned for all terrestrial ecosystem features. These measures are vague. Uncertainty is not disclosed: "*Where impacts to terrestrial ecosystem features cannot be avoided through planning or design, additional mitigation measures applied during construction and operation/ maintenance are applied to further minimize negative effects. In situations where appropriate mitigation measures are not available, or significant net adverse effects will remain following the application of mitigation, compensation may be applied to offset the negative effect through replacement of the feature/function elsewhere. During construction, environmental protection and mitigation involves: Implementation of standard construction practices; Conformance with commitments made during the environmental assessment process; and recognition of additional control measures that may be identified through good construction environmental practice."(8-72)* Vegetation-Butternut Mitigation Strategy Auditing (implicit) and adaptive management are planned for the success of survival of the	A follow-up program aimed to ensure that the *"predicted net negative effects are not exceeded; That the unexpected negative effects are addressed; and that the predicted benefits are realized"(9-1)* In addition, adaptive management is considered for all environmental impacts but it does not address any uncertainties in particular. In addition, adaptive management measures are never discussed in depth. The Comprehensive Study states: *"To verify the accuracy of the environmental assessment and determine the effectiveness of mitigation measures. In accordance with the requirements*

	of a hydraulic line rupturing. These spills are usually highly localized and can easily be cleaned up by on-site teams using normally available equipment. In the unlikely event of a major spill, there could be contamination of the soil, groundwater and surface water. This in turn could have adverse effects on groundwater quality, on fish and fish habitat, and on wetland habitats, and wildlife could then ingest or absorb contaminants. Depending on the nature of the spill, it can also have an impact on residential, commercial, agricultural and other land uses. Emergency plans are recognized as effective ways of limiting the severity of environmental effects.To this end, MTO will develop and implement preventative measures and contingency planning in accordance with the CSA publication "Emergency Planning for Industry (CAN/CSA-Z731-99). A Spills Response Plan (SRP) will also be developed which will address the requirements of the Ontario Environmental Protection Act. MTO and its agents value the safety of their employees and the public, and will implement a Health and Safety plan during the construction and operation phases of the Project."(86) CSR Effects of Accidents and Malfunctions are mentioned on page 85. Clear risk scenarios can be identified but these are not discussed in depth. EIS In Chapter 8 (impacts *recommended design and assessment of the undertaking*) monitoring and mitigation measures are discussed for each environmental impact Air Quality No uncertainty disclosure (9-3). Fisheries -Uncertainty (explicit) about degree and type of potential adjustment and habitat effects variation because of variation of the specific fluvial geomorphologic and habitat conditions associated with the affected watercourse reach is disclosed. It is being addressed with more research and the design of mitigation measures in accordance (before the start of the project). However, these mitigation measures are not disclosed in the report. They should be. The potentiality for "post-construction monitoring activities" is being mentioned for situations where Redside Dace is present, but nothing is disclosed. *"The unique aspects of this project in relation to the large structures required to accommodate the ultimate design scenario may require further specific restoration considerations, as outlined in the site-specific mitigation measures. Specifically, the vegetation loss and die-back under the ultimate design structures is anticipated to have potential implications for maintenance of channel form, morphology and associated habitat elements under the structures. The degree and type of potential adjustment and habitat related effects will vary with the specific fluvial geomorphologic and habitat conditions associated with the affected watercourse reach. Therefore, to address this*	Butternut tree. Uncertainty is not disclosed. *"Monitoring of the success of the transplants and /or grafts should be completed for a period of time (e.g., 5 years) to ensure survival of the trees. The timeline will be specified in the ESA permit issued by MNR. Where transplants and/or grafts are not successful, a suitable response /action will be identified (e.g., replacement plantings). Again, a replacement plan for failing stock will be part of the ESA permit requirements."(8-74)* Restoration of Areas Disturbed by Construction Auditing (implicit) and adaptive management (implicit) are disclosed for the success of the restoration work. Uncertainty is not disclosed. *"Conduct a five-year monitoring program as an integral tool for determining success of restoration works, and to identify and manage problems, and implement follow-up measures, as required, to meet the restoration objectives of the project."(8-75)* In chapter 9, the monitoring of restoration objectives is also mentioned. Adaptive management is explicitly mentioned: *"Monitor restoration objectives to ensure the success of the program (i.e., invasive species management, forest/plantation thinning and planting, etc.). Monitoring will vary depending on the program being monitored and in terms of parameters, duration and outcome (i.e., to direct adaptive management, trigger the required replacement of dead planted material, etc.). The actual vegetation restoration monitoring programs will be developed in greater detail during subsequent design phases."(9-2)* Changes in groundwater fluctuation found in wetland vegetation stress In chapter 9, wetlands will be monitored to assess the impacts on groundwater fluctuations (implicit auditing) and implement the necessary contingency plans (implicit adaptive management). Uncertainty is not disclosed: *"Monitor wetlands where warranted based on the potential for temporary and/or permanent groundwater level lowering to adversely affect wetland vegetation communities. An appropriate monitoring program will be developed during subsequent design phases in order to detect wetland vegetation stress. Where appropriate, wetlands will be closely monitored during water-taking activities associated with the construction of bridge structures to document changes in groundwater elevation (undertaken by project hydrogeologists) and visual signs of vegetation stress (undertaken by an ecologists/botanists). This information will be used by the project hydrogeologists to determine the cause of any identified groundwater fluctuations, assess impacts of groundwater fluctuations, and trigger the implementation of a contingency plan, if necessary."(9-2)* Wildlife-Wildlife passage structures Wildlife passages will be monitored to determine the effectiveness of the structures (implicit auditing) in order to make alterations to the structures (implicit adaptive management). Uncertainty is not disclosed: *"Monitor the use of wildlife passage structures with approaches, responsibilities and duration to be determined, in consultation with the agencies, during subsequent design phases. Monitoring approaches would include decisions on the degree of post-construction monitoring and the number*	*of the Act, a follow-up program is required for the Project. The program will focus on those environmental components where there is a relatively larger degree of uncertainty about the predicted effects. MTO will provide annual follow-up reports on vegetation (including wetlands), surface water, groundwater, wildlife, fish and fish habitat"(V)* However, the environmental components where there is a relatively larger degree of uncertainty are not clearly identified.

