SELECTING VALUED ECOSYSTEM COMPONENTS FOR CUMULATIVE EFFECTS IN FEDERALLY ASSESSED ROAD INFRASTRUCTURE PROJECTS IN CANADA

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ABSTRACT

The concept of a 'valued ecosystem component' (VEC) was introduced in Canada in the early 1980s to bring focus to project-specific environmental assessment (EA), and its corollary, cumulative effects assessment (CEA). Despite the now central role of VECs in EA and that CEA practice has for years been plagued by poor practice reviews, surprisingly little research has been done in the past few decades to examine the principles, processes, and rationales applied to VEC selection in either assessment modality. Because VECs are at the heart of impact prediction, knowing more about how and why they are chosen and if they adequately represent cumulative effects (CEs) may help to reform CEA practice, and improve EA generally. Given this, the purpose of this thesis is to advance current understanding of VECs and VEC selection processes for CEs using comprehensive study EAs of major road transportation projects in Canada as a basis for the investigation.

The research methodology adopts standard methods of qualitative inquiry. First, an in-depth review of literature since 1983 (when the term was introduced) was undertaken to examine VEC concept definitions and applications. Second, a document analysis of 11 comprehensive study reports (CSRs) and environmental impact statement (EISs) prepared for road construction projects was conducted. These CSRs represent the total number of road projects that triggered a comprehensive study since 1995, when CEA was introduced into the *Canadian Environmental Assessment Act*. Third, semi-structured interviews with 22 individuals directly involved in the road construction project EAs were conducted. Those interviewed include project proponents, federal responsible authorities, consultants, provincial government representatives, and Canadian Environmental Assessment Agency project managers. Data were gathered regarding the types of VECs typically selected in EA and CEA, VEC selection processes and actors, their values and rationales, and tools used to aid decision-making. Emphasis was also placed on examining process effectiveness and deficiencies.

Significant findings include that science plays a very limited role in VEC selection for CEA, and overall, the CE VEC selection process is largely subjective rather than evidence-based. Further, CE VEC selection processes are strongly influenced by the initial set of VECs selected for the parent project. Most of the time, VEC lists for both project and CEA are exactly the same. Sometimes, a subset of project VECs are chosen to act as CE VECs using a deductive process called 'residual effects analysis.' CE VEC selection is not sensitive to 'triple bottom line' sustainability principles, and the level of public engagement in VEC selection decreases significantly at this stage of assessment.

In the context of road construction EAs, the major challenges to CE VEC selection are (1) the 'begin-again' approach to each new project assessment, whereby there is very little knowledge transfer or capacity building from one assessment to another; (2) the linear nature of road development, which may compound experts' evaluation of the local and regional importance of some ecological components and the decision to include them as CE VECs; and (3) the growth-inducing potentials of roads, which may result in high environmental risks to some (non-valued) components not anticipated during project VEC selection stage. Conversely, the major opportunities to improve CE VEC selection are: increasing public involvement; application of science to CE VEC selection processes; and early consideration of CEs at the scoping phase of the project assessment. The need for some form of VEC selection guidance in EA is clear, and transcends the road construction sector itself.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CCG	Canadian Coast Guard
CE VEC	cumulative effects valued ecosystem components
CE	cumulative effects
CEA	cumulative effects assessment
CEAA	Canadian Environmental Assessment Agency
CSR	comprehensive study report
DFO	Department of Fisheries and Oceans
EA	environmental assessment
EIS	environmental impact statement
ERA	environmental risk assessment
INAC	Indian and Northern Affairs Canada
INFC	Infrastructure Canada
OEPA	Office of the Environmental Protection Authority (Western Australia)
RA	responsible authority
REA	residual effects analysis
ROW	right of way
SEA	strategic environmental assessment
TC	Transport Canada
TEK	traditional ecological knowledge
VEC	valued ecosystem components
VSC	valued social components
WD	Western Economic Diversification Canada

Chapter One

Introduction

1.1 Research Problem

This research attempts to develop a better understanding of valued ecosystem component (VEC) selection processes involving cumulative effects (CEs). The identification of VECs is a vital issue in environmental assessment (EA) scoping, and important to the agendas of governments, practitioners, and researchers involved in project EAs and cumulative effects assessment (CEA) studies. Academic literature and many regulatory jurisdictions have emphasized the central role VECs should play in understanding cumulative effects (CEs) to examine "…the full range of human-generated stresses" (Duinker and Greig, 2006: 154). Unfortunately, since the concept was introduced there has been very limited discourse on selection processes for VECs for use in CEs (Ball, 2011) — despite that these VECs are being used to understand very complex spatial and temporal changes to the environment. The general literature, which provides both a conceptual and scientific basis for the advancement of CEA, is at present of limited assistance in devising and testing appropriate VEC selection tools. Although conceptual refinements to CEA are ongoing (e.g.: Harriman and Noble, 2007; Gunn and Noble, 2009a), ongoing concerns have been voiced in the literature over the lack of explicit understanding of the approach to VEC selection (e.g.: McCarty and Power, 2000; Dowlatabadi *et al.*, 2004; Bérubé, 2007).

Introduced conceptually by Beanlands and Duinker in 1983, VECs have since taken 'centre stage' in impact prediction processes (Stakhiv, 1988; Duinker and Greig, 2006; Connelly, 2008; Nunes, 2010). At the onset of formal EA practice in North America in the 1970s, the process was often cumbersome and vast, examining the potentially undesirable impacts of projects in relation to all of the environmental values that were being considered (Duinker and Greig, 2006; Morris and Therivel, 2009). More than 20 years later it was posited that a 'good' EA should not waste resources considering information that does not support an understanding of key cause and effect relationships between the project and the environment (Kennedy and Ross, 1992; Barnes *et al.*, 2010; Noble, 2010; Nunes, 2010). Beanlands and Duinker's pioneering work was aimed at streamlining EA processes in Canada by suggesting proponents address only those components identified as germane to the health of the project environment – termed *valued ecosystem components*. Under their model, Beanlands and Duinker (1983) proposed an initial scoping phase in EA in which scientific knowledge and social evaluation would be used to identify the components of the ecosystem that should be studied in detail. Science was expected to fuel the analytical stage of the EA, in which environmental baselines were examined and predictions of ecological effects were made. Specifically, VECs were meant to assist in structuring the analysis phase and provide a clear basis upon which the "significance of change" (Cocklin, 1992a: 43) to the environment generated by the proposed project could be measured. The concept of VECs has since remained a key component of the EA lexicon in many countries around the world (Connelly, 2008) and is now used interchangeably (Ball, 2001) with terms such as "key ecosystem components" (Stein *et al.*, 1999); "valued environmental resources" (James *et al.*, 2003; Cooper and Sheate, 2004); and "valued environmental and community resources" (DEAT, 2004).

For project-specific EAs, including those that incorporate CEs considerations through CEA, the use of VECs as an appropriate yardstick for determining impact significance is a well-established practice in Canada. But it is also well-known that assessing CEs within project-specific EA can be very challenging (e.g.: Duinker and Greig, 2006; Noble, 2008; Gunn and Noble, 2009a), as CEs often extend well beyond the immediate domain of proposed projects. This tension between assessing project-specific effects and broader CEs must surely complicate the VEC selection process, as suggested in several recent works (e.g.: Canter and Kamath, 1995; Duinker and Greig, 2006; Johnson *et al.*, 2011). Yet, there is little documented evidence to imply VEC selection processes for project-specific EA, *or even that the VECs themselves*, are sensitive to CEs when they are being incorporated into the assessment (Ball, 2011). As Duinker and Greig (2006) point out, one of the keys to understanding CEs is to identify where and how different stressors interact to affect VECs; thereby suggesting that a VEC, if carefully selected, can be used to draw attention to the aggregate stresses acting on the environment. Without explicit tailoring, the procedures and information developed for project-specific assessment may be inadequate for the assessment of cumulative impacts, particularly those occurring at regional scale (Davey *et al.* 2000; Kennett 2002; Cooper and Sheate 2004; Dalal-Clayton and Sadler 2005; Duinker and Greig 2006). Some 25 years ago, Roots (1986: 153) argued: "…the varying time and space scales necessary for assessment of cumulative effects may require an approach to selection of 'valued ecosystem components' that is different from that used for assessment of single projects”. Nevertheless, there remains a considerable gap in terms of understanding the processes applied in selecting VECs in project EAs and CEA. VECs are certainly valuable for predicting and managing the effects of multiple stressors on the environment, but if they are not reflective of the dynamic and expansive nature of CEs, they are unlikely to enhance VEC sustainability over a larger spatial extent and in the longer term.

There are a number of intriguing questions about VECs in the context of CEA that set a direction for this thesis: What rationales and practices are used by assessment experts and stakeholders when deciding which VECs will represent CEs? What are the descriptive attributes of the VECs selected? Do current VEC selection practices adequately reflect the nature of CEs? Are there potential opportunities that can be harnessed to improve VEC selection for CEs, and CEA and EA practice generally? Although a number of guidance documents exist for CEA practice in Canada (see: FEARO, 1994; Kingsley, 1997; Hegmann *et al.,* 1999; CEAA, 1999, 2007), they do not sufficiently address this set of questions as they focus more specifically on the nature of and assessment frameworks for CEs. Therefore, an investigation into VEC selection for CEs in project-specific EA is warranted.

The Canadian federal comprehensive study EA process was chosen an appropriate context for the research investigation. It is beneficial to understand VEC selection processes in Canadian federal comprehensive study EA, as this type of assessment accounts for the bulk of projects where CEs are a mandatory assessment component. The purpose of a comprehensive study is to ascertain that proposed mitigation measures are both appropriate and adequate to effectively address “adverse” impacts associated with the project (CEAA, 1992, 2010: S.23) both at the local and regional scale. Screening EA, in contrast, although being the most common form of assessment in Canada, often lacks the capacity to address such large-scale projects as they are generally applied to activities whose impacts are considered negligible.

That said, in July of 2012, just weeks before finalizing this thesis for defense, some important changes to the *Canadian Environmental Assessment Act* (the *Act*) were introduced. The amendments were largely triggered by a politically perceived need to cut back long EA approval processes for certain classes of proposals (e.g. review panel assessments are now limited to a maximum of 24 months), in line with the rapid economic development plans of the Canadian federal government (Armstrong, 2012; Whittingham, 2012). Notable amendments include that supervisory roles for EAs of energy projects will be transferred to the National Energy Board and the Canadian Nuclear Safety Commission (Globe-Net, 2012).

As well, certain projects have been ‘delisted’ from mandatory EA requirements, and assessment types reclassified into two broad categories – ‘standard environmental assessment’ and ‘review panel assessment’, thereby eliminating both screening assessments and comprehensive study assessments (Hopkins-Utter, 2012). To the enthusiasts of the new amendments though, the power of the Minister of the Environment to launch a regional environmental assessment in high velocity development regions should in a way strengthen CEA as aggregate effects of multiple developments can easily be studied (Menegakis, 2012). It has been argued however that the amendment is silent on “the mechanisms for assessing the cumulative effects of the numerous “small” projects that will no longer require environmental assessments” (CELA, 2012: 5).

Both the immediate and far-reaching implications of the amendments to Canadian EA practice are as yet unknown. On the whole, the amendments have been criticized as politically-motivated and as an attempt to weaken federal EA review process in order to appease the energy development sector (Whittingham, 2012).The substantive issues that warrant this study, however, are unaffected by the new amendments because VECs continue to remain an important component of Canadian EA, regardless of the label or classification of the study. Questions on VEC selection ultimately transcend the legislative wrangling in any country given that EA is practiced in nearly 100 counties (Noble, 2010) and is generally considered one of the world’s most important environmental management tools. At any rate, a faster approvals process in Canada should not come at the expense of thorough, environmentally sound decision-making especially with respect to CEs.

In the context of the comprehensive study then, the Canadian transportation sector (road construction) was selected as the context for the study due to the number of comprehensive study reports available and the spatial and temporal implications of such projects, which portend a challenge, in terms of scale and scope, to CEA. The stress of roads on the environment can result in myriad direct and indirect impacts ranging from emissions of air, noise, light and heat pollution, to regional effects such as wildlife habitat fragmentation and rapid community growth. There are often also very wide-ranging effects such as global warming from carbon dioxide emissions (Tricker, 2007). The focus is on road construction projects completed since the introduction of CEA into the Canadian Environmental Assessment Act (CEAA) in 1995.

1.1.1 Research Purpose and Objectives

While processes for selecting VECs for CEs in project-specific EA are largely unclear, both academic and professional literature seems to agree VECs have a central role to play in any effective EA process (Stakhiv, 1988; Duinker and Greig, 2006; Connelly, 2008; Morris and Therivel, 2009; Nunes, 2010). It follows that adequate assessment of CEs within project-specific EAs may not be divorced from the thoroughness and credibility of VEC selection process, or the appropriateness of VECs chosen. As such, the purpose of this thesis is to advance current understanding of VECs and VEC selection processes for CEs using comprehensive study EAs of major road transportation projects in Canada as a basis for investigation. The objectives of this thesis are to:

1. Investigate the VECs used to assess CEs in each comprehensive study, to determine if they are 'distinct' from project-specific VECs identified in the scoping stage;
2. Examine the VEC selection principles, processes, and rationale applied in each study in order to gauge 'sensitivity' to CEs and the effectiveness of current practice; and
3. Identify opportunities and challenges to improve VEC selection for CEs in project EAs in the transportation sector, and more broadly.

1.2 The Potential of the 'Valued Ecosystem Components' Concept

Valued ecosystem components have gained widespread recognition in EA practice globally because of the focus they can give to an EA process, i.e. they serve as the basis for comprehensive analysis of environmental effects (Orian, 1990; Spellberg, 1991). EA practitioners use VECs to provide insight into the significance of environmental change induced by development activities in the environment and the management and monitoring of such change (Ross, 1998; Spaling and Smit, 1993; Gunn and Noble, 2009a; Canter and Atkinson, 2011). Specifically, practitioners look toward VECs as a means to measure potential environmental stressors (Hegmann *et al.*, 2009; Noble, 2005; Park *et al.*, 2010), identify and define specific performance indicators (Canter and Atkinson, 2008; CCME, 2009), and evaluate the effectiveness of proposed mitigation strategies and the EA process altogether (Hanson *et al.*, 2009). Valued ecosystem components have been linked to other forms of assessment including strategic environmental assessment (e.g.: Noble, 2004; Noble, 2009; Sinclair *et al.*, 2009) and sustainability assessment (e.g.: Winfield *et al.*, 2010; Senner, 2011). The VEC selection stage has been identified as a critical stage in environmental decision-making and referred to as both the "building blocks" (Sidle and Sharpley, 1991:2; Porter and Murray, 2010: 4) and the "assessment endpoints" of an effective impact assessment process (Suter, 1990:275; Chambers *et al.*, 1995:275; Hay *et al.*, 1996: 86; Lohani *et al.*, 1997:7; Harwell and Gentile, 2006:208).

The concept has also grown in relevance over the years beyond the field of EA, partly because it forms the nucleus of most types of development project-related assessments and because of its potential for application in the fields of ecological risk assessment (ERA) and broader environmental studies (e.g.: Cirone and Duncan, 2000; McDaniels, 2000; Chapman *et al.*, 2002). The primary application of VECs is within EA based on their role in gauging the effects of development proposals, while the secondary application focuses on their role in ecological studies as "assessment endpoints" guiding environmental policy decisions (Lohani *et al.*, 1997). Regarding the latter, Harwell and Gentile (2006) suggest the two essential components of an ERA framework are: (i) characterization of the stressor (exposure) profile, where a ''stressor'' is defined as any physical, chemical, or biological change that could affect an ecological system; and (ii) characterization of ecological consequences from environmental stressors, evaluated as effects on a set of assessment endpoints, also termed valued ecosystem components (VECs). This framework is particularly relevant to CEs as it addresses "…exposures to multiple stressors…, multiple ecological systems and attributes, natural variability and uncertainties, recovery potential, spatial and temporal heterogeneity, and scale issues in order to support informed decision making using the best available scientific knowledge" (Harwell and Gentile, 206: 204) which are the central concerns in CEA. By implication, the relevance of the VEC concept then is not only that it addresses the shallowness of 'counting everything' approach – a situation where the emphasis of an EA process is placed on collecting large volume of data with little predictive value (Treweek, 1999), but also because it offers the means by which broader environmental and ecological issues, including sustainability and CEs, can be measured, monitored, and associated adverse impacts mitigated.

Valued ecosystem components represent a formal expression of environmental values that are to be protected and can be assessed formally through input from the society (Suter, 1990). As can be implied from this understanding, VEC selection decisions are premised on the values of individuals involved in the process. Suter (1990: 9) further states that such components "must be valued by society, but they are not ultimate values. Rather, they are the highest values that can be assessed formally." In other words, VECs are not simply the most critical environmental component(s), scientifically or biologically speaking; they represent the components that receive the highest and best attention in a particular assessment based on the perception of the majority of stakeholders involved: this may or may not be congruent with 'best science'. This raises an ethical question regarding VEC selection: "By what evidence does a stakeholder judge what should be valued?" Lohani *et al.* (1997) report factors of influence in the choice of a VEC to include its legal status, political concerns, scientific judgment, and/or commercial or economic importance. Further, according to Lohani *et al.,* such VECs must have unambiguous operational definition, be accessible to prediction and measurement, and susceptible to hazards. Similarly, Chambers *et al.* (1995) identify three factors that served as inputs to the VEC (assessment endpoints) selection process, namely species important: a) in the functioning of the ecosystem; b) in the production of food for subsistence; or c) due to their cultural or medicinal significance.

The above VEC selection criteria are so broad as to allow almost any component to make the list, especially when viewed in the context of 'cultural and medicinal significance' as suggested by Chambers *et al.* (1995). If selection criteria are too open, the choice of VECs may be rather problematic as it allows stakeholders to hide under such openness to 'smuggle in' any resource as VECs. In fact, Lohani *et al.* (1997:5) argue that the selection of VECs for their study added to a "host of special problems" that undermines the outcome of the assessment process. Similarly, Feehan (2001) observed that the 'open' criteria used to determine VECs pose a challenge to the scientific integrity or actual reflection of ecosystem health in the process. They report on two major dangers of 'open' criteria. First, public pressure may place focus on a particular feature of the environment because it is rare and not if it, being altered, could result in habitat degradation or ecosystem decline; and second, some components may be termed valued because "they are well-studied and familiar" (p. 6). Feehan suggests the need for a more transparent and rigorous approach to selecting VECs beyond the realm of 'expedience'. Although Stakhiv (1988) asserts that the subjective public evaluation does not diminish or conflict with the role of scientists in comprehensive analyses of environmental resources, the selection of VECs upon which such analyses are based is likely highly influenced by stakeholders' subjectivity.

To fully understand VECs and their application within project-specific CEA, research must look at more than their roles as guiding posts to evaluating environmental effects, but also examine factors that shape VEC decisions and how the rationales applied mirrors the types of cumulative changes that are triggered by road construction projects. This underscores the need to investigate VEC selection processes to better understand what VECs are actually chosen and why when dealing with CEs.

1.3 Determining Valued Ecosystem Components for Cumulative Effects Assessment

Cumulative effects are primarily composed of the consequences of multiple sources of perturbation on the environment. VECs have long been valuable in providing insight into the nature of these often nebulous effects (Ross, 1998). The definition of CEs provided by Spaling and Smit (1993:3) describes them as "…the accumulation of human-induced changes in valued ecosystem components (VECs) across space and over time that occur in an additive or interactive manner". A crucial step in assessing CEs is to identify VECs that adequately capture CEs 'pathways' in space (physical processes of accumulation), as well as how environmental stressors combine to impact the ecosystems across time (past, present, and future), and the overall consequences of a project on the ecosystem (Ross, 1998). In this regard, empirical studies are available to illustrate the temporal and spatial implications of multiple activities on a variety of ecosystems. Each of these studies provides essential insight into the use of VECs in CEs assessment and management. For example, Shirina *et al.* (2011) use VECs to predict and quantify the synergistic effects of multiple drivers of environmental change on a variety of VECs in a multi-functional wetland. Similarly, in the absence of sufficient data on both temporal and spatial processes to engage in detailed impact assessment, a suite of VECs were identified to study the CEs of an integrated coastal area of the city of Xiamen, China (Xue *et al.*, 2004). VECs also served a useful reference or parameter for evaluating the magnitude of the environmental and social impact of roads (United Nations, 2001). This study in particular shows that the impacts of roads on social VECs (e.g. health, safety, economic well-being, security, community cohesiveness, social values, and cultural heritage) are at par with those on biophysical VECs and suggests an improved institutional framework to effectively address the impacts of road development in a holistic manner.

The foregoing studies represent the bulk of available works on the role of VECs in understanding CEs, which is surprising given their central role in project EA. Other available works on VECs have focused on the temporal and geographic extents of VECs appropriate at the level of CEA (e.g.: Tollefson and Wipond, 1998; Treweek, 1999; McGarigal *et al.,* 2001).

Some authors seem to agree that there is no single, widely accepted, or 'appropriate' scale for selecting VECs: while spatial scale may vary based on the planning area and may be based on watersheds, ecoregions, river basins or even habitat ranges of key species, the time scale is often influenced by species or component recovery rates (Tollefson and Wipond, 1998; Treweek, 1999) which are also highly variable. Other authors such as McGarigal *et al.* (2001) suggest that there may in fact be an optimal range of scales to detect the CEs of combined activities on VECs within a planning region. As environmental resources applicable in CEA studies can be spatially heterogeneous, a regional context is often suggested as 'best' for the selection of CEVECs. For instance, Gunn and Noble (2009b) assert that a regional context is necessary to assessing CEA where the focus is on the broader indicators of regional environmental change or ecosystem sustainability including those applicable to project-specific EA.

Looking at the few other studies on VECs, there seems to be more questions than answers on every subject of investigation pertinent to CEA. According to Dowlatabadi *et al.* (2004: 3), "the changing definition of what is valued" remains a challenge in assessing CEs. Senner (2011) reports that 'what truly matters' in impact assessment is the CEs of developments on a VEC because that is what actually happens to such VECs. Ball (2011) recently attempted to characterize factors that shape VEC selection in the context of watershed CEA in southern Saskatchewan. His work suggests that selection of VECs and their indicators in the cases examined does not address the requirements of aquatic CEA in a watershed context. Rather, VEC choices seem to be skewed toward regulatory compliance and licensing arrangements (Ball 2011). His study lends importance to the current study which also investigates the nature of VEC selection and what motivates it.

There is no real controversy about the fundamental role of VECs in an effective CEA, and perhaps Duinker and Greig (2006: 154) communicated this best by saying:

> …instead of focusing on whether a single project may have unacceptable impacts on a specific VEC, the sustainability of that VEC can be understood properly only by examining the full range of human-generated stresses on the VEC. It must be recognized that VEC conservation depends on ensuring that the total effects of all stresses are kept within tolerable and acceptable levels.

Rather, the issue is that VEC selection in project-specific EAs in Canada is simply not well understood. It is not known whether VEC selection reflects the regional nature of many CEs processes, nor whether as subjective, value-laden process it actually serves environmental 'best interests'. Scholarly works seem to have taken for granted an understanding of the VEC selection process overall and more especially for those used in regard CEs. A failure to scope an EA effectively through the selection of appropriate VECs creates the risk that unnecessary work will be undertaken, or that the significant consequences are missed (Treweek, 2001; Snell and Cowell, 2006). Considering that VECs are the investigative focal points of impact assessment, and by proxy CEA (Hegmann *et al.*, 1999; Johnson *et al.*, 2011; Shirina *et al.*, 2011), and that very little research has been done in this area, a systematic inquiry into CE VEC selection is warranted and, arguably, quite necessary to advance EA practice.

1.4 Thesis Organization

The thesis adopts a traditional format. Chapter 2 is a review of relevant literature providing insight into the current state of research on VEC selection in EA, CEA, and for road construction projects more specifically. The review helps clarify the research gap and positions this study in relation to it. Chapter 3 gives a detailed summary of the research methodology, how each method contributes to the research objectives, and how data were collected and analyzed. Chapter 4 comprehensively reports the results of the investigation, while Chapter 5 highlights and interprets key findings from the results. The approach taken is to first analyze significant results obtained through each research method, and later to offer a synthetic discussion of key findings across the entire body of research. Reference to key cumulative effects literature is made throughout to contextualize discussion points. Chapter 6 contains major conclusions arising from the study and provides a list of recommendations to improve VEC selection for CEs, particularly for the transportation sector. Suggestions for related future research are also made.

Chapter Two

Literature Review

2.1 Valued Ecosystem Component

2.1.1 Origins of the VEC Concept

In the early days of EA practice, the attempt by project proponents to satisfy regulatory requirements often resulted in production of large EA reports hardly understood (where available) by non-technical public, and whose contents often offered little assistance in decision-making (Kennedy and Ross, 1992; Treweek, 1999). As a result, large-scale projects at the time were beginning to attract criticisms. For instance, in a critique of the *Beaufort Sea-Mackenzie Delta* EIA (1982), Kennedy and Ross (1992: 477) stated:

> …the EIA consisted of over seven volumes of information. Lacking previous models, this EIA attempted to address all of the potential project impacts on a wide number of resources. As little effort was directed towards the identification of key issues, the EIA was weakly focused, voluminous, technically oriented, and poorly organized for use by either regulatory bodies or the public.

As more attention was being drawn to the perceived weakness of EA reports, the need for a more rigorous and issue-based scoping process became apparent.

In 1983, Beanlands and Duinker coined the concept of "valued ecosystem component" (VEC) in a report that developed an ecological framework for EA practice in Canada. Valued ecosystem components were meant to focus decision-making in the EA and improve its quality. Their report, which was the first of its kind in Canada, concluded that because VECs set the direction for the entire assessment process, the 'means' and 'criteria' for selecting VECs should be defined unequivocally at the outset. The 'VEC-based' approach has since taken a center-stage in all types of EA including project-specific, cumulative effects assessment, strategic EA, as well as ecological risk assessment (see Figure 2.1).

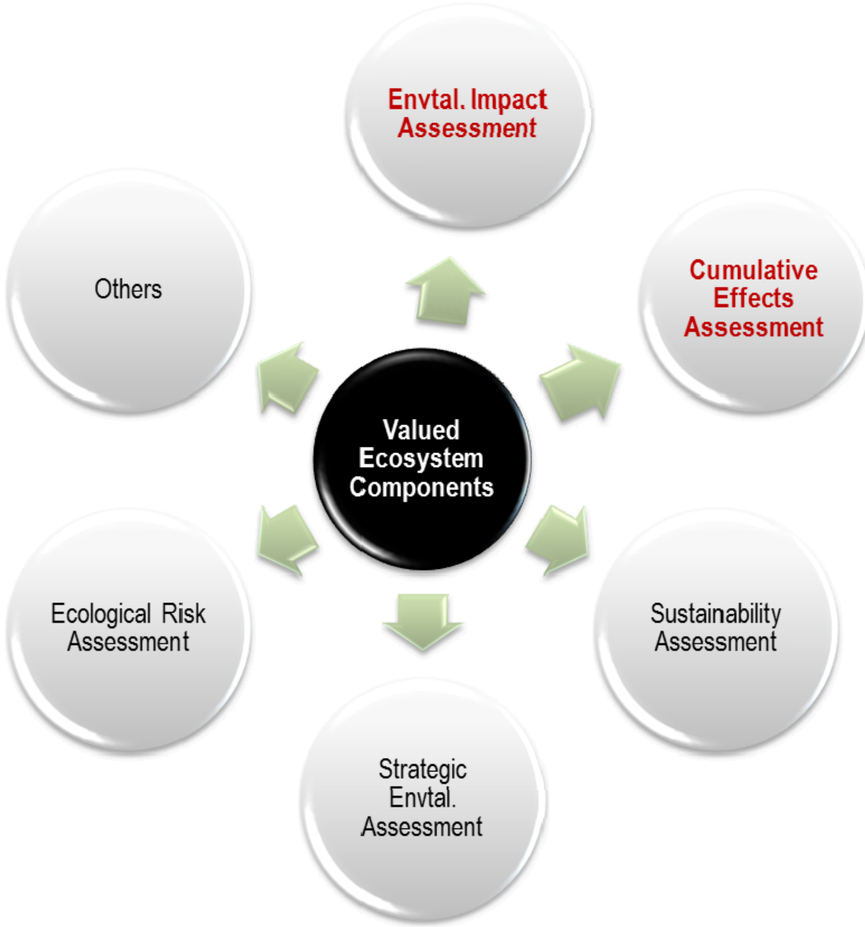

Figure 2.1: Application of VECs to different forms of environmental assessment

A central objective in utilizing VECs within an EA process is to set a common evaluative standard early in the EA process, especially with respect to the scientific quality of the impact assessment. Consequently, VECs have been likened to both 'building blocks' (Sidle and Sharpley, 1991:2) and the 'assessment endpoints' of an effective impact assessment process (Suter, 1990:275; Chambers *et al.*, 1995:275; Lohani *et al.*, 1997; Harwell and Gentile, 2006:208). Essentially, Beanlands and Duinker's framework was developed to address the challenges associated with project-specific EAs. Applying VECs to cumulative effects was not specifically envisaged; neither with regard to their expansive nature nor their multiple scales of interaction which would typically exceed the boundaries of a project-specific EA. As early as 1986, Roots *et al.* argued: "the varying time and space scales necessary for assessment of cumulative effects may require an approach to selection of 'valued ecosystem components,' that is different from that used for assessment of single projects" (Roots *et al.*, 1986: 153).

Yet, selecting VECs for cumulative effects as an aspect of EA practice sits among a wide constellation of issues undermining the effectiveness of CEA in project-specific context (Dowlatabadi *et al.*, 2004; Bérubé, 2007). Generally speaking, much of CEA practice within project-specific EAs has been viewed with disapproval over the years (e.g.: Canter and Kamath, 1995; Duinker and Greig, 2006; Noble, 2008; Gunn and Noble, 2009a; Johnson *et al.,* 2011). Common barriers to better practice include: the limited spatial and temporal scales within which project-specific EAs are examined (Duinker and Greig, 2006; Johnson *et al.*, 2006); inadequate scientific thoroughness in impact prediction (Greig and Duinker, 2007, 2011; Seitz *et al.*, 2011; Chiasson, 2012), and the inability to fully capture or predict the interactions among multiple stressors (Harriman and Noble, 2008; Gunn and Noble, 2011; Seitz *et al.*, 2011). For many proposed projects, the time, resources, project scope, and planning orientation are usually too restrictive and inward-focused to effectively examine CEA (Gunn, 2009). These shortcomings have potential implications for how VECs for cumulative effects are selected in such a context. To explain further, the following sections examine the current state of research on VECs in EA and CEA generally, and then within the context of road construction projects more specifically.

2.1.2 Definitions of Valued Ecosystem Components

In order to develop a full understanding of the VEC concept, the term has to be examined in the context of Beanlands and Duinker's (1983:18) pioneering work:

> "…the environmental attributes or components identified as a result of a social scoping exercise… (which) may be determined on the basis of perceived public concerns related to social, cultural, economic or aesthetic values. They may also reflect the scientific concerns of the professional community as expressed through the social scoping procedures…"

In Beanlands and Duinkers' original definition, it is quite clear that VECs are primarily conceived to be "environmental attributes" selected because of social, economic, aesthetic or scientific concerns. This biophysical emphasis has been observed by a number of researchers (e.g.: Szuster and Flaherty, 2002; Bérubé, 2007; Noble, 2010) and has primarily shaped the understanding of VECs in impact assessment, although different definitions are used depending on the context and jurisdiction of use. In contrast though, some authors (e.g.: Shoemaker, 1994; Coffen-Smout *et al.*, 2001) suggest the scope of VEC should extend beyond ecological issues to include social, economic, cultural, and natural components of the environment.

Adopting an expansive definition of VECs is different than adopting an expansive approach to the assessment. Treweek (1999) describes the shallowness of a 'count everything' approach – a situation where the emphasis of an EA process is placed on collecting large volume of data with little predictive value – and stresses the need to focus the assessment process on VECs. Treweek defines VECs as: "ecosystem components that are considered to be important or valuable and that merit detailed consideration in the EcIA [ecological impact assessment] process" (p. 92). This definition supports the original objective of introducing VECs, i.e. that a good EA should not waste resources considering information that does not support an understanding of the potential environmental effects of a proposed development (Kennedy and Ross, 1992; Duinker and Greg, 2006; Barnes *et al.*, 2010; Noble, 2010; Nunes, 2010). The point was that examining the undesirable impacts of projects in relation to all environmental values would be rather cumbersome and too vast to achieve the goal of an impact assessment (Duinker and Greig, 2006; Morris and Therivel, 2009).

The work of Gaudet *et al.* (1995) also supports the original, biophysical-focused definition of VECs. They define VECs as resources or environmental features that: (i) are important to human populations (intrinsic, economic, and/or social value); (ii) have local, regional, provincial, national, and/or international profiles; (iii) if altered from their existing status, will be important in evaluating the impacts of development and in focusing management or regulatory policy. Gaudet *et al.*'s definition of VECs addresses the actors (human populations) involved, the jurisdiction or scope of consideration, and the ecosystem management role of VECs. However, some authors have adopted more narrow interpretations of the concept. These include defining VECs as narrowly focused on achieving environmental protection and conservation objectives (Tricker, 2007); as a form of response to public opinions or concerns (Shoemaker, 1994; Gordon, 1998), and to achieve ecosystem management objectives (Gordon, 1998). This is not to say that these definitions do not contribute to an understanding of VECs, in fact they do when they are viewed collectively, but that such definitions are individually too restrictive in capturing the original objectives of VECs in an EA process.

