Assessment of the capacity for watershed cumulative effects assessment and management in the South Saskatchewan Watershed, Canada

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By

PRAJWAL M. BASNET

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Abstract

The cumulative effects of watershed development and large water withdrawals are placing the sustainability of freshwater resources at risk due to alteration of watershed hydrology, stream geomorphology, groundwater recharge, and adverse effects to the aquatic ecology of water resources. The consideration of cumulative environmental effects in development decisions under current project-specific assessment does not fully encompass the interacting effects of multiple stressors over space and time. As a result, the cumulative effects of land uses and development on watershed processes are not properly assessed and managed. There is a recognized need to shift from local, project-scale cumulative effects assessments to broader, landscape, or regional scale assessments to accurately assess cumulative effects to watershed processes and river system condition. The problem is that there is little understanding of the current capacity to do so. This research: i) developed a set of indicators for evaluation of regional capacity to support watershed cumulative effects assessment and management (CEAM) requisites, ii) applied those indicators to the South Saskatchewan Watershed (SSW), iii) identified capacity needs and constraints to watershed CEAM in SSW, and iv) identified lessons learned and opportunities for capacity building to support watershed CEAM principles and practice.

Capacity indicator questions were developed for a set of eight institutional requirements for watershed CEAM, identified from a previous study of watershed CEAM in the SSW. Research methods included a web-based survey of academics, regulators, industry and environmental organizations, which consisted of both closed ended and open-ended questions based on the capacity indicators. Survey results were analyzed using the Statistical Package for the Social Sciences and qualitative methods. Results indicate that the primary threats to water quality and quantity in the SSW, as identified by study participants, are broad-scale stressors that are not subject to project-specific environmental assessment regulations. To address these broad-scale stresses, cumulative effects assessment at the regional level needs to be done; however, it was identified that there is currently a lack of mechanisms to support watershed CEAM. The need for a lead agency, multi-stakeholder collaboration, and financial and human resources were identified as the most important requisites from the research results for implementing and sustaining watershed CEAM programs. Research results revealed that watershed CEAM cannot be driven solely ‘bottom-up’ and government must lead watershed CEAM activities. Participants noted that there is collaboration ongoing in the SSW to meet CEAM objectives, but it is limited. There is a lack of clarity around common goals for watershed and sub-watershed management, and a lack of transparency in sharing data. Many participants commented that expertise is available for watershed CEAM, but there is a lack of organizational and financial resources to develop successful plans and actions.

Key words: Watersheds; Cumulative environmental effects; watershed cumulative effects assessment and management

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This work is dedicated to the memory of my father

Juddha Mardan Basnet

(1957-1993)

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LIST OF ABBREVIATIONS

AB	Alberta
AUC	Alberta Utilities Commission
AEPEA	Alberta Environmental Protection and Enhancement Act
CEA	Cumulative Effects Assessment
CEAA	Canadian Environmental Assessment Act
CEAM	Cumulative Effects Assessment and Management
CEMA	Cumulative Environmental Management Association
EAs	Environmental Assessments
EEA	European Environment Agency
EIA	Environmental Impact Assessment
ENGOs	Environmental Non-governmental organization
ERCB	Energy Resource Conservation Board
EU	European Union
GIS	Geographic Information System
GIWS	Global Institute for Water Security
LUF	Land Use Framework
NGOs	Nongovernmental Organizations
RAMP	Regional Aquatics Monitoring Program
SEAA	Saskatchewan Environmental Assessment Act
SK	Saskatchewan
SSR	South Saskatchewan River
SSW	South Saskatchewan Watershed
SPSS	Statistical Package for the Social Sciences

SWA	Saskatchewan Watershed Authority
SWP	Source Water Protection Plan
US EPA	United States Environmental Protection Agency
VECs	Valued Ecosystem Components
WSA	Saskatchewan Water Security Agency

CHAPTER 1

INTRODUCTION

1.1 Introduction

Watersheds are complex, dynamic entities that provide important ecological goods and services such as habitat for plants and animals, drinking water for people and wildlife and an opportunity for recreation and enjoyment of nature (Meinzen-Dick et al., 2002; German et al., 2007). However, climate change, along with landscape disturbance caused by human development activities, combined with increasing water withdrawals and the large scale development of water resource infrastructures such as dams, pipelines, and irrigation are contributing to reduced water availability, deteriorating water quality, the alteration of watershed hydrology, stream geomorphology, groundwater recharge, and adverse effects to the aquatic ecology of water resources (Schindler, 2001; Gleick, 2003; Schindler and Donahue, 2006; Noble et al., 2011; Seitz et al., 2011). In the Canadian context, Schindler and Donahue (2006) have suggested an impending water crisis, particularly in Canada's western watersheds. The cumulative effects of watershed development and large freshwater withdrawals are placing the sustainability of freshwater resources at risk (Schindler and Donahue, 2006; Sheelanere et al., 2013).