	uncertainty and inform the refinement of the design of watercourse crossings that require relocation, particularly where the watercourses are sensitive to erosion and/or support sensitive species or habitats, the following measures are recommended: The site-specific susceptibility to erosion and lateral migration of the affected channel sections should be assessed further during subsequent design phases to determine the need for, and type/design of measures that can best achieve the ultimate objective of providing long-term channel stability, with minimum instream hardening/fixing and intrusion into the stream channels. This assessment should be integrated with a detailed understanding of the specific fish habitat elements that may be affected; Materials that fall in the water will be carefully retrieved using appropriate mitigation measures to minimize disturbance; In situations where Redside Dace are present, a specific assessment program should be developed and implemented, in consultation with the recognized experts and appropriate agency staff and in accordance with the Endangered Species Act (ESA) process. Opportunities for collaboration on post-construction monitoring activities should also be explored and implemented as feasible."(8-118) -In that same section, the potential for erosion and sediment control failures is considered but the contingency and response plans are not disclosed. Here, the responsible authority is not disclosed. Uncertainty is implicitly disclosed. *"An environmental inspector experienced in working around watercourses will be responsible for inspecting the erosion and sediment control measures and identifying deficiencies. The inspector will also assess all of the other general mitigation measures to ensure they are implemented as intended. The inspector will ensure all environmental mitigation and design measures are properly installed/constructed and maintained, and appropriate contingency and response plans are in place and implemented if required."(8-119)* -Uncertainty regarding the potential for and degree of potential effects to fish habitat form and function as a result of secondary effects on channel stability will be addressed with more research before the construction of the project. No information about this is disclosed in the report. The potentiality for "comprehensive post-construction monitoring" is mentioned to assess channel stability but nothing is disclosed. The uncertainty regarding the complete loss of the pool functions from the overall reach due to die-back of vegetation under the Spring Creek crossing structure will also be addressed through more research but nothing is disclosed in the EIS. The report states: *"opportunities to enhance existing pools or create new pool habitat for Redside Dace will also be identified"* but the reference is not strong enough to be considered as monitoring, auditing nor adaptive management: *"The uncertainty regarding the potential for and degree of potential effects to fish habitat*	*of passageways to be monitored. Preferably, a minimum of several small and several larger passageways throughout the project area would be monitored. The purpose of monitoring wildlife passage structures is to determine the effectiveness of the structures. This is done in order to identify needed alterations to the structures (e.g., add more funnel fencing, remove materials in underpasses etc.) and to determine which species or groups use the structures. Monitoring of this nature will provide information on the design and construction effectiveness of passage structures that can benefit future projects."(*9-2) Groundwater quantity/quality (CSR) Auditing and adaptive management are both implicitly disclosed for the inspection of private wells. Uncertainty is not disclosed. *"MTO will monitor nearby private wells prior to, during and following construction for both groundwater quality and quantity. Should monitoring and/or well inspections detect a measurable effect on private wells, contingency mitigation measures and compensation will be provided in accordance with MTO policies and directives. These measures could include well repairs or deepening, well replacements. Unavoidable changes to groundwater quality and/or quantity affecting private wells would be compensated through the provision of a temporary or permanent water supply as determined on a case-by-case basis."(42)* Surface Water Quality- Storm water management-Surface Water Monitoring (CSR) Adaptive management and auditing are both implicitly mentioned. Uncertainty is not disclosed. *"The Conditions of Approval also require MTO to prepare and implement a Surface Water Monitoring and Mitigation Plan, including: the methodology and schedule for the collection of surface water quality data, including monitoring parameters, locations and frequencies, including monitoring of thermal discharges from selected SWM facilities. At a minimum, data would be collected between the year prior to construction and the year following construction. Additional measures that would be implemented should the surface water monitoring program identify any areas where water quality targets are not being met; and an Ice Prevention and De-icing Management Plan including the best management practices to be employed by MTO, identification of road salt vulnerable areas and the additional mitigation measures needed in these areas."(48)* Vegetation-Butternut Tree: (CSR) As mentioned before, monitoring (explicit), auditing (implicit) and adaptive management (implicit) are disclosed for the Butternut Tree. Uncertainty is not disclosed. *"Given that a Recovery Strategy and Butternut related policies to support the implementation of Ontario's Endangered Species Act have not been finalized, MTO has developed a preliminary mitigation strategy in consultation with the MNR and Forest Gene Conservation Association (FGCA). In general, the strategy involves transplanting retainable trees of suitable sizes, collection of reproductive material (e.g., nuts and/or cuttings), planting of nursery stock at appropriate ratios, monitoring of transplants and/or grafts and taking contingency measures. It is anticipated that implementation of the mitigation strategy will*	

	form and function as a result of secondary effects on channel stability of the anticipated loss or die-back of vegetation in the long term at the Brougham Creek Tributary B, Spring Creek and East Duffins Creek crossings (Sites 7, 8 and 9) will be addressed through further site-specific assessment during subsequent design phases. This detailed assessment will integrate both fluvial geomorphologic and site specific fish habitat functions, with specific consideration of the potential for lateral widening to affect salmonid refuge and rearing pools at Brougham Creek Tributary B and East Duffins, and Redside Dace refuge pools at Spring Creek. The findings will confirm whether or not specific physical channel measures are warranted, and to inform their specific design. Comprehensive post-construction monitoring will also be undertaken to assess stability following installation of the structures. Since Redside Dace were also identified using pool(s) downstream of the ROW, complete loss of the pool functions from the overall reach due to die-back of vegetation under the Spring Creek crossing structure is not anticipated. However, given the limited representation of pools along the reach generally, the uncertainty regarding this conclusion will be addressed through further site-specific review to confirm beyond-ROW use. Opportunities to enhance existing pools or create new pool habitat for Redside Dace will also be identified."(8-125) Noise No specific monitoring requirements identified (9-3) Habitat restoration, creation and enhancement A high level of uncertainty about land requirements for habitat restoration is mentioned but not addressed: *"Given the confidential and sensitive nature of advanced willing seller/willing buyer negotiations and future property acquisition by MTO (once the EA is approved), and recognizing that there are other land interests and pressures (e.g., agricultural production or urban development), there is a high level of uncertainty about 'how much' land could be allocated to habitat restoration/creation/enhancement. However, the Project Team has identified 'suggested' areas for potential future consideration and this will form the basis of developing restoration/creation/enhancement plans during subsequent design phases."(8-77)*	*achieve an overall net benefit to the species. The mitigation strategy evolved during subsequent design phases of the Project and will be enforced under the Endangered Species Act permit."(68)* CSR In the Comprehensive Study the purpose of the follow-up program is: *"To verify the accuracy of the environmental assessment and determine the effectiveness of mitigation measures. In accordance with the requirements of the Act, a follow-up program is required for the Project. The program will focus on those environmental components where there is a relatively larger degree of uncertainty about the predicted effects. MTO will provide annual follow-up reports on vegetation (including wetlands), surface water, groundwater, wildlife, fish and fish habitat"(V)* On page 121 a planning is disclosed for follow-up programs with the timing for each environmental sector. While this table does not disclose adaptive management measures, the disclosure of such table with the appropriate schedule and responsible authority is exemplary. Adaptive management is explicitly mentioned. Moreover, section 8.4 describes the roles and the responsibilities of government agencies in the follow-up program (Transport Canada and Fisheries and Oceans Canada, Environment Canada, Natural Resources Canada, and the Canadian Environmental Assessment Agency).	
11. Aquarius Gold Mine Project	The cost of mitigation measures is disclosed but these measures remains vague. In term of contingency measures; environmental effects of possible malfunctions or accidents are discussed in section 9.6. Different accidents are identified but risk scenarios are not discussed in depth. The potential failures of mitigation measures are mentioned but quickly justified by the same argument each time: either not significant, short time or minor impacts. Fisheries and Aquatic resources -Uncertainty about mitigation measures about	On page 539, a summary of the follow-up program is disclosed: "the following sections summarize, and in some cases expand upon or add to, follow-up/monitoring programs presented elsewhere in the EA document"(539) However, no relevant details were disclosed in the EIA. Page 539 auditing is implicit for all impacts Page 539 adaptive management is implicit for all impacts Uncertainty is not mentioned nor disclosed.	Uncertainties are well acknowledged for a CSR. Uncertainties are discussed in separate sections for each impact. However, these are never explained and poorly addressed.