In order to provide some guidance under which proponents and stakeholders can efficiently prepare environmental impact statements, a number of Canadian government agencies and organizations are explicit on the definition of VECs. For instance, in the *Cumulative Effects Assessment Practitioner Guide* developed for use under the federal EA process, which has served as a primary reference document for Canadian practitioners on using VECs in CEA, Hegmann *et al.* (1999:4) define a VEC as: "any part of the environment that is considered important by the proponent, public, scientists and government involved in the assessment process. Importance may be determined on the basis of cultural values or scientific concern". Many provincial EA jurisdictions appear to simply follow this definition as further efforts are not made in provincial EA legislation to be explicit on the definition of VEC. British Columbia is an exception to this trend. In its *Environmental Assessment Office User Guide*, the term 'valued component' is used and defined as: "components (environmental, economic, social, heritage or health) that are considered important by the proponent, public, First Nations, scientists and government agencies involved in the assessment process" (Government of BC, 2010: 27).

Outside of a legislative context though, it seems organizations prefer not to adopt terribly explicit definitions of VECs. In its online environmental terminology and discovery service (ETDS), the European Environmental Agency (EEA) defines VECs as: "an appraised, evaluated or estimated element or ingredient of a biological community and its non-living environmental surroundings" (accessed December 2, 2011 at: http://www.eionet.europa.eu/gemet/concept?cp=8892&langcode=en&ns=1). This is a rather vague, open interpretation of the term. To take another example, the International Northern Sea Route Programme (INSROP) also offers a broad understanding of VECs as: "a resource or environmental feature that is important (not only economically) to a local human population, or has a national or international profile, or if altered from its existing status, will be important for the evaluation of environmental impacts of industrial developments, and the focusing of administrative efforts". Although broad, this definition acknowledges the purpose of VECs which is to structure the analysis phase of the EA (Gaudet *et al.*, 1995) and provide a clear basis upon which the "significance of change" (Cocklin, 1992a) that will be generated by the proposed project can be measured.

According to Coffen-Smout *et al.* (2001:39), there is a continued need for definitions that reflect the broad realities of ecosystems: "The valued ecosystem components methodology provides an adaptable basis for identifying key issues but present definitions will need to be expanded to address the broader objectives proposed under an ecosystem approach, as well as to include evolving public concerns related to social, cultural, and economic uses…" In spite of the divergence in definitions of VECs, the common understanding seems to be that they are environmental attributes whose indicators provide an important criterion by which changes to the environment can be evaluated and upon which the analysis stage of an EA can be focused. While it may not be necessary to establish a universal definition of VECs, their central role in the EA process and CEA (discussed in the next section) makes VEC selection an important process to understand.

2.1.3 Uses for VECs in Environmental Assessment

Since the work of Beanlands and Duinker (1983), the idea of using VECs as the focal point of an EA has gained significant momentum as numerous communities inside and outside Canada, both regulatory and academic have embraced the use of the concept in their EA processes. Particularly, in recent years, more and more legislation is requiring that VECs be used as the basis to determine the suite of indicators that are then used to evaluate impact significance in different forms of assessment (e.g.: DEAT, 2004; Sanchez and Morrison-Saunders, 2010; Fry *et al.*, 2011). For example, the European Union under its Water Framework Directive has promoted the use of VECs to conduct SEA of water projects (Fry *et al.*, 2011). Certain jurisdictions in Australia have also followed this trend. For instance, in South Australia, VECs are recognized under the *Environmental Protection Act* (1993) as important to promote the principles of ecologically sustainable development (Section b (iv)).

Similarly, the Western Australia Office of the Environmental Protection Authority (OEPA) categorizes what it terms "key environmental factors" into two components – *critical environmental assets* and *high value assets* (Sanchez and Morrison-Saunders, 2010). While the former is a term used to describe factors of foremost importance in an EA, the latter is used to designate other environmental components or assets that require high level protection. An earlier classification adopted by OEPA focused on selected environmental components such as: "declared rare flora" and "threatened ecological communities" (Sanchez and Morrison-Saunders, 2010: 4). In either case, the objective was to aid decisions on applications submitted to the agency by providing project officers with a quick overview of the spatial context of development proposals.

Apart from the function of VECs to aid decisions on the need for and scope of EA, some authors focus on linking a VEC-based approach to sustainability. Duinker and Greig (2006), for example, in their critique of the efficacy of CEA practice in Canada posited that the main task of EA is to contribute to "sustainable development by safeguarding VEC sustainability in the face of development that might compromise that sustainability" (p. 153). Because consideration of all environmental values associated with a development proposal may result in most components not receiving adequate attention, and as a consequence result in undesirable impacts, focusing on VECs is valuable to achieving sustainability where detailed consideration is on fewer components. In this regard, Swor and Canter (2008) suggest linking VECs used for CEA with environmental sustainability and incorporating both into a larger strategic (programmatic) study to achieve regional planning objectives.

Another related use for VECs is to understand the implications of development projects in regions with limited geographic knowledge and data. For instance, the task of examining the relative importance of marine resources in the Northern Sea Route (NSR) was shaped by the identification of appropriate VECs along the route (Valsson, 2006). A major outcome of this initiative is the preparation of a *Dynamic Environmental Atlas* to understand the extent of impacts that a project may produce on different components of the environment in the region and to appreciate the "potential or ability of various animal species to interfere with NSR activities" (p. 144). This rationalization focuses on environmental protection and sustainability of such pristine region in the light of large scale human intervention envisaged along the route. Six broad regional VECs were identified in the Atlas (i.e. indigenous-local peoples; water-border zone; benthic invertebrates; fish; birds; and marine mammals) and have since served as subjects of scientific investigations in the region (Brude *et al.*, 1998; Valsson, 2006; Brubaker and Ragner, 2010).

From the applications of VECs described above, a few themes appear to be consistent across all of them. There is something about decision-making, environmental protection, and sustainability as well as the roles of VECs in linking human perturbations to ecosystem health, and preventing ecosystem deterioration. Despite the various applications of the VEC concept, very little work has been done to determine how VECs are selected in project-specific EAs, and there is virtually no literature that clearly describes how VECs within a more complex framework of cumulative effects assessment are conceptualized or evaluated. The next section examines some of this limited literature, beginning with the nature of cumulative effects and progressing to the role of VECs in their assessment.

2.2 Cumulative Environmental Effects

2.2.1 The Nature of Cumulative Effects

Large-scale project developments often have diverse consequences some of which are not easily obvious within the immediate environment of the project. Even the effects that are common and easily predictable can cause adverse effects on some components of the environment when viewed in a longer temporal context. Failure to take these kinds of effects into proper consideration at the onset can result in significant damage to the environment (Roots *et al.*, 1986; Bonnell and Storey, 2000). In addition, the aggregate of such effects often exceed the sum of individual effects when left to accumulate over time and space (Spaling and Smit, 1993). A number of nomenclatures have been used to describe these types of effects; these include cumulative environmental change, cumulative effects, cumulative environmental effects, and cumulative impacts. The absence of a common terminology is not an issue of much debate in EA literature as most agree cumulative effects are those 'beyond project' spatial and temporal impacts (Beanlands *et al.*, 1986).

As a result, in many EA regulatory jurisdictions, the need to understand cumulative effects of projects has steadily gained attention over the past twenty years (Bonnell and Storey, 2000; Smith, 2006; Canter and Ross, 2008; Heckbert *et al.*, 2010; Schultz, 2012). Whereas in the period before 1980s, a formal requirement to consider cumulative effects of projects was a subject of little consideration lacking regulatory procedure, there was a rapid awareness in most western countries of such need from the 1990s. For instance in Canada, the creation of the Canadian Environmental Assessment Research Council (CEARC) in 1984 brought the need for the consideration of cumulative effects of projects into the official limelight (Duinker, 1994; Harriman and Noble, 2008); however, it was not until 1995 that the CEA was made a mandatory requirement under the *Canadian Environmental Assessment Act* (Duinker and Greig, 2006). With the latest changes to this legislation, mentioned in Chapter 1, CEA remains a requirement of project proponents.

In spite of this advancement, cumulative effects definition remains a contentious topic in literature. In fact it can be said that in the over 40 years history of EA, there appears no class of effects whose definition has generated more controversy than cumulative effects (Kamaras, 1993; Canter and Kamath, 1995; Duinker and Greig, 2006; Smith, 2006). This is evident from the overwhelming number of publications that critique both the conceptual understanding and the practice of cumulative effects. Stakhiv (1988) put this controversy in a clearer perspective: “a larger lexicon of terms is used to characterize the vast diversity of cumulative effects themselves. Such terms as synergistic, interactive, crescive, time crowded, etc., need better definition, but in the meantime we must contend with terminological imprecision” (p. 728). Boyle *et al.* (1997) argue that “while some effects are additive, some synergistic and some probably ‘subtractive’, others are too complicated to simply characterize”. However, the task of defining cumulative effects has been approached in different perspectives. Most of these definitions originate from complex interaction between multiple human activities, the environmental systems, and the spatial and temporal scales. For instance, one of the foremost definitions of cumulative effects is provided by US Council on Environmental Quality (1978):

> the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.” (Sec. 1508.7)

Lee and Gosselink (1988), however, noted that this definition places more emphasis on the incremental nature of cumulative impacts on the environment, rather than on recognition of the ways that environmental effects accumulate. In other words, cumulative effects have time and spatial dimensions, and the pathways could be additive or synergistic and sometimes indirect (Smit and Spaling, 1995; Brismar, 2004). Many other authors, in line with the CEQ definitions, have focused on this aggregative context by stressing “other past, present, and reasonably foreseeable future impacts” (e.g.: Johnston, 1994; Ross, 1998; Canter, 1999; Hegmann *et al.*, 1999; Walker and Johnston, 1999; MacDonald, 2000).

Another approach is to define cumulative effects on the basis of the sources of change and pathways of effects interaction. In this regard, the environment is viewed as a system with multiple sources of perturbations which act together to impact its processes (Cocklin, 1993; Bedford, 1999; Krzyzanowski, 2011; Scherer, 2011). Cocklin (1993: 454) states that cumulative effects are “effects of multiple inputs to, or withdrawals from, natural systems.” Krzyzanowski (2011) also argues that such effects should be seen as “the outcomes of numerous pathways of influence initiated by the interactions between multiple human activities in shared space and time” (p. 254). Similarly, Scherer (2011) describes cumulative effects as “the net effect that a resource experiences from the combined influences of multiple management practices or influences often in combination with natural disturbance regimes distributed through space or time, or both" (p. 14).

In contrast, Reid (2010) argues that the controversy surrounding the definition of cumulative effects is unwarranted as 'there is nothing sophisticated or mysterious about the term "cumulative effects."' She posits that this simply implies that the cumulative effect is greater than just the accumulated effects or the simple sum of effects because interactions between the effects are often involved (Scherer, 2011). While divergent conceptualizations of cumulative effects may be some cause for concern, the assessment of cumulative effects is a much more controversial subject within the context of project-specific EA due to numerous and persistent challenges. These are outlined in the following section.

2.2.2 Cumulative Effects Assessment Challenges Within Project-Specific EA

The challenge of conducting CEA as part of project-specific EA has long been recognized. In such a context, according to Roots *et al.* (1986), CEA is a 'hydra-headed issue' fraught with controversy. Andrew (2008) went so far as to describe CEA as an "orphaned concept" which despite its crucial role "will not fit easily into present land-use decision-making systems" (p. 28), including EA.

Many authors have documented procedural shortcomings (e.g.: Kennett, 2000; Baxter *et al.*, 2001; Duinker and Greig, 2006; Therivel and Ross, 2007; Gunn and Noble, 2009a; 2009b, 2011; Connelly, 2011), but the central stumbling block is understanding how focusing on a single project can help in the analysis of the much broader geographic impacts that a CEA is supposed to address. Briefly, some specific criticisms include:

i. failure in terms of the limited scope and scale of a single project which focuses on project-related stressors and thus excludes the potential to address issues of broader environmental implications that CEA is meant to consider (e.g.: Benson, 2003; Duinker and Greig, 2006, Gunn and Noble, 2011);
ii. currently available methodologies for conducting CEA do not fit neatly into a single project context (e.g.: Piper, 2001; Cooper and Sheate, 2002);
iii. ambiguity in the criteria and requirements for CEA in certain regulatory jurisdictions which often mask the extent of issues to be considered in the project EA (e.g.: Kennett, 1999)

Overall, the pervading impression is that project-specific assessment lacks the essential breadth and innovation required to undertake such a complex task, a fact which has continued to provoke serious debate as to the relevance of CEA in such restrictive context (Duinker and Greig, 2006; Gunn and Noble, 2011). Although CEA is a direct response to perceived deficiencies in conventional approaches to EA (Gardner *et al.*, 1988; Gardner, 1989), the "general shallow interpretation of what cumulative effects really are" (Duinker and Greig, 2006: 156) is an added challenge to considering such effects under a single project.

Process-wise, CEA has been viewed as a subjective and context-driven exercise that is often inadequately understood, sometimes even by those who carry out the assessment (Gunn and Noble, 2011). The situation is not helped by the fact that required data on other projects are often not accessible to those involved in single project assessment (Canter and Kamath, 1995); and when supposedly "good data are gathered, project-focused EIAs often fail to conclude a likelihood of significant residual cumulative effects, yet clearly over time obvious and ample evidence has been found to the contrary" (Johnson *et al.*, 2011: 482). Such inadequacies compromise the credibility of the EA process itself, the expert judgment of decision-makers, and the continued success of the entire CEA practice.

In response to these deficiencies, consideration of CEA under a strategic environmental assessment (SEA) framework has been suggested. For instance, Gunn (2008) noted that the ability of SEA, especially at the regional scale, to address broad scale of assessment and focus of future developments provides a ready platform for effective consideration of CEA. Similarly, Dalal-Clayton and Sadler (1998) hinge the rationale for SEA on the basis of its potential to strengthen project-specific EA, advance sustainability agendas, and address cumulative and large-scale effects. The SEA context allows CEA to focus on 'regionally relevant' VECs (Gunn and Noble, 2009a), whose aggregative effects can hardly be understood within project-specific CEAs. Developing institutional capacity required at the strategic or regional scale to overcome technical challenges associated with project-specific CEA will be important for the improvement of the current practice.

However, understanding VEC selection process for CEA is also part of this capacity development, whether viewed in a project-specific or a regional context. In other words, while a strategic/regional framework is important to address cumulative effects, and should be pursued; there is more to a healthy ecosystem than simply defining a regional assessment framework. At the foundation of the assessment process, it is very important to pay attention to ensuring that appropriate VECs are selected to reflect complex environmental system interactions, including social and economic features. The central role of VECs in CEA is now briefly discussed in the next section.

2.2.3 A VEC-Based Approach to Cumulative Effects Assessment

In a typical CEA process, one of the tasks at the outset is the selection of appropriate regional VECs. By definition, the term 'regional VECs' implies that such components reflect regional issues of concerns that transcend the project's local environment e.g. biodiversity, habitat connectivity, air quality, fragmentation (Harriman and Noble, 2008; Noble and Harriman, 2008). While VECs routinely selected under project-specific EAs may be considered as regional VECs, the emphasis is on components that are valuable in examining the full range of stresses expected at a broader scale of a region and in developing mitigation and planning initiatives that can help address such stresses (Duinker and Greig, 2006; Noble, 2010).

A major goal at this stage is to determine key environmental concerns that can be used to make informed decisions about sources of perturbations, their pathways as well as the required mitigation efforts (Hegmann *et al.*, 2009; Noble, 2005; Park *et al.*, 2010). Within the last 20 years in particular, a VEC-based approach has taken centre-stage in CEA processes (e.g.: McCold and Salisbury, 1996; PDE and Hills, 2001; Canter and Ross, 2008; Noble, 2011; Connelly, 2011; Johnson *et al.*, 2011). Canter and Ross (2008), for instance, argue VECs should form the fulcrum of CEA studies, as they provide a means to adequately integrate "project effects at local, regional, and strategic spatial areas" (p. 1). Duinker and Greig (2006: 154) seem to agree, stating that a VEC-focused CEA could ensure the total effects of human-induced stresses are kept "within tolerable and acceptable levels". In practice, VEC-centered CEA seems to be quite common. For example, a review of 50 UK environmental impact statements by Cooper and Sheate (2002) revealed: "the scope of cumulative effects investigated was focused on…valued environmental resources" (p. 424).

Focusing on VECs can provide an opportunity for taking a closer look at key environmental issues and their sustainability implications than may be necessary in project EA (Bérubé, 2007; Senner, 2011). For example, a review of 12 CEAs of Hydro-Quebec's (Canada) concluded that a well-documented scoping exercise should ideally offer valuable opportunity to identify appropriate VECs and relevant indicators to examine temporal changes induced by multiple activities to the environment (Bérubé, 2007). VECs are generally relevant to the sustainability agenda (Duinker and Greig, 2006; Swor and Canter, 2008; Senner, 2011). Senner strongly argues (2011) CEA is about sustainability appraisal of VECs, as it predicts the actual degree of exposure a VEC would encounter and the resilience of such VECs over a long term. However, the means by which VEC decisions are made should be consistent, transparent, and objective enough to ensure that right judgments are made (Treweek, 1999; OECD, 2001).

Definition of a 'regional VEC' is necessary in order to select components that are sensitive to effects at regional scale, although such definitive standard is clearly missing. On a conceptual basis, a watershed basin approach provides a scale than can integrate features across the river basin and those suitable at project local area (Ball, 2011). On administrative scale, Sinclair (1997) suggests that certain VECs (e.g. water quality) is best treated at a regional scale – the level of the 'eco-district' – because of its sensitivity to agricultural practice at such a scale. Spatially, it could be viewed as species abundance or distribution across a project regional boundary (e.g. a regional population of caribou) (Duinker and Greig, 2006).

In the long run, the validity (or otherwise) of an assessment result strongly depends on the criteria used to select the VECs and the quality and rigor of the assessment process (Hay *et al.*, 1996). While current Canadian EA guidance documents place high value on a participatory approach early on in an EA process, when project-specific VECs are typically selected, the means and procedures for integrating stakeholders' inputs into decision-making remain unclear. For example, McCarty and Power (2000) acknowledge the value of VECs to EA decision-making and in particular the inclusion of 'social values' into the process. They also note that participatory processes support regulatory efficiency and effectiveness. However, the absence of "specific details on the mechanisms for selecting valued ecosystem components" (p. 317) notably undermines the benefits of such an inclusive process.

It is clear by the foregoing that the selection of VECs for cumulative effects involves a complex set of decisions (Bérubé, 2007) and that concern over the lack of explicit understanding of the approach to VEC selection is increasing (e.g.: McCarty and Power, 2000; Dowlatabadi *et al.*, 2004; Bérubé, 2007). Practitioners continue to struggle under the constraint imposed by lack of guidance for making decisions on CE VECs (e.g.: Bérubé, 2007; Dowlatabadi, 2004), and in many circumstances, concern is warranted given the spatial and temporal scales in which CEA is carried out.

For many non-linear, site-specific projects (e.g. mining, waste management facility, marine terminal etc.), EA consultation processes are somewhat easier to define and subsequently integrate into decision-making. Cumulative effects assessment in this case is limited to effects that can be directly and physically associated with the proposed project, in combination with other existing and reasonably foreseeable projects. On the contrary, linear development projects (roads, pipelines, transmission lines etc.) generally traverse many different physical, political and social jurisdictions and by implication, involve a much broader range and complex set of potential cumulative effects, both spatially and temporally. This renders the VEC selection process a rather even more complex undertaking, particularly with respect to public consultation. In particular, proposed linear road construction projects often attract a myriad of controversies given the usually large spatial context that is affected, as well as the unpredictable social consequences of roads. As such, EAs of road construction projects make an especially interesting context within which to examine VEC selection for CEs. The next section examines the environmental effects of road construction and how the spatial and temporal dimensions of this type of linear project development can lead to pressure on VECs and a range of cumulative effects.

2.3 Road Construction Project Assessment

2.3.1 Typical Effects of Road Construction

In the 20th century, road expansion projects have been a key driver of economic growth (Pirie, 1993; Brunger, 2003; Coffin, 2007). The rapid development that occurred in Europe and North America following Second Industrial Revolution was significantly influenced by massive investment in the transport sector, and this investment trend continues on a global basis. In addition to urban road building, there is still heavy emphasis on road construction to link isolated communities and enhance the movement of natural resources to export or processing locations. In Canada, transportation policy has placed major emphasis on linking east-west axes of the country (Strange, 1988; Phillips and Nolan, 2007). Consequently, significant investment has been made into road building within and between provinces. The Transportation Association of Canada (TAC) estimated the 'total length' of the road network in the country as at 2005 to be approximately 1.4 million kilometers, most of which is managed under provincial jurisdiction (Padova, 2005; TAC, 2006). But the trend has not changed. Over the past decade and coming decades, there will be significantly more development of roads in Canada to expand the range of access to and exploit remote natural resources. Anticipating this trend, it is both important and current to investigate the implications of such developments on VECs as part of the CEA process.

There is a large body of empirical evidence available at both local and international levels on the environmental effects of roads, especially in the field of ecology (e.g.: Forman, 1998; Forman and Alexander, 1998; Spellerberg, 1998; Forman, 2000; Jones *et al.*, 2000; Lugo and Gucinski, 2000; Trombulak and Frisell, 2000; Saunders *et al.*, 2001; Geneletti, 2003; Brock and Kelt, 2004; Dodd Jr. *et al.*, 2004; Hawbaker, 2004; Jaeger *et al.*, 2005; Coffin, 2007; Delgado *et al.*, 2007; Fu *et al.*, 2010; Daigle, 2010). Trombulak and Frisell (2000) suggest that direct environmental effects of roads can be categorized into seven areas: (1) increased wildlife mortality associated with construction; (2) increased human mortality due to vehicle collision; (3) modification of wildlife behavior; (4) alteration of the physical environment; (5) alteration of the chemical environment; (6) spread of exotic species; and (7) increased alteration and use of habitats by humans. Road and road-related activities are particularly significant in terms of their effects upon wildlife species. As observed by Forman and Alexander (1998: 212), vehicular roads have probably overtaken “hunting as the leading direct human cause of vertebrate mortality on land.”

Daigle’s (2010) recent review of literature on the environmental impacts of roads, management responses, and related research gaps offers some useful insights on this issue. The review focuses on three broad environmental components – terrestrial and aquatic wildlife, plant communities, and physical elements of the environment – with primary reference to landscapes in British Columbia (Canada). Apart from the direct impacts of roads that often result in habitat loss and ecosystem degradation, Daigle (2010) compiled a list of twenty road-related activities that are issues of environmental concern in the province. These include slope failures; sediment production and transport; stream and pond contamination; effects upon stream water temperature and drinking water quality; among others. In all of the areas reviewed, the study found that "the environmental consequences of roads are becoming increasingly important in management decisions… (and) substantial research information and ample recommendations are available from specialists” (p. 78–79).

While there is general agreement that road construction is a leading cause of adverse effects on VECs and warrants impact assessment, as multiple roads are built in an area there is a ‘compounding’ effect upon environmental receptors (McGarigal, 2001; Tricker, 2007). When selecting VECs for a road construction project assessment, therefore, the literature appears to suggest that VEC sustainability will be an impossible goal if the cumulative effects of multiple road projects are ignored.

2.3.2 Cumulative Effects of Road Construction

According to Tricker (2007), the stress of road transportation on the environment can result in multiple direct (and indirect) impacts ranging from emissions of air, noise, light and heat pollution, to regional effects such as fragmentation of wildlife habitats and rapid community growth, to long-term effects such as global warming effects from carbon dioxide emissions. Wasike (2001) describes four common scenarios that can trigger cumulative effects related to road construction: i) single, large events such as the construction of a major highway, (ii) multiple, interrelated road projects within a region, (iii) sudden, catastrophic events such as a major landslide into a river or waterbody, and (iv) incremental, widespread, slow-change events such as a poorly designed culvert or drainage system along a road passing through a watershed. Any of these cumulative effect 'pathways' can result in additive, interactive, or synergistic effects, resulting in damage to the function and structure of affected VECs. For instance, with respect to wetlands, Noble *et al.* (2011) recommend expanding the assessment scope beyond the immediate boundaries of a linear development to capture both indirect and induced effects of the project, including effects on regional hydrology.

It is obvious, based on the above, that the spatial and temporal implications of road projects pose a challenge within the scope of a single project assessment. For this reason, there have been calls for attention to the cumulative nature of road-related environmental impacts. For example, the United States Council for Environmental Quality, recognizing the additive nature of road effects, suggests that the evaluation of effects of similar past actions such as the construction of pipelines and power lines through a particular forest region or expanse of land may provide a more reliable basis for predicting the likely effects of a proposed road construction (CEQ, 1997). Tricker (2007) argues that CEA of road construction will help to widen the scope of analysis by emphasizing the key facets of sustainable development. A few authors have argued that environmental impacts from road developments are best addressed within the framework of a comprehensive environmental assessment study (e.g.: McGarigal, 2001; Wasike, 2001; World Bank, 2005). In this approach, the total impact on VECs is predicted within the historical context of existing impacts, and in conjunction with any other development projects and actions affecting the same resources.

Unfortunately, most of the literature available on the cumulative effects of road construction is very rudimentary, with a very limited number of case studies (mostly in the field of ecology). Most papers and reports simply mention the subject rather than study it directly. Where some illuminating research has been carried out, the 'nibbling losses' – gradual disturbance and losses of land and habitat (Baskerville *et al.*, 1986: 161; Contant and Wiggins, 1991) – induced by roads have been the major emphasis. McGarigal *et al.* (2001) investigated the spatial and temporal magnitude of change in landscape structure induced by road construction in combination with logging activities in the San Juan Mountains in Colorado (USA). They observed that the cumulative effects of both activities are trivial within a short temporal limit (10 years) but become significant over a longer time (40 years). When observed spatially, the result is in the reverse: effects were minimal at a longer spatial scale (228,000 ha) but evident in the intermediate scale of 1000-10000 ha. They suggest there may be an optimal range of scales to detect the cumulative effects of multiple activities on landscape structure within the study area. Another, later study by Ziegler *et al.* (2004) observed in Thailand that when combining road construction with other agricultural activities, roads contribute disproportionately to regional basin runoff and sediment yield. Hence, relationships between activities and VECs are not always clear-cut and may involve a strategic approach towards ascertaining aggregate effects of roads on VECs (Jaeger *et al.*, 2007; EEA, 2011).

Related to measuring and monitoring cumulative impacts, Tricker (2007) proposes a methodological framework wherein the direct impacts of transport are combined with the indirect impacts of land use development and the living environmental systems to understand the cumulative effects of transport on selected VECs (Figure 2.2). He differentiates between 'living environmental systems' and the 'built environment' in his framework: while the former encompasses entire ecosystems and ecology, the latter is more narrowly focused on land use developments. In this framework, it is the combined assessment of (i) the travel or accessibility provided by the road (i.e. socio-economic factors); (ii) the induced land-use changes; and (iii) the biophysical encroachment or alteration of natural cycles, which combine to create cumulative impacts upon VECs.

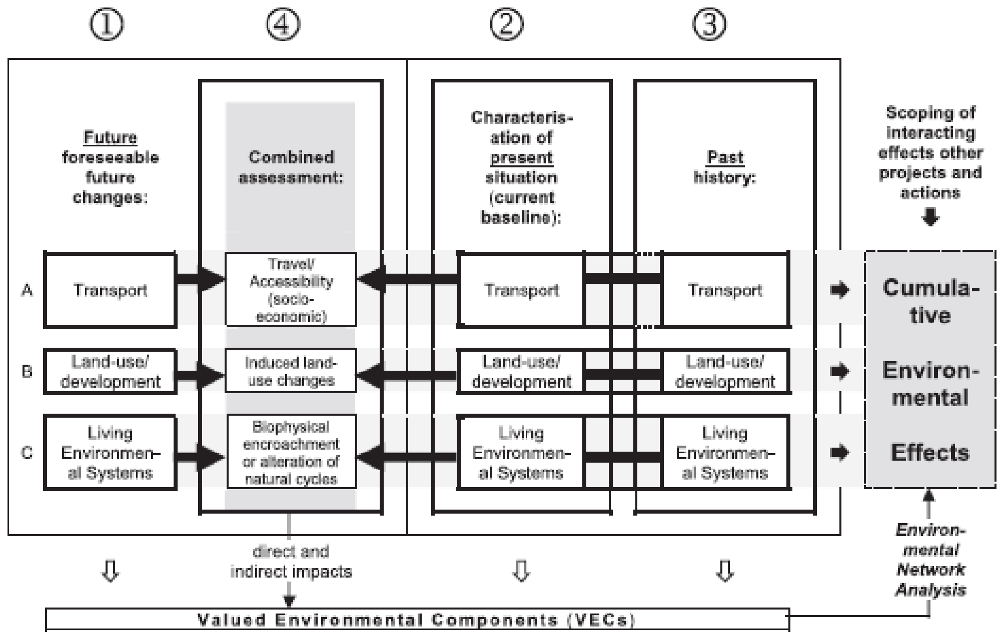

Figure 2.2: Methodological framework for the collection of data on cumulative impacts. Source: Reproduced with permission from Tricker (2007)

Tricker's framework suggests the cumulative effects of roads can be understood as a system, something also suggested by Coffin (2007) who believes that the research in such area "is far from well-developed" (p. 403). Although research on the subject is limited, it is clear that the environmental effects of roads are more complex than simply linking road development with economic growth and direct environmental effects. Tricker (2007:302) notes, with reference to major road projects in the UK, the "assessment of cumulative effects relies upon a wider integration of transport and the environment at all levels of policy and plan making" but at no instance has such level of integration been allowed to succeed. As a result, road projects often "suffer from the 'last bullet point' syndrome, with issues such as pollution, emissions and wastes, encroachment, and natural resource use being cursorily addressed along with 'other' factors such as townscape, community, safety, dynamic, or soft factors." 'Integration' is obviously a major factor in addressing the effects of road construction projects. Part of the formula for success likely includes a supportive regulatory framework for EA both in Canada and elsewhere.

2.3.3 Federal Requirements for CEA of Road Projects in Canada

According to a recent World Bank (2005) report, road projects have major environmental consequences including ecosystem disturbance, demographic changes, population resettlement, and loss of productive agricultural lands, and thus should be subject to an environmental assessment. Indeed, over the past several decades Canada and many other industrialized nations have introduced legislation requiring an environmental impact assessment to be completed ahead of new road construction projects (Byron *et al.*, 2000).

The *Canadian Environmental Assessment Act* (1995), which applied to the comprehensive studies examined in this research (introduced in Chapter 3), required that cumulative environmental effects be considered in all project assessments, including those for road construction.[1] The Canadian government classifies impact assessment according to the perceived significance of potential environmental effects and the level of public concern about a proposed development. The *Act* (sc. 1992, c.37) requires that certain projects deemed "likely to have significant adverse environmental effects" are subject to a special class of assessment called a 'comprehensive study'. When 'triggered' by the legislation, comprehensive studies allow for larger, complex development activities including road construction projects to be thoroughly evaluated by a panel of experts in consultation with the proponent, affected communities, and other interested parties. The purpose of this type of assessment, according to the *Act*, is to ascertain that proposed mitigation measures are both appropriate and adequate to effectively address "adverse" (often cumulative) impacts associated with the project (s.23). The *Comprehensive study list regulations* (schedule 29) specifically requires that "an all-season public highway that will be more than 50 km in length and either will be located on a new right-of-way or will lead to a community that lacks all-season public highway access" be assessed for cumulative effects. Since the *Act* (S.C. 1992, c.37) was amended in 1995 to incorporate cumulative effects into the project EA process, a total of 11 comprehensive studies involving road construction projects have been completed.

The requirement for conducting CEA is clearly articulated in the Act (s.16). Both the practice and guidance documents provided have also featured and promoted a VEC-based approach. A major highlight of the *Act* is also its emphasis on public participation at every

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In April 2012, the federal government introduced a new Canadian Environmental Assessment Act, which became effective July 2012. The objective of the amendment is to ensure process efficiency. For more information, see: http://www.ceaa-acee.gc.ca/default.asp?lang=En&xml=D1E2DF52-EF47-45CC-AD6E-F897C51957F8

critical stage of the process, particularly the involvement of the indigenous people (Sections 18, 19, 55 & 58). However, individual project stakeholders have been left to the task of selecting relevant VECs with no standard in place to follow. A context-specific approach makes it difficult to know which parameters to apply to VEC selection when the questions of cumulative effects are raised (Baxter *et al.*2001; Bérubé, 2007). As noted in Chapter 1, in an apparent move to scale back federal EA process, some amendments to the *Act* came into force in July 2012 (Denstedt and Duncanson, 2012). However, the pervading challenge of finding appropriate mechanisms for determining VECs remains in answering the question of CEA effectiveness in Canada.

In the road construction context, particularly, it is necessary to consider how selection of VECs for CEs is being facilitated and if it can be improved to help an assessment more effectively address both project-specific and cumulative effects. Although it has been argued that CEA would most effectively capture the environmental changes resulting from road construction and necessary legal supports have been created in Canada to address this, there has never been an evaluation of the VEC selection process in comprehensive studies for road construction projects, or otherwise.