Cumulative environmental effects are broadly defined as the net effect that a resource experiences from the combined influences of multiple development stressors or influences, often in combination with natural disturbance regimes, across space or time or both (Sidle and Hombeck, 1991; Reiter and Beschta, 1995; Reid, 2010; Scherer, 2011). Such cumulative effects are interactive and additive in nature and they are very much synergistic. This implies that a cumulative effect is greater than just the accumulated effect or the simple sum of effects because interactions between effects are often involved that are complex in nature (Scherer, 2011). Cumulative effects assessment (CEA) then is the process of evaluating the potential impacts of such collective stress on the environment and is a requirement in many countries (Seitz et al., 2011), including in Canada at the federal level under the *Canadian Environmental Assessment Act*.

In a watershed context, cumulative effects result from the changes in watershed processes, often caused by land-use activities, in-stream use, and natural processes (Scherer, 2011; Reid, 1993;

Reid, 2010). Project-based environmental impact assessment (EIA), required federally under the *Canadian Environmental Assessment Act* (CEAA, 2012), and under the laws of each of the provinces and territories, is the primary instrument in Canada for assessing and managing the cumulative effects of development in watersheds. However, according to Duinker and Greig (2006), the current way of practicing CEA in Canada is perhaps doing more damage than good. The consideration of cumulative effects in development decisions under project-specific assessment is limited in spatial and temporal scale, often lacks a sound scientific basis and does not fully encompass the interacting effects of multiple stressors on the environment over space and time (Baxter et al., 2001; Therivel and Ross, 2007; Seitz et al., 2011). As a result, the cumulative effects of land uses and development on watershed processes are not properly assessed and managed. Specifically, the current project-based approach to CEA does not provide the results needed to understand broader environmental change or to make long-term decisions concerning the sustainability of current and future development actions in watersheds (Noble, 2010).

There have been constant and consistent messages that CEA in Canada's watersheds is simply not working (Dubé, 2003; Seitz et al., 2011; Sheelanere et al., 2013). In response, there are calls to advance CEA beyond the scope and scale of project-based EIA (see Schindler and Donahue, 2006; Squires et al., 2010; Seitz et al., 2011; Noble et al., 2011; Ball et al., 2012a) and to shift from local, project-scale approaches to CEA to broader, landscape, or regional scale assessments to accurately assess cumulative effects to watershed processes and river systems (Duinker and Greig, 2006; Seitz et al., 2011). Specifically, there is a growing recognition of the need for more watershed- based approaches to cumulative effects assessment and management (Reid, 1998; Culp et al., 2000; Brismar, 2004; Schindler and Donahue, 2006; Noble et al., 2011; Ball et al., 2012a; Sheelanere et al., 2013).

Watershed cumulative effects assessment and management (CEAM) examines the interactions between landscape changes that accumulate over time and space and river system response, and examines the outcomes of these interactions under different futures of growth and development in the watershed (Seitz et al., 2011). There are number of advantages and benefits from watershed CEAM for the assessment and management of river systems and aquatic environments (Sheelanere, 2010; Ball, 2011; Ball et al., 2012b). Notwithstanding considerable growth in international awareness, however, the assessment of cumulative effects at the regional scale and above the project tier has only recently attracted serious attention from practitioners, planners and regulators (Harriman and Noble, 2009). In the Canadian context, efforts to advance watershed CEAM initiatives and programs over the past fifteen years and across a range of jurisdictions have achieved only mixed success (Dubé et al., 2006; Schindler and Donahue, 2006; Noble et al., 2011). Part of the problem is that the science of how to do watershed CEAM is advancing, but there remains limited understanding of the institutional arrangements and capacity needs to implement and sustain it (Noble et al., 2011; Chilima et al., 2013; Sheelanere et al., 2013).