	Vader's lake spawning restoration site. Justified, as the creek would revert to pre-impact conditions. "*In the event that the Vader's Lake spawning restoration site does not attract spawning trout, or naturally evolving site conditions over time results in access problems, then the brook trout status in Vader's Lake and North tributary Creek would potentially revert to pre-impact conditions. We do not expect that this will happen."* (483) Residual effects are rated as non-significant. *"To the extent that DFO and MNR have accepted that the fish habitat compensation measures proposed herein are sufficient to offset expected habitat compensation package"(528).* -Uncertainties are disclosed regarding mitigation measures. The neglect of uncertainties are justified by the non-significance of the impacts: *"Uncertainties associated with the general success of proposed fish habitat compensation measures are considered to be within acceptable limits for reasons outlined in Section 102.4"*(528). -Uncertainty about the success of walleye introduction (implicitly disclosed); It is addressed with implicit auditing: "*The aspect that will remain to be verified, however, will be the success of walleye introduction. This success will depend primarily on the suitability of spawning habitat associated with (1) granular shoals developed from rehabilitation of the Legare Lake separator dyke between legare Lake and the open pit; (2) gravel spawning beds developed within the proposed creek connection between Aquariys Lake and the new pit Lake; and (3) additional spawning areas at the inflow from the south beaver pond. "(528)* -Uncertainties about impact prediction regarding the reconfiguration of the Deep Lake Lake#2 to support a self-sustaining brook trout population, and the ability of a restored South Crooked Creek to support brook trout. Auditing is suggested to deal with these unceratinties. *"Additional uncertainties involve the reconfiguration of the Deep Lake-Lake #2-Low Lake complex (i.e., the 3-Lakes option) to support a self-sustaining brook trout population, and the ability of a restored South Crooked Creek to support brook trout. Based on hydrogeological conditions, there is every indication that the 3-lakes option will be successful. However, further detailed site-specific studies will be required to verify the extent of the potential to generate groundwater upwelling to Deep Lake and Lake #2. With regard to the restoration of South Crooked Creek, there is little doubt that the habitat can be restored to a condition similar to that presently existing. However, the very small size of this system and the presence of numerous beaver dams limit overall habitat suitability for brook trout. These limitations will also be present (or will develop) with system restoration."(*528) Groundwater -Uncertainty about the failures of mitigation measures is not discussed because impacts		

	will occur in terms of years *"The impacts would occur in terms of years and there would be ample opportunities to restore the mitigation measures"(462).* *"Expected residual Project effects on the tailings area groundwater system are regarded as being not significant"* (462). -Section 11.1.1.4 discusses uncertainties about modeling predictions. They are not addressed; Also, there is no section 9.2.1.1: *"The assessment of uncertainties, regarding residual groundwater effects, is largely tied to modeling assumptions. These are discussed in Sections 9.1.2,9.2.1.1, and 12.3"(520).* Surface water No uncertainty disclosure and vague contingency plans: *"Environmental effects associated with the failure or breach of a storm water collection pond would be a minor, short-term influx of suspended solids to the receiving water body. The storm water collection pond would be repaired as soon as possible"* (467). Residual environmental effects are rated as non significant -Impact prediction uncertainty about the extent to which cooper concentrations in the final tailings effluent will be reduced beyond those provided by volumetric mass balance calculations: *"The only uncertainty in the above analysis is the extent to which copper concentrations in the final tailings effluent will be reduced beyond those provided by volumetric mass balance calculations. A 50% reduction, as a reasonable estimate, based on general experience with such systems. All other considerations are straightforward" (526).* Uncertainty is not explained; it is being justified by "general experience". Wetland -Implicit uncertainty about the failure of mitigation measures. The neglect of uncertainty is justified by the wetlands resilience. *"No environmental effects are anticipated in the event of restoration failure as natural succession would continue, with the result that wetland habitats will develop on their own, but simply over a greater time period." (487)* Terrestrial Environment -Implicit uncertainty about the failure or malfunction of mitigation measures-Justified: because the effect is not significant considering the availability of other feeding areas in the region: "*The potential effects associated with failure or malfunction of mitigation measures included the possible temporary abandonment, or reduced usage, of moose feeding areas during the life of the mine. These are not considered to be significant as aquatic feeding areas occur in other areas of the Crooked Creek watershed, as well as in adjacent watersheds." (490)* Migratory Birds No uncertainty disclosure and mitigation measures are vague: *"To minimize these effects, to the extent possible, every effort will be made to avoid major tree clearing operations during the*		

	nesting and rearing season." (491) Different accidents are mentioned but not discussed: *"Developing an environmental emergencies response information package (i.e. Emergency Response Plan)." (555*) Residual impacts: the definition of significance include: context, extent, likelihood of occurrence and reversibility. Likelihood of occurrence has three level: unlikely to occur (level1), could reasonably be expected to occur (level 2), and will occur, or likely to occur (level 3). These levels are never explained. Terrestrial Environment (vegetation communities, wildlife concentration area, uncommon or rare species, migratory birds and bird habitat) All residual are rated as non-significant: "Habitat losses will occur as described" (529). Uncertainty is not discussed in that section; failure of mitigation measures is not discussed. Noise level All residual impacts are non-significant. Uncertainties are discussed in a separate section (explicitly mentioned). -Uncertainties about noise level prediction are addressed using conservative assumptions: *"The model applications, used in predicting noise levels, are those recommended for use by the MOE, and are conservative in their assumptions. Finally measures can be further optimized during operations. Uncertainties are therefore considered to be minimal, and can easily be addressed as site monitoring data become available." (536)*		
12. Waskaganish Project	The environmental management plan of the project is called the "*Road Impact Management Plan"* (RIMP). The budget is disclosed for such plan ($675000), The RIMP is composed of two subprograms: The subprogram for mitigation measures ($175000) and the subprogram for follow-up of the social and natural environment ($500000). The disclosure of the costs of such measures is exemplary. The current mitigation measures are generally disclosed in a table (111). Uncertainties are not mentioned nor disclosed. No risk scenarios are disclosed. For fur animals, the report states: *"No mitigation measures are planned in regard to risks of collision on the alignment" (133).* It seems that the authors gave the excuse of the "nature of the project" to not make strong effort to mitigate the risks of collisions with wildlife.	No uncertainties are identified nor addressed in the subprogram for mitigation measures, the subprogram for the follow-up of the social and natural environment. However, the authors clearly express their will to assess the effectiveness of the mitigation measures, to evaluate the unexpected impacts of the project and to make adjustments in accordance: *"Periodically and systematically evaluating the nature and scope of the project's impacts*, *the effectiveness of adopted measures Identifying all unplanned repercussions and elaborating new measures to be taken, if applicable" (110).* In the *running and managing the subprogram* section, guidance is given on the implementation of the follow-up program. The follow-up program will run for five years and a databank will be created that will ensure that: "*Regular, systemic recording of information on the project and how it is progressing; Periodic measurement of changes; Assessment of the pertinence and effectiveness of measures taken; Identification of any unforeseen and residual impacts; Development of new measures, as required; Identification of yearly environmental trends; Regular revision of socioeconomic indicators; Regular revision of socio-ecological indicators; Any specific studies that may be necessary; Incorporation of any new developments related to the project; factoring in of new social and economic conditions and new needs of community, as required."(113)* Adaptive management is implicitly mentioned for mitigation measures (the references are weak) -For impacts on rare plants: *"In order to preserve rare plant communities, an inventory of rare species was carried out. For the moment, results*	The budget is disclosed for mitigation measures and the follow-up program. Ex-post evaluation is implicitly disclosed. Adaptive management is implicitly considered for impacts on rare plants, erosion and watercourse flow and water quality. Here, uncertainty is disclosed regarding erosion. The word "unforeseen" is used to express that uncertainty.