2.4 Summary: The Research Gap

While quest for project approval is the main concern of proponents doing CEA, regulators are presumably more concerned with meeting the environmental protection goals of their agencies (e.g.: Kennett, 1999; Duinker and Greig, 2006). Unfortunately, the requirements and processes for conducting CEA are not well articulated (e.g.: Kennett, 1999; Piper, 2001; Cooper and Sheate, 2002) and consequently, environmental protection is often treated as a secondary goal to project approval (Boyd, 2003). On the whole, there is widespread conviction that a project-specific context does not provide an adequate basis for assessing cumulative effects (e.g.: Kennett, 2000; Baxter *et al.*, 2001; Duinker and Greig, 2006; Therivel and Ross, 2007; Dales, 2011; Gunn and Noble, 2011). Among the wide-ranging issues suggested in literature, selection of VECs for cumulative effects in project-specific EA is one of the key problematic areas of current practice (e.g.: McCarty and Power, 2000; Dowlatabadi *et al.*, 2004; Bérubé, 2007; Ball *et al.*, 2012).

The concept of VECs was rooted in the EA development process in Canada, and largely based on the work of Beanlands and Duinker (1983). But Beanlands and Duinker's work pays hardly any attention to the issue of how VEC selection is actually approached, especially with respect to cumulative effects exigencies. The idea that project-specific CEA can be effective without understanding how VECs are determined is a flawed one. The efficacy, or otherwise, of CEA in project EA can better be understood by concentrating not only on the analytic science centered on VECs (ecological scoping) but also on the principles and process of determining those VECs (social scoping). Bérubé (2007) supports this position by arguing the selection of VECs for CE presents a 'first-degree' challenge in the assessment of Hydro-Quebec projects.

Overall, studies on VEC selection appear to be relatively scarce. One notable exception though is the recent review of EA projects in Southern Saskatchewan with respect to aquatic VECs by Ball *et al.* (2012). They found that VECs were most often selected to address a proponent's exposure to liability and penalty under certain federal legislation (e.g. *Fisheries Act* and *Species at Risk Act*) and to reflect organizational mandates of stakeholder agencies involved in the process. They also found that where public consultation was part of the EA process, the number and diversity of VECs considered was higher. If the result described by Ball *et al.* is representative of current practice where sound ecological principles are often sacrificed to regulatory biases and proponent's objectives, additional investigation is necessary to examine the implications for cumulative effects.

To summarize, based on the literature reviewed herein, the following major points are known about the nature of CE VEC selection processes:

- that the use of VECs as focus of CEA has been well documented but there is a general lack of understanding of the principles, processes, as well as rationales applied to CE VECs (McCarty and Power, 2000; Coffen-Smout *et al.,* 2001; Dowlatabadi *et al.*, 2004; Bérubé, 2007);
- that some set of VECs is typically adopted in both project-specific EA and CEA, but that the distinction between project and CE VECs, if any, has not been well clarified. In the context of cumulative effects, we do need to know the source(s) of VECs adopted, but arguably, it is more important to know how objective and transparent the process is, as well as its sensitivity to the complex nature of cumulative effects (Duinker and Greig, 2006; Gunn and Noble, 2009b).
- that knowledge of suitable temporal and spatial scales in EA is essential when working with large landscapes with complex and diverse population or varieties of

environmental receptors, but that the means to determine appropriate scales for the assessment of CE VECs have not been well clarified. Without explicit clarification of appropriate scales, selecting CE VECs presents a great challenge to practitioners (Tollefson and Wipond, 1998; Treweek, 1999; McGarigal, 2001; Gunn and Noble, 2009b).

- that current VEC selection practices involve subjective public consultation processes which may be prejudiced by individual preferences and pop culture (i.e. what is making news at the moment), but that much less is known about the extent to which science influences VEC selection. A basic guide or set of principles that can be modified based on project needs and regional contexts may be needed in order to add credibility to VEC selection and EA generally (McCarty and Power, 2000; Feehan, 2001; Dowlatabadi *et al.*, 2004; Ball, 2012).

Overall, relatively little about VEC selection processes is known: this subject is essentially a 'black box' in the wider field of EA research.

Out of this considerable gap in knowledge, a range of interesting research questions emerges as good starting points including: What procedures and decision rules are followed by stakeholders who undertake VEC selection activities for CEA, who is involved, and what can be learned from these results? If cumulative effects are what truly matter in impact assessment, how can CE VEC selection processes be made more transparent and perhaps more rigorous? With the overwhelming number of environmental components to select from, which criteria should be used to select CE VECs from the many that are 'important' socially, economically, and environmentally? And finally, are CE VECs distinguishable from project-specific VECs, and if so, how? This thesis begins to answer such questions through an investigation of VEC selection processes in comprehensive study EA for road construction projects. The intent is to help strengthen CEA practice in Canada and elsewhere where the use of VECs is at the heart of the EA process.

Chapter Three

Methodology: Research Design and Selected Case Studies

The study adopts standard methods of qualitative inquiry in collecting and analyzing data. The data come from three sources: in-depth literature review; document analysis of project environmental impact statements (EISs) and comprehensive study reports (CSRs); and semi-structured interviews. Table 3.1 illustrates the relationship of the methods to each research objective.

Table 3.1 Research objectives, supporting methods, and data output

Research Objectives		
1. Investigate the VECs used to assess CEs in each comprehensive study, to determine if they are 'distinct' from project-specific VECs identified in the scoping stage	2. Examine the VEC selection principles, processes, and rationale applied in each study in order to gauge 'sensitivity' to CEs and the effectiveness of current practice	3. Identify opportunities and challenges to improve VEC selection for CEs in project EAs in the transportation sector, and more broadly.
Supporting Research Methods		
Literature Review	Literature Review	Literature Review
EIS/CSR Document Analysis	EIS/CSR Document Analysis	Semi-structured Interviews
	Semi-structured Interviews	
Data Outputs		
List of VEC terminologies	Process of determining VECs	Challenges with current practice
List of project VECs	Rationales for inclusion of VECs	Lessons from good practice
List of cumulative effects VECs	Stakeholders involved in VEC selection	Issues for future practice
Relationship between project and cumulative effects VECs	Influence of spatial and temporal boundaries	
	The role of science	

Note: The table indicates that all the research objectives were supported by the in-depth literature review. Objectives 1 and 2 were also met by performing document analysis of EISs and CSRs. Semi-structured interviews provided the additional data needed to meet Objectives 2 and 3. The table also shows what type of information was sought through each of the methods.

The appropriateness of a qualitative methodology is underscored by its potential to encourage multiple meanings and realities, which is an important factor in an investigative research such as this (Creswell, 2009). For the literature review, most of the data were gathered between January and September 2011, although an initial literature search began earlier in the fall of 2010. Additional materials were being gathered until the completion of the study in September 2011. Next, there was an exhaustive review of the EISs/CSRs for the selected comprehensive study road construction EAs to identify current selection processes and rationale for inclusion of VECs for cumulative effects. Thematic data collected from the review of literature and CSRs were later augmented by semi-structured interviews which focused on the responses of individuals who were directly and actively involved in the EA processes of selected projects especially the comprehensive study component. The combined data outputs of these methods were used to explore the research questions as discussed in Chapter 1. Data collection methods ran consecutively for the most part, with some overlap. Details of the various research methods used are now presented in Sections 3.1, 3.2, and 3.3 of this chapter.

3.1 Literature Review

An in-depth review of literature was first conducted to demonstrate the existing state of knowledge on VECs and their treatment in both project-specific EA and cumulative effects studies. The review of literature as a method focused on peer reviewed, grey literature as well as federal environmental assessment legislations from 1983. The choice of 1983 as the starting point was to gather sufficient information on application and selection of VECs since the concept was introduced by Beanlands and Duinker.

While primary emphasis was placed on CEA literature, the search was extended to other areas in environmental assessment, and areas outside the field (e.g. ecological risk assessment) that have discussed valued ecosystem components. Papers were identified using electronic database searches; manual searches of key journals; online searches for relevant 'grey' literature; and the 'snowball method', i.e. scanning reference lists and using judgment to decide whether to pursue those materials further (Greenhalgh and Peacock, 2005). Some of the key journals relied on include: (1) *Environmental Assessment Policy and Management*; (2) *Environmental Impact Assessment Review*; (3) *Environmental Management*; (4) *Environmental Monitoring and Assessment*; (5); *Environmental Planning and Management*; and (6) *Impact Assessment and Project Appraisal*.

The first task was to have a predefined set of phrases that are associated with the subject as guiding posts in the literature search. To lay credibility to the literature sources, priority was given to peer-reviewed academic journals with direct relevance to the subjects of VECs and cumulative effects research. The actual review of selected literature was guided by the predefined lists of concepts and words such as valued ecosystem components, cumulative effects, or their synonyms. Having sorted available materials based on currency and relevance, the abstract or the summary of selected materials was read to have an overview of the content.

A spreadsheet was used to categorize results from the literature using a slightly modified version of the review criteria designed for the analysis of CSRs/EIS as shown in Table 3.3 later in this chapter. For example, a study may address what is found or recommended with respect to VEC selection rationale, relationship between project and cumulative effects VECs or the application of science in the process, whereas some studies may address issues of early consideration of CEs and its implications for selecting appropriate VECs. In some cases, the authors were not explicit on a particular theme but inferences were made based on the apparent tone of the report. As noted above, not all the studies were within the scope of EA field, rather they cover other subjects where VEC had featured as a subject. Yet, the review focuses on providing an understanding of VEC selection process as evident from available literature and covers all data outputs itemized in Table 3.1 above.

3.2 Document Analysis

In Canada, a comprehensive study is a type of EA conducted for larger, more complex projects that have the potential for significant negative environmental effects or draw public interest and concern (Noble, 2010; CNSC, 2011). Typically, prior to the 2012 amendments to the *Act*, there are four types of studies that are applied to project EAs at the federal level: screening (both model and class), comprehensive study, mediation, and review panel. While a model screening EA is generally applied to individual projects, class screening is applied to certain types of projects that involve similar activities or are routinely carried out under the jurisdiction of a federal agency (e.g. routine projects in National Park communities such as installation of underground power lines). Comprehensive studies are guided by the *Comprehensive Study List Regulations* as defined in *the Act*; and whether a project is referred to mediation or review panel depends on the level of public concern and the Federal Minister of the Environment's discretion. Figure 3.1 provides an overview of the decision flow to determine the type of EA required for a proposed project. However, the purpose of a comprehensive study is to provide information necessary to assist the Minister in taking a decision to allow or disallow a proposed development project.

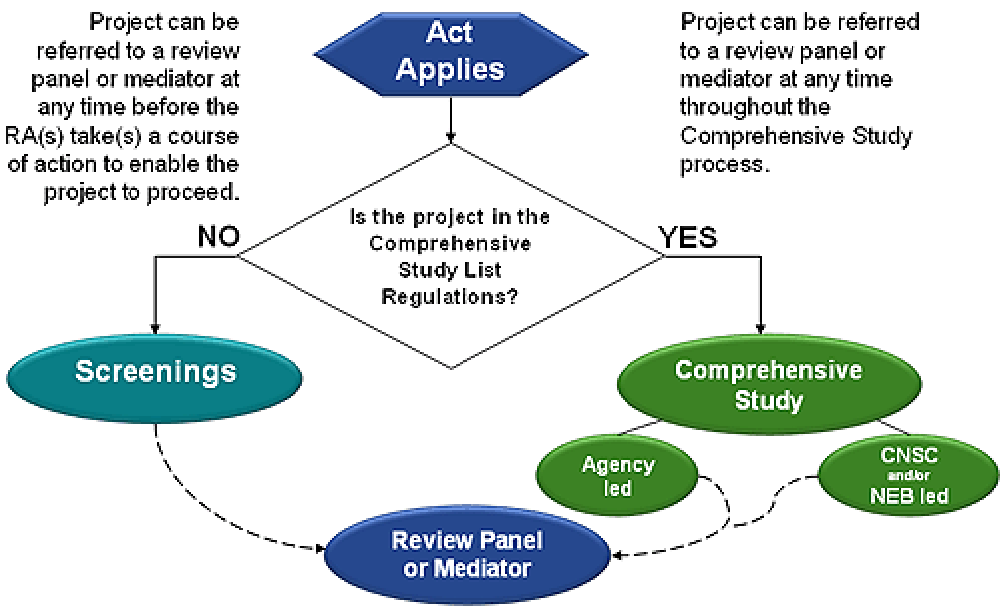

Figure 3.1: Decision chart for determining type of EA

Source: Canadian Environmental Assessment Registry (December, 2011). A RA may request the Minister of the Environment to refer the project to a mediator or review panel (s. 25 of the Act) at any time before, during or after a screening or comprehensive study, as long as the RA has not yet exercised or performed one of the powers, duties or functions listed in section 5 of the Act, where a RA is of the opinion that: (i) it is uncertain whether the project is likely to cause significant adverse environmental effects; (ii) the project is likely to cause significant adverse environmental effects; or (iii) public concerns warrant a referral.
http://www.ceaa.gc.ca/default.asp?lang=En&n=B58A1210-1&offset=4&toc=show

A comprehensive study EA will typically produce both an EIS and a CSR, either separately or as a joint report. The first step is often to prepare an EIS, an environmental assessment report primarily designed to present the potential effects of a proposed development (Sander, 1997), to regulatory authorities with primary jurisdiction for the project (i.e. provincial EA departments). Essentially, a comprehensive study report (CSR) is expected under the federal process to provide the summary of the results of a comprehensive study including conclusions and recommendations resulting from the study. In this research, primary emphasis was therefore placed on CSRs. Environmental impact statements were used as additional sources of information if a CSR was considered inadequate to provide meaningful information. For instance, the Athabasca Seasonal Road (one of the earliest comprehensive studies done for a road construction project in Canada), the CSR was only 32 pages with just two paragraphs dedicated to cumulative effects assessment. Thus, the EIS was also consulted to glean more information for this study. The emphasis on CSRs was also warranted given that CEA is a mandatory component of comprehensive study EAs in Canada. Nine CSRs and EISs were chosen for document analysis between January and March 2011, with an additional two identified in May of the same year. Thus, 11 project EAs were selected for in-depth document analysis as discussed in section 3.3.2.

3.2.1 Selection Criteria

All road construction comprehensive studies conducted under the Canadian Environmental Assessment Act since the introduction of cumulative effects assessment into the Act in 1995 were considered in this thesis. The identification of projects for this study was an easy task since the Canadian Environmental Assessment Agency maintains a Registry containing an online listing of all projects under federal process. The retrieval of the CSRs and EISs was a relatively more challenging process especially with regard to earlier projects where CSRs or EISs are not available in electronic format. All eleven CSRs sampled, which represent the total number prepared federally as of May 2011, were identified through the Registry. Seven were available online, while the other reports were eventually secured through direct appeals to either the proponents or the federal responsible authorities for the projects. After much effort to locate the EIS for one of the early projects (i.e. Athabasca Seasonal Road), a contact in Saskatchewan was able to provide a lead on how to secure the document. Although one would expect that such documents are available in public domains for easy retrieval and public access (especially in major public libraries), only one of the documents was secured through the University of Saskatchewan's Library. In all, the collection of reports/documents spanned a period of four months – from March to June 2011.

3.2.2 Overview of Selected Case Studies

The purpose of this section is to briefly introduce each of the 11 comprehensive study EAs. Understanding the nature of each of the selected projects is crucial not only because two of the methods employed in the study – document analysis and semi-structured interviews – are based on the cases; but because it also provides an understanding of the specific context of each project as a basis for comparing the approaches to VEC selection in each of the projects. First, a general description of each project is given including the project name, location, and road length. Second, a brief description of the triggers for a comprehensive study of each project is presented. Third, the responsible authorities (RA) and controversies around the project are explained, if any. Table 3.4 provides a brief summary of all the projects, while Figure 3.2 shows the location of each project within Canada.

i. Athabasca Seasonal Road, Saskatchewan – 1996

Based on the Canadian Environmental Assessment Registry listing, Athabasca Seasonal Road is the first road construction project where comprehensive study was a component of the EA process. The project proposal was prompted by the Canadian Coast Guard's (CCG) withdrawal, effective 1996, of dredging and navigation services in the region, which was the only regular means of connecting the region to other part of the province. In lieu of these services, a 180km seasonal road was proposed to link Points North Landing to Black Lake for the purpose of supplying Northern Saskatchewan communities; including an ice road to Fond du Lac, a 30m cleared road right-of-way, and bridges and culvert crossings. The length of the road, which is above the 50km threshold for screening road project EAs, triggered a federal comprehensive study. Two federal departments were involved: Department of Fisheries and Oceans (DFO) (overseeing CCG), and Indian and Northern Affairs Canada (INAC), because both provided financial support for the proposed project. The assessment process which started in July 1995 received the Minister's decision that the project was not likely to cause significant adverse environmental effects in December, 1996.

ii. Greenville to Kincolith Road, British Columbia – 1999

This project involved a 24km all-season public highway located in the northwest of British Columbia (BC), along the north side of the Nass River between the villages of Greenville and Kincolith. The road was proposed in October, 1996 by the BC Ministry of Transportation and Highways to link the isolated First Nations communities of Kincolith to the provincial Highway 16. The road was to be an all-season public highway leading to a community that then lacked public highway access and therefore triggered the federal comprehensive study process. The construction of a bridge across the Iknouk River encroaching onto federal lands required a permit from the CCG (DFO) and INAC as the lead RA was also providing federal funding. Following the review of the environmental assessment report and public comments by the Minister, the process that started in January 1997 was approved in October 1999.

iii. Waskaganish Permanent Road, Quebec – 1999

The Waskaganish community was the only Cree village located on the Quebec coast of James Bay lacking a permanent link with the regional and provincial road network at the time of this project proposal. In 1998, the Waskaganish Band Council proposed a 102km permanent road that would link the village with the existing Matagami-LG2 road, a provincial highway. Indian and Northern Affairs Canada was to commit $24 million to the project and act as the lead RA. Because the project would affect several watercourses by way of crossings, there was need for federal permit from DFO. A federal comprehensive study process was triggered since the proposed road length was greater than 50 km on a new right-of-way, leading to a community without any access to a public permanent road. The assessment process started in December 1998 and by July 1999, the Minister's approval was granted; making it one of the fasted comprehensive study EAs.

iv. St. Theresa Point / Wasagamack Airstrip and Connecting Road, Manitoba – 2001

In 2001, the then Manitoba Transportation and Government Services (now Manitoba Infrastructure and Transportation) proposed a 28km road to facilitate inter-community transportation between two remote communities called St. Theresa Point and Wasagamack. Apart from the linkage road, the project also involved the construction and maintenance of a new airport facility, including a 1524m long runway and the decommissioning of an existing airstrip in St. Mary (located about 1.5 km from the St. Theresa Point). The project's description prompted a comprehensive study EA as defined under Section 30 (b) and (c) of the Comprehensive Study Regulations List: construction of "an airport" or "an all-season runway with a length of 1500 m or more". INAC was involved due to the commitment of federal funding while DFO's involvement was with respect to water crossings of navigable waters. The assessment process commenced in September 1997 and received the Minister's decision in December 2001.

v. Trans Labrador Highway (Phase III), Newfoundland and Labrador – 2003

The 250km Trans Labrador Highway Phase III project is the longest of all road construction projects assessed by way of comprehensive study in Canada. When proposed by the Newfoundland and Labrador Department of Works, Services, and Transportation in 2002, it was to be a continuation of the existing two phases of highway. The preferred routing began east of Muskrat Falls, crossing over the Churchill River at Black Rocks, approximately 9km west of the Hamilton Intersection in Happy Valley-Goose Bay. The route was then to continue southeast for approximately 75 km before turning and traveling slightly northeast for an additional 175km to join Phase II at Cartwright Junction, 87km south of Cartwright. The length of the road inevitably triggered a federal comprehensive study process. The RA for the project was the DFO because of permit required under the *Navigable Waters Protection Act* and the *Fisheries Act*. The Minister's approval was granted in July 2004 after over a 2-year assessment process which started in May 2002.

vi. New Route 2 Trans-Canada Highway Perth-Andover to Woodstock, New Brunswick – 2004

This project involved the construction of a four-lane highway in New Brunswick stretching from Perth-Andover to Woodstock. When proposed, the highway was to be located west of the existing Trans-Canada Highway between the Saint John River and the United States border, with no major bridge structures required. The purpose of construction was to address traffic and safety concerns associated with uncontrolled highway access, and the increasing level of through-traffic and truck traffic on the existing two-lane Trans-Canada Highway. Three RAs were involved: (i) Transport Canada (TC) (ii) Infrastructure Canada, and (iii) Department of Fisheries and Oceans. Transport Canada's involvement was based on the provision of 50% of the funding under the Canadian Strategic Infrastructure Fund (CSIF) administered by Infrastructure Canada. The involvement of DFO was due to the approval required under the *Fisheries Act* and *Navigable Waters Protection Act* as the road was to pass through several water crossings. The project required a comprehensive study because (a) the length of the proposed highway was greater than the 50km threshold, and (b) it was also to be located on a new right-of-way (ROW). The assessment process commenced in March 2002 and by August 2004, the Minister's approval was granted.

vii. Local Access Road – Highway 58, Fox Lake and Garden River, Alberta – 2007

This road project was essentially to be an upgrade of existing 'winter' access roads to the Fox Lake and Garden River communities in northern Alberta to 'all-season' access roads. The project was proposed by the Little Red River Cree Nation and involved the construction of a total of 64.8km road length (57.8km as an upgrade of an existing winter road and 7km of a new all-season access road) to the communities of Garden River and Fox Lake. The length of the proposed roads triggered a federal comprehensive study under section 29(b) of the

Comprehensive Study List Regulations. The four RAs were: INAC, Parks Canada, DFO, and TC. While INAC provided funding support for the project, other RAs were involved due to the permits required under different federal laws. Specifically, Parks Canada was involved because of the construction of the road within the boundaries of Wood Buffalo National Park while TC's approval was mandatory under the *Navigable Waters Protection Act.* The assessment process was one of the longest for road projects – the process commenced in July 2002; the CSR was prepared in 2007; and the Minister's approval came in April 2008.

viii. Wollaston Lake Road, Saskatchewan – 2007

Access to the settlements of Wollaston Lake and Hatchet Lake was being provided on an ice road during winter months, by barge in summer months, and year-round by air. The project proposed by Saskatchewan Highways and Transportation was a 100km all-weather road to link First Nations communities in the vicinity of these lakes to the existing Highway 905. The road length and access to First Nations communities without previous access to a permanent highway, as described in Section 29(b) of the Comprehensive Study List Regulations, triggered a comprehensive study EA. As a result of funding assistance provided by INAC and Western Economic Diversification (WD), they were designated as the RAs for the EA process. The federal comprehensive study commenced in 2005 and the Minister's decision was granted in June 2009.

ix. Completion of Highway 35 between Saint-Jean-sur-Richelieu and the U.S. Border, Quebec – 2008

This project was a proposal for the extension of Highway 35 to complete the missing highway link between Interstate 89, located just south of the American border, and the existing section of Highway 35 in Canada, which ends east of the Richelieu River. The possibility of a financial contribution under the Canada Strategic Infrastructure Fund and the Border Infrastructure Fund, administered by Infrastructure Canada (INFC) and Transport Canada (TC), required the involvement of both Agencies as RAs. Department of Fisheries and Oceans was also an RA for the project due to *Fisheries Act* triggers – authorizations for 32 water body crossings were needed to complete the project. The project was only a 38 km long road but because it 'slightly' encroached into the Phillipsburg migratory bird sanctuary, a comprehensive study EA was required. Section 2(i) of the Comprehensive Study Regulation List states: "(t)he proposed construction, decommissioning or abandonment, in a wildlife area or migratory bird sanctuary, of a railway line or public highway" must undergo a comprehensive study. The process commenced in 2005 and the Minister's approval was granted in December 2008.

x. 407 East Transportation Corridor, Ontario – 2011

This project was to be an extension of the existing provincial Highway 407 transportation corridor, a 70km long road located east of Toronto within the Region of Durham which included a highway component and a dedicated corridor for transit. The proponent, Ontario Ministry of Transportation, initiated a provincial EA process in January 2005 and the requirements were completed in June 2010. Concurrently, the project was being assessed as a screening EA under the federal process. However, the Supreme Court of Canada's ruling in January 2010 in the case of *MiningWatch Canada v. Canada (Minister of Fisheries and Oceans et al.)* led to some clarification in the interpretation of the Comprehensive Study Regulation List[2]. Five federal RAs were involved: (i) TC, for use of federal lands; (ii) DFO, authorization was required pursuant to section 35(2) of the *Fisheries Act*; (iii) Environment Canada, for expert advice on management of air, water, soil, and other renewable resources as well as migratory birds; (iv) Health Canada, for expert advice on air and noise quality; and (v) Natural Resources Canada, for providing expertise regarding hydrogeology. The comprehensive study commenced in July 2010 and the RAs' approval was granted in September 2011.

xi. Lake Winnipeg East Side Road Project, Manitoba – 2011

Lake Winnipeg East Side Road was a 156km all-season road proposed by the Manitoba Floodway and East Side Road Authority. It was to commence at Provincial Road 304, east of Manigotagan, Manitoba, and extend 156 km to the south shore of the Berens River. The preferred route was to include the Rice River Road, an existing forestry road between the Manigotagan and Bloodvein rivers, and a new ROW between the Bloodvein and Berens rivers. The project was part of a strategic initiative by the provincial government to address the unreliable nature of the existing winter road network given current weather trends. There

[2]The Supreme Court of Canada found in a decision released on January 21, 2010 that the responsible authority cannot just conduct an environmental assessment screening study for a project listed on the Comprehensive Study List. While the RAs have the power to employ any approach to coordinate the process, they do not have the power to change the type of assessment a project must undergo. The ruling affected 407 East Transportation Corridor, Ontario as well as the Lake Winnipeg East Side Road which were already undergoing screening EAs but have comprehensive study triggers.

were two triggers for the federal comprehensive study EA process: (i) it was to be an all-season public highway more than 50 km in length, located on a new right-of-way, and (ii) it would lead to communities that currently lacked all-season public highway access. While DFO and TC were involved on regulatory grounds, likely financial assistance and other regulatory factors necessitated the involvement of INAC as well. The project was equally affected by the Supreme Court's ruling of January 2010. The project commenced as a screening EA in December 2009, was rescheduled as a comprehensive study EA in March 2010, and the RAs' decision that the project was not likely to cause significant adverse effects was made in August 2011.

No	Project	Prov.	Year
1	Greenville to Kincolith Road	BC	1999
2	Local Access Road - Highway 58, Fox Lake and Garden River	AB	2007
3	Athabasca Seasonal Road	SK/AB	1996
4	Wollaston Lake Road	SK	2007
5	Lake Winnipeg East Side Road Project	MB	2011
6	St. Theresa Point/Wasagamack Airstrip & Connecting Road	MB	2001
7	Waskaganish Permanent Road	QC	1999
8	407 East Transportation Corridor Project	ON	2011
9	Completion of Hwy 35 btw St-Jean-sur-Richelieu & US Border	QC	2008
10	New Route 2 Trans Canada HwyPerth-Andover to Woodstock	NB	2004
11	Trans Labrador Highway Project (Phase III)	LB	2003

Figure 3.2 Location of selected road construction projects within Canada

Table 3.2 Details of the selected comprehensive study road construction EAs

No^	Project Name	Proponent (Provincial Jurisdiction)	Year of CSR/EIS	Road Length (km)	Responsible Authorities
1	407 East Transportation Corridor	Ontario Ministry of Transportation (ON)	2011	70	DFO; TC
2	Athabasca Seasonal Road	Saskatchewan Highways & Transportation (SK)	1996	180	DFO; INAC
3	Completion of Highway 35 between Saint-Jean-sur-Richelieu and the U.S. Border	Department of Transport Quebec (QC)	2008	38 *	TC; IC; DFO
4	Greenville to Kincolith Road	Ministry of Transportation and Highways (BC)	1999	24 !	INAC; DFO
5	Lake Winnipeg East Side Road Project	The Manitoba Floodway and East Side Road Authority (MB)	2011	156	DFO, INAC, TC
6	Local Access Road - Highway 58, Fox Lake and Garden River	The Little Red River Cree Nation (AB)	2007	64.8	INAC; PC; DFO; TC
7	New Route 2 Trans-Canada Highway Perth-Andover to Woodstock	New Brunswick Dept. of Transportation (NB)	2004	70.7	TC; IC; DFO
8	St. Theresa Point / Wasagamack Airstrip and Connecting Road	Manitoba Transportation and Govt. Services (MB)	2001	28 +	INAC; DFO
9	Trans Labrador Highway Project - Phase III	NL Dept. of Works, Services and Trans (NL)	2003	250	DFO; TC
10	Waskaganish Permanent Road	Waskaganish Band Council (QC)	1999	102	INAC; DFO
11	Wollaston Lake Road	Saskatchewan Highways and Transportation (SK)	2007	100	INAC; WD

Notes:
* The project encroached into a migratory bird sanctuary
! Road provided access to communities which lacked all-season highway
+Project included a runway greater than 1500 m in length. (^)See Figure 3.2 for location of each project

3.2.3 Approach to Analysis

The purpose of the document analysis was to provide insight into the general approach to determining VECs for cumulative effects in each of the cases described above. To give structure to the analysis, a list of criteria (shown in Table 3.3) were adopted to systematically investigate the nature, thoroughness, and credibility of each process used for selecting VECs for cumulative effects. The criteria were developed based on previous works on effectiveness of cumulative effects reporting (*see* Burris and Canter, 1997; Cooper and Canter, 1997; Cooper and Sheate, 2002; Schultz, 2012). More specifically, the review process yielded data regarding the type and sources of VECs, selection actors, timing and rationale, and tools used to aid decision-making. Emphasis was also placed on examining process effectiveness and deficiencies. The results of the document analysis are presented in Chapter 4in both project-specific and aggregate forms, in as detailed a manner as possible.

Table 3.3 Review criteria for the comprehensive study reports

No.	Criterion	Rationale for inclusion and data sought
1.	Project description and trigger(s) of comprehensive study	To provide a project overview, i.e. location, road length, CSR year, proponents, federal responsible authorities, what triggered comprehensive study, and other relevant comments.
2.	Term used as equivalent to 'VEC' and definition, if any?	To examine 'VEC' terminology and any related definitions in order to understand the context in which VEC selection was approached. While providing a definition does not mean a 'good job' is done, its inclusion could serve as a basis or rationale for the inclusion of a particular VEC.
3.	Separate and detailed listing/discussion of cumulative effects VECs	To determine what CEs VECs are selected, if any. It is also essential to know that cumulative effects are separately treated, as this is required by the CEA Act. The treatment of cumulative effects separately would be helpful to understand how VECs selected for assessment were determined.
4.	Number of project VECs compared to cumulative effects VECs?	To determine the relationship between selected project VECs and CEs VECs. Are these lists one in the same, or is one a sub-set of the other? It may also be established that there is no link between the two sets of VECs.
5.	Determinants/sources of CEs VECs	To examine the determinants and sources of CEs VECs in each case. This should provide insight into the thoroughness and credibility of the selection process, and whether an adequate job was done to develop the VEC list.
6.	Explicit statement of rationale for inclusion	To examine the rationale for inclusion of particular CEs VECs. This would suggest that a list of criteria for inclusion is indeed in place and whether due diligence was done to ensure consistency and that selected VECs reflect the nature of cumulative effects.
7.	Spatial boundary adjustment for selection of each VEC	Cumulative effects VECs are supposed to be based on a wider regional scope, i.e. sources of change and pathways of accumulation should not be restricted to the project's local study area. An understanding of the spatial extent of consideration for selected VECs helps to ensure that an appropriate scale was employed for VEC selection which in turn should support the analysis of cumulative effects.
8.	Temporal boundary adjustment for selection of each VEC	Temporal boundary adjustment is equally important for reasons stated in (7) above.
9.	Use of science (or quantitative description of) as a tool to select CEs VECs	The initial concept of a VEC included that science or scientific methods are expected to play an important role in the selection process, especially for biophysical VECs. Whether or not this is done in each CSR helps indicate whether or not a thorough 'scientific' analysis is carried out for the study.
10.	Explanation provided on how the particular nature of the road construction project at hand influences the selection of cumulative effects VECs	While this is not an explicit requirement of cumulative effects assessment, it is important to understand how the project context influenced the choice of VECs for the assessment
11.	Cumulative effects mentioned during initial project scoping	The timing of consideration of cumulative effects in the assessment process can have influence upon the selection process; i.e. early mentioning (during scoping) may be a good sign that the choice of CEs VECs was given a conscientious consideration from the beginning

The CSR analysis involved a systematic, step-by-step process where data were extracted into an electronic spreadsheet and organized for subsequent interpretation. There was an initial scanning of the CSRs project-by-project to record data that are easily accessible such as those on project description and VEC terminologies. Then, an in-depth analysis of the documents with focus on relevant sections was conducted using the criteria described in Table 3.3 above. The page numbers and sections where data were extracted were also recorded for easy referencing. A major challenge with the CSR analysis was the inconsistency in the structure of the reports. While in some cases the tables of contents were detailed enough to provide insight into the appropriate sections for review, for many of the reports, the researcher needed to first read a major part of the CSRs to understand where required data could be located. However, to ensure that the emerging themes are grounded in the original data, the researcher reread the appropriate sections of the CSRs where the data earlier came from and where information from the CSRs was inadequate, the EISs were consulted to get further details. The document analysis spanned a period of seven months i.e. from March to September 2011. One important objective of the CSR review was to identify stakeholders and experts involved in VEC selection for each study to obtain further information by way of interview. Hence, once the document analysis was complete, the next phase of the methodology was to speak to those individuals. Section 3.3 explains the purpose and nature of these interviews.