1.2 Purpose and objectives

There has been some appraisal in the Athabasca (Skwaruk, 2011), Lower Fraser (Kristensen, 2011), Grand River Basin (Chilima et al., 2013) and South Saskatchewan watershed **(**Sheelanere et al., 2010; Noble et al., 2011) of the policy, capacity needs and practices of watershed CEAM, but a suite of indicators and systematic and quantitative evaluation of the capacity to implement and sustain CEAM in Canada's watersheds has yet to be done. The overall purpose of this research was to develop and apply a framework to assess regional capacity to support watershed CEAM requisites. In this context, capacity is defined simply as the ability to plan for, implement and maintain watershed CEAM. The research focused on the South Saskatchewan watershed, a transboundary watershed located in the provinces of Alberta and Saskatchewan, Canada.

The specific objectives of this research were to:

i. develop a set of indicators for evaluation of regional capacity to support watershed CEAM requisites;
ii. apply the indicators to the South Saskatchewan watershed;
iii. identify capacity needs and constraints to watershed CEAM in the South Saskatchewan watershed;
iv. identify lessons learned and opportunities for capacity building to support CEAM principles and practice.

1.3 Thesis organization

The thesis is presented in five chapters following the Introduction chapter. Chapter 2 provides detail insight on cumulative effects EIA and CEA, including challenges to CEA, watershed CEAM, and need for capacity building for watershed CEAM. The research methods and South Saskatchewan watershed study area are described in Chapter 3, followed by the results of the research in Chapter 4. Chapter 5 discusses the research results and the implications for advancing watershed CEAM. The research conclusions are presented in Chapter 6, along with suggestions for the future research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A watershed or drainage basin is a region that drains into a specific body of water, such as a river, lake, pond, or ocean and includes all the land, air, plants and animals within its borders. Each watershed has a unique mixture of land and water habitats and uses; from wetlands, rivers and lakes to forests, grasslands, farms, towns and cities (Davies and Hanley, 2010). The major services provided by watersheds to society include water flow regulation (maintenance of dry season flows and flood control), improved water quality (nutrient load control, chemical load control, and salinity control), increase in total water yield / increased water supply (surface or groundwater), stabilization of stream flow distribution, erosion and sedimentation control, enhanced soil quality, hydropower generation, habitat for various wildlife species, supporting biodiversity, recreational opportunities (Pattanayak, 2004). Due to these dynamic services, watersheds play a vital role in the sustainability of the environment and society (Meinzen-Dick et al., 2002; German et al., 2007).

Reduced water availability and deteriorating water quality are some of the consequences of increased landscape disturbance caused by human development activities and climate change (Schindler, 2001; Cooley and Gleick, 2011; Schindler and Donahue, 2006; Noble et al., 2011; Seitz et al., 2011). There is an urgent need to take a critical look at the motives for watershed management, the beneficiaries and methods used to reach specified objectives (German et al., 2007). Among social scientists and others, watershed assessment and management is seen as a framework for enhancing collective action and equity in natural resource access and governance (Meinzen-Dick et al., 2002; German et al., 2007). This chapter provides a brief overview of cumulative effects and examines the range of approaches to CEAM and the relationship between CEAM and watershed management.

2.2 Cumulative effects

Cumulative effects are the effects that originate from the combined actions of anthropogenic and natural disturbances over space and time, and have the potential to significantly alter environmental conditions (Noble et al., 2011). Such effects are often characterized as the net effect that a resource or environmental receptor experiences from the combined influences of multiple development stressors, often in combination with natural disturbance, across space or over time or both (Sidle and Hombeck, 1991; Reiter and Beschta, 1995; Reid, 2010; Scherer, 2011).

Cumulative effects can be ‘creeping’ or incremental, whereby effects accumulate slowly over space and time. For example, Odum (1982) describes the loss of coastal wetlands on the east coast of the Unite States between 1950 and 1970, noting that no one purposely planned to destroy almost 50% of coastal wetlands between Connecticut and Massachusetts but that such conditions emerged as the result of incremental, and individually minor actions and the accumulated conversion of hundreds of small tracts of wetlands. Cumulative effects can also be synergistic in nature, which is greater than just the accumulated effect or the simple sum of individual effects; interactions between effects are often involved that are complex in nature (Scherer, 2011). For example, a study conducted by Dubé et al. (2012a) on Yukon River Basin identified mining, sewage discharges, use of pesticides in the past, long-range transport, military operations, and climate change as major factors behind the cumulative impacts on the Yukon Basin, which lead to contamination of fish and surface waters, alteration in hydrology, and shift in biogeochemical loads.