		are not available. In the event the rare plant species are present in the right-of-way, a modification of the road alignment or relocation of the population will be proposed" (132). -For impacts on erosion: *"In the context of the supervision of the construction work, the environmental supervisor will have to ensure that current mitigation measures against erosion are applied. In the event that unforeseen erosion is caused by the work, it will be necessary to ensure that the slopes are stabilized using the measures considered appropriate."(134)* -For watercourse flow and water quality: *"During construction, it will be necessary to ensure that the culverts are installed in accordance with the plans and specifications. Subsequently, the maintenance teams will ensure the adequate functioning of the culverts and correct any problems" (136).*	

Appendix 3: Categorization Tables

1. The Joslyn North Mine Project

Sectors	Mitigation measures			Contingency Plans			Follow-up Programs		
	Uncertainty about	o/x/xx	Uncertainty adressed with	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with
Air	1. Residual impacts prediction from the project gases and particulate emissions (Moderate confidence-uncertainty associated with planned emissions)	xx-Explicit Data, context or model uncertainty, stochastic, epistemic and recognized uncertainty	Auditing and adaptive management - implicitly mentioned for measuring methane emissions and fugitive emissions (it is not explicitly said if these are meant to address the uncertainties from the impact predictions) Uncertainty is not directly addressed. All residual and cumulative impacts are rated as insignificant	Accidents and Malfunctions	xx(RP all)	Risk scenarios are mentioned but remain vague	No uncertainty disclosure	o	None
	2. Residual impact prediction on potential human health effects and visibility impairment (Moderate confidence-uncertainty in PM emissions)	xx-Explicit Data, context or model uncertainty, stochastic, epistemic and recognized uncertainty							
	3. Residual impacts prediction from acidification of sensitive soils, water bodies and vegetation (Low confidence-more uncertainty in deposition estimates)	xx-Explicit Data, context or model uncertainty, stochastic, epistemic and recognized uncertainty							
	4. Residual impacts prediction from potential eutrophication of sensitive ecosystem (Low confidence -more uncertainty in deposition estimates)	xx-Explicit Data, context or model uncertainty, stochastic, epistemic and recognized uncertainty							
	5. Cumulative impact prediction on potential human health effects (Low confidence-regional emissions not well understood)	xx-Implicit Data, context or model uncertainty, stochastic, epistemic and recognized uncertainty							
	6. Cumulative impacts prediction from odor perception (Moderate confidence)	x-Implicit							
	7. Cumulative impacts prediction on human health effects and visibility impairment (Low confidence)	x-Implicit							
	8. Cumulative impacts prediction on human health effects: (Moderate confidence)	x-Implicit							
	9. Cumulative impacts prediction for damage to vegetation (Low confidence)	x-Implicit							
	10. Cumulative impacts prediction from PAI deposition that would result in the acidification of sensitive soils, water bodies and vegetation (Low confidence)	x-Implicit	For deposition of PAI and nitrogen, conservative estimates were used.						
	11. Cumulative impacts prediction from nitrogen deposition that would result in the potential eutrophication of sensitive ecosystems (Low confidence)	x-Implicit							
Fisheries	12. Impact predictions RP- uncertainty of the predictive models in the predictions and compensation measures 13.mitigation measures: RP- uncertainty of the predictive models in the predictions and compensation	xx-Explicit Model, epistemic and recognized uncertainty	RP-Follow-up Programs: implicit auditing and explicit adaptive management (vague) RP-Auditing is implicitly mentioned in the RP to verify the commitments in the	Contingency planning	xx	Risk Scenario not disclosed	No uncertainty disclosure	o	None

	measures		"no-net-loss" plan. In the EIS: Auditing is implicitly mentioned to assess the effectiveness of fish habitat enhancement plans						
Hydrology, groundwater and Water	14. Project impacts prediction on groundwater from flow in BWS (Basal Water Sands) to/from Athabasca River: Moderate confidence	x-Implicit	Not addressed :In RP-Auditing (implicit) and adaptive management to assess project impacts, validate and adjust models and mitigate problems (for all impacts on groundwater)				No uncertainty disclosure	o	None
	15. Cumulative impacts prediction on groundwater from flow in BWS (Basal Water Sands) to/from Athabasca River (Low confidence)	x-Implicit							
	16. Project impacts prediction for groundwater contamination (Moderate confidence)	x-Implicit							
	17. For residual impacts prediction for groundwater contamination (Moderate confidence)	x-Implicit							
	18. For project impact prediction on changes in channel geometry and sediment concentration due to flow changes and excavations (Moderate confidence)	x-Implicit	Not addressed						
	19. For cumulative impacts prediction on changes in channel geometry and sediment concentration due to flow changes and excavations (Moderate confidence)	x-Implicit	Not addressed						
	20. For residual impact prediction about the reduction in minimum flows due to water withdrawals (Low confidence)	x-Implicit							
	21. RP-water quantity cumulative effects prediction: uncertainty about how regional impacts would affect the productivity of the lower Athabasca River Watershed	xx-Explicit Stochastic, epistemic, data and recognized uncertainty	Auditing is implicit and adaptive management is mentioned but remains vague						
	22 RP-Impact prediction: uncertainties about the effects of industrial development on the water quality in the lower Athabasca River	xx-Explicit Stochastic and epistemic, data, context and recognized uncertainty	A better monitoring program and auditing (implicit)						
Soil and Terrain	23.For project impact prediction, 24. Residual impact prediction and 25. Cumulative impact prediction on soil acidification from emissions (generated from the predicted air emission estimates and uncertainty comes from the predictions of effects of acidification on the different soils types) (Low confidence)	xx-Explicit Data, context, stochastic and epistemic and recognized uncertainty	Air emission estimates are conservative and then when all combined they are likely to be overestimated. Monitoring is used to determine the accuracy of the prediction (Implicit auditing) Both emissions and deposition will be monitored.				No uncertainty disclosure	o	None
Noise	No uncertainty disclosure	o	None					o	None
Vegetation and Wetland	No uncertainty	o	RP-success of the reclaimed wetlands: Auditing is vague and adaptive management is not mentioned					o	None