3.3 Semi-Structured Interviews

The goal of using interviews was to better understand both the process mechanics and factors of influence in the VEC selection process for cumulative effects. A semi-structured interview schedule was adopted (as opposed to fully structured or unstructured) to facilitate an exploration of the subject of investigation as thorough as possible. A semi-structured interview is a verbal interchange where an interviewer attempts to elicit information from participants by asking a set of predetermined questions that are presented in a thoughtful, orderly and partially structured but flexible manner (Longhurst, 2003). It was assumed that certain dynamics and controversies associated with the VEC selection process, and pivotal to the research, were not documented as part of the EIS or CSR, thus necessitating the interviews. This method allowed for exploration of the process as experienced by the principal actors themselves. All interviews were conducted via telephone between June 15 and August 4, 2011, subsequent to the preliminary review of the EIS/CSRs, which helped identify potential interviewees. Further details of the interviews are given below.

3.3.1 Interview Participants

In a traditional EA process, apart from the proponents, stakeholders are broadly classified into two groups – the professionals and concerned/affected public. The interviews were focused on the professional stakeholders and proponents of selected road projects. The participants were not necessarily those with cumulative effects expertise but those who possess sufficient knowledge of the selected EA process to make an informed judgment about VECs that were selected. Altogether, those interviewed consist of: consultants, proponents, regulators, responsible authorities (RAs), and provincial government department's representatives. Twenty-two (22) individuals across 10 projects representing these five different categories of key actors in comprehensive study EAs were involved in the interview process. Table 3.4 shows the interview participants' distribution by role: the majority of the participants are/were consultants (7) and project proponents (5). It was relatively straightforward to classify each participant, as their professional titles are often stated in the EIS/CSR. Most of participants were initially identified based on their names being listed in the EISs and CSRs and were directly contacted via email to request their participation in the research (see Appendix A for 'Participant Consent Form'). Given that not all potential interviewees may be found through project documents, those identified through the EIS/CSR review were asked to identify other potential participants; a method known as snowball sampling (McIntyre, 2005; Singleton and Straits, 2009). However repeated efforts to recruit participants for two of the comprehensive studies (i.e. Local Access Road – Highway 58 and St. Theresa Point /Wasagamack Airstrip and Connecting Road) yielded no results; hence analysis of those projects was based solely on their CSRs.

Table 3.4 Distribution of interviewees by role in selected projects

Role	Description	Number of Participants (22)
Consultants	Individual under a corporate entity who has the capacity to analyze and advise proponents at different stages of the EA process; they are often responsible for the preparation of the EIS and analysis of the environmental effects	Seven consultants across six projects, of which six have vast understanding of cumulative effects assessment and one with experience in traditional land use
Proponents	Persons or entities identified in the project application form as the primary drivers of the proposed development. For all of the road construction projects used, proponents are either the provincial government or First Nations	Five officials across four different projects; all of which are transport experts with experience in federal EA process
Regulators	Representatives of the Canadian Environmental Assessment Agency (CEAA).They ensure the requirements of the Canadian Environmental Assessment Act are strictly followed during federal EA process	Four officials involved in four different projects
Responsible authorities*	Responsible for coordinating the federal environmental assessment process, e.g. Transport Canada, Fisheries & Oceans Canada, Indian & Northern Affairs Commission (INAC), etc. They are often responsible for preparing the CSR and making initial decision on the project before the Minister's final approval is granted.	Three officials from two different federal departments (i.e. INAC and Transport Canada) involved in three different projects
Provincial government department's representatives	Provincial government officials who are often contacted to give technical inputs into an EA process especially with regard to particular environmental components where existing knowledge of proponents is limited	Three officials with expertise in wildlife, conservation, and standard and guidelines who were involved with two different projects

*Federal Agencies such as DFO, INAC etc. were usually designated as RAs for all types of federal EA process. But as of July 12, 2010, the CEAA assumed responsibility for conducting comprehensive studies, except those regulated by the National Energy Board (NEB) and Canadian Nuclear Safety Commission (CNSC). Although by definition not a responsible authority, the CEAA is now responsible for exercising the powers, and performing the duties and functions of the responsible authority for comprehensive study from the time a comprehensive study is identified until the comprehensive study report is provided to the Minister. http://www.ceaa.gc.ca/default.asp?lang=En&n=B58A1210-1&offset=4&toc=show (accessed December 21, 2011)

3.3.2 Interview Procedures

All interviews were conducted via telephone, as the geographical range of interviewees across six different provinces in Canada did not allow for face-to-face meetings. An initial invitational email introducing the research and its objectives was sent to all potential interviewees (see Appendix B for a sample of the recruitment letter). Following an indication of willingness to participate, a standard 'participant consent form' approved by the University of Saskatchewan Behavioral Ethics Board was sent to all interviewees to inform them of their rights. Since face-to-face was impractical given the circumstances, consent to participate was obtained through three channels: by fax; by portable document format (.pdf) sent via email; and by proxy, i.e. the researcher signing the consent form on the interviewee's behalf following verbal consent at the beginning of the interview. A standard interview schedule (with minor variation according to the role of the interviewee) was forwarded prior to each interview to allow participants reflect on their involvement in the EA process and consult relevant documents that could inform their responses (see Appendix C for the sample of the interview schedule). This was also done to ensure participants were in a more comfortable position to answer the questions given that some of the projects were executed more than ten years ago.

The interview questions were designed to explore in as much detail as possible, the process to determine VECs for cumulative effects, which stakeholders were involved, and their perceptions of the VEC selection process including challenges and suggestions for improvement. To ensure the interview schedule was understandable and effective; a set of evaluative questions was asked of the first three interviewees at the close of the interview. This approach to 'pilot testing' the interview schedule was adopted given that the nature of the questions demanded expert opinion and specific project knowledge and would have been difficult for a neutral audience to evaluate before being administered.

3.3.3 Approach to Analysis

In line with standard procedures for analyzing qualitative interview data, an inductive coding process was adopted to gain as much understanding of the interview data as possible, both in project-specific and aggregate contexts. The following 4-staged process was used to analyze the interview data:

1. Data transcription and review: Each interview lasted between 25 minutes and 1 hour. All interviews were digitally recorded in MP3 format and backed up in a separate disk to avoid data loss after which they were immediately transcribed into a Microsoft© Word document. The transcripts were proofread to ensure they were as close as possible to the recorded words of the interviewees and to facilitate a familiarity with

the data before actual analysis was carried out. Notes were taken during some of the interviews to complement the full interview transcripts. These were not analyzed as 'data' but rather relied on as interpretive aid to certain recorded statements.

2. Coding: Coding involves 'combing' data for themes, ideas and categories and then marking similar passages of text with a label so that they can easily be retrieved at a later stage for further comparison and analysis (Lewins *et al.*, 2005). A number of qualitative analysis software programs are designed for this purpose, including *Atlas.ti* and Nvivo©9, and will sort, classify, compare, and analyze large volume of textual data. For this interview study, all interview transcripts were uploaded into Nvivo©9 using a field-by-field approach which allows for addition of empirical labels as coding progresses. This initial coding of data is often called open coding (Strauss and Corbin, 1998; Scott and Howell, 2008).

3. Themes and pattern identification: Axial coding was used to identify themes and sub-themes as they emerged from the initial data coding. What axial coding does is to provide rich insights into the conditions, context, interaction, and consequence of and between fields (Strauss and Corbin, 1998; Mills *et al.*, 2006). Further inter-relationships among themes and sub-themes are discovered and subsequently lead to aggregate data trends.

4. Summarization: Interpretation of the meaning of identified themes and sub-themes was finally done in light of the primary research questions. The aim is to highlight more commonly expressed arguments in the discussions and show the general patterns and trends in the interviewees' arguments. To add strength to the observed patterns, a quasi-quantitative analysis is employed for data presentation. Direct quotations are also selected and inserted to support critical arguments in the context in which they were raised.

As it may be difficult to totally screen out bias in a research such as this (Bryman *et al.,* 2009), due diligence has been employed to reduce bias to the barest minimum. In the entire process of the research, the awareness of occurrence of bias was constantly noted and stringent effort was made to ensure objectivity and researcher's detachment from the research. Section 3.4 provides an overview of how researchers' bias and ethical issues were managed.

3.4 Research Ethics and Researcher's Bias

Traditionally, qualitative research techniques have been subjected to several criticisms for lacking "scientific rigour" that are associated with quantitative research (May and Pope, 1995). Although there is no consensus on the semantics and meanings of these drawbacks, a number of issues are obvious in literature. First, there is the question of validity; that is, the accuracy, meaningfulness, and credibility of the research process (May and Pope, 1995; Myers, 2000; Giorgi, 2002; Leedy and Ormrod, 2005); second, the reproducibility of the research product (Kirk and Miller, 1986); and third, the issue of researcher's bias and subjectivity (Collier and Mahoney, 1996; Hartman *et al*., 2002). The above criticisms do not only overlap in meaning, context, and application, they are also not absolutely particular to the qualitative paradigm.

However, these are issues that must be addressed to give credibility to the quality of the study. To ensure the validity of the research, the researcher employs the use of predefined list of criteria for literature and CSR/EIS review, ensures transcript accuracy, and was consistent with codes defined for interview analysis (Creswell, 2009). Also, in reporting the data, a quasi-quantitative analysis technique is used for the EIS/CSR review and the semi-structured interviews. Codes and themes created qualitatively were described quantitatively by counting the number of times they occur in the text data (Creswell, 2009). Replicability, though important for generalizing conclusions, should not be entirely viewed as a demerit of a qualitative research. Delmar (2010: 121) states: "we need to accept that also context-dependent knowledge, with its different mode of expression, can offer us true understanding, but in another form of expression in its replicability and applicability". In order to minimize the level of this bias however, the use of triangulation is employed – a procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study (Creswell and Miller, 2000).

Since one of the methods adopted for the research is semi-structured interviews, this raised two ethical questions – confidentiality and informed consent. The researcher adhered strictly to the ethics application as approved by the University of Saskatchewan's Behavioral Research and Ethics Board (Beh-REB) which warrants that both issues are addressed. All the participants were aware of their right of withdrawal in part or whole 30 days after the interview was granted and also of the usage and storage of the information being provided. Anonymity of respondents was also ensured in data reporting as most results are presented in aggregate form, and where quotations were to be used, emphasis was on the role rather than the obvious identities of the interviewee. On the whole, there was a careful handling of the issues of validity, replicability, and researcher bias to guarantee the credibility of the research findings.

Chapter Four

Results

4.1 Approaches to VEC Selection: The Literature

4.1.1 VEC Terminologies

A 'valued ecosystem component' is a valued attribute of the environment identified during the scoping phase of EA to focus the analysis. There are alternatives to this term. Some suggest the term 'valued environmental component' (Clark, 1986; Shoemaker, 1994; Van Sluijs, 1996; Kurtz, 2001; Andre, 2004; Horvath and Barnes, 2004) is preferable as it captures a broader range of attributes including human components such as society, culture, and community well-being. Other variations include 'valued environmental resources' (Stakhiv, 1988; Smith, 2000; James *et al.*, 2003; Cooper, 2004; Cooper and Sheate, 2004; Maggi, 2011), 'key ecosystem components' (Stein *et al.*, 1999), and 'valued environmental and community resources' (Tomlinson and Fry, 2000; Pearman *et al.*, 2003; DEAT, 2004; Tomlinson and Fry, 2000; IADC, 2008).

Used in the literature in some cases, were terms like: 'valued social components' (Hay *et al.*, 1996; Hegmann *et al.*, 1999; Ehrlich and Sian, 2004; Porter and Murray, 2010); 'valued ecological components' (Treweek, 1999; Rapport *et al.*, 2002; Krausman and Harris, 2011); 'valued cultural components' (Dowlatabadi, 2004; Mackenzie Valley Review Board, 2009); and 'valued atmospheric components' (Clark, 1986; Crutzen and Graedel, 1986; Orians *et al.*, 1986; Toth, 1989; Ward, 1990), to clearly denote the specific environmental media a component represents. Some authors (e.g.: Porter and Murray, 2010) suggest the use of multifarious terms is confusing and may pose a challenge to stakeholders involved in component selection process, especially the non-technical public.

One alternative favoured by some practitioners in the scoping stage of an assessment (e.g.: Dowlatabadi *et al.*, 2004; Ehrlich and Sian, 2004; Terriplan Consultants, 2006) is simply to use the generic term 'valued component' to capture all environmental attributes including biological, cultural, ecological, economic, physical, and social. Table 4.1 catalogues the various terminologies used in the literature. Regardless of the many options, ‘valued ecosystem component’—introduced by Beanlands and Duinker (1983)—is the term most commonly employed.

Table 4.1 VEC terminology and example sources[3]

VEC Terminologies	References
Valued ecosystem components	Beanlands and Duinker, 1983; Orians, 1986; Stakhiv, 1988; Barnes and Westworth, 1994; Ross, 1998; Hegmann *et al.*, 1999; Piper, 2004; Duinker and Greig, 2006; Connelly, 2008; Noble, 2010
Valued environmental components	Clark, 1986; Shoemaker, 1994; Van Sluijs, 1996; Kurtz, 2001; Andre, 2004; Horvath and Barnes, 2004
Valued environmental resources	Stakhiv, 1988; Smith, 2000; James *et al.*, 2003; Cooper, 2004; Cooper and Sheate, 2004; Maggi, 2011
Key ecosystem components	Stein *et al.*, 1999
Valued environmental and community resources	Tomlinson and Fry, 2000; Pearman *et al.*, 2003; DEAT, 2004; Tomlinson and Fry, 2000; IADC, 2008
Valued social components	Hay *et al.*, 1996; Hegmann *et al.*, 1999; Ehrlich and Sian, 2004; Porter and Murray, 2010
Valued ecological components	Treweek, 1999; Rapport *et al.*, 2002; Krausman and Harris, 2011
Valued cultural components	Dowlatabadi, 2004; Mackenzie Valley Review Board, 2009
Valued atmospheric components	Clark, 1986; Orians *et al.*, 1986; Crutzen and Graedel, 1986; Toth, 1989; Ward, 1990
Valued components	Dowlatabadi *et al.*, 2004; Ehrlich and Sian, 2004; Terriplan Consultants, 2006

4.1.2 Rationales for Selecting Specific VECs

Studies offer a wide variety reasons or rationales as to why a particular environmental feature merits consideration as a VEC, whether in project EA or otherwise. Of these, ecological importance and societal/public value appear to be very common (Table 4.2). For instance, in the proceedings of a workshop on a marine ecosystem monitoring network in Canada, Hay *et al.* (1996) adopt the following as criteria for VEC selection: rarity; fragility; ecological importance; scientific value; and societal value. There are other, less ‘environmental’ reasons that drive VEC selection, however. Thomas (2001), for example, identifies legal compliance, economic importance, scientific factors, and professional opinion as leading influences in VEC selection. A range of other authors (e.g.: Chambers *et al.*, 1995; Abbruzzese and Leibowitz, 1997; Lohani *et al.*, 1997; Treweek, 2001; Szuster and Flaherty, 2002; Cooper, 2004; Bérubé, 2007; Leschine and Petersen, 2007) report centering VEC

[3] In no particular order.

selection on spiritual; aesthetical; biodiversity and conservation; cultural; medicinal; and recreational values.

Table 4.2 Rationales for VEC selection and example sources[4]

Rationales	References
Aesthetic value	Cooper, 2004; Leschine and Petersen, 2007
Biodiversity and conservation value	Ward and Jacoby, 1992; CEQ, 1997; Treweek, 2001; Rueggeberg and Lanarc, 2009
Cultural value	CEQ, 1997; Ehrlich and Sian, 2004; Leschine and Petersen, 2007; McAfee and Malouin, 2008
Ecological importance	Ward and Jacoby, 1992; Wedeles and Williams, 1995; Hay *et al.*, 1996; CEQ, 1997; Mosbech, 2000; Thomas, 2001; Leschine and Petersen, 2007; McAfee and Malouin, 2008; Gallaugher and Wood, 2009
Commercial/Economic importance	Ward and Jacoby, 1992; CEQ, 1997; Thomas, 2001; Leschine and Petersen, 2007; McAfee and Malouin, 2008
Legal/regulatory concerns	Ward and Jacoby, 1992; CEQ, 1997; Thomas, 2001; Ball, 2011
Medicinal importance	Chambers *et al.*, 1995
Societal/Public value	Ward and Jacoby, 1992; Hay *et al.*, 1996; CEQ, 1997; Thomas, 2001; McAfee and Malouin, 2008
Recreational value	Ward and Jacoby, 1992; Lohani *et al.*, 1997
Scientific value[1]	Hay *et al.*, 1996; Thomas, 2001
Spiritual importance	Leschine and Petersen, 2007

[1]Hay *et al.* (1996) describes 'scientific value' as the ability of a component to provide opportunities for scientific study or monitoring, and hence of high interpretative value. This rationale is closely linked with 'ecological importance', which may explain why other studies do not include it as a separate factor in selecting VECs. However, while opportunity for monitoring is well recognized, what is less emphasized as a rationale is the opportunity for 'scientific study' of a VEC.

4.1.3 Stakeholders Involved

Selection of VECs is essentially based on the experience of those involved at the scoping phase of an EA, according to authors such as Howitt (2001), Thomas (2001), and Elliot and Thomas (2009). Thomas (2001: 184) notes:

> Clearly decisions about what is valued will depend on the experiences of those involved. In general, experience is at the base of most of the techniques that have been developed to assist with scoping. The personal and professional experience of the person planning the (assessment) is always going to be a starting point for development of the scope. This experience can be expanded by including the input of colleagues, and by calling on the experience of relevant experts.

[4] In no particular order.

The diversity of potential actors in VEC selection can be categorized into three main groups: (1) *institutional representatives* – individuals with expertise in EA process and/or by regulatory requirements are expected to be involved, i.e. scientists, regulatory agencies; federal responsible authorities, and the provincial government departments (Orians *et al.*, 1986; Kubo *et al.*, 2007; Huerbana, 2009); (2) *proponents* – individual or organizations identified in the project application form as the primary drivers of the proposed development; in most cases, proponents delegate consultants to represent their interest which is to secure approval (Mulvihill, 2003; Antoniuk, 2009); and (3) *public stakeholders* – generally include those who may be directly affected by the project or have some concerns regarding the likely consequence of a project; either individuals or members of a group (Mulvihill, 2003; IADC, 2008; Huerbana, 2009). This category of scoping participants includes First Nations communities, environmental non-governmental organizations (e.g.: Smith, 2000; Cooper, 2004; Huerbana, 2009), and citizens acting on their own interests.

A multi-disciplinary project committee made up of experts from relevant government department is sometimes established to lead the scoping, and the rest of the assessment phases (Mulvihill and Jacobs, 1998; PDE and Hills, 2001; Mulvihill, 2003). However, policy makers, particularly regulators and responsible authorities, are consistently most influential in determining a final list of VECs (Beanlands, 1988; Abbruzzese and Leibowitz, 1997; Morgan, 1998; Weston, 2000). Orians (1986: 4) explains: "…politically we are organized such that the different valued ecosystem components are under the administration of different agencies, each charged with the protection and enhancement of their particular components". In other words, policy makers must protect the interests they are mandated to protect, and this influence is reflected in VEC selection. Regardless, it has been observed that "[w]hen valued ecosystem components have been readily identified and have been recognized and generally agreed on by the public, this approach has sometimes been successful" (Orians *et al.*, 1986: 102). Orians *et al.* cited the case of Lake Washington's sewage pollution control project (in the United States) as "…very effective, because the public readily comprehended the issues and agreed on the value of a clean lake" (p. 102).

4.1.4 Means of Seeking Input into the VEC Selection Process

Proponents and regulatory authorities use a variety of activities to encourage input, exchange of ideas, and public awareness in the scoping phase of EA including workshops, focus groups, interviews, newspaper advertisements, etc. (e.g.: Tsumokawa and Hoban, 1997; Hegmann, 1999; Marusich, 2001; James *et al.*, 2004; Mackenzie Valley Review Board, 2009). The intent is to generate public opinions and information that may serve as inputs into the VEC selection process. In most cases, public consultation is statutorily required (e.g. comprehensive study EAs in Canada). In other cases, the nature of a proposal compels public involvement (e.g. nuclear waste management; Stevenson, 2003).

There is evidence that some attention is being paid to First Nations communities in Canada regarding their involvement in VEC selection. For instance, Mulvihill and Jacobs (1998: 359) report in the case of Great Whale Hydroelectric project in Northern Quebec that "…in some cases, stories were turned into technical criteria or valued ecosystem components, which reflect ways of structuring and valuing the environment using classification systems that may vary by culture and community". Similarly, several authors argue for consideration of traditional ecological knowledge (TEK) in VEC selection (Stevenson, 1995, 1996, 2005; Sadler, 1996; Tsumokawa and Hoban, 1997; Emery, 2000; Marusich, 2001), which implies sourcing inputs from the perspective of local/Aboriginal populations.

Inputs are also derived from a review of literature relevant to the project in question and the socio-ecological systems of the region. Larkin (1984), as cited in Orians *et al.* (1995), posits that 50% to 75% of the initial information needed for an EA, including the identification of VECs, can be gathered through literature review. Other types of input include information derived from previous project EA reports and EA term of reference (TOR), and that derived from the commissioning of new (field) scientific research. Although the role of science is not prominent at project VEC selection stage (Orians *et al.*, 1986; Sadler, 1996; Tsumokawa and Hoban, 1997; Mosbech, 2000), a few studies do argue for the application of scientific knowledge at this stage. For example, Orians *et al.* (1986: 15) say:

> Scientists should be involved from the beginning of a project in setting goals, in identifying valued ecosystem components, and in scoping the problem… Scientists do not determine the values attached by society to ecosystem components, but they might know which organisms have important roles in the ecosystem that are not understood or appreciated by the general public. Scientists can help to assemble information about a project site and about similar sites and projects elsewhere. They are also helpful in defining goals, because of their knowledge of potential outcomes of manipulations that might be considered. They can advise on the implications of trying to achieve particular goals, on the measurement of values, and on why seemingly compatible values might conflict. The involvement of scientists does not guarantee success, but it should increase the probability that project plans are appropriate.

The various means of seeking input into VEC selection are summarized in Table 4.3 below.

Table 4.3 Means of seeking input for VEC selection[5]

Means	References
Public consultation	Tsumokawa and Hoban, 1997; Gordons, 1998; Marusich, 2001; Stevenson, 2003; Cooper, 2004; Huerbana, 2009
First Nations communities	Stevenson, 1995; Mulvihill and Jacobs, 1998; Mackenzie Valley Review Board, 2009
Traditional ecological knowledge	Stevenson, 1995, 1996, 2005; Sadler, 1996; Tsumokawa and Hoban, 1997; Emery, 2000; Marusich, 2001
Literature review	Toth, 1989; Okrainetz, 1992; Orians *et al.*, 1995;Howitt, 2001; Marusich, 2001;Noble, 2008
Previous project EA reports / EIS	Sadler, 1996
EA term of reference	Marusich, 2001
New scientific research	Orians *et al.*, 1986; Sadler, 1996; Tsumokawa and Hoban, 1997; Mosbech, 2000

4.1.5 Selecting VECs for Cumulative Effects

Despite the attention project-based VEC selection has received in the literature, little information is available on the selection of VECs for CEs. Some authors agree that CE VECs should be a subset of project VECs, suggesting the process will involve 'fine-tuning' project-specific VECs to arrive at what constitute 'appropriate regional VECs' for CEs (e.g.: Hegmann *et al.* 1999; Baxter *et al.*, 2001; PDE and Hills, 2001). For example, Baxter *et al.* (2001) advocate a method for identifying a subset of project VECs that they call 'context scoping'. This involves gathering more information about other stressors as well as the project's spatial and temporal boundaries and linking the information with the original set of project VECs to determine cumulative effects VECs. In essence, VECs found to be 'significantly impacted' by the project during EA are assessed for cumulative effects.

There are several alternative approaches to CE VEC selection reported in the literature. Bérubé (2007), referring to Hydro-Québec projects, reports CE VECs were identified based on the potential for interactive effects among multiple projects, and legal requirements. However, he recommends reliance on project VECs in cases where there is lack of adequate data to determine impact significance at the project EA level. As part of each CEA required in Canadian National Parks, Kalff (1995) suggests relying on public consultation, a resource description and analysis report, and the management of goals of the specific park to identify VECs appropriate for CEs analysis. Canter and Ross (2008)

[5] In no particular order.

recommended considering the current and anticipated stressed condition of a VEC, whether it has protected status, and whether the likely presence of other human activities will significantly impact that VEC: if so, it should be identified as a CE VEC. The use of predictive models, though not always able to adequately capture specific stressors on the environment, has also been applied to CE VEC selection (Gunn and Noble, 2009a; Johnson, 2011).

The next stage in the research methodology was to investigate empirical examples of VEC selection processes for CEs. The next two sections document the findings of a review of comprehensive study EA reports in the transport sector and semi-structured interviews with individuals directly involved in VEC selection for road construction projects.

4.2 Results of the Comprehensive Study Report (CSR) Analysis

4.2.1 Triggers and Terminology

Triggers for comprehensive study of road construction projects are variable and differed among the projects reviewed. The most common trigger for a comprehensive study (8 of 11 projects) was a proposed road length of greater than 50km: a threshold established by the federal government. In five of the cases studied, the trigger for a comprehensive study was that the proposed road project would lead to community previously without public access of this type. A comprehensive study is also required when the proposed road would be located on a new transportation corridor or right-of-way (ROW). Based on the cases reviewed, the ROW trigger always occurs in tandem with another trigger; namely the 50 km threshold trigger. Less frequent triggers for a comprehensive study include: a road project involving an airport component; or an all-season runway greater than 1500m (i.e. St. Theresa/ Wasagamack project); or a project encroaching into a migratory bird sanctuary (e.g. completion of Highway 35). The particular triggers of each CSR reviewed are indicated in Table 4.4.

Table 4.4 Triggers of comprehensive study for selected road projects

Triggers	Road length > 50 km	community previously without public access	located on a new ROW	includes an airport component	includes an all-season runway > 1500 m	Encroaches into migratory bird sanctuary
407 ETR	√					
Athabasca	√					
Completion of Hwy 35						√
Greenville to Kincolith		√				
Lake Winnipeg ESR	√	√	√			
Highway 58	√	√				
New Route 2 Trans-Canada	√		√			
St. Theresa/ Wasagamack				√	√	
Trans Labrador (Phase III)	√					
Waskaganish	√	√	√			
Wollaston Lake Road	√	√				
Frequency (n=11)	**8**	**5**	**3**	**1**	**1**	**1**

Note: The '√' symbol indicates the reported trigger(s) of CSR for each of the road projects

The terminologies used to represent VECs in each of the CSRs are shown in Table 4.5. For the majority of projects (6 of 11), stakeholders tended to use the 'valued ecosystem component' term. In another three projects, 'valued environmental component' was used. In one project (i.e. Greenville to Kincolith) 'relevant environmental component' was used. In three of the projects, the term 'valued social component' was used to distinguish between biophysical and social features of the environment. In these projects, the biophysical components were referred to as valued ecosystem components. Interestingly, in just five of the 11 CSRs a definition of 'VEC' (or similar term) was provided. These definitions are reproduced in Table 4.6.

Table 4.5 VEC terminologies used in road transport CSRs

VEC Terminologies	Valued ecosystem component	Valued environmental component	Valued and selected component	Relevant ecosystem component	Valued social component	Definition of term(s) used provided	
						Y	N
407 East Trans. Corridor*	√					√	
Athabasca	√				√		√
Completion of Hwy 35ˆ	√				√	√	
Greenville to Kincolith				√			√
Lake Winnipeg ESR	√						√
Highway 58		√				√	
New Route 2 Trans-Canada		√				√	
St. Theresa/ Wasagamack˜	√				√		√
Trans Labrador (Phase III)		√					√
Waskaganish			√			√	
Wollaston Lake Roadº	√					√	
Frequency (n=1)	**6**	**3**	**1**	**1**	**3**	**6**	**5**

* In 407 ETR, VECs focused on biophysical issues while the VSC term was used to address socio-cultural features; (ˆ) For completion of Hwy 35, the term VEC was not explicitly denoted in the CSR although the treatment of environmental components reflects a VEC-based approach; (˜) Socio-cultural components were referred to as VECs in St. Theresa/Wasagamack project; (º) In the Wollaston Lake Road project, the term VEC was variously interpreted as 'valued ecosystem components', 'valued ecological components', and 'valued social components' without any explanation. The '√' symbol indicates reported VEC term(s) used in each of the project CSRs.

Table 4.6 Definitions of VEC terms used in the CSRs

Projects	Term(s) used	Definition:
407 ETR	valued ecosystem components	specific features or attributes of the environment that are considered to be important for regulatory reasons, or because of their social, cultural, economic or ecological value
Athabasca+	valued ecosystem components	none given*
Completion of Hwy 35+	valued ecosystem components	any part or aspect of the environment that is considered important by the proponent, the public, scientists, government or any other administrative entity involved in the assessment process
Greenville to Kincolith	relevant environmental components	none given*
Lake Winnipeg ESR	valued environmental components	none given*
Highway 58	valued environmental components	components of the environment (biophysical, socio-cultural, and economic) that are valued by society
New Route 2 Trans-Canada+	valued ecosystem components	components of the environment that may be affected by the project, and are of scientific, ecological or cultural importance
St. Theresa/ Wasagamack	valued environmental components	none given*
Trans Labrador (Phase III)	valued and selected component	none given*
Waskaganish	valued ecosystem components	component of the natural ecosystem which is perceived to be of social, cultural, economic or ecological significance as identified through consultation with affected people and through scientific opinion.
Wollaston Lake Road+	valued ecosystem components	none given*

+ The 'valued social component' (VSC) concept was used in these projects but none provides a definition different from the VEC concept adopted.* No definition of the VEC term used is provided in the CSR.

4.2.2 Project VECs vs. CE VECs

In six of the CSRs studied, CE VECs are discussed in a separate CEA component of the document; while in the other five, CE VECs are discussed in the project component of the document. The total number of VECs selected for both the project and CEA components were compared to describe the relationship between the two components. Looking at Figure 4.1 below, results indicate that for the majority (6 out of 11) of the projects, CE VECs are a subset of project VECs. For instance, in the case of the New Route 2 CSR, eleven VECs were used to assess project-wide impacts while only eight out of the 11 project VECs were selected for CEA analysis. Also of note was the tendency to use the same number of VECs for both project and CEA components. The approach, which simply transfers project VECs

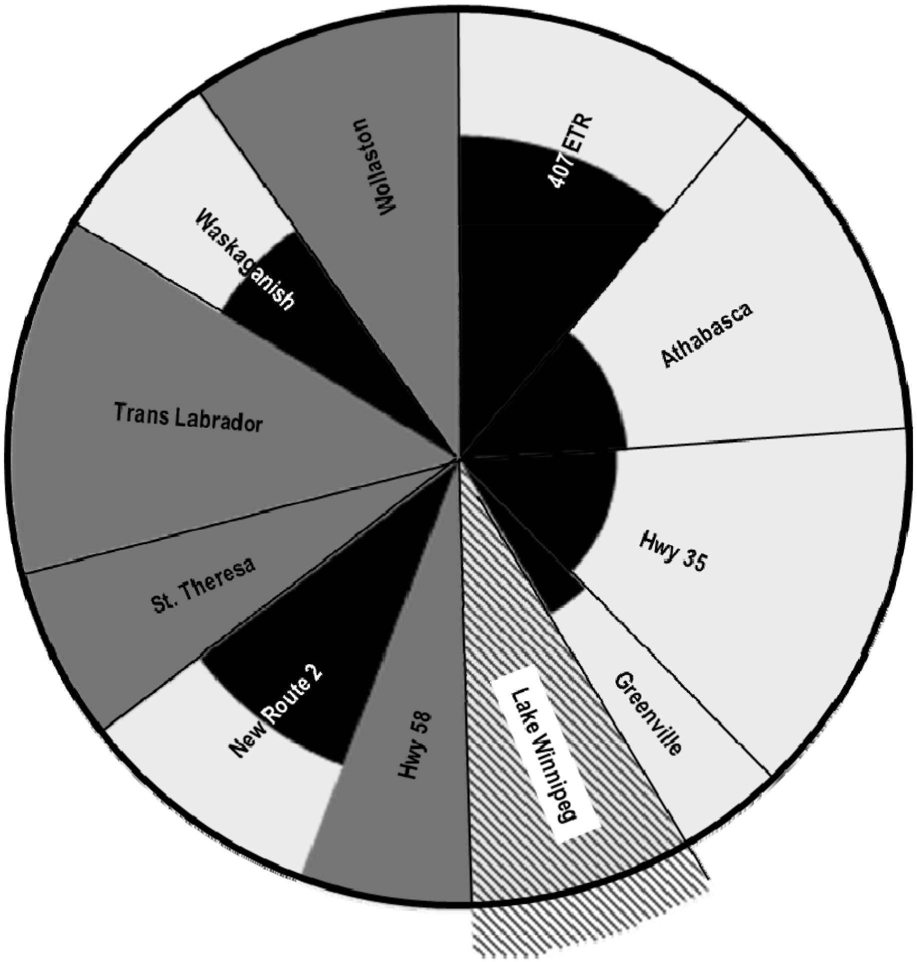

Figure 4.1 Relationship between numbers of project VECs versus CE VEC

No	Project	P-VEC	C-VEC
1	407 ETR	14	10
2	Athabasca	16	6
3	Completion of Hwy 35	17	6
4	Greenville to Kincolith	5	2
5	Lake Winnipeg ESR	10	11
6	Highway 58	8	8
7	New Route 2 Trans-Canada	11	8
8	St. Theresa/ Wasagamack	8	8
9	Trans Labrador (Phase III)	16	16
10	Waskaganish	8	5
11	Wollaston Lake Road	12	12

Note:
The pie chart depicts the ratio of project VECs to CE VECs. For example, in the case of the 407 ESR project, 14 VECs were chosen, but only 10 of these became CE VECs. The light grey shade denotes projects where the number of project VECs equals the number of CE VECs. Black shading indicates cases where CE VECs are a subset of project VECs. The exception is Lake Winnipeg project (denoted by hatched shading) where the number of CE VECs exceeded the number of project VECs.

for use as CE VECs, was adopted in four of the CSRs. For one of the projects, however, the Lake Winnipeg East Side Road, the number of CE VECs exceeded those used for the project assessment.