Cumulative effects then are simply the total effects that a valued ecosystem components (VEC) experience as a result of disturbance pressures (Greig and Duinker, 2007). According to Ross (1994), cumulative environmental effects are the only effects that really matter in environmental assessment and management practice. The cumulative effects of current human development activities in watersheds have the potential to adversely affect the quality of watershed processes and function. In a watershed context, cumulative effects include any changes that involve watershed processes and are influenced by multiple land-use activities (Reid, 1993; Noble et al., 2011). Environmental parameters including soil topography and vegetation, which, in turn modify the transport of water, sediment, organic matter and pollutants that culminate in river systems can be directly altered due to land use activities in a watershed (Reid, 1993; Johnson et al., 1997; Schindler, 2001; Noble et al., 2011). As such, river system health is largely a function of the types of interactions and processes that occur on the landscape and within the boundary of the watershed (Seitz et al., 2011, Noble et al., 2011). Cumulative effects to watersheds can also include landscape disturbances or impacts that occur in the drainage area that are not necessarily due to watershed processes, but still have the potential to adversely affect water quality or quantity (Noble et al., 2011).

2.3 Approaches to cumulative effects assessment in Canada's watersheds

There are four primary approaches to addressing cumulative effects in Canada's watersheds, namely project-based EIA, environmental effects monitoring programs, science-based watershed studies, and regional land use or watershed planning. The problem is that none of these approaches is sufficient, individually, to assess and manage cumulative environmental effects to watersheds (Dubé et al., 2006; Schindler and Donahue, 2006; Seitz et al., 2011; Ball et al., 2012b; Sheelanere et al., 2013). Therefore, this shows the research gap and an opportunity for a new approach.

2.3.1 Environmental impact assessment

Project developments are subject to assessment under federal and various provincial EIA laws and regulations in an effort to contribute to project development and impact management decisions in support of sustainable development (Gibson, 2002; Orrego, 2007; Sheelanere et al., 2013). Typically, EIA is performed as part of applications for the approval of an individual project development and provides information on how the project may affect the local environment and how best to manage the effects. Under *CEAA* 2012, an environmental assessment focuses on potential adverse environmental effects that are within federal jurisdiction, including: fish and fish habitat; other aquatic species; migratory birds; federal lands; effects that cross provincial or international boundaries; effects that impact on Aboriginal peoples, such as their use of lands and resources for traditional purposes; and, changes to the environment that are directly linked to or necessarily incidental to any federal decisions about a project (Canada, 2012).

In principle, an EIA will consider a comprehensive set of factors that includes, among other things, cumulative effects (Canada, 2012). That EIA in Canada is to include cumulative effects, including the effects of a project proposal in combination with other past, existing and foreseeable future development is not new under CEAA 2012 (see Hegmann and Yarranton, 2011); it was also embedded in the former *Canadian Environmental Assessment Act* (Canada, 1992) and promoted through the Canadian Environmental Assessment Agency's (1999) Operational Policy Statement on the assessment of cumulative effects.

That said, the practice of CEA under EIA frameworks has been heavily criticized for failing to capture the full range of effects to VECs, including watersheds and river systems (Therivel and Ross, 2007; Noble et al., 2011; Seitz et al., 2011; Ball et al., 2012a). The practice of CEA under EIA has been fraught with a number of problems that compromise its ability to provide useful information with which to anticipate the possible cumulative effects of developments (Baxter et al., 2001; Duinker and Greig, 2006; Greig and Duinker, 2007). In a review of the state of CEA practice, for example, Duinker and Greig (2006) identified a number of constraints to CEA under EIA including the focus on project-induced stress and making sure that the impacts of a project are acceptably small, rather than understanding the total effects of all stressors on affected VECs; the focus on meeting regulatory approval versus understanding VEC quality and longer-term sustainability; thresholds being defined within the context of a project's stress as opposed to the resilience of the VEC; and the short-term focus on project approval and predicting the 'most likely' impacts rather than dealing with longer-term futures.

If CEA is not done properly, the quality of assessment suffers resulting in uninformed and poor decisions (Connelly, 2011). Determining which future activities and disturbance to include in assessments in EIA has proven especially problematic. A lack of clarity in establishing the boundaries of assessment, combined with the lack of necessary information and unclear thresholds for assessing cumulative effects, has been seen in limiting the capacity of an individual proponent to determine the cumulative effects of their project on broader watershed processes (Noble et al., 2011). The limited connection between the science of CEA and conventional EIA practice has also been identified as problematic (Squires et al., 2010; Seitz et al., 2011; Noble et al., 2011) – it is not the goal of project proponents to undertake CEA science.