Wildlife	26. Mitigation measures effectiveness: Uncertainty about an appropriate mine development setback from the Ells River to allow a wildlife corridor around the project and that there is uncertainty with using the Ells River valley as a wildlife corridor	xx-Explicit Data, epistemic and recognized uncertainty	To address that uncertainty, the Panel recommends more studies and a precautionary approach (no details are given in that regard). No clear guidance/deadlines are given					o	None
	27. Mitigation measure effectiveness-RP: uncertainty exists as to whether some wildlife, including species at risk, would be able to repopulate the local study area once reclamation is complete	xx-Explicit Stochastic and epistemic, data and recognized uncertainty	RP-Auditing and adaptive management are implicitly mentioned. More research is also suggested. RP-good reclamation practices For all other impacts: implicit auditing and explicit adaptive management that remains vague						
	28. Local and regional impacts prediction on habitat availability for Canadian Toad Limited information on regional distribution (Low confidence)	xx-Implicit Data, stochastic and recognized uncertainty							
	29. Local and regional impacts prediction on habitat availability Great gray Owl Limited information on regional distribution (Low confidence)	xx-Implicit Data, stochastic and recognized uncertainty							
	30. Local and regional impacts prediction on direct mortality of Canadian Toad: Limited information on regional distribution (Low confidence)	xx-Implicit Data, stochastic and recognized uncertainty							
	31. Regional impacts prediction for black bear and moose direct mortality (Moderate confidence)	x-Implicit							
Biodiversity	32. Impacts prediction on species diversity (Moderate confidence)	x-Implicit	Not addressed-Implicit auditing and adaptive management for reclamation sites but they do not address any uncertainties in particular					o	None
	33. Impacts prediction on unique wildlife species (Moderate confidence)	x-Implicit							
	34. Impact prediction on overall wildlife species diversity index (Moderate confidence)	x-Implicit							
	35. Project impacts prediction on landscape diversity (mean patch size) (Moderate confidence)	x-Implicit							

2. Marmot Basin Project

Sectors	Mitigation measures			Contingency Plans			Follow-up Programs		
	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with
Air	1.Impact prediction on the air data available for the ski area (no air data)	xx-Implicit Data, context, epistemic, stochastic and recognized uncertainty	Not addressed	Accidents and Malfunctions	xx	Risk scenarios are mentioned but remain vague	None	o	None
							None	o	None
Fisheries	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hydrology, groundwater and water	2.Impact prediction on the accuracy of the stream flow data for Marmot Creek within the Marmot Basin Ski Area	xx-Implicit Data, context, stochastic, epistemic and recognized uncertainty	Not addressed	Accidents and Malfunctions	xx	Risk scenarios are mentioned but remain vague	None	o	None
Noise	No uncertainty disclosure	o	None				None	o	None
Soil and Terrain	No uncertainty disclosure	o	Implicit adaptive management (does not address any uncertainties; not disclosed)				None	o	None
Vegetation and Wetland	3. Impact prediction on old-growth forest	xx-Implicit Data, context, stochastic, epistemic and recognized uncertainty	Not addressed (justified by the abundance of forests in the area)				None	o	None
	None	o	Auditing is implicitly considered for changes in vegetation but no explicit commitments are made						
Wildlife	4. Impact prediction about available information that does not permit an accurate means to measure and assess the impact of skier traffic on highway wildlife mortality-	xx-Implicit Data, context, epistemic, stochastic and recognized uncertainty	Not addressed				None	o	None
Biodiversity	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

3. Prosperity Gold-Copper Project

Sectors	Mitigation measures			Contingency Plans			Follow-up Programs		
	Uncertainty about	o/x/xx	Uncertainty adressed with	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with
Air	Not disclosed	o	For air emissions: conservative estimates were used-there is a high degree of confidence that emissions are being over-estimated.	Accident and malfunctions	xx	Risk scenarios are well identified and discussed in a separate volume (9); Uncertainty is not explicitly mentioned	No uncertainty disclosure	o	None
	1.Impact prediction regarding weather patterns brought about by climate changes and 2.mitigation measures in case of extreme weather effectiveness.	xx-Explicit Data, context, epistemic, stochastic and recognized	Adaptive management (Explicit but not disclosed).						
	3.Impact prediction about GHG effects (Greenhouse Gases)-Environment Canada (2007) and the CEAA (2003) consider that it is not possible to attribute potential effects to the emissions from any specific project	x-Implicit	Not addressed						
Fisheries	4.Mitigation measures-Fish and Fish habitat compensation plan	xx-Explicit Data, context, epistemic, stochastic and recognized	Auditing (implicit) and adaptive management (not disclosed)						
Hydrology, groundwater and water	5.Impact prediction regarding the mass balance model used to predict pit water quality	xx-Explicit Model, context, epistemic and recognized	It is subjectively addressed by the authors that assure that the technology available (implicit adaptive management-not disclosed) will be able to address any excess of the water quality guidelines adequately						
	6.Impact prediction about metal loads generated by the different waste sources	xx-Explicit Data, epistemic, context and recognized	Monitoring						
	7.Impact prediction regarding pit discharge concentration	xx-Explicit Data, epistemic, context and recognized	Mitigation measures (not disclosed in depth)						
	8.Impact prediction regarding the estimate of tonset	xx-Explicit Model, data, context epistemic and recognized	"worst case" variables were used						
	9.Impact prediction on distinguishing pre-closure logging and post-closure Project effects on aquatic ecosystem	x-Explicit	Monitoring						
	10.Impact prediction regarding baseline condition of surface water hydrology	xx-Explicit Data, epistemic, context, stochastic and recognized	Not addressed						
	11.Cumulative impacts prediction regarding the numerical models used to predict the cumulative effects on surface water stream flow	xx-Explicit Model, epistemic, context, stochastic and recognized	Justified-cumulative effects are likely to be short term (10-15 years) and not considered as significant cumulative effects						
	12.Impact prediction regarding the change in groundwater elevation due to complex hydrological conditions	xx-Implicit Model, data, context epistemic and stochastic and recognized	Auditing, not disclosed, no adaptive management						
	13.Impact prediction of changes in groundwater flows due hydrology that is highly variable	xx-Implicit Data, model, context, epistemic and stochastic and recognized	Sensitivity analyses						
	14.Impact prediction regarding groundwater quality baseline conditions (flow and quality)	xx-Implicit Data, model, context, epistemic and stochastic and recognized	Various assessments and evaluation by various expert (remain vague);implicit adaptive management (but extremely vague)						
	15.Impact prediction regarding water chemistry due to the complexity of natural watershed processed	xx-Implicit Data, model, context, epistemic and stochastic and	Justified- Water chemistry will remain within "water quality guideline"/implicit auditing-verify water						