Appendix D contains a comprehensive list of the VECs in all of the CSRs. A total of 51 VECs were selected for all the projects. Of these, as shown in Table 4.7, the most common were: *fish and fish habitats* (across 10 projects), *vegetation and vegetation communities* (8), *wildlife and wildlife habitat* (8), *species at risk* (7), and *water quality* (6). Valued ecosystem components such as *current use of land and resources by Aboriginal people, geomorphology and geology*, and *wetlands* were also common: each was identified in five projects. With regard to CE VECs, priority was given to *fish and fish habitats* (6 projects), *species at risk* (6 projects), *vegetation and vegetation communities* (6 projects), *wetlands* (5 projects), and *wildlife and wildlife habitat* (5 projects). Two more VECs – *water quality* and *birds/migratory birds* – were also selected in four of the projects.

Table 4.7: Commonly selected VECs for both project and cumulative effects components

Top 8 (Project VECs)		Top 7 (Cumulative effects VECs)	
1	fish and fish habitats **(10)**	1	fish and fish habitats **(6)**
2	vegetation and vegetation communities **(8)**	2	vegetation and vegetation communities **(6)**
3	wildlife and wildlife habitat **(8)**	3	species at risk **(6)**
4	species at risk **(7)**	4	wetlands **(5)**
5	water quality **(6)**	5	wildlife and wildlife habitat **(5)**
6	current use of land by Aboriginal people **(5)**	6	water quality **(4)**
7	geomorphology and geology **(5)**	7	birds/migratory birds **(4)**
8	wetlands **(5)**		

All the CSRs devoted a certain amount of space to CEA, ranging from one page (i.e. Athabasca Seasonal Road) to as many as 123 pages (i.e. New Route 2 Trans-Canada road project). To focus the review in light of the research objectives, emphasis was placed primarily on reporting of VEC selection processes. It was found that the process for selecting VECs, a key procedure integral to CEA, was explicitly discussed in just under half of the projects (thus increasing the importance of follow-up interviews with those responsible for the task in each assessment). It might be assumed that where separate section is dedicated to VEC selection, more detail about the process might be reported. However, the amount of detail in each CSR varies significantly from project to project (see Table 4.8).

Table 4.8 Separate and detailed discussion of how CE VECs were selected

VEC Terminologies	Separate		Detailed	
	Y	N	Y	N
407 ETC	√		√	
Athabasca		√		√
Completion of Hwy 35	√			√
Greenville to Kincolith	√		√	
Lake Winnipeg ESR	√		√	
Highway 58		√		√
New Route 2 Trans-Canada	√		√	
St. Theresa/ Wasagamack		√		√
Trans Labrador (Phase III)		√		√
Waskaganish		√		√
Wollaston Lake Road	√			√
Frequency (n=1)	**6**	**5**	**4**	**7**

Source: Various CSRs – (i) 407 East Transport Corridor; (ii) Athabasca Seasonal Road; (iii) Completion of Hwy 35; (iv) Greenville to Kincolith; (v) Lake Winnipeg ESR; (vi) Highway 58; (vii) New Route 2 Trans-Canada; (viii) St. Theresa/ Wasagamack; (ix) Trans Labrador (Phase III); (x) Waskaganish Permanent Road; (xi) Wollaston Lake Road.
Note: '√' symbol is used to indicate whether or not the discussion of CE VEC selection was 'separate' and/or 'detailed' in the CSRs.

Among the CSRs examined, there is no standard reporting format, which makes gauging the thoroughness of the CE VEC selection processes based solely on the reports a difficult task. In terms of the level of details provided, the trends are very revealing – individual CSR adopts different approaches as summarized below:

a. *407 East Transport Corridor:* Residual effects on each of the VECs are discussed separately and where there were likely adverse effects, they are moved to CEA section for further analysis;

b. *Athabasca Seasonal Road:* Two short paragraphs dedicated to CEs and affected environmental resources itemized without any discussion;

c. *Completion of Highway 35:* Residual effects analysis was the only criterion used, no other details were provided except the results of the CEA;

d. *Greenville to Kincolith Project:* A separate section of the CSR was dedicated to how 2 VECs – Vancouver Canada Geese and Grizzly bear – used to assess CEs were selected;

e. *Lake Winnipeg East Side Road:* An additional VEC – *Current Use of Land and Resources by Aboriginal People* – was added to the list of project VECs to assess CE;

f. *Highway 58, St. Theresa/Wasagamack, and Wollaston Lake Road*: All project VECs were used for CEA; no new VECs were selected;

g. *New Route 2 Trans-Canada:* In spite of the detailed approach to VEC selection in the report, discussion of CE VECs is very shallow and ambiguous;

h. *Trans-Labrador (Phase III) project:* CE was discussed VEC by VEC; some paragraphs were allotted to CE when discussing the environmental effects on VECs.

4.2.3 VEC Selection Rationales

As indicated in Table 4.9, the rationales behind VEC selection as documented in both the project and CE components of the CSRs were also examined. A diversity of rationales was revealed in both report components. In determining project VECs, ecological importance was the most common basis upon which to justify inclusion in the assessment. All the CSRs cited the ecological role of a particular species as the single most important factor for choice as VEC, particularly the biophysical VECs. As explicitly stated in nine of the CSRs, regulatory concerns (9) can also weigh heavily in VEC choices. Other rationales for inclusion as project VECs included socio-economic factors and cultural features, such as cultural value (7); economic importance (7); social and recreational value (6); conservation value (5); traditional/Aboriginal use (4); educational interest (2); scientific importance (1); and human health risk (1). It has been suggested that in actuality, the selection of individual VECs can almost never be tied to a single motivational factor (Leschine and Petersen, 2007). There will always be a challenge in overlapping definitions or functions of a VEC, and so one can assume that the rationales listed in the CSRs are 'simplifications' of the range of reasons, political, ecological or otherwise, that an environmental feature is ultimately designated as a VEC in a project assessment.

Table 4.9 indicates as well that the rationale for CE VEC selection is highly influenced by the outcome of the residual adverse effects analysis. It was found that in seven CSRs, where the number of CE VECs are different from (or subset of) project VECs, CE VECs used were those with significant residual adverse effects-identified in the parent project assessment. In the rest of the projects, the need to select 'new' CE VECs did not arise because all of the project VECs were assessed later on for potential CEs.

Table 4.9 Rationale for inclusion as VECs (Project vs. CE)

	Project Component												Cumulative Effects Components				
	Rationale Stated		regulatory concerns	ecological function/integrity	conservation / biodiversity value	social / recreational value	economic importance	cultural value	traditional aboriginal use	educational interest	scientific interest	human health value	Rationale Stated		residual effects	regulatory factor	special conservation concern
	Y	N											Y	N			
407 ETR	√		x	x		x	x	x					x		x	x	
Athabasca	√			x		x	x	x						x			
Completion of Hwy 35	√		x	x	x	x		x					x		x		
Greenville to Kincolith		√	x	x									x		x		
Lake Winnipeg ESR	√		x	x	x		x	x	x	x	x		x		x		
Highway 58	√		x	x	x			x	x					x			
New Route 2 Trans-Canada	√		x	x	x	x	x	x	x			x	x		x	x	x
St. Theresa/ Wasagamack	√			x			x	x						x	x		
Trans Labrador (Phase III)		√	x	x	x	x		x	x					x	x		
Waskaganish	√		x	x	x	x	x			x				x	x		
Wollaston Lake Road	√		x	x		x	x							x	x		
Total	**9**	**2**	**9**	**11**	**6**	**7**	**7**	**8**	**4**	**2**	**1**	**1**	**5**	**6**	**9**	**1**	**1**

Note: The ‘x’ mark shows that a rationale influences the choice of VECs in a particular project. The ‘√’ symbol is used to indicate whether or not rationales were stated in the CSRs. The general understanding is that CE VECs are selected based on the analysis of residual effects on project VECs. The following parameters are often used to assess the significance of residual adverse effects: (i) magnitude: the size or degree of the effects compared against baseline conditions or reference levels, and other applicable measurement parameters (i.e., standards, guidelines, objectives); (ii) extent: the geographic area over or throughout which the effects are likely to be measurable; (iii) duration: the time period over which the effects are likely to last; (iv) frequency: the rate of recurrence of the effects (or conditions causing the effect); (v) permanence: the degree to which the effects can or will be reversed (typically measured by the time it will take to restore the environmental attribute or feature); and (vi) ecological context: the importance of the environmental attribute or feature to ecosystem health and function. Where mitigation strategies are non-existent or doubtful, such VECs are considered further under CEA section. 407 ETR = Rationale for the inclusion of each VEC were itemized and residual effects on each VEC were discussed; Athabasca = No rationale provided for CE VEC selection; Completion of Hwy 35 = rationales discussed under a different heading i.e. determining residual effects (CSR, 66); Definition was provided; selected VECs are those that have residual effects; Waskaganish = Educational Interest – public education & awareness (p. 24); Wollaston Lake Road = All VECs were assessed for potential CEs.

4.2.4 Stakeholder Involvement in VEC Selection

Because CE VECs are primarily project VECs upon which potential residual impacts are likely, active stakeholders participation and a more comprehensive approach to selecting VECs are most times associated with the project assessment. For instance, as shown in Table 4.10, while statutory authorities, professional communities (e.g. scientists, CEAA, proponents, consultants, and RAs) and public stakeholders (aboriginal peoples, affected populations, and the general public) were always involved in VEC selection in the project component of the CSRs, the selection of VECs for CEs for most of the projects is a more myopic decision of the proponents and consultants involved with regulatory input from RAs and CEAA. An example of this is found in the CSR for Wollaston Lake Road where it is stated: "the selection of cumulative environmental assessment VECs represents the concerns of the proponent, the public and the RAs *as were identified in the EIS*" emphasis authors' (p. 85).

The focus on residual effect analysis also influences the CE VEC selection in terms of seeking process inputs (see Table 4.11). Apart from the Greenville to Kincolith project where separate ecological studies were conducted to identify CE VECs, only a few studies included how information for deciding VEC was collected at this stage of assessment. In terms of project VECs, the most common means of process input was public consultation, which was used in all of the projects except Greenville to Kincolith project. Other documented types of input include: aboriginal consultation (8), regulatory documents (7), traditional knowledge (5); project terms of reference (ToR) (3); and literature and published works (3).

Table 4.10 Stakeholders involved in selecting VECs (Project vs. CE)

Stakeholders involved in selecting Project VECs	Project Component									Cumulative Effects Components							
	Stakeholders Listed/Discussed		public	CEAA	RAs/federal depts	proponents	consultants	provincial dept	aboriginal / affected population	Stakeholders Listed/ Discussed		consultants	proponents	federal/provincial regulators	RAs	public	consultants
	Yes	No								Yes	No						
407 ETR	√		x	x	x	x	x	x	x	√		x	x	x	x	x	x
Athabasca	√		x	x	x	x	x	x			√	no details provided					
Completion of Hwy 35	√		x	x	x	x		x		√		x	x	x	x	x	x
Greenville to Kincolith	√				x	x	x	x		√		x	x	x	x	x	x
Lake Winnipeg ESR	√		x	x	x	x			x	√		x	x	x	x	x	
Highway 58	√		x	x	x	x	x	x	x		√						
New Route 2 Trans-Canada	√		x	x	x	x	x	x	x	√		x	x	x	x	x	x
St. Theresa/ Wasagamack	√		x	x	x	x	x	x	x		√						
Trans Labrador (Phase III)	√		x		x	x	x		x	√							
Waskaganish	√				x	x	x		x		√	x	x	x	x		
Wollaston Lake Road	√		x		x	x		x	x		√		x	x	x	x	
Percent	**11**	**0**	**9**	**7**	**11**	**11**	**8**	**8**	**0**	**6**	**5**	**6**	**6**	**6**	**6**	**6**	**4**

Note: The ‘x’ mark shows that a particular stakeholder group was involved in the choice of VECs in a particular project. The ‘√’ symbol is used to indicate whether or not the stakeholders were listed/discussed in the CSRs. No ‘new’ VECs were selected in four of the projects (columns greyed out) as all project VECs were used for CEA. CE VECs selection is often a decision between the consultants and the proponents with regulatory inputs from the RAs and CEAA. In assessing residual effects, consultants may apply the use of predictive models to gauge level of significance of effects on VECs. The process also includes incorporating views expressed by the public, government agencies, Aboriginal groups/affected population, and the RAs. Information is also sought from relevant government departments on the availability of appropriate mitigation strategies and monitoring requirements.

Table 4.11 Means of seeking inputs for VEC selection process (Project vs. CE)

Means of seeking inputs for VEC selection process	Project Component										Cumulative effects Components					
	Means Stated		public consultations	regulatory documents	ecological studies	aboriginal consultation	traditional knowledge	experience with previous projects	existing published information	TOR	Means Stated		public consultations	regulatory inputs	ecological studies	project guidelines
	Yes	No									Yes	No				
407 ETR	√		x			x						√	no details provided			
Athabasca	√		x									√	no details provided			
Completion of Hwy 35	√		x	x	x							√				
Greenville to Kincolith	√				x						√				x	
Lake Winnipeg ESR	√		x	x	x	x	x					√				
Highway 58	√		x	x	x	x	x	x		x		√	no details provided			
New Route 2 Trans-Canada	√		x	x	x	x			x	x	√		x	x		x
St. Theresa/ Wasagamack	√		x	x		x	x					√				
Trans Labrador (Phase III)	√		x	x		x			x	x		√				
Waskaganish	√		x		x	x	x				√		x			
Wollaston Lake Road	√		x	x	x	x	x	x	x		√		x	x		
Total	**11**	**0**	**10**	**7**	**7**	**8**	**5**	**2**	**3**	**3**	**4**	**7**	**3**	**2**	**1**	**1**

Note: The 'x' mark shows that a particular medium of seeking input was used in the choice of VECs in a particular project. The '√' symbol is used to indicate whether or not means were listed/discussed in the CSRs. No 'new' VECs were selected in four of the projects (columns greyed out) as all project VECs were used for CEA. Science plays a very important role in assessing residual adverse impacts. A common drawback is that even when a subset of the project VECs is used as CE VECs, the decision factors are often omitted in the CSRs.

4.2.5. Timing of Cumulative Effects Consideration

Analysis of the CSRs reveals CEs are typically first considered in the scoping phase of the EA process (Table 4.12). The importance given to early consideration of CEs probably results from it being explicitly stated in Section 16 (1a) of the Canadian Environmental Assessment Act (1995) as often cited in most reports. For most of the CSRs however, it was not clear how this consideration influenced the selection of VECs. The exception was the case of Wollaston Lake Road which clearly states that such early consideration influenced VEC selection with particular reference to CEA (Wollaston Lake CSR: 85). This fact may have also influenced the conduct of a separate study to identify VECs used to assess CEs for the Greenville to Kincolith road project.

Table 4.12 Cumulative effects mentioned during the scoping phase

Cumulative effects mentioned during the scoping phase?	Y	N	Notes
407 ETR		√	Questions on CEs management came up during the public consultation but there is no evidence in both EIS (p.4-43) and the CSR that it influenced the choice of VECs
Athabasca		√	
Completion of Hwy 35	√		Potential CEs of the project were envisaged at the scoping phase (CSR: p.3) but no evidence that this subsequently influenced VEC selection
Greenville to Kincolith	√		The project report specifies the requirement to consider CE from the outset (CSR: p. 20); that may have influenced the conduct of a separate study to identify Vancouver Canada Geese and Grizzly bears as CE VECs
Lake Winnipeg ESR	√		Cumulative impacts were part of the consideration during the scoping phase but emphasis was placed more on the CEA and not VEC selection
Highway 58	√		CEs were top on the list of the project's scoping issues (CSR: p. 34)
New Route 2 Trans-Canada	√		This CSR presents the most detailed approach to VEC selection for CEs (p. 573); CE was also a major issue considered at the scoping phase
St. Theresa/ Wasagamack	√		CEs noted at the scoping phase but no evidence that it influenced VEC selection
Trans Labrador (Phase III)	√		
Waskaganish	√		CEs noted at the scoping phase but no evidence that it influenced VEC selection
Wollaston Lake Road	√		CEs were considered and did influence VEC selection for CE (p. 85)
Frequency	9	2	

Source: Various CSRs – (i) 407 East Transport Corridor; (ii) Athabasca Seasonal Road; (iii) Completion of Hwy 35; (iv) Greenville to Kincolith; (v) Lake Winnipeg ESR; (vi) Highway 58; (vii) New Route 2 Trans-Canada; (viii) St. Theresa/ Wasagamack; (ix) Trans Labrador (Phase III); (x) Waskaganish Permanent Road; (xi) Wollaston Lake Road.

Note: The '√' symbol is used to indicate whether or not cumulative effects were mentioned during the scoping phase of the EA process. Although consideration of CEs was a recurrent factor at the scoping/ planning phase of most of the projects, and many of the CSRs would cite the provisions of paragraphs 16 (1a) of the Canadian Environmental Assessment Act (1995), there is no evidence to conclude this affected the selection of VECs. The exemption is the case of Greenville to Kincolith road where this may have triggered the conduct of a separate study to identify CE VECs.

4.2.6 The Influence of Science, Project Boundaries, and Road Characteristics on VEC Selection

Three additional factors related to VEC selection were considered in the analysis: the role of science; the extent to which both spatial and temporal boundaries affected CE VEC selection; and whether the particular nature of the road construction project influenced the selection of CE VECs. Little information could be found to address these three points of enquiry. The application of science or scientific method to select VECs for CEs was largely insignificant. By 'insignificant' it is meant that biophysical issues are addressed but no information on whether final decisions were based on scientific certainty of selected VECs accurately providing enough information on cumulative effects of the proposals. Apart from Greenville to Kincolith project, VECs were selected based on consultations with the public and statutory agencies in the scoping phase of the assessment. The only opportunity for science to influence VEC selection is related to the analysis of residual adverse effects as a means to determine CE VECs. Even at this stage, VEC selection is sometimes still subject to the value judgments of stakeholders. For instance, in the case of the New Route 2 Trans-Canada project, the criteria for determining residual environmental effects were: "…established based on information obtained during issues scoping, available information on the status and characteristics of the VEC, and professional judgment" (New Route 2 Trans-Canada CSR: 75).

With regard to the influence of a project's boundaries on VEC selection, the general impression given in the CSRs was that boundary considerations (both spatial and temporal) do not influence the selection of CE VECs. Although not explicitly stated, it was observed that in most of the CSRs, assessment boundaries for each particular VEC were often adjusted during the examination of the environmental effects of the project, but not during VEC selection process. Similarly, there is no explicit documentation of how the unique characteristics of a road construction project affected the VECs selection in any of the projects.

4.2.7 Summary of CSR Review Findings

Much useful information on how VECs are selected for project and CE components of project-specific EA was provided in the CSRs studied as documented in this section. However, valuable information such as the actual decision-making processes and associated challenges could not be easily derived or amenable to synthesis from the reports. The next section presents the results of the semi-structured interviews to further expatiate on current understanding of the selection processes and challenges across different road construction projects based on the experience of stakeholders directly involved in the projects.

4.3 Interview Results

This section presents themes identified in the analysis of the semi-structured interview data (full interview schedule is reproduced in Appendix C). These results are presented in both project-specific and aggregate forms. Direct quotations that represent majority viewpoints are used to illustrate themes, as are frequency tables that show numbers of interviewees raising a particular point. Some minority and 'unique' perspectives are also reported where such help is beneficial to deepen the understanding of the theme under consideration. The two previous sections provided initial insight into how project VEC selection is approached. The interview results reinforce many of the earlier findings while providing a deeper understanding of the 'grey' areas in the CSR analysis with respect to CE VEC selection. As a reminder, 22 interviews were carried out with experts on 10 road construction projects. Refer back to Table 3.4 in Chapter 3 on page 49 for a detailed description.

4.3.1 Determining Project VECs

Participants reported a range of opinions about how VECs were selected in the project they were involved with. Consistent with the results of the literature review and the CSR analysis, a recurring theme in the interview data was that the public was given an important role in the selection of project VECs. While 64% of the interviewees (14 of the 22) felt using the term 'VEC' during public consultation was not a major issue, and could be understood by members of the public, 36% of the interviewees (8) found it more appropriate to use VEC in an interpretive sense especially when dealing with the local population and First Nations' communities. One respondent explains: "…we didn't go to ask which is "valued ecosystem component?" what we asked is what is important to them. "What are the things that are important? What are the things you want protected?" From the questions we asked we derived the VECs." Any inconsistency in the use of VEC terminology notwithstanding, it is evident that public opinion was very valuable during VEC selection stage of most projects.

The different ways in which the public was involved varies from project to project, however. For most of the projects, as described by 68% (15) of interviewees, the process of incorporating public opinion into VEC selection was often through public meetings where communities and individuals were solicited to register their concerns. These concerns were later distilled for possible inclusion in the VEC list. In few cases, however (strongly noted by five interviewees), it was a more inclusive, more rigorous process. One of these was the Waskaganish Permanent Road project. A consultant noted:

> …we worked in the community for six months. We were on the site; then we collaborated with ...hunters' and trappers' associations, with groups of women, with youths, with all different groups in the community. It was not only a question of involving the people, sometimes it was complete involvement of the people, of the researchers, all the time every day.

Such statements are indicative of the level of thoroughness employed in certain projects to obtain information on what features to be selected as VECs, especially from the perspective of the public.

Participants also reported that project VEC selection is largely a product of teamwork strategies among different stakeholders such as negotiation, collaboration, and brainstorming. According to 55%of the interviewees (12), this approach helps to reach decisions quickly on which VEC to select: "…you tend to reach consensus quite quickly. There might just be a couple of items you might just need to deal with but majority of them are chosen with very consistent views". In contrast to this general perception, however, some interviewees (3) commented on conflicting opinions and various biases:

> There are different perspectives, different backgrounds of the group of individuals who are together trying to decide what should be looked at, what should not be looked at. Everyone has different biases, different backgrounds, different knowledge of this kind of project. It's coming into agreement on what should be looked at or what shouldn't be looked at… that's part of the biggest challenge.

Certain decision-making complexities—such as public opinion impasses—often become apparent during public consultation. In these cases, VEC selection decisions are apparently made based on the 'loudest voice', as reflected in the quotation below:

> One of the interesting features that came out that looks important is deer. Originally there are some on the project team that think it's important, but most people of the 'east side' don't really like deer meat. So deer is not looked upon favorably. Deer carries a disease called ringworm and they could be passed on to humans. So many people don't like deer and it's not used as a food source. Again, caribou from my perspective is lovely meat but in this area people don't really like caribou, they say they don't like the taste. So you really started to see a difference in opinion. Whereas the moose is a very exceedingly important valued ecosystem component; of course *we decide based on overriding stakeholders* (emphasis added).

Such statements are evident of how personal or group "likes and dislikes" can be influential at such critical decision-making stage.

In addition to an engaged public, six interviewees also indicated how local knowledge was helpful in deciding VECs. Local knowledge became a valuable tool to understand local habitats and environmental relationships where expert knowledge is limited or non-existent. According to a consultant involved with the Greenville to Kincolith project: "…we went out to meet local people …and we sat down among them, took some maps and asked what lives here, what are the natural resources for this animal that may be of concern, so we got that information". In the 407 East Side road project, local knowledge also contributed to the identification of wildlife as a VEC:

> Wildlife is a really good indicator that we got from the public because even though we had some general observational information about where wildlife were crossing, it was really the public that gave us insights into where the appropriate crossings for deer would be, based on their observation, because they are out there.

The use of local knowledge suggests that where data on wildlife species were available for VEC selection purposes, such information may be inadequate to determine the value attached to the species without such leads from local population. In essence, local knowledge allows affected communities to provide more valuable, on-site relevant information based on their experience of the project local area.

According to the interview results, federal and provincial EA requirements (8 responses) and project-specific guidelines (seven responses) were also influential in project VEC selection. Regarding the former, a project manager from the CEAA said,

> There are some other factors that influence the selection of VECs; for instance under the *Canadian Environmental Assessment Act*, there are some obligatory factors that we have to look at. For instance, the environmental effect on current use of land for traditional purposes by Aboriginal people in a way is VEC. So we are required to look at that through the legislation.

Regarding the latter, another CEAA staff noted: "…the other way of determining VECs as well is government will be issuing project-specific guidelines" that would serve as inputs into how VECs are selected. Thus, the results show that there are diverse decision factors that shape decisions on what constitute project VECs. Figure 4.2 captures key opinions expressed by the interviewees on their understanding of the process. On the whole, most (12) agreed that the process is subjective and largely based on compromise among stakeholders involved.

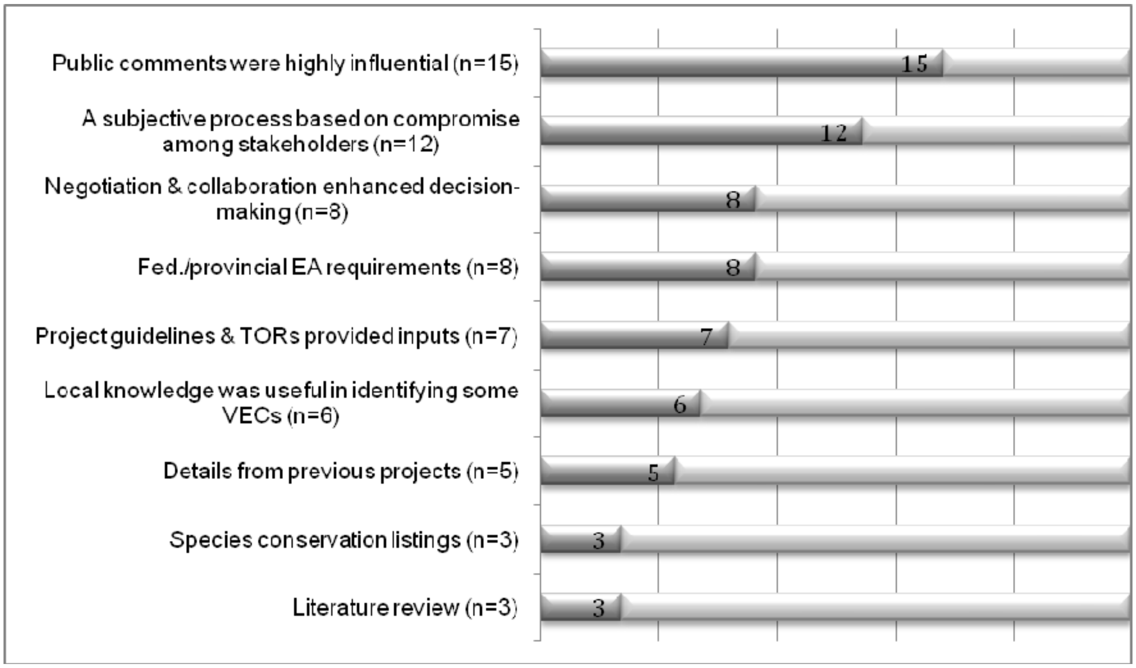

Figure 4.2 Key factors influencing project VEC selection process as expressed by interviewees.

A few other factors influencing project VEC determination, but identified far less frequently, include: details from previous projects (n = 5), species conservation listings (n = 3), and literature review (n = 2). Each of these factors, in addition to the themes discussed above, combined to influence the type and nature of VECs selected for a project. According to Figure 4.2, it is apparent that for project VEC selection there is a clear reliance on certain influential factors over others, namely public opinions, compromise, and negotiation. Interestingly, this was not also the case for VEC selection regarding cumulative effects.

4.3.2 Selecting Cumulative Effects VECs

Selection of CE VECs seemed to happen in many different ways: the interview data do not reveal a clear picture of a universal approach or process. The most recurrent theme among interview responses is that there *is no common approach or clear guidance* to determining CE VECs, or instruction on how to distinguish between project and CE VECs. The data instead show that CE VEC selection depends highly upon individual project circumstances and that there is no 'one size fits all' approach. A number of elements of influence upon CE VEC selection could be deciphered from interview responses, shown in

Table 4.13 below. These factors are however relevant to limited number of projects (6) where CE VECs are a subset of project VECs as reflected upon by the interviewees.

Table 4.13 Factors of influence on selecting CE VECs*

Factor of influence	No. of respondents
Residual effects analysis	10
Knowledge of the project region	8
Legislative and regulatory requirements	7
Details from previous EA documents	5
The established list project VECs	5

* These results are derived only from the following six projects: (i) 407 East Transport Corridor; (ii) Athabasca Seasonal Road; (iii) Completion of Hwy 35; (iv) Greenville to Kincolith; (v) New Route 2 Trans-Canada; (vi) Waskaganish Permanent Road

The rationale given for consulting residual effects analysis (REA) when selecting CE VECs (an analysis done for the parent project assessment) is twofold. First, in some cases REA was carried out on all project VECs to ascertain the magnitude of adverse effects and all VECs later undergo CEA regardless of whether they showed minor or significant residual impacts. Thus, the REA is 'consulted.' This approach is strongly connected with the operational rules of some of the companies contracted to act as consultants. In other words, consultants may not be required in their contracts to distinguish between project and CE VECs: i.e. it is allowable to use a similar set of VECs to gauge both project and CEs. One consultant explains as follows:

> The VECs that we use for cumulative effects assessment were the same ones selected for the project. That is the same methodology that we employ in the company across the country. You won't see us selecting new VECs associated with that aspect of environmental assessment. We select the VECs beginning with project assessment and then we carry it on to assessment of the cumulative effects.

Second, the interview results conversely reveal REA is sometimes used as analytic tool to determine the subset of project VECs that will be used to assess CEs. As stated by one of the CEAA project managers with experience in three of the selected road projects:

> The way that I prefer is first to identify what the project effects are, what are the mitigation measures and residual effects and from there, then decide where you will focus your cumulative effects… We usually tell the proponents that they will need to focus their cumulative effects assessment on the following VECs and usually I prefer to list about four or five maximum so that they do a better job doing the cumulative effects. So that's my preference.

Hence, it can be said that the two approaches represent conflicting philosophies, which often shape decisions on suitable VECs for CE, particularly when REA is conducted as a part of a comprehensive study. But from the interview results, there is no evidence to suggest that one approach is preferred or preferable to the other.

Also indicated in Table 4.13, a substantial number of interviewees (8) believe that an extensive understanding of the project region is an important asset when VECs are selected to assess CEs. Some interviewees commented that this knowledge serves as an effective way of improving the rigor of the selection process: "…we know the areas …and it's fairly easy to know what will be the key concerns in the cumulative effects sense…(and)…so part of that requires knowing things about certain current conditions and having good information source to tell you… what the current state of the land is." This rich knowledge has the potential to influence the weight attached to different environmental components while arguing for the inclusion of particular VECs.

As with project VEC selection, legislative and regulatory concerns are also factored into CE VEC selection processes. Legislation and regulations help to not only identify which CE VECs must be included, but which might be excluded. One of interviewees from CEAA stated:

> …one of the things that we consider sometime is fish and fish habitat because there is a legal requirement to compensate effects on fish and fish habitat. When you know the project effects on fish and fish habitat, you could consider for example that there will not be any residual effects of the project because it would have been compensated… because there is a regulation or an Act that requires compensation of those effects.

So in this case, legal requirements in place to mitigate effects on fish and fish habitat might mean one does not need to assess CE VECs associated with fish and their habitats. In contrast to this position however, fish and fish habitat was considered as a CE VEC in majority (6) of the projects as earlier stated. This reveals the level of disparity that is associated with current process, especially while interpreting legal requirements for a particular environmental component.

Although respondents' reliance on previous EA reports to determine CE VECs was relatively low (n=5), it is worth mentioning as relevant feature of CE VEC selection processes. Some interviewees (3) reported that consulting past EA studies helped enrich the experience of those responsible for selecting CE VECs; simplified the understanding of overlapping effects; and assisted in extracting project-specific details that enhanced understanding of CE VECs. However, these benefits do not suggest that interview participants agreed on the merits of consulting previous EA reports for the purpose of selecting CE VECs. A few interviewees felt that rather than aiding the selection of appropriate VECs for both the project and the CEA, this factor resulted in a less than thorough or effective treatment of VEC issues. A member of the standing committee representing the proponents for one of the projects remarked:

> In terms of the valued ecosystem components, I went back to the documents today; the process to me involves a lot of subjectivities adopted by the consultants. The consultants have done other EAs in the past and in their first draft they lifted all the valued ecosystem components, and categorized them as whether they are socio-economic or ecological or whatever. So that was one of the processes that took place.

Despite the array of influential factors on CE VEC selection mentioned by interviewees, a majority (13) believed that processes are largely driven by compromise among stakeholders involved in that stage of assessment:

> Once the baseline study was done and we know what's on ground, the VECs that everybody could agree on were refined to provide a little bit more focus to them. That kind of happened with regulatory input, and certainly professional and scientific input, while we follow on the completion of the baseline study"

All the data on this subject strongly indicate that while all stakeholders contribute to selecting project VECs, the decision on whether to include a CE VEC rests with the proponents and the consultant, with regulatory and responsible authorities providing necessary checks and balances in the process.