2.3.2 Environmental effects monitoring programs

Whereas the EIA process occurs before a project is approved, environmental effects monitoring (EEM) programs occur after a project is operational, and involves determining whether an existing project has had or is continuing to have significant impacts on the environment (Kilgour et al., 2006). There are two formal EEM programs in Canada at the federal level, EEM for pulp mills and EEM for metal mines. The federal EEM program was first implemented in the late 1980s to detect the effects of pulp mill and metal mining effluents on surface waters as required under the federal *Fisheries Act* (Environment Canada, 1998, 2001b; Dumaresq et al., 2002; Walker et al., 2002; Dubé, 2003). There is also an EEM program in the Northwest Territories, the Cumulative Impact Monitoring Program (NWT CIMP) – a non-regulatory effort to ensure that environmental information is collected and available to Northerners, decision-makers and industry to support monitoring related initiatives (NWT CIMP, 2012).

Environmental effects monitoring approaches are focused on the receiving environment and measure environmental effects or response, based on the notion that reliance on stressor-based approaches alone is insufficient (Kilgour et al., 2006). Ideally, EIA and EEM are complimentary, with the EIA process identifies environmental attributes considered important and predicts effects, and the EEM process demonstrates whether predicted or unpredicted effects have occurred (Kilgour et al., 2006). However, regulatory-based EEM programs are limited in their application and often conducted in isolation of both EIA (Kilgour et al., 2006) and watershed planning (Schindler and Donahue, 2006; Seitz et al., 2011).

2.3.3 Science-based watershed studies

Science-based watershed studies are said to provide a more quantitative and scientifically rigorous effects-based approach to understand cumulative change in the environment (Dubé et al., 2006; Squires et al., 2010). These science based approaches focus first on measuring changes in the aquatic environment (i.e., determining the existing environmental state) and second on developing cause-effect relationships if effects are measured (Dubé, 2003; Dubé et al., 2006; Squires et al., 2010). Regional CEA requires a consistent, science-based process over large scales (Dubé, 2003).

The science based approach is founded on the premise that, if the watershed health is affected by the cumulative effects of manmade activities, then mitigation is required and any new project proposals must ensure development activities do not affect the environment further (Squires et al., 2010). Examples of science based watershed assessment include the Moose River Basin study (Munkittrick et al., 2000), and studies under the Northern Rivers Basin Study (Culp et al., 2000), and the Northern Rivers Ecosystem Initiative (see Dubé et al., 2006).

Part of the challenge with science-based studies is that such studies are typically conducted outside the scope of any regulation or watershed planning and land use framework. Although conducted at the appropriate scale, and effective for determining the health of a system, the development of predictive models to understand how a river system may respond to future development pressures in a watershed has not been forthcoming in cumulative effects science (Squires et al., 2010). The focus has largely been on retrospective assessment and designing causal relationships. Conducted largely by universities and funded through government-based research programs, Parkins (2011) describes science-based watershed studies as “short-term bursts of activity” and “short-lived organizational commitments” that come up short in meeting the demands and expectations for CEAM in watershed and land-use planning.

2.3.4 Regional land use or watershed planning

Regional land use or watershed planning offers an opportunity to move beyond the project based EIA to an assessment of cumulative effects of regional plans and objectives (Noble, 2000; Parkins, 2011). One example of regional land use planning is the Great Sand Hills, which was commenced in 1991 with the Great Sand Hills Land Use Strategy (Noble, 2008). However, there remain several challenges in this approach, which include the limitations of technical and scientific capacities, issues of power and control of information, the limits of our own human imaginations, and a thin veneer of democratic decision-making that is often associated with regional planning (Parkins, 2011). Schindler and Donahue (2006) argue that such planning processes rarely give due consideration to the science of cumulative effects, but are instead often politically motivated or based on the goals and aspirations of watershed users that do not necessarily conform to ecological limits.