		recognized	quality prediction" (not disclosed) no adaptive management						
	16.Impact prediction about water chemistry in Big Onion Lake further into the future after year 100	xx-Explicit Model, epistemic, stochastic and recognized	Mitigation measures (not disclosed)						
	17.Impact prediction regarding water chemistry regarding the parameter estimates used in the model	xx-Explicit Model, epistemic and epistemic, stochastic and recognized	Sensitivity analyses						
	18.Mitigation measures uncertainty: uncertainty about the underlying geochemical laboratory test work and actual site conditions after mine construction	xx-Explicit Data, model, epistemic, stochastic and recognized	With worst case model for prediction of water quality (conservative approach)						
	19.Impact prediction of pit water quality	xx-Explicit Data, context, epistemic, stochastic and recognized	Implicit adaptive management-Taseko is confident that both the opportunity and the technology are available to address any exceedances adequately (but these are not disclosed)						
	21.Impact prediction about metal loads generated by the different waste sources	xx-Explicit Data, context, epistemic, stochastic and recognized	Monitoring programs during operations and closure to assess the actual geochemical performance of the project and implicit auditing ("assess the actual geochemical performance of the project) adaptive management is implicit but well explained but not disclosed in depth						
	22.Impact prediction about predicted versus actual pit discharge concentrations	xx-Explicit Data, context, epistemic, stochastic and recognized	Adaptive management-development of generic or site-specific Water Quality Guidelines for the Project during the permitting stage (thresholds are disclosed but in general measures remain vague)						
	23.Impact prediction about sediment quality due to the complexity of the aquatic system	xx-Explicit Data, context, epistemic, stochastic and recognized	Implicit auditing (no adaptive management)						
	24.Impact prediction about aquatic ecology	xx-Explicit Data, context, stochastic, epistemic and recognized	Monitoring of phytoplankton, zooplankton and benthic invertebrate, along with water and sediment will be required-no information on what will be done with the information						
Noise	Not disclosed	o	Prediction Confidence is high because conservative estimates were used						
Soil and Terrain	24.Impact prediction-the extent to which groundwater influence terrain stability	xx-Explicit Data, context, stochastic, epistemic and recognized	Follow-up (explicit) and monitoring (not disclosed)						
	25.Impact prediction regarding spatial information on soil metal exceedance	xx-Implicit Data, context, stochastic, epistemic and recognized	Not addressed						
	26.Impact prediction and 27.mitigation measures about soil fertility changes and reclamation activities	xx-Implicit Data, context, stochastic, epistemic and recognized	Adaptive management (implicit and not disclosed)						
Vegetation and Wetland	28.Mitigation measures about the likelihood of old forest recovery due to long periods required and the influence of, natural disturbance (climate change) and commercial forest harvesting activities	xx-Explicit Data, context, stochastic, epistemic and recognized	Reclamation monitoring will be sufficient (no adaptive management)						
	29.Cumulative effects for old forest loss due to the mountain pine beetle infestation	xx-Implicit Data, context, stochastic, epistemic and recognized	Not addressed						

	30.Cumulative environmental effects and 31.significance prediction on wetland ecosystem regarding legislative context (forest licenses) and environmental context (pine beetle infestation, interaction with climate change or fire)	xx-Explicit Data, context, stochastic and recognized	Not addressed						
	32.Impact prediction (prediction confidence is medium for wetland ecosystem loss)	x-Implicit	Not addressed						
	33.Residual impacts (scientific certainty is medium for maximum footprint on the changes in plant structure and composition for wetlands)	xx-Explicit Statistical methods (statistical uncertainty) or best professional judgement (bias) but not discussed in depth	Not addressed						
	34.Impact prediction (prediction confidence is medium) about changes in riparian ecosystem community structure and composition	x-Implicit	Not addressed						
	35.Residual impacts on riparian ecosystem (scientific certainty is medium for the maximum footprint regarding the changes in riparian ecosystem structure and composition)	xx-Explicit Statistical methods (statistical uncertainty) or best professional judgement (bias) but not discussed in depth	Not addressed						
	36.Impact prediction regarding Grassland Ecosystem Loss (prediction confidence is medium)	x-Implicit	Not addressed						
	37.Impact prediction regarding rare plants populations (lack of information) and rare plants loss as well as 38.Residual effects on rare plants (low level of confidence)	xx-Implicit Data, context, stochastic, epistemic and recognized	Monitoring to determine population but no auditing nor adaptive management						
Wildlife	39.Mitigation measures and 40.impact predictions regarding the project related wildlife vehicle collision/road kills	xx-Implicit Data, context, stochastic, epistemic and recognized	Implicit auditing and adaptive management but not disclosed						
	41.Impact prediction regarding the model used for the availability of seasonal feeding habitat for Grizzly Bear and Black Bear	xx-Implicit Model, context, stochastic, epistemic and recognized	Not addressed						
	42.Impact prediction on grizzly bear (RP)	xx-Explicit Data, recognized, stochastic and epistemic and recognized	Justified- the small nature of the project and the abundance of the specie in the region justifies the uncertainty						
	43.Impact prediction on the availability and loss of habitat for Grizzly Bear, Black Bear, Fisher, Townsend's Big-eared Bat, Great Blue Heron, Mallard, Barrow's Goldeneye, Sandhill Crane, Long-billed Curlew, Lewis's Woodpecker, Yellow-breasted Chat, Sagebrush Brewer's Sparrow, Sharp-tailed Grouse, Owls and Amphibians	xx-Implicit Model, context, stochastic, epistemic and recognized	Not addressed						
	44.Impact prediction regarding the information on abundance of Yellow-breasted Chat, Sagebrush Brewer's Sparrow, Sharp-tailed Grouse, Owls, and Amphibians	xx-Implicit Data, context, stochastic, epistemic and recognized	Not addressed						
	45.Residual impacts on amphibians (prediction confidence is medium)	x-Implicit	Not addressed						
	46.Impact prediction on terrestrial invertebrates (little information)	xx-Implicit Data, context, stochastic, epistemic and recognized	Not addressed						
Biodiversity	47.Impact prediction regarding the status (uncertainty regarding the genetic distinctiveness of the rainbow trout) of the Rainbow Trout-RP	xx-Explicit Data, context, stochastic, epistemic and recognized	Justified- the specie is common in the region (adaptive management but vague)						

4. Prince George Hart Water Supply Project

Sectors	Mitigation measures			Contingency Plans			Follow-up Programs		
	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with
Air **Fisheries** **Hydrology, groundwater and water** **Noise** **Soil and Terrain** **Vegetation and Wetland** **Wildlife** **Biodiversity**	Not disclosed for any particular impacts	o	n/a	Accidents, malfunctions and adverse conditions	xx	Risk scenarios are mentioned but remain vague	No uncertainty disclosure	o	None

5. The Swan Valley Gasification Project

Sectors	Mitigation measures			Contingency Plans			Follow-up Programs		
	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with
Air	Not disclosed	o	None	Possible malfunctions of operational systems	xx	Risk scenario not disclosed in depth; Monitoring is used to address unusually severe precipitation event and to identify potential pipeline leaks	Not disclosed	o	None
Fisheries	Regarding the sensitivity of the eight Swan River tributaries that the pipeline crosses	xx-implicit Data, stochastic, epistemic, context and recognized	Will trigger screening procedure						
Groundwater, hydrology and water	Not disclosed	o	None						
Noise	Not disclosed	o	None						
Soil and Terrain	Impact prediction regarding soil stability	x-implicit	More research and additional precautions (not disclosed)						
Vegetation and Wetland	No uncertainty disclosure	o	Monitoring, auditing (implicit) and adaptive management (implicit): assess the effectiveness of mitigation measures. In particular, the effectiveness of re-vegetation programs and slope erosion prevention measures will be examined. In the event that areas of concern are noted during the inspection, appropriate measures (e.g., stabilization and/ or reseeding) will be implemented to correct the problem						
Wildlife	No uncertainty disclosure	o	None						
Biodiversity	No uncertainty disclosure	o	None						