4.3.3 The Role of Science

As part of the interview protocol, participants were asked to describe the role science played in the selection of VECs in general and then particularly with regard to CEs, based on the project they were involved. A strong trend in the responses (12) was that science plays limited role in project VEC decisions, generally speaking, but does provide some assistance in determining CE VECs. It was not uncommon, for instance, for participants to make statements such as the following:

> (i) It's really not rocket science, it's not really hard and that's (a) reflection of the whole environmental assessment field itself. It's not an exact science – it involves a lot of consideration being given to speculations or judgment calls.
>
> (ii) It's quite a bit of what is based on your judgment or what is important to the land user and what is important as we define in our environmental law and that is how we decide on these

> things. The science of the cumulative effects assessment comes when you are doing the analysis. But as we identify the VECs we want to protect, it's really a subjective type of process to just kind of find out what is important to the First Nations, stakeholders in the group as well as government... So that's how we decide on which VECs we are going to use and we get to the science when we are doing the analysis of the effects.

While some interviewees feel they possess enough scientific expertise to make qualified choices about CE VECs, others involved in VEC selection clearly had more socio-economic and cultural expertise than environmental. One example of this was a case where an archaeologist who had been employed by a First Nations community to represent its interests and ensure that traditional land use was not negatively impacted by the project, and a wildlife expert who had several years of experience "assessing the impacts of birds on air traffic safety from the bird airstrike perspective" came together to select project and CEs VECs. Furthermore, the decision-making surrounding selection of VECs seems to be somewhat of a challenge to some sections of the scientific community who "feel the ecosystem approach is being circumvented by just focusing on certain parts of the environment or certain species or issues", and the process thus appear parochial, as noted by one consultant interviewed. Thus, the 'scientific expertise' brought to bear upon VEC selection was variable, and not generally comprehensive, ecologically speaking.

There were several examples of participants mentioning that field and in-depth investigations were conducted before making a case for certain VECs. Consistent with the observation from the CSR for Greenville to Kincolith project, one of the interview participants gave an indication of a science-based selection process, saying: "…it is largely a science-based exercise. It might be informed by professional opinions or expert advice at some level but it's primarily science-based." Some participants did insist the process they were involved in was very much a combination of both science and value judgments, with value judgment receiving greater emphasis. Overall, a majority of the interview participants (12) believe that the entire VEC selection approach is a subjective process heavily dependent on professional judgment and the opinions of key stakeholders.

4.3.4 Timing of Cumulative Effects Consideration

Addressing CEs early in the scoping phase of an EA study may have great impact on the appropriateness of VECs used in the analysis phase (e.g.: Baxter *et al.*, 2001). Nevertheless what happens in reality, according to the projects investigated for this study, is something often quite different, i.e. the interview results clearly show an inconsistency in this 'best practice' approach. Figure 4.3 shows that while 12 of the interviewees claim that CE was part of the scoping phase, 10 interviewees reported something to the contrary.

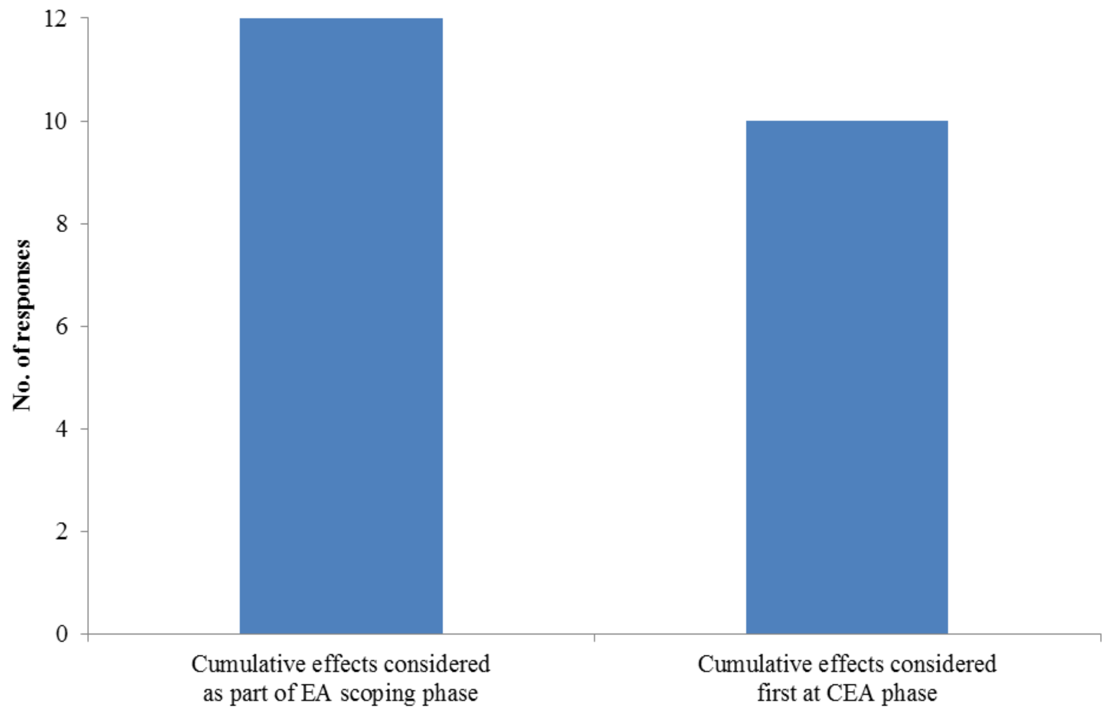

Figure 4.3 Stage of assessment when cumulative effects are first considered.

The excerpt below is representative of the general pattern of responses when CE VECs were not explicitly considered in the scoping phase of the assessment:

> Generally, it was narrowed down after the general EA. When we did our scoping document, we went over a list of VECs for direct impact of the project. That was probably available and we saw public comment on it. We didn't base the (cumulative) analysis of the project on the VECs; we only considered the ones that have residual effects at the end of it…

This practice suggests that the potential for a VEC to interact with other VECs may not be part of the original VEC selection criteria at the scoping phase, and thus using residual analysis to determine what get assessed for cumulative effects is an indication that the level of details required for such analysis might have been missed.

Further analysis of the data reveals three explanations for this deviation from best practice: those who accepted that cumulative effects consideration early in scoping phase was omitted even though necessary; the belief that early consideration would not “bring anything new”; and those who claimed ‘ignorance’ because “cumulative effects assessment is a federal process” which would not normally come up in an EA scoping phase, particularly for projects that started under provincial regulations. In the other projects where CEs were specifically considered during scoping, many of the interviewees indicated that doing so helped to protect against inadequate baseline data collection: “The reason for that is that we didn’t want to get to the cumulative effects assessment and then have to go back in reassessing something or collect more data late in the environmental assessment process”. It is therefore evident that interviewees are divergent in their perception of the importance of early consideration of cumulative effects as a strong factor of influence in selecting CE VECs.

4.3.5 The Influence of Spatial and Temporal Boundaries

According to a majority of interviewees (16), consideration of spatial and temporal scale did not influence CE VEC selection but was an integral consideration in CEA. This category of interviewees suggested that spatial boundaries are best applied VEC by VEC, as a suitable spatial boundary for a static VEC (e.g. vegetation and vegetation communities) during analysis, and argued that such boundary adjustment may be inapplicable to a highly mobile VEC (e.g. deer population). This perspective is congruent with guidelines in the literature on boundary setting for VEC assessment in EA (e.g.: Baxter *et al.*, 2001; Bérubé, 2007; Connelly, 2011). With regard to ‘mobile VECs’, one interviewee said “an ecologically sensible boundary” (e.g. a watershed) was defined for each of the VECs to examine potential impacts in an appropriate context. A proponent explains:

> We had to look at all the factors on their own and some of them have greater spatial boundaries than others. Like some of the effluents. If you look at noise, as you get away from the source it becomes a non-issue whereas if you are looking at groundwater, something upstream of a corridor… let’s just pick a kilometer upstream of a corridor…(something) may have a different impact than something a kilometer downstream. The distance is the same but the impact is different because you are going to have a greater impact on what is downstream than what you are going to have upstream.

It is not clear how this adjustment influenced the choice of CE VECs, but provides useful information on how cumulative impacts on VECs were spatially considered during the CEA process.

Many (7) interviewees mentioned that setting a temporal scale for VEC assessment is a rather more difficult task than establishing physical boundaries. Even if all the projects in the so-called 'foreseeable' future are identified, and appropriate effort is made to include them in the analysis, the growth-inducing nature of road projects as a trigger of socio-economic development can limit the accuracy of temporal boundaries defined for assessing CE VECs. One of the consultants interviewed acknowledged this as a major challenge during CEA phase of the project:

> The temporal (boundary) can really be difficult because especially in an environment where you don't really have a clue of what the new developments may be 20 years down the road, 15 years down the road. We've been part of the Highways (Department) and the Environment (Department) really has no other activity going on and to project into the future too far is almost impossible sometimes. It's really difficult to come up with the temporal scale for some of these VECs.

Overall, the results suggest a weak connection between boundary (both spatial and temporal) adjustment and CE VEC selection process, which may be limiting the credibility or appropriateness of the VECs for broader environmental scales they are applied. The final section of this chapter details a number of specific challenges to CE VEC selection, particularly in the context of road construction projects.

4.3.6 General and Particular Challenges with Selecting CE VECs

In addition to several drawbacks underlying different aspects of VEC selection processes that were discussed in the previous sections, this section attempts to categorize them into specific broad areas based on the responses of the interviewees in order to shed lights on the nature and magnitude of the challenges. It can be said that several general and a few particular challenges undermine the effectiveness of current VEC selection practices in comprehensive EAs for road constructions projects in Canada. These challenges can be divided into three categories: process, data, and project. Process-related challenges include comprehension, consistency, lack of guidance, and efficiency. Data-related challenges include availability, financing, accessibility, and use-ability; and with respect to project-type challenges, interviewees' perceived that the particular nature of road construction projects could present some challenges to selection of CE VECs. All of these are summarized in Figure 4.4 below.

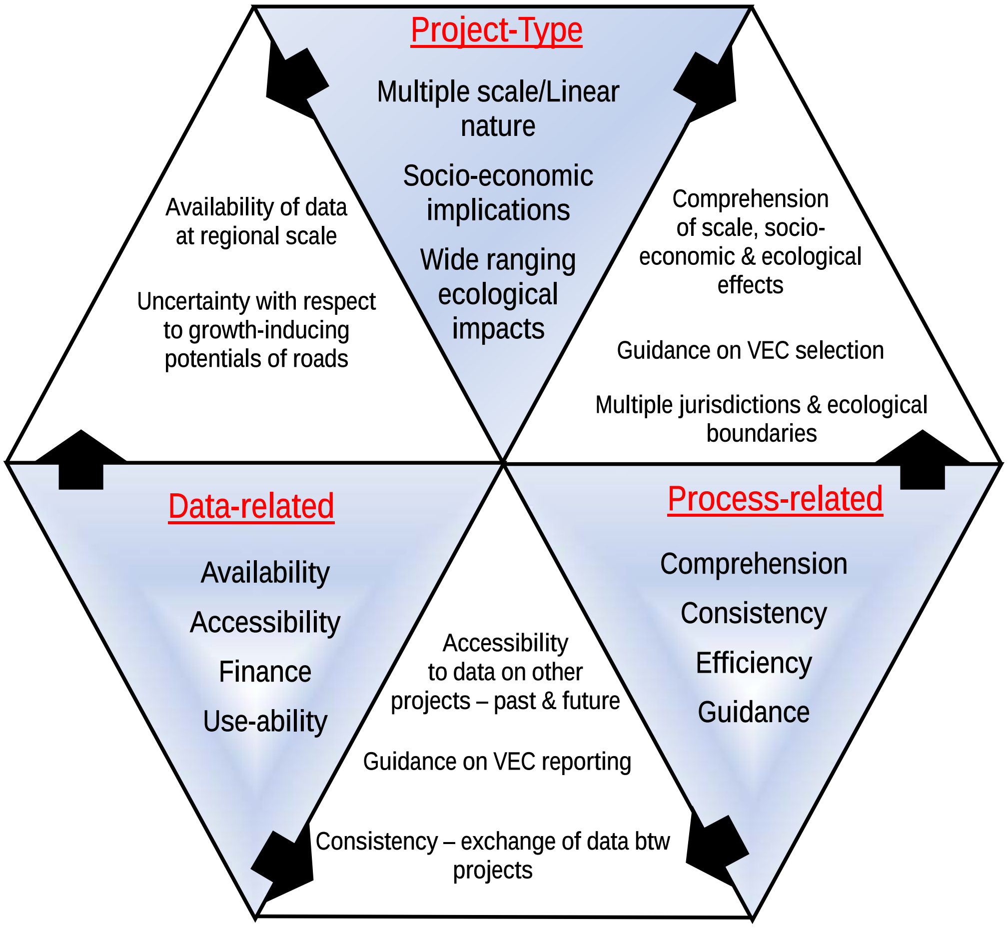

Figure 4.4: Challenges associated with selecting VECs for cumulative effects

Process-related challenges: The most common process-related challenges noted by interviewees were practice inconsistency and the absence of clear guidance to determine CE VECs. A provincial government official remarked that because “there hasn’t been a kind of consistent approach,” different projects completed within the same region usually returned a different set of VECs. The lack of consistency forecloses the possibility “to determine what level of details or what level of direction” is required to ensure stakeholders are objective in their choice of VECs. In fact, another CEAA official commented: “I know that’s the issue that we have when we ask colleagues here ‘do you have any good example to provide this proponent?’ and basically none of us has good example... for cumulative effects assessment.”

In fact, if one judges by the interview data collected in this study, guidance for VEC selection seems to be entirely absent. Not one interviewee mentioned a set of guidelines that they turned to for assistance.

Another factor identified some respondents (4) as a process challenge was comprehension (or interpretation) of VECs for CEs. This was primarily related to the fact that some environmental features can sometimes double both as a VEC and an activity that must be factored into assessing CE. A proponent cited the example of forestry "where there was argument"; i.e. forestry activities can act as stressors but also must serve as VECs sometimes in cases where such forests do not have a protected status.

The final process-related challenge, notable especially among proponents and consultants, was the question of efficiency. Terms such as "time-wasting", "frustrating", "ridiculous", "colossal mess", "painful", "terrible" etc. were used to describe the CE VEC selection process. One participant (a proponent) spoke at length on this subject and provided an insightful, if somewhat critical, perspective:

> So in terms of this project, it's been a very painful process. I should say that it's been a terrible process… the federal government has no sense of schedule, no sense of being able to meet the schedule. The federal (government) is messed up really badly, to put it in a mild term. It's a colossal mess. (The) Federal authority needs to sit back and say what are we doing and why are we doing it…*It's what you provided that will be assessed* (emphasis added)… which is a little close process, a ridiculous process. This is as pertained to cumulative effects precisely; they need to get their head up on what exactly are you going to assess for cumulative effects because when you start congesting the process as if what is done on this land will take away half of the boreal (forest), then you need to sit down and ask what is the definite (reasonable) thing to do.

With regard to the entire CEA process, results show a very high level of dissatisfaction overall (10) triggered in part by the challenges associated with VEC selection and other post-selection issues. It is interesting to note that no other significant reasons for this dissatisfaction were mentioned other than those related to the "CEA Practitioner's Guide". One consultant described the *Guide* as an obsolete document that requires total overhauling:

> In Canada, people tend to use that practitioners' guide and try to get out of doing it properly. I think it's a shame that people are using something from basically 1995 that was produced in 1999 by a bunch of people that really were just learning about cumulative effects themselves and did not at the time use the expertise and knowledge outside of Canada; just their own community examples and approaches to cumulative effects that were used. People are just learning about cumulative effects and now more and better things have been done around the world in other countries like Australia and different parts of Canada like North West Territories and Yukon and Northern BC too.

Hence, it seems that there is no clear operational guide, with particular reference to CE VEC selection, for most stakeholders involved to rely on in defending the inclusion of a particular VEC or to support those proposed by other parties.

Data-related challenges: Yet another theme that ran through the interviews with respect to selecting CE VEC was the challenge of data: i.e. its availability, financing, accessibility, and use-ability. The responses of most interviewees (13) suggested that data availability was a major challenge, especially at the regional scale of assessment where CE is supposed to focus. One consultant explains:

> Frankly, there is no data available on a regional scale. The availability of regional database on key VECs was critical. That is the big challenge… There are things that are definitely measurable but there is no regional information about them. We couldn't put it in a more regional context to see the potential CEs or whether they are significant or not.

Closely linked to this challenge is the question of who funds the data collection: "Going out to collect such data gets to be very expensive and proponents typically don't want to (collect) data that they don't see as practically useful to their operations" was the remark of a provincial government official. Another provincial government official posed the following question: "…who funds both the baseline data collection and the use of those data in the cumulative effects arena?" Therefore, evidence shows that some interviewees believe there is tendency to do a shoddy job due to the expensive nature of data required to make decisions on VECs to be used. Even when data are available, there are challenges related to the accessibility and use-ability of that data, according to interviewees. A proponent provided insight into accessibility challenges:

> And also there is one more challenge to cumulative effects assessment… how you get that information? There may be different proponents in the past that have information that a new proponent needs to do that cumulative impact assessment and other proponents may be unwilling to share that data. Let me say some are willing to share data but so many proponents make it in so many different formats that may not be that useful when you try to combine all that data to make sense of it.

Overall, data-related challenge remains the most cited factor that undermines the efficacy of the process guiding selection of CE VECs.

Road project-type challenges: The results show that selecting CE VECs for road construction projects is a more difficult task when compared to some non-linear projects (e.g. mining).

Study participants argued this was true from a number of angles but the two themes most frequently mentioned were related to the socio-economic implications (9 responses) and multiple spatial scales associated with road construction (5 responses). With respect to the socio-economic implications of road construction, it was a difficult task "…understanding what the addition of the road means to the area … [it may provide] access to hunting, perhaps reduces the cost of resource extraction, increase the interest in forestry or mining; it's tough to know what the road might mean to different communities in terms of cumulative effects". Other specific project-related challenges mentioned by interviewees include that roads operate at multiple spatial scales (e.g. multiple watersheds, different wildlife population boundaries) and the fact that road projects come with wider opportunities for alternative routings. For instance, one of the consultants noted: "You have to back it up and work in different scales. Different scales in terms of baseline data collection, different scale in terms of the environmental assessment implications." Just two interviewees, a consultant and a CEAA staff member respectively, noted the ecological implications (challenges) of road construction projects:

> Transportation projects have been one of the few projects that you actually predict that you are going to kill animals as a result of the development… incidentally, not on purpose but accidentally or incidentally as a result of the project. It's one thing that comes to mind but I don't want to think of it too much.
>
> Basically it means they require a permit to destroy, modify, change the habitat, so it means all the highway projects always or most of the time have effects on fish habitats and by default, we always add to look at for cumulative effect of course.

To capture the significance of all project-type challenges in a single quote, one consultant said: "…access causes problems and whether they be social or environmental, those problems are well known. Everybody turns a blind eye to those issues (yet) we need to put them into the context of cumulative effects". This quote highlights the 'snowballing' effects of road construction projects and their implications for selecting appropriate VECs. Given the context of road projects as an example of linear development, selection of appropriate VECs needs to take into consideration the different spatial scales that are involved, in addition to any social growth (e.g. jobs, improved accessibility, amenities) or ills (e.g. alcohol consumption, accidents, health issues etc.) that may follow particularly as a result of human population increase.

Chapter Five

Discussion

5.1 Selecting VECs: Silences and Controversies in the Literature

5.1.1 VEC Terminologies: Creative vs. Generic

The results show researchers and practitioners are using creative terminology to adapt the notion of what VECs should be, consistent with what was found with Ball *et al*.'s (2012) work in the South Saskatchewan watershed. Valued *environmental* component is the most notable of these refinements as it expands upon the original concept of valued *ecosystem* component. Concepts such as valued *social* components, valued *ecological* components, and valued *cultural* components, among others, are variously used to describe specific features of the environment and to separate such features from the generic term valued *ecosystem* component (Table 4.1). These specific classifications do not necessarily interfere with the conceptual understanding of a VEC, however. Such specific terminology might help practitioners to organize VEC selection processes; more easily identify appropriate indicators for analysis (for example: data required, stakeholders to consult, impact modeling tools etc.); speed decision-making; and help make the assessment process more transparent in general. Yet, it may also create a difficult situation if certain VECs are found to 'overlap', appearing on more than one list (for both the project and the CEA within the project). There could be tendency for stakeholders to select VECs (and ultimately make recommendations) based on different mandates rather than making decisions that are a true reflection of the environment. By changing the 'focus' of the VEC concept in EA, the overall accuracy of the assessment results would be risked as selection of VECs may be made to pacify different interests. To avoid confusion, the use of a single, generic term such as *valued components* might seem easier (for example, Dowlatabadi *et al*., 2004; Ehrlich and Sian, 2004; and Terriplan Consultants, 2006 have all adopted this term), but it may also lead to other practice challenges such as inconsistency, as nebulous concepts tend to do.

5.1.2 VEC Rationales: A Biophysical Emphasis

A more objective approach to VEC selection might mean that the physical, economic as well as the socio-cultural attributes of the environment should be given proportionate weight or consideration relative to the regional context of an EA. The limited guidance available on selecting project VECs as documented in the literature (Kingsley, 1997; Hegmann *et al*., 1999; CEAA, 1999, 2007) promotes this type of balanced approach. On a critical note, however, biophysical components often receive the dominant share of attention, even among scholars who supposedly believe in taking a holistic approach to the concept of the environment in EA. For instance, some rationales for VEC inclusion (summary with references appears in Table 4.2) such as biodiversity/conservation value and scientific value, which may appear to stand alone and not necessarily be predominantly biophysical in nature, are in fact often considered as proxies of ecological significance in some other ecological literature (e.g.: Hay *et al*., 1996). Many of the VECs that have legal/regulatory backing are also predominantly biophysical in nature (e.g. fish and fish habitat, species at risk, wildlife etc.). There is far less attention paid in the literature to the value and nature of social and economic VECs than one might expect. While an 'unbalanced' approach to VEC selection may not necessary be a drawback in practice, depending on the goals of assessment, the concept of sustainable environment is anchored on balancing physical, social as well as economic factors when making decisions on environmental issues. Further, it has been found that road construction causes as much adverse impacts to social VECs as for biophysical VECs (United Nations, 2001).

5.1.3 Public Engagement: The Main Determinant of VECs

The literature also emphasizes the role of public engagement and the importance of consultation mechanisms used throughout an impact assessment process, especially at the scoping phase. Typically, information is gathered through public meetings, interviews, and submissions by interested parties on VECs of choice. This information is later distilled and evaluated through expert judgment to decide on final list of VECs for a project-specific EA (which may or may not be later designated a CE VEC as part of the eventual CEA). The challenge with this arrangement is that those involved in the expert judgment exercise may rely on 'public opinion' without adequate scientific vetting, as final decisions on VEC lists rest with the policy-makers (i.e. regulatory agencies and responsible authorities) (Beanlands, 1988; Abbruzzese and Leibowitz, 1997; Sinclair, 1997; Morgan, 1998; Weston, 2000). The literature further reveals that public involvement in VEC selection often serves as a 'catalyst' to the scoping process (Orians *et al*., 1986). On the other hand, while public consultation appears to be the major influence on choice of VECs, 'validity' and 'quality control' in the EA process demand that stakeholders understand how their views are incorporated into the EA decision-making (Staronova, 2007: 255). There is little evidence in the literature to suggest this type of communication is embedded in VEC selection exercises.

5.1.4 The Role of Science and Scientists in VEC Selection: Weak at Present

Since the 1980s, value judgment (through public participation) has become at least as important, if not more important, than scientific application in EA. Consequently, EA has been critiqued for lacking in scientific integrity (e.g.: Lemons, 1994; Sadler, 1996; Morrison-Saunders and Bailey, 1999, 2003). This subjectivity can endanger the VEC selection process if it becomes viewed as an exercise in 'horse-trading', and perhaps not so much an exercise in civic science (Cashmore, 2004). From the results, a major finding has been made regarding the role of science (both natural and social) as an important factor in selecting VECs, particularly for cumulative effects.

Several authors in years immediately following the introduction of the VEC concept argue strongly that science needs to be afforded a more important role in VEC selection processes (e.g.: Orians *et al*., 1986; Sadler, 1996; Shoemaker, 1994; World Bank, 1997; Mosbech, 2000), although not much had been written on this perspective in the last decade. Yet, none of the literature reviewed for this thesis demonstrates that science does in fact take a prominent role in VEC selection in Canada or elsewhere at present. This is a surprising finding because EA was originally conceived and promoted as a science-driven process. Further, calls for the reintegration of science into EA have been fairly prolific in recent years (Greig and Duinker, 2011; Seitz *et al*., 2011; Chiasson, 2012; etc.).

Orians *et al*. (1986) provide an important insight into the relevance of science in such exercises: they assert while the public (i.e. society) has the prerogative of deciding what is 'valued' in an EA, largely because they are primarily affected by a development, 'evidence-based' decisions grounded in science should be considered equally valuable to the process. According to Orians *et al*. (1986: 15), "Scientists do not determine the values attached by society to ecosystem components, but they might know which organisms have important roles in the ecosystem that are not understood or appreciated by the general public." They may also be able to advise on "why seemingly compatible values might conflict" (p. 15).

During the deliberation process for VECs, scientists should be involved early on in VEC development (Orians *et al*. 1986) and there should be opportunities for stakeholders to support whatever argument is being presented with scientific data (Shoemaker, 1994). In fact, certain VECs can only be selected based on scientific understanding of their role in the ecosystem and not just by pure subjectivity of the stakeholders.

Although not a point of emphasis in the literature, it bears mentioning that scientists can also play a useful role in developing valuable data sets as well as the tool with which to get such data on projects of similar nature. This can help inform stakeholders' understanding of cumulative effects in a region and the value being attached by different interests to any particular ecosystem component. As reported in section 4.3.6, some of the challenges to current practice are data-related.

5.1.5 Cumulative Effects VEC Reporting: Scanty at Best

Going forward, while some discussion of VEC selection processes and rationales in EA is extant in literature, CE VEC selection processes are under-reported. The general picture that emerges from the literature is that CE VECs are largely dependent on a parent project's VEC list i.e. they are a subset of the project VECs. The process of refining project VECs to determine CE VECs is variable, and is done according to: context-scoping (Baxter *et al*., 2001); potential to have interactive effects with other projects (Bérubé, 2007; Canter and Ross, 2008); legal or protected status of a project VEC (Bérubé, 2007; Canter and Ross, 2008); and the use of predictive models (Gunn and Noble, 2009a; Johnson, 2011). Thus, based on the literature, there is no standard approach to CE VEC selection and the process appears to be highly context- and project-driven (Ball, 2011). While this perhaps makes sense, given the parameters for each proposed development project are unique, it does perhaps raise further concern about the quality of CE VEC selection processes if no standards whatsoever are being set or followed.

The Canadian Environmental Assessment Act (1992 and subsequent amendments) establishes processes for conducting federal EA and it is being administered by the Canadian Environmental Assessment Agency. There is Comprehensive Study List legislation specifically designed to govern the conduct of a comprehensive study. In addition to the Reference Guide for CEA released in 1994, a CEA Practitioner Guide was prepared in 1999 by a team of experts in CEA to assist practitioners involved in CEA studies. Similarly, an Operational Policy Statement (1999, 2007) with regards to the federal EA processes is in place to support the existing legislation and act as a guidance document on CEA. While all of the above documents emphasize the central role VECs should play in the assessment of CE, none was specific on the process for VEC decision-making. The decision is left to project proponents or their consultants, although RAs and CEAA staff have a supervisory role in the process. There are also no provisions with regard to the amount of detail to report on the VEC selection process for CEA.

The *CEA Act* as well as other guidance documents (i.e. Heggman *et al*., 1999; OPS, 1999, 2007) specifies that for a VEC to be assessed for CE, it must be found to have the potential to be impacted "in combination with other projects or activities that have been or will be carried out". While several authors advocate this "in combination" approach (e.g.: Bérubé, 2007; Canter and Ross, 2008), none of the literature seems to illuminate how considerations for other project developments, past, present, or future, are actually incorporated into CE VEC selection, although guidance exists for the analysis of the combined effects on affected (selected) VECs (CEQ, 1997). Research commentary to date has largely focused on the analytic phase of the CEA rather than the specifics of VEC determination.

5.2 Observable Dichotomies and Issues for Concern in Selected Case Studies

5.2.1 VECs Play Central Role in Comprehensive Study EA, But Shallowly Reported

The CSR analysis clearly indicates that VECs play a central and essential role in the assessment of project impacts. All but one of the 11 projects examined focus explicitly on VECs to evaluate project impacts, including those related to cumulative effects. There are a few examples among the projects examined where the definition of a VEC differs slightly from the original version used by Beanlands and Duinker (1983) (e.g.: Waskaganish Permanent Road's definition in Table 4.6 on page 63, emphasis on *natural ecosystem*), but the general meaning and intent behind VEC definitions appears to be quite consistent across all of the projects. The term "valued ecosystem component" is the most commonly used.

The level of documentation of VECs and VEC selection (i.e. level of detail given to the subject in the CSR) is inconsistent and generally quite low across the projects examined, including for the CEA component of CSRs. It was found that, typically, about 25 pages at most of a six or seven hundred page CSR are devoted to discussion of VECs (and this discussion is often stated alongside other issues in the reports). This may be because although project proponents have been required to consider cumulative effects since the federal *CEA Act* entered into force in 1995, no explicit guidelines have yet been established on the level of detail that should be provided when reporting VEC selection. In fact, this study has found no guidelines at all that suggest decisions related to VEC choices should be disclosed in writing. It may be argued that though a voluminous report does not necessarily suggest that a credible process is followed, it might lead readers and affected people to ask important questions about the process and outcomes of VEC decisions and the overall assessment. It is common practice in the CSRs, for instance, to list the VECs and then identify in tabular format whether the VEC was selected due to 'ecological concern', 'regulatory concern', 'traditional use concern', 'economic concern', etc. This allows questions to be raised on why VEC A and not VEC B is selected based on ecological concern or what value criteria are used to evaluate different components to arrive at those selected at VECs. The answers may prove important when defending the EA decision to the public.

Prior to the release of Heggman's CEA practitioner guidelines report (1999), documentation of VEC selection processes in road construction CSRs was evidently very shallow. For example, this shallowness is explicit in the Athabasca Seasonal Road CSR (1996) where the CSR was a 32-page "over-abridged"[6] version of the EIS, and just two paragraphs are devoted to discussion of VECs. Even studies conducted after the Heggman report, though significantly better than the Athabasca report, offered little detail about VEC selection process. A specific example from this investigation is the St. Theresa Point/ Wasagamack Airstrip and Connecting Road (2001): while consideration was given to identification of project VECs and some details provided on the effects of the project on selected VECs, the CEA section is a two-paragraph summary highlighting the key CE issues without offering any further analysis of the process adopted in determining CE VECs. In reality, the respective length of the space dedicated to the subject may not be the most important issue; rather what information is communicated about VEC selection rationale. However, based on the results it is obvious there is need to deal more squarely and explicitly with the documentation of how certain decisions related to VECs are made.

In a few CSRs, there is some indication that a more in-depth approach has been taken to selecting VECs. For example, in the New Route 2 Trans-Canada project CSR, rationales

[6] The CSR was a condensed version of the environmental impact statement (EIS). The two paragraphs dedicated to cumulative effects in the EIS were copied verbatim for the CSR. There is no clear explanation on VEC selection processes or the methods used in approaching CEA.

for inclusion of all VECs were explicitly discussed in the report. Also, in the Greenville to Kincolith Road project report, while the process of arriving at CE VECs may not represent the ideal[7], the rationales for their selection were at least explicitly discussed. However, RAs and the stakeholders responsible for preparing the majority of the CSRs apparently overlooked the importance of documenting such a process. The nature of the contents of most CSRs suggests they are tailored towards securing regulatory approval, by emphasizing project impacts and the measures being put in place for mitigation or compensation of such impacts (see Table 4.9, emphasis on regulatory concerns and residual effects as rationales for CE VEC selection).

The foregoing raises some obvious questions about the use and documentation of the VEC concept in CSRs in general: (i) what is the evidence that a thorough and objective process is being followed without documentation of the process? (ii) What level of detail is necessary when reporting on VEC selection processes? and (iii) Can a regulatory change to require documentation of VEC selection processes enhance the efficacy and efficiency of the practice? Perhaps answers to these can be pursued in future research studies, as later suggested in Chapter 6.

5.2.2 Rationales for Selecting Project VECs: Ecological Values Reign

In terms of actually choosing VECs for a project, the CSR results indicate that a project's ecological context is highly influential. In eight of the projects, the road length exceeded 50km with five leading to community without previous public access. Most of these projects cited ecological importance as the main justification for VEC selection (Table 4.9). By 'ecological rationale' it is meant that focus is placed on components of the natural environment. This finding is congruent with several previous studies which have also emphasized that the ecological importance (including rarity and fragility) of a particular component is the single most important rationale in the choice of VECs (e.g.: Ward and Jacoby, 1992; Wedeles and Williams, 1995; Hay *et al.*, 1996; CEQ, 1997; Mosbech, 2000; Thomas, 2001; Leschine and Petersen, 2007; McAfee and Malouin, 2008; Gallaugher and Wood, 2009).