2.4 Toward a more integrated approach: watershed cumulative effects assessment and management

In response to the limitations of these individual programs and efforts, there has been a growing interest in the integration of assessment, monitoring and management programs under watershed CEAM frameworks (Dubé, 2003; Noble et al., 2011; Seitz et al., 2011; Ball et al., 2012a; Squires and Dubé, 2012). Watershed CEAM focuses on the receiving environment and considers all of the effects on a given ecological receptor (see Peterson et al., 1987; Cocklin et al., 1992; Reid, 1993) under past, present and future conditions (CCME, 2009; Seitz et al., 2011). Watershed CEAM examines the interactions between landscape changes that accumulate over time and space and river system response, and examines the outcomes of these interactions under different futures of growth and development in the watershed (Seitz et al., 2011).

CEAM for Canada's watersheds is necessary, but the current approach to CEAM is simply not working (Dubé, 2003; Duinker and Greig, 2006; Harriman and Noble, 2008). In the Canadian context, efforts to advance watershed CEAM initiatives and programs over the past fifteen years and across a range of jurisdictions have achieved only mixed success (Dubé et al., 2006; Schindler and Donahue, 2006; Noble and Patrick, 2008). Part of the problem is that the science of how to do watershed CEAM is advancing, but there remains limited understanding of the institutional arrangements and capacity needed necessary to implement and sustain it (Noble et al., 2011). There is a growing recognition of the need for a more integrative approach to CEAM for watersheds under the framework of watershed CEAM (Kilgour et al., 2006; Ball et al., 2012a; Sheelanere et al., 2013). A framework is needed that can operate at the watershed scale, but also be capable of directing individual project-based developments (Sheelanere et al., 2013).

Watershed CEAM could make the current practice of EIA more effective and would also stand to benefit from EIA practices, which can offer site-specific and temporally-specific data beneficial to regional analysis, continual identification of assessment components of local significance, as well as the opportunity to affect development (see Ball et al., 2012a). Governments need to play a major role and take the leadership for watershed CEAM by: establishing objectives and thresholds based on sound scientific guidance; ensuring that point-specific project-based EIAs are relevant to evaluating and monitoring cumulative effects at the broader watershed scale; and providing direction to project specific EIAs through terms of reference set based on knowledge gained from broader watershed CEAM programs (Seitz et al., 2011; Noble, 2010). Squires and Dubé (2012) also noted that in order to be effective, watershed CEAM must be regulated and authorities (federal and/or provincial governments) who have access to the amount of data and expertise required must take on a leadership role to ensure its successful implementation.

2.5 Watershed CEAM capacity

Parkins (2011) argues that CEAM efforts in Canada have been “short-term bursts of activity and short-lived organizational commitments.” Capacity building is the process of gaining technical, managerial and institutional knowledge in relation to the socio-economic structure, cultural standards and values of the society concerned (Hamdy et al., 1998). Capacity building aims to increase the flexibility of institutions and society to adapt the changing circumstances and incorporates human, scientific, technological, organizational, institutional, and resource capabilities (Hamdy et al., 1998). The concepts of capacity and capacity building have received considerable attention since the early 1990s in the field of water resource management, and several important international initiatives has been shown such as Global Consultation on Safe Water and Sanitation organized by the United Nations Development Programme, Delft conferences on 1991 and 1996 (de Loë et al., 2005). Capacity building is a major aspect of formulating a water resource management strategy (Hamdy et al., 1998).

Building capacity for water management is a complex and multi-dimensional challenge and focuses narrowly on one aspect only, for example, more financial resources or more technical knowledge, may be ineffective if other aspects are neglected and overlooked (Ivey et al., 2002). Regarding the technical capacity, there are many other factors that influence it, including the availability of data, and the extent to which the local organization is able to draw on the resources of other organizations (de Loë et al., 2005). Capacity may be associated with by-laws (or ordinances); provincial statutes and regulations; and policies and plans created by actors at the local and provincial scales which create an institutional environment that guides and influences the interactions and activities of stakeholders, organizations, and levels of government (Hamdy et al., 1998; de Loë et al., 2002, Timmer et al., 2007). Institutional and capacity constraints can pose significant challenges to CEAM, and advancing CEAM for watersheds requires an improved understanding of the institutional environment and capacity conditions for implementation (see Griffiths et al., 1998; Shannon, 1998; Noble, 2011; Chilima et al., 2013; Sheelanere et al., 2013).

Sheelanere et al. (2013) identified eight institutional requirements, or requisites, for the implementation of watershed CEAM, based on research in the South Saskatchewan watershed (see Table 2.1). These eight requisites suggest that government leadership is required for effective watershed CEAM to move beyond the current inward focus on project approvals toward an outward focus on the cumulative effects of all disturbances in a watershed; that watershed CEAM requires complementary monitoring programs at the project and watershed scale, and a means to ensure the sharing of monitoring data across watershed stakeholders; and a nested planning framework is required to coordinate watershed planning objectives with individual project impact assessment and decision making processes (Sheelanere et al., 2013).