6. Liquefied Natural Gas Terminal Project

Sectors	Mitigation measures			Contingency Plans			Follow-up Programs		
	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with
Air **Fisheries** **Groundwater, hydrology and water** **Noise** **Soil and Terrain** **Vegetation and Wetland** **Wildlife** **Biodiversity**	Not disclosed	o	None	Contingencies (in the tables; The likelihoods of residual adverse environmental effects' rating have a low level of confidence for accidents, malfunctions, and unplanned events)	xx	Risk Scenario but not disclosed in depth	Not disclosed	o	None

7. Lower Churchill Hydroelectric Generation Project

Sectors	Mitigation measures			Contingency Plans			Follow-up Programs		
	Uncertainty about	o/x/xx	Uncertainty adressed with	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with
Air	1.Impact prediction and 2.mitigation measures for all atmospheric impacts	x-explicit	Ongoing monitoring, implicit adaptive management (auditing is ignored)	Unplanned occurrence and emergency situation	xx	Risk scenario not discussed in depth	No uncertainty disclosure	o	None
	3.Impact prediction regarding the scale of climate change effects	x-explicit	Ongoing monitoring						
Fisheries	4.Mitigation measure effectiveness regarding removing soil in the drawdown zone to mitigate mercury effects on fish	x-explicit	Precautionary approach (vague); Pilot study to audit the effectiveness of mitigation measures				Feasibility of effective monitoring and adaptive management of fish habitat compensation works	xx-implicit; Context uncertainty	The panel called for better baseline information, thresholds to trigger adaptive managements; more efforts and more information on the monitoring program
	5.Impact prediction regarding the number of fish that might go though the turbines and therefore uncertainty about the effects at the population level	xx-explicit Data, context, stochastic, epistemic and recognized	More research (monitoring to verity both juvenile and adult fish movement); compensation measures and adaptive management (explicit but not disclosed)						
	6.Mitigation measures effectiveness regarding fish health (fish loss, alteration and compensation)	xx-explicit Data, context, stochastic, epistemic and recognized uncertainty	Adaptive management (explicit and vague) and implicit auditing (none of them are disclosed). The residual effects are potentially irreversible, significant and adverse.						
Hydrology, groundwater and water	7.Impact prediction about water quality effect: how the ecosystem would respond during the transitional period and how long stabilization would take	xx-explicit-context, stochastic, epistemic and recognized	Adaptive management (explicitly but not disclosed) and the implementation of an erosion and sedimentation prevention strategy				Potential failure of adaptive management	xx-Implicit Data, context, recognized, stochastic and epistemic uncertainty	Precautionary approach (not disclosed)
Noise	None	o	Not addressed						
Soil and Terrain	8.Impact prediction on unexpected seepage, piping, ground cracking and any indications of ground instability	x-implicit	Implicit auditing and adaptive management of the mitigation measures (not disclosed)				No uncertainty disclosure	o	None
	9.Impact prediction about restabilization consequences for bank erosion and loss of terrestrial habitat	xx-explicit Data, stochastic, epistemic, context, recognized	Not addressed-effects will be significant for terrestrial habitats (can not be mitigated)						
Vegetation and Wetland	10.Mitigation measures about the success of the habitat compensation plans for wetlands	x-explicit	-Not addressed: The panel recommends a detailed compensation plan- the residual adverse effect of the Project on wetlands and riparian habitats,				No uncertainty disclosure	o	None

			even with appropriate mitigation, is significant						
	11.Impact prediction on the presence and impacts of rare plants	xx-implicit Data, stochastic, epistemic, context, recognized	Monitoring (vague) and adaptive management (explicit and vague)						
Wildlife	12.Mitigation measures about the success of the riparian habitat compensation plans	x-explicit	-Not addressed: The panel recommends a detailed compensation plan-the residual adverse effect of the Project on wetlands and riparian habitats, even with appropriate mitigation, is significant						
	13.Impact prediction and 14.Mitigation measures about the scale of the impacts on the Red Wine Mountain Caribou Heard (factors of threat and factors of recovery)	xx-explicit Data, stochastic, epistemic, context, recognized	-Not addressed: The proponent should ensure all reasonable efforts in the recovery of Red Wine Caribou Herd (research and recovery efforts-not disclosed) – the panel concluded that the project would cause a significant adverse environmental effect on the Red Wine Mountain Caribou						
	15.Cumulative impacts significance determination for the George River Caribou	xx-implicit Data, stochastic, epistemic, context, recognized	Not addressed						
Biodiversity	16.Impact prediction regarding the ecological impacts of mercury downstream	xx-Explicit Data, context, stochastic, epistemic and recognized	Adaptive management (explicit and vague), more research (on water quality) and additional mitigation measures						
	17.Impact prediction and 18. Effectiveness of mitigation measures regarding all terrestrial issues	x-Explicit	Monitoring, auditing (implicit) and adaptive management (explicit). These are not disclosed						

8. Mackenzie Gas Project

Sectors	Mitigation measures			Contingency Plans			Follow-up Programs		
	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with
Air	1. Impact prediction regarding air quality	x-Explicit	Conservative approach	Unforeseen events	xx-implicit	9 risk scenarios are mentioned but not discussed in depth. Adaptive management of these plans are also implicitly considered	Not disclosed	o	None
Fisheries	2. Impact prediction-Subsidence from reservoir depletion at Niglintgak and Taglu and its resulting effect on habitats used by freshwater and brackish water species in the future	xx-Explicit: Data, model, stochastic and recognized uncertainty	Precautionary approach (no details)						
Hydrology, groundwater and water	3. Impact prediction for effects on groundwater regarding the distribution of karst systems force	x-explicit	Not addressed						
	4. Impact prediction on flow and water level regarding hydrologic data	xx-implicit: Data, stochastic, context, epistemic and recognized uncertainty	Not addressed						
	5. Impact prediction on the effects of runoff, drainage pattern and water level and velocity	x-Explicit	Conservative approach						