Further, although primary emphasis is placed on ecological issues and values, a major finding in this study is that selection of a VEC cannot be generally be tied to a single

[7]Both the project and CE VEC lists were initially identified by the proponent and subsequently confirmed by the Project Committee. No public consultation was held.

rationale. This was noted earlier by Leschine and Petersen (2007) who found a VEC deemed important for its ecological function may also have high conservation value as well as protected/legal status, and even recreational value. This is understandable, and perhaps important, given that the scoping process is supposed to provide all necessary justification that can help make a well-informed VEC decision. Even though this 'plural rationale' approach is observed in most of the CSRs, none provide explanation on how individual rationales were synthesized to arrive at the VECs selected. It was also unclear from the CSRs whether a 'plural rationale' was a requirement for a VEC to be included. Discussion on VECs was presented as if such synthesis were common understanding to the decision-makers and the general public reading the reports. The CSR results show there is certainly room for improvement in terms of documenting values and rationales. It might be quite useful to provide a full value accounting for each VEC in the CSR to demonstrate its relative importance among the others, and both its scientific and social value within the assessment. An emphasis on a VEC's relative importance may lead to very different mitigation and monitoring responses than would a plan built around a generalized set of VECs.

5.2.3 Biophysical vs. Social vs. Economic VECs: Lack of Balance

Considering which VECs are used to assess both project-specific and cumulative effects in the CSRs examined, biophysical VECs clearly receive priority attention. For example, seven of the eight commonly selected project-specific VECs in the cases reviewed are biophysical in nature (Table 4.7). This makes sense of course, given the above finding that most rationales driving VEC selection are ecologically grounded. It also makes sense given that federal EAs were reviewed and under the Canadian Environmental Assessment Act (1995) 'environment' is defined first and foremost as the biophysical environment, and social and economic impacts are defined only insofar as they are a result of a change in the biophysical environment. So in many respects, it was found that the selection of VECs is consistent with the definition and scope of environment/environmental effect under the *Act*. Yet is still surprising that *current use of land by Aboriginal people* (selected in five projects) is the only social VEC that appears on this list, and none that are economic. One might argue that the EA process in Canada has now been designed in such a way that encourages the involvement of Aboriginal people. This is by far more than merely acknowledging Aboriginal peoples' roles in EA process; the low emphasis placed on non-biophysical VECs suggests that more efforts are required in bringing social and biophysical VECs at par as suggested in previous works (e.g. United Nations, 2001). Not surprisingly, the seven most commonly selected CE VECs are also biophysical in nature.

Three factors might explain this bias in CE VEC selection: practicality, methodology, and regulations. As a practical matter, the literature suggests that biophysical components are conspicuous and easily attract public attention; and as such they often attract the attention of stakeholders, in contrast to social or economic components which are more difficult to define and measure (e.g.: Feehan, 2001:6). Both of the latter are equally notable but often lack specific parameters that can easily be analyzed (Sinclair, 1997) or definitively linked to project effects. Methodologically, the use of residual effects analysis (REA) as tool to determine CE VEC has high tendency to return biophysical VECs as CE VECs. Based on the factors often used for the assessment – probability of occurrence, scientific certainty, and level of confidence – the biophysical components appear to command greater attention because of data availability. Comparatively, there is often limited opportunity for social or economic VECs to figure prominently in the assessment process due to a paucity of data. And on the regulatory side, most environmental components that are often supported by legislation are biophysical in nature (e.g., water, fish, forest, birds etc). In addition, in the CEA *Act*, 'Environment' is defined first and foremost as the biophysical environment, and social and economic impacts are defined only insofar as they are a result of a change in the biophysical environment.

5.2.4 Distinguishing CE VECs: All or a Subset of Project VECs

The CSR analysis suggests there are two major approaches to separating or distinguishing CE VECs from project VECs. Foremost among these is a peculiar system of adopting all project VECs as CE VECs, which implies that the issue of VEC selection is given no further consideration at the CEA phase of the project assessment. In most projects where this procedure is followed, consultants have considerable or absolute authority in determining which VECs become the basis of the CEA. Only in a few cases, including Wollaston Lake Road and Highway 58 projects, do other factors play a role, such as a steering committee decision to simplify the process. In such cases, an all-inclusive approach is first used to determine an initial set of project VECs, but public stakeholders later have no formal role in the decision to move any VECs into the CEA phase. The role of the public should not be restricted to the project scoping phase only if the goal of transparency and accountability is to be achieved. This pattern was also observed in the St. Theresa/Wasagamack project, but no rationale was stated for adopting such an approach.

The second approach is to use ‘residual environmental effects analysis’ (REA) to filter project VECs, which results in the identification of a subset of the project VECs to be used as CEs VECs. Figure 5.1 shows a typical residual environmental effects analysis matrix. Using this approach, each project VEC is analyzed based on the probability of occurrence and scientific certainty to determine the likelihood of residual impact occurrence. The result is used to rate the level of adverse effects as ‘significant’, ‘not significant’, or ‘positive’, meaning positive changes to the environment are anticipated. Where there is a significant adverse effect predicted for a VEC, that VEC is moved across into the CEA, provided the VEC is also affected by other actions/projects. The Highway 35 and Waskaganish projects are cases where this approach was the single most important factor that shaped CEs VEC selection.

Residual Environmental Effects Summary Matrix for [Name of Environmental Components]

Residual Environmental Effects Summary Matrix Valued Environmental Component: <u>**NAME OF ENVIRONMENTAL COMPONENTS**</u>				
Phase	Residual Environmental Effects Rating	Level of Confidence	Likelihood	
			Probability of Occurrence	Scientific Certainty
Construction				
Operation				
Maintenance				
Accidents, Malfunctions and Unplanned Events				
Project Overall				

<u>**Key:**</u>

Residual Environmental Effects Rating:
S = Significant Adverse Environmental Effect
NS =Not Significant Adverse Environmental
P = Positive Environmental Effects

Probability of Occurrence: based on professional judgment
1 = Low probability of occurrence
2 = Medium probability of occurrence
3 = High probability of occurrence

Level of confidence:
1 = Low level of confidence
2 = Medium level of confidence
3 = High level of confidence

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

Figure 5.1: Residual environmental effects summary matrix
Source: (Jacques Whitford Environmental Limited, 2004) – New Route 2 Trans-Canada project – p. 82.

With respect to the first rationale (i.e. the use of similar VECs in both the project and CEA components), clearly the practice does not allow for an in-depth evaluation of a project's regional impacts as ideally required for CEA. It has been suggested that some VECs are best considered in a regional context due to their obvious ability to absorb impacts at broader spatial and temporal scales (i.e. regional policy implications for any VEC should also come into play). For instance, Sinclair (1997) suggests that water quality is best treated at a regional scale – the level of the 'eco-district' – because of its sensitivity to agricultural practice at such a scale. This implies that not all project VECs are necessarily relevant at the scale of a CEA and that the project VEC list should not wholly become the CE VEC list. At the same time, it is startling that in spite of using REA, only four (out of six) of the projects selected water quality as a CE VEC. In the other two projects where water quality was not considered a CE VEC, can it be assumed or concluded that no other project/action has impacted or will impact water quality in the "past, present, or reasonably foreseeable future" in the projects' regions? This finding further highlights the importance of having a VEC selection process which is transparent and objective and based on standardized guidance or principles. In this way, the legitimacy of prediction outcomes involving such VECs can possibly be enhanced.

The inadequacy of the REA as a way to determine the CE VEC list is related to its primary application. The main purpose of a REA is to determine the magnitude of environmental changes that would happen to a VEC and how mitigate-able such changes are, i.e., to ensure that mitigation and monitoring strategies are in place. It is not a specific tool to determine CE VECs. In some of the projects, data collected reflected the local project environment but regional data perhaps more suitable to CEA were not included in the analysis. In essence, as argued by Duinker and Greig (2006), the use of REA has the tendency to omit VECs that have 'insignificant' effect from a single proposal or whose effects are mitigate-able but when combined with other activities have the possibility of being adversely affected. As a result, REA does not have the capacity to solely inform stakeholders of relevant CE VECs but can only be one input among many others that can be harnessed to decide CE VECs.

5.2.5 VECs and VEC Indicators: Conflicting and Inconsistent Usage

Another key finding is the conflicting or overlapping use of various VECs in many of the projects. An analysis of the comprehensive list of VECs used in the 11 CSRs (see Appendix D) shows that profiling (naming and categorizing) of the VECs in many of the projects is somewhat inconsistent. Some projects identify broad environmental concerns as

VECs and then go on to use certain indicators to measure them. But in some other projects, those same elements that were initially used as ‘indicators of a VEC’ at the project assessment level were later considered as full VECs in the cumulative effects stage. This observation is consistent with findings from South Saskatchewan watershed CEA studies where certain environmental components served variably as both a VEC and a VEC indicator (e.g. ground water quality as an indicator of surface water quality), depending upon the project in question (Ball, 2011). For instance, in Greenville to Kincolith road project, after selecting *wildlife* and *bird* as project VECs, it was decided at the CE stage that grizzly bear (a proxy of wildlife) and Vancouver Canada geese (a proxy of bird) should be considered as CE VECs.

For projects where the above scenario applies, the approach may be attractive because it allows stakeholders to be more specific on indicator(s) that may be exposed to cumulative effects and help decide on how a related, in-depth CE analysis can be conducted for that indicator/VEC. Arguably though, this may be how science (and possibly scientists) is being incorporated into the VEC selection process. Another appealing feature of this approach may be the perceived opportunity to respond to the specific demand of particular stakeholders or regulatory concerns. For instance in New Route 2 Project, *Appalachian Forest Hardwood* and *Atlantic salmon* were chosen in place of the generic VECs – *Vegetation* and *Fish* – due to regulatory and societal demands that such indicators be considered under CEA.

VEC indicators are necessary to understand what data are required to measure the synergistic effects of multiple developments on a particular VEC. Shoemaker (1994) documents how identifying appropriate VEC indicators can yield a considerable benefit in a CEA process. However, he further suggests that such understanding of VEC indicators will more likely develop within the institutional context and consultation process of a particular assessment, because these are the two key elements that shape the VEC decisions. Arguably though, the inconsistent usage of VECs and VEC indicators raises the question of what exactly should be considered as VEC whether for the project-specific EA or at the CEA stage, and what terms are perhaps ‘too broad’ or ‘too specific’. In the absence of some sort of definitive guidance, such inconsistencies will continue to attract debate and perhaps affect the perceived legitimacy of CEA studies. The inconsistencies certainly might add some confusion to regional assessment processes tasked with collating empirical knowledge gathered for individual project assessments. For road construction, due to its large spatial scale, VECs could be identified at the broader scale of a region (macro-scale) while different indicators for the same VECs may be selected at different intervals. For instance, wildlife may be a VEC but bear and deer populations may be selected as indicators to assess cumulative impacts on wildlife.

5.3 Interviewees' Perceptions of Current Practice and Associated Challenges

5.3.1 Generating VECs: Heavy Reliance on Local Knowledge

The results of the interviews reveal that public consultation, opinions of Aboriginal communities and newly commissioned or existing ecological studies in a project's region are most often relied on as a starting point to determine project VECs. Information from the EA's 'terms of reference' and past EA reports are also typically used in this process. These patterns are consistent across the 11 projects investigated. However, local knowledge offered by the public is particularly important in identifying certain biophysical VECs such as certain wetlands and local wildlife populations, especially where ecological data are non-existent. By incorporating local knowledge, the results suggest it is possible to identify suitable VECs even when scientific information, expert opinion, or societal interest is relatively scarce.

To properly address certain aspects of the environment such as 'water quality' and 'migratory wildlife', local knowledge alone may not be sufficient. Because the generation and communication of local knowledge is mostly a subjective, non-scientific process (Leschine and Petersen, 2007); the results indicate that information about a certain environmental components and their sensitivity to a proposed development could be sourced elsewhere. For such VECs, appropriate information can be obtained through scientific inputs as suggested by Orians *et al.* (1986). These inputs may come in the form of a new ecological study or consulting existing relevant literature. Such studies, however, need to be approached with caution. It should be understood that researchers work where they want to or where they are directed to most of the time, and not necessarily in locations where development pressures are possible in the future (especially when triggered by road construction). Except where such studies are commissioned to address a specific environmental component, researchers often frame their studies in terms of its importance in a general sense, which could artificially sway those conducting CEs. To ensure the credibility of VECs being selected, the most crucial factor is to make judgment based on concrete and verifiable evidence and to acknowledge any limitations associated with the methods or tools applied in making such judgment.

5.3.2 A Special Role for Aboriginal Communities

Recognition of the role of the public in EA scoping, particularly in identifying VECs, is a fundamental consideration in all the projects examined. Many of the interviewees emphasized this, though the depth of public consultation varies between projects. Notably, the role of Aboriginal communities as distinct from the general public has implications for the success of the scoping process (Stevenson, 1995; Mulvihill and Jacobs, 1998; Mackenzie Valley Review Board, 2009). Nine of the projects directly involved Aboriginal communities, and in fact two of the projects – Waskaganish Permanent Road and Highway 58– were proposed by an Aboriginal council.

Many researchers have discussed the need to separate Aboriginal communities from 'other' public and their role in VEC selection (e.g.: Mulvihill and Jacobs, 1998; Smith, 2000; Stevenson, 2003). In certain jurisdictions, some consultants form partnerships with Aboriginal communities to undertake the EA studies, especially where proposed developments are to predominantly take place within such territories. Such partnerships, as indicated by one interviewee, sometimes include registering the company's operational name using a local indigenous language (e.g. *Inuit*). In addition to involving Aboriginals in VEC selection, this approach also enhances project acceptability and further speeds up the negotiation process. Further, the approach can be cost-saving for road construction as certain indigenous techniques can prove valuable for environmental remedial purposes in addition to use of local materials and manpower (see United Nations, 2001). However, interview evidence also shows that the involvement of the Aboriginal communities in VEC selection is inherently informal due to differing viewpoints on what constitutes VECs among such populations. Typically 'indirect' questions are posed to Aboriginal participants to capture their input and with further refinement by 'experts', VECs are determined. Although the objective of this approach may be to encourage Aboriginal populations to make a contribution without the barriers of complex EA concepts; as strategic stakeholders in VEC decisions, it is perhaps unfortunate their inputs are made to be filtered by 'higher' authorities. Although the approach may have its merit considering the time required to educate local populations to ensure effective participation, a more desirable approach would be to treat such contributions as equally important by including Aboriginal people in the process of refining their inputs, and the final determination of VECs. One may then argue that the inclusion of the Aboriginal communities is primarily driven by the legal requirements for their involvement in EA process under the federal legislation.

5.3.3 The Influence of Scale: Lack of Regional Influence on CE VECs

Although it has been suggested that cumulative effects should be considered in the scoping phase of an EA (for example: Baxter *et al*., 2001), the emphasis of project-specific EA remains on ascertaining direct effects to the immediate area. This was very clear in the interviews as 73% (16 out of 22) of the participants stated that scale adjustment was not a necessary consideration in CE VEC selection. In reality, the extent of spatial scale, if not properly adjusted, has the tendency to either mask or magnify the level of exposure to a VEC (Noble, 2008). In a similar vein, there are components that may be affected outside the temporal boundary set for a single project. It follows that CE VECs should be guided by different spatial and temporal scales, to ensure the credibility of the process. As such, the interview results suggest the effectiveness of the process for selecting appropriate VECs for use in CEA is questionable: different sets of data and different scales of assessment may be needed. These may complement existing project VECs, but they also may not. For example, in addition to data regarding the length and width of the road, it may be necessary to understand the expected length of construction period as well as the estimated traffic volume, and how these dimensions are factored into the CE VEC decisions.

The effectiveness of a CEA lies in the ability of the process to inform decision-makers about the level of change expected from the interaction of the project with other projects, both spatial and temporal, and the availability of adequate mitigation strategies. A better approach to selecting VECs to monitor such large-scale effects is perhaps to expand the selection boundary beyond the project's scale. Perhaps the industrial footprint (spatial and temporal) needs to be better defined through the process or even a result of the process, rather than an input to it. Or it may be prudent to invest relatively little effort in assessing CE under project EA – and make it clear that not much is expected to come forth – and instead devote effort at implementing regional strategic approach to CEA starting from selection of appropriate regional VECs. In this regard, Gunn and Noble's (2009b) recommendation for regional strategic environmental assessment, which captures regional CE VECs but is also linked with project EA, might offer a way forward. In essence, more research is required on how both temporal and spatial scale can and should influence decisions on CE VECs in project EA.

5.3.4 Residual Effects Analysis Poses Problems for CE VEC Selection

From the interview results, the extent to which REA influences CEs VEC decisions was stressed by 10 interviewees (out of 22) across six of the projects. Even though the REA approach described earlier in Section 5.2 provides a fairly objective means of determining CEs VECs, as scientific certainty is a consideration in the analysis, the interview results clearly show that whether or not a VEC is selected depends upon the amount of data available to make the analysis. As noted earlier, the seven most commonly selected CE VECs are biophysical in nature. By its nature – which is data intensive – REA creates a strong incentive for biophysical VECs to be selected since the selection of a component is greatly enhanced by its visibility and measurability. A very important finding is that a VEC can fail to get selected for CEA via REA even though there is evidence that the proposed project may impact the VEC significantly (probability of occurrence), directly due to a lack of data needed to determine the scientific certainty of the impact. The implication, though not a direct result of the research per se, is that REA creates a bias toward popular (well-studied) biophysical VECs at the expense of social, economic, and other VECs in project-specific EA. The highly common usage of REA in EA suggests that more work has to be done to explain the link to CEA, rather than it remaining a defining tool without an explanation of its suitability to selection of CE VECs.

5.3.5 Other VEC Selection Criteria: Short-Sighted and Subjective

A highly influential rationale in the choice of CEs VECs is legal compliance. This is a rule by which certain VECs can be automatically included or excluded from CEA regardless of the result of the REA. If required legally, a VEC can have low probability of occurrence, low scientific certainty, or insignificant adverse environmental effects, and still be guaranteed consideration for cumulative effects. Conversely, some project VECs may have high residual adverse effect but, according to one of the interviewees, "because there is a regulation or an *Act* that requires compensation of those effects" they are sometimes excluded from the cumulative effects list (e.g. fish and fish habitats).

The above is exemplified in the case of the 407 East Corridor project where *fish and fish habitat* was not assessed for cumulative effects because of the existing "No Net Loss" policy for fish and fish habitats. This policy is based on the effort of the DFO to ensure fish mortality recorded due to a proposed development is duly compensated for either through natural or artificial means of reproduction. Features such as wildlife population, species at risk, wetlands, and migratory birds are also examples of VECs that often must be considered for CEA due to legal requirements. This, however, is not consistent across projects as *fish and fish habitat* was considered as a CE VEC in six of the projects examined though selected as project VECs across 10 projects. This inconsistency reinforces the context-specific approach of the current practice.

As notable as VECs significantly and directly affected by a proposed development are, due consideration must be given to VECs perhaps marginally affected by the proposed project but also impacted by other projects in the vicinity. In fact, as noted earlier in Chapter 2, this is what the Canadian federal *CEA Act* recommends: the consideration of a project's effects on VECs *in combination* with other past, present, and future projects. It is possible that when viewed in the regional and longer-term contexts of the project development area, a more serious, interactive effect upon a VEC may occur even where direct effects of the proposed project are predicted to be minor. This study of current practice shows that not enough attention is been paid to these types of scenarios. The issue was noted previously by Duinker and Greig (2006):

> Unfortunately, however, this is how we see most EIAs currently conducted. The usual approach is to call for a normal EIA first, and then to tack on a token CEA in a separate cumulative effects chapter of the main EIA document. Some would make the persuasive argument that any project EIA should first try to determine whether the proposed project, with and without impact mitigation, might itself have any effects on VECs. After all, can assessors not conclude that a project cannot have any significant cumulative effects if it has no significant effects by itself? As attractive as this argument may be initially, it breaks down as soon as we consider the distinct possibility that two projects in the same vicinity, one ahead of the other in sequence, may each have undetectable impacts by themselves, but horrific impacts together. For example, suppose the threshold for water removal from a stream, from the standpoint of effects on fish populations, were 70%. Thus, as long as the stream has 30% of its flow during any low-flow period, one would not be able to detect effects on the fish. If one project is to draw out 40% of the flow, this would have no impact by itself. If another other project is to draw out 35% of the flow, it also would have no impact by itself. However, the two projects together would draw out 75% of the original flow, with devastating (cumulative) effects on the fish. An EIA for either project would miss this possibility if cumulative effects were dismissed because the project itself was deemed to have inconsequential effects on the fish through water removal (p. 157).

From the above argument, it is obvious that change is needed with regard to the definition of 'significance' and characterization of the baseline environment, particularly when CE VECs are being considered in project EA. A necessary precondition to selecting CE VECs is to understand if effects contributed by a particular project (whether significant or minor) push the aggregate effects beyond the threshold set for a particular component whether designated as project VEC or not. In the interviews on road construction projects, there was no mention of any measures to determine how such interactions may be factored into deciding CE VECs.

Because road projects are linear and extend for long distances, there is a high probability of interaction with other road and related development projects. Thus, previous EAs conducted within the region become an important source of additional information. Consulting these would increase the range of knowledge for stakeholders when determining VECs, and possibly the quality of their decisions, if consistency in VEC use and selection is a practice. The results of the interviews suggest this is generally not happening though. [Of course, part of the challenge—discussed below—may be lack of access to pertinent information on other projects in a region.] Instead stakeholders frequently rely on judgment calls and assumptions to determine project interactions while selecting VECs. Current VEC selection processes involve a high degree of subjectivity, tailoring to the project context, and a weak foundation for CE VEC choices. In other words, they are not as thorough as they could be.

Absence of guidance intensified the challenge as the choice of VECs was often influenced by opinions that may be based more on the 'feelings' or 'experiences' of a particular stakeholder rather than actual environmental realities. Moreover, since guidance is lacking, stakeholders tend to interpret the concept of a VEC as loosely as possible to suit personal interests and perceptions. One instance of this was when there was debate in the Lake Winnipeg East Side Road Project on whether 'forestry' should be considered either an activity or a VEC. This scenario especially stresses that wherever subjectivity dominates, decision-making becomes much more complex, given that guidance is non-existent. The result is a selection not based on solid evidence to support a stakeholder's claim.

5.3.6 Data Challenges Pervade CEA

Many authors have previously discussed how inadequate data contributes to process challenges in CEs VEC selection and EA generally (e.g.: Drouin and LeBlanc, 1994; Sallenave, 1994; Kennett, 1999; DEAT, 2004; Bérubé, 2007; Connelly, 2008; CCME, 2009). Dimensions of the challenge include: data insufficiencies (e.g.: Duinker and Greig, 2006); collection of data which bear little or no relevance to cumulative effects analysis (Fuggle, 2005); and shortage of funds to collect extensive data (Duinker and Greig, 2006). Similar challenges were cited in the interviews for this study.

The most common data-related challenge for road construction projects was lack of financial resources for data collection. While the 11 CSRs provide little information about cost barriers, some of the interviewees commented on the subject. They indicated that as data collection can be very expensive, proponents typically take a precautionary approach to data procurement. They want to avoid collecting any data not practically useful to their operations. Assuming that more emphasis is placed on integrating scientific inputs into VEC selection processes in the future, these processes will remain compromised if emphasis is placed on cost savings to the proponent at the expense of making sound judgment. As this topic has been covered extensively elsewhere in EA literature (Connelly, 2008; Duinker and Greig, 2006) it does not need to be discussed in depth here.

5.3.7 The Road Construction Context: A Different Class of Effects

The interview results show that the nature of road construction projects as examples of linear projects raise a different class of issues for CEs VEC selection. The wide-ranging spatial scales associated with roads, their permanence, their very long-term effects, and their unpredictable socio-economic implications (i.e. its growth-inducing effects) make CE VEC identification in this development context particularly difficult. Nearly 40% (9 of 22 interviewees) of those interviewed indicated that the level of social change that roads cause to a previously inaccessible community is inherently unpredictable, and this affects the selection of social VECs in CEA. Because social VECs are not easily quantifiable, most studies will mention but not consider them as CE VECs and this may be a major omission. As evident in the analysis of the CSRs, no socio-economic and cultural VECs are found among the top seven most frequently selected CE VECs. What can be said, however, is that identifying appropriate social VECs will be much easier to perform in cases where an explicit guidance on the process is made available for use.

The linear nature of road development creates some interesting complications for VEC selection. For instance, while some VECs such as wetlands and certain wildlife population may be ubiquitous at the north end of a proposed highway they may not be present at all at the south end of the same road, some 50 or more kilometres away. Different scales of analysis can make environmental components seem more or less critical in an assessment context (Therivel and Ross, 2007; Noble, 2008). Such variability makes it difficult for experts to evaluate the local and regional importance of such components for inclusion as CEs VECs. For example, in Greenville to Kincolith project, an interviewee noted that the selection of the grizzly bear as a CE VEC was based on a scale different from the traditional “local study area (LSA) versus the regional study area (RSA)” basis. Rather than focusing on these spatial classifications, “individual bear spatial scale below the local study area” was used to identify different bear populations which warranted their consideration as CE VECs. Where such level of details is not observed, the decision scale could either be too narrow (local project area) or too broad (regional project area) to facilitate sound decision; consequently, important components may be missed out in CE VEC selection because of the expansive (or sometimes restrictive) spatial scale that may be adopted (Mulvihill and Baker 2001). This implies that the question of an optimal scale to assess CE on VECs require further investigation (McGarigal *et al.,* 2001).

5.4 Conceptualizing Current Practice and Opportunities for Improved Practice

As far as current practice in the road construction sector is concerned, cumulative effects, as practiced under project specific EAs, seem to have a narrower meaning than suggested in broader EA literature. Theoretically, cumulative effects consideration requires that findings from previous assessments carried out within the same region are incorporated into selection of appropriate regionally-relevant VECs in order to gauge the interactive or synergistic nature of such effects. This understanding is not readily apparent in many of the CSRs and was only mentioned by one interviewee. Reference to other EA reports in the CSRs was found to be minimal, although it was common to examine other studies to gauge direct interactions of the proposed development, as proposed in the *CEA Act*. All the CSRs listed 'other' projects in the regional context descriptions of the projects to be considered, but they provide little understanding of whether this process ultimately influenced the selection of CE VECs.

Although the conceptual understanding of VECs and their central role in CEA are advancing based on the findings of this study, the key limitation to the process of determining CE VECs is the absence of guidance. Compared with the level of expertise available to conduct other phases of an EA and project-specific CEA in the last two decades, appropriate methodologies for VEC selection, particularly for cumulative effects, are apparently missing, and more of the process is found to be subjective rather than evidence-based. Despite the lack of guidance and subjectivity, two key approaches to CE VEC selection in the road construction context have emerged: (i) using similar VECs for both project and CE assessments; and (ii) using a subset of project VECs as CE VECs. Figure 5.2 illustrates these two pathways.

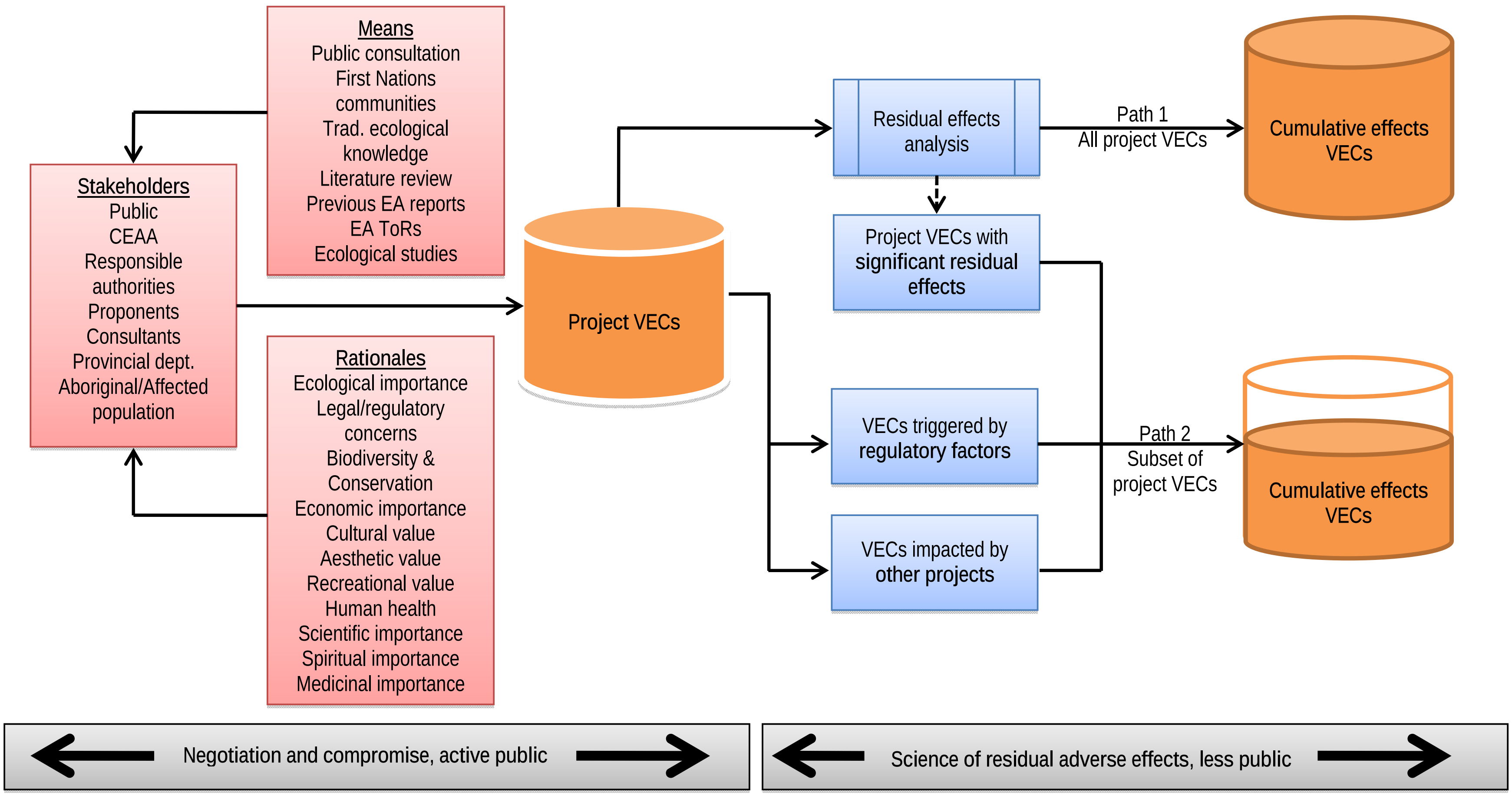

Figure 5.2: Conceptual model of VEC selection processes for project-based environmental assessment and its cumulative effects assessment component

In Figure 5.2, the relationships between the various factors that shape selection of VECs are represented. The diagram is based on the aggregate results from all the data sources. As indicated on the left hand side of the diagram, project VEC selection involves a multi-stakeholder process that encourages decision-making through diverse means and rationales. Stakeholders with diverse backgrounds often have different interests and mandates with conflicting ideas on what should be valued. However, different means such as public consultation, traditional ecological knowledge (TEK), new ecological studies etc. are used to gather opinions after which they are subjected to various rationales to arrive at the final VEC list.

As stated earlier, rationales could be overlapping and a VEC may be recommended based on a single rationale or on an array of means, rationales, and support from different stakeholders. An environmental component with multiple rationales and supports has a higher potential to be selected, as consensus can more easily be reached. A few VECs fall into this latter category (e.g. water quality, vegetation, wildlife), thus explaining their inclusion as VECs in many of the projects. Inclusion of some other VECs is quite a bit more challenging; particularly when a VEC is being promoted by few stakeholders. If there are no defining rules to guide selection process, and from the study results it appears there is not, decision-making about which VECs should become project VECs is often slowed down resulting in delay to the subsequent phases of the assessment. The hallmark of the project VEC selection phase is that it encourages active public participation, with negotiation and compromise at the heart of process.

The right hand side of the diagram illustrates the two different CE VEC selection pathways. Each of these processes has a strong link with the initial project VEC list. The first pathway, shown at the top of the right hand side of Figure 5.2, does not lead to any alteration to the parent project VEC list as the whole set of VECs are adopted as CE VECs. In this case, the REA is only consulted to evaluate the magnitude of change to project VECs expected and the available mitigation strategies. This is in contrast to the second pathway, shown at the bottom of the right hand side of Figure 5.2, where in addition to (a) regulatory concerns for certain VECs and (b) potential for a project VEC to interact with other projects, (c) the REA is used to filter project VECs, i.e. those with significant residual effects are chosen as CE VECs. The combination of these three factors generates a subset of the initial project VEC list as CE VECs. Typically at this stage, little or no public participation is involved and the only science is those conducted as part of the REA.

A few implications regarding public participation in VEC selection warrant mentioning. As indicated in Section 5.2 and Table 5.2, public engagement is an important component of VEC selection. Although EA literature is replete with comments on the important role of the public in EA scoping, this study reveals most of the emphasis to date in this regard has been on the general EA scoping process and concerns about proposed development effects on the welfare of the concerned public. Only recently have aspects of public involvement in VEC selection also been considered, and that is principally within the broad context of using traditional ecological knowledge (TEK) as a means of identifying VECs (e.g.: Stevenson, 1995, 1996, 2005; Sadler, 1996; World Bank, 1997; Emery, 2000; Marusich, 2001). Consequently, this study is very valuable in that it reveals the central role public engagement plays in most of the cases reviewed. Public engagement is one way of assigning 'value' to the environment, because the physical and social perturbations can be easily understood by the affected public. There is no question that the level of public engagement is a very important factor that can aid quick decision and sound judgment during VEC selection. This was exemplified in the case of Waskaganish Permanent Road project where the proponents and the consulting team involved the local populations from selection to documentation stage.