	6. Uncertainty about impact prediction about effect on water level and velocity regarding the delta area (complex environment and lack of data on channel geometry)	xx-implicit: Data, context, stochastic, epistemic and recognized uncertainty	Precautionary approach						
	7. Impact prediction regarding effects on water level and velocity	xx-implicit: Data, context, stochastic, epistemic and recognized uncertainty (we can assume that it is the same uncertainty than above))	Not addressed						
	8. Impact prediction regarding the effects on sediment concentration (limited amount of information on sediment concentration and its regional variability in water bodies)	xx-implicit: Data, context, stochastic, epistemic and recognized uncertainty	Conservative estimates and precautionary principle						
	9. Impact prediction regarding the significance of effects on sediment concentration	xx-implicit: Data, context, stochastic, epistemic and recognized uncertainty (same as above)	Not addressed						
	10. Impact prediction regarding effects on channel morphology about the information on hydraulics and sediment transport in delta channel	xx-implicit: Data, context, stochastic, epistemic and recognized uncertainty	Not addressed						
	11. Impact prediction regarding water quality about baseline data,	xx-explicit: Data, stochastic, epistemic and	Conservative estimates						
	13. Impact prediction regarding water quality about the calculation of critical loads	xx-explicit: Model, stochastic, epistemic and recognized uncertainty	Conservative estimates						
	14. Impact prediction regarding the significance of effects on water quality from sediment releases (current understanding of chemical processes)	xx-Implicit: Context, stochastic, epistemic and recognized uncertainty	Not addressed						
Noise	15. Impact prediction regarding noise level	x-Explicit	Conservative estimates				Not disclosed	o	None
Soil and Terrain	16. Impact prediction related to soil conditions	x-Explicit	Conservative estimates and precautionary approach						
Vegetation and Wetland	17. Impact prediction regarding rare plants and vegetation communities	xx-Explicit: Data, context, stochastic, epistemic and recognized uncertainty	Conservative estimates and precautionary approach						
	18. Mitigation measures about the reestablishment techniques for specific rare plants	xx-Implicit: Data, context, stochastic, epistemic and recognized uncertainty	Not addressed						
	19. Impact prediction regarding nitrogen deposition and it impact on vegetation	x-Explicit	Monitoring (vague)						
Wildlife	20. Impact prediction about wildlife mortality rates	xx-Implicit: Data, stochastic, epistemic and recognized uncertainty	Not addressed						
	21. Impact prediction about wildlife	xx-Implicit: Data, stochastic,	Monitoring and implicit						

	distribution and population changes from mortality (due to the uncertainty above)	epistemic and recognized uncertainty	auditing of mitigation measures						
	22. Impact prediction about wildlife movement	xx-Implicit: Data, context, stochastic, epistemic and recognized uncertainty	Monitoring						
	23. Impact prediction regarding wildlife reaction to habitat change about bird habitat modelling results	xx-Implicit: Data, model, context, stochastic, epistemic and recognized uncertainty	Monitoring						
	24. Mitigation measures effectiveness of reclamation practices in the face of climate change	x-Implicit	Monitoring and adaptive management (implicit)						
Biodiversity	Not disclosed	o	None						

9. Deep Panuke Offshore Gas Project

Sectors	Mitigation measures			Contingency Plans			Follow-up Programs		
	Uncertainty about	o/x/xx	Uncertainty adressed with	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with
Air	1. Residual effects regarding localized reduction in air quality	x-Implicit	Not addressed	Accidents and malfunctions	xx	Risk scenario	Not disclosed	o	None
	2. Residual effects regarding severe reduction in air quality	x-implicit	Not addressed						
	3. Residual effects regarding potential flaring of H_2S or SO_2 and reduction of air quality	x-implicit	Not addressed						
	4. Residual effects regarding potential venting of CH_4 and reduction of air quality	x-implicit	Not addressed						
Fisheries	Not disclosed	o	None						
Groundwater, hydrology and water	5. Residual effects regarding localized water quality reduction	x-Implicit	Not addressed						
Noise	Not disclosed	o	None						
Soil and Terrain	Not disclosed	o	None						
Vegetation and Wetland	Not disclosed	o	None						
Wildlife	6. Residual effects regarding malfunctions and accidents impacts :oiling of species (marine mammals and turtles)	x-implicit	Not addressed						
Biodiversity	Not disclosed	o	None						

10. 407 Transportation Corridor Project

Sectors	Mitigation measures			Contingency Plans			Follow-up Programs		
	Uncertainty about	o/x/xx	Uncertainty adressed with	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with
Air	Not disclosed	o	None	Accidents and Malfunctions	xx	Risk scenario	Not disclosed	o	None
Fisheries	1. Impact prediction and 2. Mitigation measure regarding the degree and type of potential adjustment and habitat effects variation because of variation of the specific fluvial geomorphologic and habitat conditions associated with the affected watercourse reach	xx-explicit: Context, stochastic, epistemic and recognized uncertainty	More research and design of mitigation measures (these are not disclosed) and monitoring for situations where Redside Dace is present, but nothing is disclosed						
	3. Impact prediction regarding the potential for and degree of potential effects to fish habitat form and function as a result of secondary effects on channel stability	x-Explicit	More research						
Groundwater, hydrology and water	Not disclosed	o	None						
Noise	Not disclosed	o	None						
Soil and Terrain	4. Mitigation measures regarding erosion and 5. Sediment control failures	x-Implicit	Adaptive management (implicit auditing)						
Vegetation and Wetland	Not disclosed	None	None						
Wildlife	6. Mitigation measures about land requirements for habitat restoration	xx-Explicit: Economic context, stochastic and recognized uncertainty	Not addressed						
Biodiversity	Not disclosed		None						

11. Aquarius Gold Mine Project

Sectors	Mitigation measures			Contingency Plans			Follow-up Programs		
	Uncertainty about	o/x/xx	Uncertainty adressed with	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with
Air	Not disclosed	o	None	Accidents	xx	Risk scenarios are not discussed in depth	Not disclosed	0	None
Fisheries	1. Mitigation measures about Vader's lake spawning restoration site	x-Implicit	Justified, as the creek would revert to pre-impact conditions						
	2. Mitigation measure regarding the success of the fish habitat compensation plan	x-Explicit	Justified by the non-significance of the impact						
	3. Impact prediction about the success of walleye introduction	x-Implicit	Auditing (implicit)						
	4. Impact prediction regarding the reconfiguration of the Deep Lake Lake#2 to support a self-sustaining brook trout population, and the ability of a restored South Crooked Creek to support brook trout	x-Explicit	Auditing (implicit)						
Groundwater, hydrology and water	5. Mitigation measures for groundwater	x-Implicit	Uncertainty is not discussed because impacts will occur in terms of years						
	6. Impact prediction about modeling predictions regarding groundwater	x-Explicit	Not addressed						
	7. Impact prediction about the extent to which cooper concentrations in the final tailings effluent will be reduced beyond those provided by volumetric mass balance calculations	x-Explicit	Justified by "general experience"						
Noise	8. Impact prediction regarding noise level	x-Explicit	Conservative estimates and monitoring						

Soil and Terrain	Not disclosed	o	None						
Vegetation and Wetland	9. Mitigation measures regarding wetland	x-Implicit	Justified by the non-significance of the impact. The wetlands will develop on their own.						
Wildlife	10. Mitigation measures for terrestrial environment regarding feeding areas	x-Implicit	Justified: because the effect is not significant considering the availability of other feeding areas in the region						
Biodiversity	Not disclosed	o	None						

12. Waskaganish Road Project

Sectors	Mitigation measures			Contingency Plans			Follow-up Programs		
	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with	Uncertainty about	o/x/xx	Uncertainty addressed with
Air	Not disclosed	o	None (follow-up program)	Contingencies	o	Risk scenarios are not disclosed	None	o	None
Fisheries									
Groundwater, hydrology and water									
Noise									
Soil and Terrain									
Vegetation and Wetland									
Wildlife									
Biodiversity									