This study also importantly reveals that the level of public engagement tends to decrease at the CEA stage of VEC selection. Generally this is the case, although it is not clear from the present data that the process follows the same pattern in all the projects. The public is likely to be less involved in the later stages of the EA, where cumulative effects issues are often confined, than in the early stages of the EA which are always characterized by certain decision controversies. The context-specific approach adopted for most of the projects makes it difficult to generalize in regard to the level of public engagement involved in the process. The road length and community diversity may also be an important factor. One would expect that a road construction project involving several communities may attract a sustained public concern throughout the project phases, including when cumulative effects are being considered. In contrast, public involvement may be relatively limited in a one-community road project such as the case of Waskaganish Permanent Road. Notwithstanding, it can be said in general, that increased public engagement in the CEA stage will tend to help measure the 'value' attached to a particular environmental component in addition to hastening the selection process.

Finally, looking across all of the study results, a number of weaknesses in VEC selection processes are readily apparent, but so are a number of 'good practice signals'. These are summarized in Table 5.1 below.

Table 5.1 VEC selection processes: weaknesses and 'good signals'

Weakness (Project List)	'Good practice signal' (Project List)
• CE VECs are highly dependent on initial project VECs (all projects)	• Science was influential in VEC selection (Greenville to Kincolith Road)
• Lack of equal attention to social and economic VECs (all projects)	• Public engagement was encouraged both in project and CEA stages (Waskaganish Permanent Road)
• Public engagement wanes in selection of CE VECs (all projects)	• Detailed reporting of VEC selection rationales (e.g. New Route 2 Trans-Canada project)
• Loudest voice has greatest influence (all projects)	• Early consideration of cumulative effects (Completion of Hwy 35; Greenville to Kincolith; Lake Winnipeg ESR; Highway 58; New Route 2 Trans-Canada; St. Theresa/ Wasagamack; Trans Labrador (Phase III); Waskaganish Permanent Road; Wollaston Lake Road)
• Lack of balance between judgment calls and science (All projects except Greenville to Kincolith Road)	

The strong influence of the parent project is evident in CE VEC selection processes across all projects. This suggests that such a scenario is likely to be common practice even for projects other than road projects. If so, many important regional VECs may be omitted in the CEA unless this was part of the consideration at project VEC selection stage. Additional stressors such as nearby projects, best considered at the CEA stage, might increase the relevance of certain environmental components that may or may not have been selected as a VEC during project scoping because the argument for such was not strong enough then. This perhaps underscores the need for separate mechanisms other than REA for conducting CE VEC selection. It seems insufficient to choose CE VECs based on limited information available at the initial project phase where details of the interaction with other projects were not evident.

A further observation is that in all projects, CE VEC selection was not sensitive to the holistic context of the 'triple bottom line' sustainability principles: society, economy, and environment. The results of this study clearly show that there is a lack of consideration of social and economic VECs in EA, and particularly in CEA. Biophysical VECs still take center stage. This is problematic given that calls to integrate sustainability principles into EA practice are increasing (e.g.: Duinker and Greig, 2006; Swor and Canter, 2008; Senner, 2011). Correction of this one-sidedness is likely necessary for CEA, and EA generally, to better contribute to local and regional sustainable development.

Public engagement is uncommon and public involvement is often considered less important in the CE VEC selection according to the results of this study. It should be noted, however, that public engagement was encouraged in both project and CE VEC selection in the Waskaganish Permanent Road project and this should be regarded as a positive signal from current practice. Cumulative effects assessment has been described as the "real impact assessment" on VECs (e.g.: Senner, 2011: 504); therefore, the input of the public at this stage of assessment cannot be less important. At the same time, another weakness of current practice is that project VEC selection is largely based on the 'loudest voice syndrome', with little or no scientific basis for decision-making. At least in the road construction sector, a more balanced approach to public and scientific input in VEC selection is needed in both EA and CEA.

Relatedly, there is a definite a lack of balance[8] between scientific evidence and 'judgment calls' based on opinions and assumptions in the VEC selection processes of all the projects examined—except for the Greenville to Kincolith project. In that case, it was found that science can indeed be influential in CE VEC decisions if broad ecological studies are conducted and scientists are involved early in the process. Another option is to use scientific evidence to assign a relative ranking of environmental components of interest and identify components of higher concern, ecologically speaking. This may lead to a better understanding of the potential cumulative effects of a proposal as VEC decisions are being based on verifiable data.

There are a couple of other examples of good practice from the project set examined worth mentioning. Baxter *et al.* (2001) suggest that early consideration of cumulative effects in project EA would improve both the accuracy of, and confidence in, CEA results. It is clearly stated in many of the projects where cumulative effects were listed as part of issues considered at the initial stage. This practice is however vague in terms of technical details

[8] In this case 'balance' means evidence-based approach where science is made to reinforce the judgment calls of stakeholders.

provided and probably in terms of the strength of influence of such considerations on initial VECs selected. Practitioners preparing the CSRs must therefore document how early consideration of cumulative effects influences the choice of VECs selected at the initial scoping stage, and the rigour of such process may be helpful to determine what further effort is required at the CE VEC selection stage.

Finally, with respect to documentation of the CEA process, the New Route 2 Trans Canada Road project CSR did explain the rationales behind each CE VEC choice by providing geographic details, and went on to explicitly state impact significance criteria for each VEC. This suggests that a relatively more thorough job might have been done when deciding CE VECs in this case than in others, where such details were absent.

While the study did reveal a great deal of information about certain aspects of VEC selection processes, including the relationship between project and CE VECs, the roles of science vs. public opinion, etc., certain aspects of the process are still largely unexplained. Most notably, the specific decision rules around VEC choices, and whether there are any, remain unclear. Despite the wide array of rationales and means guiding stakeholders' decisions at the project VEC selection phase, there is no information about how those values are ranked. Both the literature as well as the CSRs is silent on this, and none of those interviewed indicated that some sort of ranking methods were adopted. The question that is yet unanswered is: 'value' from whose or what perspective? What is broadly apparent from the study results is that although environmental rationales are being touted, value judgments are largely anthropocentric (i.e. from human perspective). When humans are faced with conflicting opinions (or values) there is often pressure by individual stakeholders to increase the acceptance of their own opinions. The consequence is that environmental considerations may be sacrificed for human prejudices as conflicts are being avoided. If appropriate selection guidance is made available then such prejudice may be reduced to the barest minimum, if objectivity and transparency inform the design of such guidance. In the absence of such guidance, some components may be used as VECs when in fact they are more suitable as VEC indicators, while certain important VECs are completely missed; thereby compromising the credibility of the EA results.

Chapter 6 provides a conclusion to the study by summarizing the main lessons learned and areas where more research is needed to strengthen future practice.

Chapter Six

Conclusions

Using road construction projects as a context, this thesis investigated issues associated with VEC selection processes and their implications for the efficacy of CEA studies under federal comprehensive study EA in Canada. The challenges associated with selecting VECs are well recognized in cumulative effects literature in Canada (e.g.: McCarty and Power, 2000; Dowlatabadi *et al.*, 2004; Bérubé, 2007) but with more information on what is going on in key development sectors, the EA community can begin to address this 'black box' and move toward more transparent, rigorous and beneficial practice. This chapter summarizes the major conclusions that can be drawn with respect to the research objectives, recommends improvements to practice, and suggests next steps for future research.

6.1 Addressing the Research Objectives

6.1.1 Objective I – The Distinction between Project VECs and CE VECs

The number as well as the type and nature of VECs selected differ considerably across projects. The range of VECs selected in each project is too broad to be synthesized into a single VEC list that can be used across road construction projects. The nebulous divide between what constitute a VEC and a VEC indicator adds to this complexity. However, this study does allow three major conclusions to be drawn with respect to the distinction between project and CE VECs. First, there is high preference for biophysical VECs in both project-based assessment and CEA. Second, CE VECs are highly dependent on the initial project VEC list, despite that comprehensive studies differ considerably in their methodology for VEC selection. Third, both project and CE VECs are defined based on conditions and concerns in the local project area rather than the other way around, whereby regional or sectoral CEs issues might be used to help pinpoint project VECs and especially CE VECs. Despite Roots' (1986) argument for different spatial and temporal scales for selecting CE VECs, there is no evidence that this is the practice in cases reviewed. What is needed in project EA may be to leave CEA to the realms of either strategic EA or regional planning. Yet another option is to reduce our expectations of CEA in a project context. Perhaps a more limited form of CEA in project assessment looking at the 'direct CEs' of the proposed project is all that can be expected. In practice, it seems, this is what is being done anyway.

6.1.2 Objective II –VEC Selection Processes and Their Sensitivity to CEs

The approach to VEC selection is not particularly 'shallow' in that more than a cursory attempt is made to perform this important exercise, but it is still consistently subjective, and science plays an insignificant role in the process overall. Public concern, particularly where the project involved more than one community and larger geographical scale, is the leading driver in project VEC selection and ecological arguments are most common to justify the choice of a VEC. However, public involvement in CE VEC selection is very limited, to the point it is almost non-existent. As well, social and economic VECs rarely appear on CE VEC lists, even though road construction projects by nature have significant social and economic impacts, and even though local and Aboriginal communities typically participate in initial project VEC selection exercises. In spite of significant recent advances in the science and application of CEA, transparent, balanced, principles-based methodologies for CE VEC selection are missing within project-specific EAs. In essence, there is not enough evidence from current practice to indicate that CE VECs are truly sensitive to the cumulative effects of road construction projects.

6.1.3 Objective III –Opportunities and Challenges to Improve CE VEC Selection

Within the context of the road construction sector in Canada, it can be concluded that the major challenges to CE VEC selection are (1) the 'begin-again' approach to each new project assessment, whereby there is very little knowledge transfer or capacity building from one assessment to another; (2) variability in ecosystem components due to the linear nature of road development, which may compound experts' evaluation of the local and regional importance of some components for inclusion as CEs VECs; and (3) the growth-inducing potentials of roads, which may result in high environmental risks to some (non-valued) components not anticipated during project VEC selection stage. Conversely, the major opportunities to improve CE VEC selection are: (1) increasing public involvement; (2) application of science to CE VEC selection processes; and (3) timely and early consideration of CE at the scoping phase of the project assessment. However, the need for VEC selection guidance is both the fundamental challenge and opportunity that supersedes all others identified in the course of the research, and very likely transcends the road construction sector itself.

6.2 Improving Practice

6.2.1 CE VECs Should Be Different Than Project VECs

Selection of CE VECs is data-intensive, and the collection of such data can be expensive and time-consuming. This is why major alterations to project VEC list are uncommon while considering CE VECs. The first call to action is the importance of separating CE VECs from project VECs, both in terms of the process and the outcomes. CE VECs are not simply surrogates of project VECs that can be adopted by default to measure cumulative effects. Some of them should be selected to represent issues beyond project local environment, and the way they are determined as well as their capacity to capture broader issues of regional importance, hinges to a large extent upon the mechanisms adopted for their selection. This understanding has been sorely neglected in all the projects examined, but it can be of central importance in improving the practice of CEA. By definition, cumulative effects necessitate that stakeholders consider a wider range of environmental components than those directly affected by the project, such as those affected by multiple activities that are in existence or envisaged, using the results to create the list of CE VECs. It is evident that the project-specific EA context precludes the operationalization of such detailed approach; hence a need for strategic EA as widely advocated in literature.

6.2.2 Process Guidance

Explicit guidance is recommended to help ensure similar VEC selection processes are employed within the road construction sector, and possibly more broadly, such that there is some standard to follow and upon which subsequent evaluation may be based. As cumulative effects of roads are often dual in nature, i.e. (i) gradual disturbance and losses of land and habitat (i.e. nibbling losses) and (ii) the potential to induce further activities (i.e. growth inducing potential); such guidelines should ideally take both types of dynamics into account. Scientific data requirements and sharing; process efficiency, efficacy and fairness; consideration of the typical social, economic, and environmental implications of sectoral projects; and consideration for regional CEs issues could all be explicitly addressed in a sectoral guidance document, along with recommended VEC selection criteria and decision rules. Any process guidance on VEC selection should promote decision-making based on objective scientific evidence and explicitly weighted subjective values to help reduce any bias implicit within VEC selection processes currently; thereby moving such beyond the realm of expedience as suggested by Feehan (2001). To this end, federal or provincial operational policy statements could be drafted, or such guidance might be integrated into the next volume of the CEA practitioner guide. Such work should involve multi-stakeholder collaboration among the public; government departments; scientific experts in CEA and other relevant disciplines; as well as NGOs. Given the diversity of opinions that need to be taken into account, and also recognizing that the bulk of the projects that will trigger EA in the future are within provincial EA jurisdiction, professional bodies such as the International Association for Impact Assessment or EA administrators (i.e. provincial EA leads) along with sectoral development experts may be in the best position to lead such an exercise.

6.2.3 Transparency in VEC Selection

Whether or not explicit VEC selection guidance is drafted, transparency in VEC selection processes through adequate documentation is needed in order to assess the thoroughness and the objectivity of the processes employed in reaching VEC decisions for a particular project assessment. Aspects of VEC selection that should be documented include: stakeholders involved; evaluation criteria; and decision-making process and tools. Increased transparency has the potential to encourage stakeholders to be more discerning and objective in their arguments for a particular component while increasing the public trust in VECs selected and the overall results of the project assessment.

6.2.4 Checklists to Simplify VEC Choices

A majority of the stakeholders that participated in this research perceive that the use of checklists might be useful in simplifying VEC selection processes. The involvement of different stakeholders in VEC selection is often accompanied by certain decision controversies: these might be more easily resolved through by having the group work its way through a standard (though adaptable) VEC checklist. The goal of a standardized selection checklist across projects may not be feasible, given that specific project context influences scoping process and decisions related to VEC. Instead, such checklists could be defined based on sectoral (e.g. transport, mining, energy) or regional (e.g. within a watershed or an eco-region) characteristics of the project. Standard lists of environmental, social, and economic lists are possible given that the same VECs seem to be selected over and over again; with the caveat that more work needs to be done to round out lists of common social and economic VECs. VEC checklists may act as an 'equalizer', balancing the 'loudest voices at the table' with those perhaps quieter yet presenting equally valid viewpoints. Further, it may prove valuable in addressing the challenges associated with open criteria whereby any resource can be classified as VEC. As an example of what to include on this checklist, definition of the VEC concept can help establish the scope of issues to consider; a well-defined ranking procedure can ensure equal attention is given to all components; and a structured decision making process can address divergent interests in a more systematic fashion. The goal is not for all projects to return similar number or type of VECs, but to introduce more rigour given the fact that relative VEC importance is often loosely interpreted.

6.2.5 Environmental Database for VECs and VEC Indicators

To support future CE VEC selection processes, database compilations of VECs and VEC indicators adopted in previous project assessments would be useful. Such lists could be organized according to natural regional boundaries (e.g. watersheds, eco-regions, river basins etc.) or according to development sector, and could be updated periodically as each new assessment is complete. This option would remedy two issues: (i) the "begin-again" approach often applied by stakeholders to each new project proposal taking place within the same regional boundaries; and (ii) the absence of data to make CE VEC decisions which have been observed in many of the projects. In this way, a single project's VECs can much more easily be placed within the context of regional cumulative effects issues that have been developing over time. As well, CE VEC lists might become more thorough and VEC selection processes more efficient. The purpose is not to adopt wholesale the regional or sectoral VEC list in a given project but to understand regionally important VECs and their indicators. The Government of British Columbia is developing a typical list called Provincial Type Quick List of VECs. It is a collection of different lists of regionally important VECs for different regions of the province. The document would serve as a guide for project proponents to examine VECs relevant to their specific project region. In essence, such lists would encourage consistency; aid quick decision-making; and help resolve issues associated with financing large data collection.

6.3 Future Research

Having identified the lack of guidance on VEC selection as a primary challenge, it is clear that further research could be undertaken regarding the appropriate format and content of such guidance. There is also the need to take a holistic view to VEC decision-making with respect to different components of the environment. The current process is inclined toward biophysical components but to facilitate the recognition of the interconnectedness of project impacts, stakeholders need to take into consideration the appropriate social and economic VECs within EA and CEA in the road construction sector.

The use of REA is an influential tool in determining CE VECs. However, using REA to select a subset of project VECs does not necessarily mean that a thorough CE VEC selection process has been followed. Further study is necessary to understand the perceptions of the international EA community on what best-practices for CE VEC selection should be. Such studies should address the question of whether either VEC selection methodology identified in this research (i.e. wholesale or subset) fulfills the spirit of CEA or whether the development of an alternative approach to selecting relevant regional VECs is needed.

As discussed earlier, in the light of the current economic drive at the federal level, the next few decades will likely lead to a rapid increase in road development. Road development, perhaps more than any other kind, will increase pressure on VECs in myriad ways (refer back to Sec. 2.3.1). Research into the industrial development history of a region and the data already assembled on VECs can lead to a regional inventory of key VECs, and possibly impacts credited to road developments. It may also form a basis for ascertaining cumulative impacts on VECs, and what proportion roads contribute to the cumulative pressure (i.e. the optimal range suggested by McGarigal *et al*., 2001). Furthermore, it may be possible to discover whether the net cumulative impact triggered by roads on certain VECs is negative or positive, as both are certainly possible.

With alternative routings being such a central concept in road design, least cost routings are of critical importance. Routing decisions are often based on economic feasibility, ecological obstacles, and negative public reactions – especially for long span roads such as those under consideration. They are also often carried out at pre-EA stage where VEC issues are not in focus. Research into least 'environmental' cost routing can possibly inform the development of VEC lists for road construction projects and further enhance the ability to manage both direct and cumulative effects. For example, it would be interesting to know what types of considerations influenced the choice of a particular route and whether environmental values were factored into such decisions. If so, is there potential for those values to inform a subsequent VEC selection process, or alternatively, is there potential for a VEC-based approach to selecting preferred route?

The context for this study is the road construction sector, however, similar research focusing on other development sectors (especially non-linear projects such as mining, nuclear plants etc.) and other scales and types of EA processes in Canada and internationally could be undertaken. This kind of research would permit a more robust generalization on VEC selection issues and enable a cross-sectoral approach to improving practice. Further insight on VEC selection might be also gained through an investigation of special EA jurisdictions that have employed more innovative and customized approaches to EA and project-specific CEA such as the Mackenzie Valley Environmental Impact Review Board (Canada). On the basis of the aggregate results, a more robust understanding of VEC selection approaches and challenges can be developed, which will help to establish best practices and strengthen subsequent guidance materials.

In addition to this, subjectivity in VEC selection processes could be examined more closely to investigate how industry, government, and public biases influence EA decisions and project approval. One approach could be to investigate how individual stakeholder's experiences and knowledge influence the value placed on particular environmental component. Further research could also be done on 'power differentials' in EA VEC selection more generally, i.e., which groups tend to wield the most influence and power at the scoping stage, and how does this ultimately affect perceptions of EA and its outcomes? Another angle may be to investigate how values can be ranked or rated using some standardized methodology with specific application to VEC selection within EA.

Finally, future research could focus on the integration of sustainability principles in VEC selection process. While the VEC concept in EA was born in part out of concern for a sustainable environment, there is limited understanding of the application of sustainability principles to VEC selection, and vice versa. More should be known about how sustainable development principles are parlayed into a final VEC list, or the degree to which VEC lists reflect regional sustainable development issues. The results could provide a means to bolster the required balance among different environmental components and reduce the dominance of biophysical issues in VEC selection altogether.

6.4 Final Remarks

This research has laid valuable groundwork upon which more detailed research can be undertaken in a bid to improve VEC selection in CEA and EA more generally. In particular, lessons from the road construction sector suggest that far-reaching changes are required to advance the practice and principles of selecting VECs, particularly for CE. With respect to legislative reform, if the goal is to balance environmental protection and economic development while speeding up EA approval process, as suggested in the recent amendments to the *Act* (via Bill C-38), mechanisms must be in place to ensure VECs selected reflect these exigencies. A long process is not an indication of a thorough exercise, of course, but as argued earlier, a faster approval process in Canada should not come at the expense of thorough, environmentally sound decision-making especially with respect to CEs: there should be no compromise regarding the quality of VEC selection process regardless of the modality of assessment or its length. In cases where critical projects are exempted from assessment or project approval is subject solely to ministerial discretion, cumulative effects cannot be easily predicted despite that such projects contribute to the total changes expected on VECs. In general, the lack of sectoral and regional assessments to assess entire programs of development, and simply information sharing from one project assessment to the next, presents a major challenge to selecting CE VECs and their indicators and is still not adequately addressed by Canadian EA legislation or policy. Moving forward, the development of some basic, standard guidelines for VEC selection practices is advocated. Standardization is conducive to measurement, and measurement is conducive to evaluation. The central role of VECs in different forms of impact assessment draws attention to the need for further research. The dynamics of VEC selection are not adequately captured by most contributions to EA literature. More attention on VEC selection processes is required to improve the efficacy of CEA practice and the broader field of impact assessment. The EA community has always made its most significant advances by being willing to evaluate itself, and with VEC selection it should be no different.

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APPENDIX A

UNIVERSITY OF SASKATCHEWAN

School of Environment and Sustainability

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PARTICIPANT CONSENT FORM

"Selecting valued ecosystem components for cumulative effects in EIA of road transportation projects in Canada"

Please read this letter carefully, and feel free to ask any questions you might have. I will review this information with you at the time of the interview.

Research Supervisor: Dr. Jill Gunn, Department of Geography & Planning and School of Environment & Sustainability, University of Saskatchewan, Saskatoon, SK, S7N 5A5, Tel: 306-966-1944, E-mail: jill.gunn@usask.ca

Student Researcher: Ayodele Olagunju, University of Saskatchewan, SK, Tel: 306-966-8462 and Cell: 306-341-3872, E-mail: ayodele.olagunju@usask.ca

Purpose and Procedure: The purpose of this research is to investigate how thorough the practice and treatment of VECs for cumulative effects is in road construction transportation project EIAs in Canada. To achieve this, in part, you are invited to participate in an interview to discuss your views on the process and rationale for valued ecosystem components' selection and whether special consideration is given to cumulative effects in the project you were involved in.

The interview will take approximately 15-20 minutes, and will be audio taped so as to facilitate data analysis. Similar interviews are taking place with project proponents, consultants, practitioners, and regulators involved in similar projects (i.e. comprehensive study transportation EIAs in Canada). Results of the interviews will be aggregated and used to evaluate the thoroughness of the current practice and treatment of valued ecosystem components for cumulative effects in project EIAs. Overall, this study will contribute to a greater understanding of the current practice, associated challenges, and factors for improvement.

Potential Risks: There are no personal risks to participating in this study. Your affiliation, but not your name, may be identified in research reports in order to lend credibility to the research. Given the limited number of participants involved in each road construction project selected, it may be possible to identify specific individuals based solely on organizational affiliation. However, you are being asked to provide your professional judgment and, as such, there is minimal personal risk. All data collected for this study will be reported in aggregate form only. Individual responses will not be revealed.

Potential Benefits: There are no direct benefits to you personally to participating in this study. The results will be used as part of a graduate thesis in the Masters' program, and shared in professional and academic conferences and journals in order to improve the current practice.

Storage of Data: Interview tapes, notes and transcriptions will be stored temporarily on a hard drive (dedicated solely to this study) in the office of the research supervisor, and in the long term on CDs in a locked cabinet of the research supervisor for a minimum of five years and until all publications, conference papers, and research thesis have been produced and disseminated. The research supervisor will be responsible for all data storage and management. The research supervisor will have access to all data.

Confidentiality: The information you provide to this study will be aggregated with information provided by other interview participants in this particular project and in six to nine other road construction transportation projects across Canada. In addition, the information will be used to produce reports for publication in scientific journals and may be presented at conferences and workshops/meetings. Your personal identity will be kept confidential at all times. You will be identified only by your position or professional affiliation (e.g. ‘organization x’). However, because the participants for this study have been selected from a relatively small group of people, some of whom may be known to each other, it is possible that you may be identifiable to other people on the basis of the information you provide. In other words, only aggregate data will be presented in the research results, but confidentiality of your involvement as a participant in this study cannot be guaranteed. If, within 30 days following completion of your interview, you have any second thoughts about your responses, you can contact me or my research supervisor, who will immediately remove your information from the data set and provide you with an opportunity to review your responses to determine whether you would like to withdraw it from the research. After 30 days, it is likely that some form of research dissemination will already have occurred.

Right to Withdraw: Your participation is voluntary, and you may withdraw from the study for any reason, at any time, without penalty of any sort, up to 30 days following completion of the interview. You may also refuse to answer specific questions. If you withdraw from the research project, any information that you have contributed will be destroyed or returned at your request. Before and after your interview, you will be reminded of your right to withdraw.

Questions: If you have any questions concerning the study, please feel free to ask at any point. You are also free to contact me or my research supervisor at the numbers provided above if you have questions at a later time. This study has been approved on ethical grounds by the University of Saskatchewan Behavioural Research Ethics Board on May 3, 2011.Any questions regarding your rights as a participant may be addressed to that committee through the Ethics Office (966-2084).Out of town participants may call collect. When the study is complete, all participants will receive a short report that outlines significant research findings.

Consent to Participate: I have read and understood the description provided above. I have been provided with an opportunity to ask questions and my questions have been answered satisfactorily. I consent to participate in the study described above; understanding that I may withdraw this consent under the terms outlined above.

__________________________ __________________________

(Name of the participant) Date

__________________________ __________________________

(Signature of the participant) Signature of Research student

APPENDIX B

UNIVERSITY OF SASKATCHEWAN

School of Environment and Sustainability

Room 323 Kirk Hall, 117 Science Place
University of Saskatchewan, Saskatoon, SK Canada
S7N 5C8

Dear Interviewee (substituted with actual name):

Request for Participation in Research Interviews

I am Ayodele Olagunju, a Masters' student in the School of Environment and Sustainability at the University of Saskatchewan, Saskatoon. As part of my masters' degree requirements, I am working on a study titled, 'Selecting Valued Ecosystem Components for Cumulative Effects in EIA of Road Transportation Projects in Canada' under the supervision of Dr. Jill Gunn, Department of Geography & Planning, and School of Environment & Sustainability, University of Saskatchewan. The study aims at providing insight into how valued ecosystem components for cumulative effects are selected in road construction projects in Canada and by this, provides a basis for improving the current practice. I am writing to request your participation in this research project.

By way of background, cumulative effects are changes to the environment caused by an action in combination with other past, present, and future actions. Explicit in cumulative effects studies is the understanding that the condition of an environment goes beyond individual project impacts and is the product of many interacting factors. Particularly for road construction projects, environmental perturbations are quite common and often of considerable socioeconomic and environmental effects, including regional impacts on valued ecosystem components. This research will attempt to investigate how thorough the practice and treatment of valued ecosystem components for cumulative effects is in project EIAs. The research is guided by three objectives: i) to investigate which valued ecosystem components in an EIA are cumulative effects related, and if they are 'distinct' from general project valued ecosystem components; ii) to examine the process and rationale for valued ecosystem components' selection and whether special consideration is given to cumulative effects; and iii) examine the extent to which selected valued ecosystem components reflect an intra-project perspective consistent with the nature of cumulative effects.

Specifically, at this stage, I am working on objective (ii), and I am inviting you to participate in a semi-structured interview via telephone. The Interview is expected to be fairly short; approximately 15 minutes long. You were identified as a potential participant based on your personal or organization's involvement in selecting valued ecosystem components for cumulative effects in _____________ (specific road project), or your contact information was provided by other study participants. I am particularly interested in your views about how valued ecosystem components for cumulative effects were chosen for this particular project.

I am attaching a standard University of Saskatchewan 'participant consent form' for your review. I will follow-up with you via telephone and email in the upcoming weeks to determine your interest in participating in this research, to schedule an interview and a time of your convenience, and to send you in advance a list of discussion topics for the interview. The tentative period for the telephone interviews is between May 15 and June 30, 2011. Meanwhile, should you have any questions, please do not hesitate to contact me at 306.341.3872 (cell) and 306-966-8462 (office), or my research supervisor, Dr. Jill Gunn, at 306-966-1944 (jill.gunn@usask.ca).

Sincerely,

Signed:

Ayodele Olagunju

APPENDIX C

UNIVERSITY OF SASKATCHEWAN

School of Environment and Sustainability

Room 323 Kirk Hall, 117 Science Place
University of Saskatchewan, Saskatoon, SK Canada
S7N 5C8

INTERVIEW GUIDE

"Selecting valued ecosystem components for cumulative effects in EIA of road transportation projects"

Themes	Questions
Project description	1. Please briefly describe the nature of the road construction transportation EA(s) you were involved in.
Process for selecting VECs for cumulative effects	2. How did you determine valued ecosystem components used for the analysis of cumulative effects? 3. Was the process based on science or was it due to the judgment of the stakeholders? Please elaborate. 4. Does the initial VEC selection process consider cumulative effects? Should it? 5. Did you adjust the scale of analysis for the VECs to reflect cumulative effects consideration?
Stakeholders involved	6. Who is typically involved in deciding those VECs?
Challenges & constraints	7. What are the challenges in deciding VECs for cumulative effects consideration?
Suggestions	8. What advice/suggestions can you offer, if any, to improve VEC selection process for cumulative effects assessment?
Comments	9. Are there any other comments that you would like to make regarding any aspect of your experience with the project?

APPENDIX D

Project VECs vs. Cumulative Effect VECs in the Road Project Comprehensive Study Reports

	Valued Ecosystem Components	407 ESR		Athabasca		Hwy 35		Greenville		Lake Winnipeg		Hwy 58		New Route 2		St. Theresa		Trans Labrador		Waskaganish		Wollaston		Total VECs	
		P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	Project	CEA
1	Aesthetics															√	√							1	1
2	Agricultural Land														√									0	1
3	Air Quality and Climate	√	√			√				√	√									√	√			4	3
4	Appalachian Hardwood Forest														√									0	1
5	Archaeology			√		√								√						√				4	0
6	Atlantic Salmon														√									0	1
7	Birds/Migratory Birds of Special Conservation Concern							√							√	√	√			√	√	√	√	4	4
8	Caribou			√	√													√	√					2	2
9	Commercial and Recreational Fishing			√	√																			1	1
10	Community Life																	√	√					1	1
11	Cultural Environment / Traditional Lifestyle	√		√						√	√	√	√											4	2
12	Current Use of Land and Resources by Aboriginal People	√		√		√					√	√	√	√										5	2
13	Employment & Business (Labour & Economy)			√	√									√				√	√					3	2
14	Fish and Fish Habitat	√		√		√	√	√		√	√	√	√	√		√	√	√	√			√	√	10	6
15	Fish and Water Quality							√							√									1	1
16	Fishing and Bird Watching Activities					√									√									1	1
17	Forest Environment						√																	0	1
18	Furbearers															√	√	√	√			√	√	3	3
19	Geomorphology / Geology	√	√	√		√												√	√			√	√	5	3
20	Grizzly Bears					√			√															1	1
21	Groundwater	√	√			√				√	√			√										4	2
22	Historic Resources											√	√					√	√					2	2
23	Hunting and Trapping			√																√				2	0
24	Hydrology					√																		1	0
25	Land Use													√						√				2	0
26	Mineral Claims			√																				1	0
27	Mining Development				√																			0	1
28	Moose and Moose Habitat														√									0	1

	Valued Ecosystem Components	407 ESR		Athabasca		Hwy 35		Greenville		Lake Winnipeg		Hwy 58		New Route 2		St. Theresa		Trans Labrador		Waskaganish		Wollaston		Total VECs	
		P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	Project	CEA
29	Noise and Vibration / Atmospheric Environment	√	√			√	√							√										3	2
30	Parks and Protected Areas			√														√	√					2	1
31	Quality of Life/Human Health & Safety					√																√	√	2	1
32	Raptors			√														√	√					2	1
33	Regional Demographics				√																			0	2
34	Reptiles & Amphibians																					√	√	1	1
35	Resource Use & Users																	√	√					1	1
36	Socio Economic Environment	√	√		√																			1	2
37	Soil and Sediments / Terrain					√				√	√	√	√									√	√	4	2
38	Species at Risk	√	√	√		√	√			√	√					√	√	√	√			√	√	7	6
39	Surface Water	√	√			√				√	√			√										4	2
40	Terrestrial & Riparian Habitat					√	√											√	√					2	2
41	Tourism & Recreation																	√	√					1	1
42	Ungulates															√	√					√	√	2	2
43	Vancouver Canada Geese								√															0	1
44	Vegetation and Vegetation Communities	√	√	√						√	√	√	√	√		√	√			√	√	√	√	8	6
45	Visual Environment					√																		1	0
46	Waste / Property Contamination	√																						1	0
47	Water Quality			√				√				√	√			√	√			√	√	√	√	6	4
48	Water Resources																	√	√					1	1
49	Waterfowl																	√	√					1	1
50	Wetlands (and Forest)	√	√			√	√			√	√			√	√			√	√					5	5
51	Wildlife and Wildlife Habitat (including migratory birds)	√	√	√				√		√	√	√	√	√						√	√	√	√	8	5
	Frequency	**14**	**10**	**16**	**6**	**17**	**6**	**5**	**2**	**10**	**11**	**8**	**8**	**11**	**8**	**8**	**8**	**16**	**16**	**8**	**5**	**12**	**12**		

Source: Various CSRs – (i) 407 East Transport Corridor; (ii) Athabasca Seasonal Road; (iii) Completion of Hwy 35; (iv) Greenville to Kincolith; (v) Lake Winnipeg ESR; (vi) Highway 58; (vii) New Route 2 Trans-Canada; (viii) St. Theresa/ Wasagamack; (ix) Trans Labrador (Phase III); (x) Waskaganish Permanent Road; (xi) Wollaston Lake Road.

Note: P = project VECs; C = cumulative effects VECs. The '√' symbol is used to indicate whether or not a particular VEC was selected for a component of the CSR.