These requisites for watershed CEAM have been applied by Noble et al. (2013) to examine institutional arrangements in the Athabasca watershed, Alberta; by Kristensen et al. (2013) in the Lower Fraser; and by Chilima et al. (2013) in the Grand River Basin, Ontario. All three of these studies focused on qualitative evaluation of institutional arrangements and emphasized on capacity building for watershed CEAM and provided an investigation regarding how watershed CEAM may be advanced on their respective study areas; however, neither study focused on the quantitative evaluation of current capacity to undertake watershed CEAM by watershed stakeholders. Further, each of these studies examined the broad requisites (e.g. presence of a lead agency) versus more detailed indicators of what constitutes an effective lead agency. Arguably, in order to further advance current understanding of the requisites for watershed CEAM, and current capacity for its implementation, there is a need for a more detailed, quantitative and systematic evaluation of watershed CEAM capacity and the underlying factors affecting it. This research is aimed at a systematic and quantitative evaluation of the current capacity to implement and sustain CEAM in the South Saskatchewan watershed.

Table 2.1 Institutional requirements for watershed cumulative effects assessment and management

Institutional requirements	Explanation
1. Lead Agency	A clearly identified, overarching agency with the authority, mandate and the capacity for CEAM, including the means to direct monitoring programs and influence decisions about land use and project development.
2. Multi stakeholder collaboration	Roles and responsibilities of various stakeholders in watershed management and sciences are well defined and stakeholders are represented in impact assessment and decision making about development.
3. Watershed baselines, indicators and thresholds	The state of the watershed needs to be known and agreed upon science-based indicators and thresholds for impact assessment and monitoring are required at both the project and watershed scale.
4. Multi-scaled monitoring	Monitoring programs are mandated at both the individual project and watershed scales, focused on water quantity and quality across the watershed, site specific actions, and land use changes that affect watershed processes.
5. Data management and coordination	Monitoring data, both spatial and aspatial, that are needed for assessing and understanding watershed cumulative effects must be made available and in common data formats to all watershed stakeholders.
6. Vertical and horizontal linkages	These are formal management and science linkages across watershed management policies and plans are well as between watershed CEAM and project-based assessment, monitoring and decision-making.
7. Enabling legislation	There is a means to implement watershed CEAM initiatives, enforce monitoring programs and compliance and ensure influence over development decisions taken at the individual project level.
8. Financial and human resources	Sufficient financial and human resources are available to implement and sustain, over the long term, CEAM programs and requirements (e.g. monitoring programs, landscape modeling, reporting, communication and data management and coordination)

Source: Sheelanere et al., 2013

2.6 Summary

There is a need to shift from local, project-scale assessments to broader, regional assessments to effectively assess cumulative effects to watershed processes and manage river system condition (Duinker and Greig, 2006; Squires et al., 2010; Seitz et al., 2011). Project-specific assessments do not provide the necessary expertise, resources, and leadership to assess the potential for cumulative impacts to occur in the entire watershed (Squires and Dubé, 2012). The science of watershed CEAM is advancing, but much less is known about the capacity to implement and sustain it. There are limitations in the understanding of the science versus the capacity to implement watershed CEAM. Capacity is the major factor in the assessment of cumulative environmental effects which determines the effective implementation of CEAM at the watershed scale (Harriman and Noble, 2008; Noble, 2008; Duinker and Greig, 2006). The CEA Literature at present focuses on the scientific and technical knowledge required to implement watershed CEAM, but mentions little about the capacity to undertake effective watershed CEAM (Noble et al., 2011). This research is aimed at a systematic and quantitative evaluation and comparison of the current capacity to implement and sustain watershed CEAM.

CHAPTER 3

RESEARCH METHODS

3.1 Study area

The South Saskatchewan Watershed (SSW) covers an area of 172,900 km^2, extending from southern Alberta to southern Saskatchewan (CPRC, 2012). The SSW originates on the eastern slopes of the Rocky Mountains flowing 1,392 km before joining the North Saskatchewan River, which drains into Hudson Bay, Manitoba (Sheelanere et al., 2013). The total population of the SSW is approximately 2.2 million, of which the majority resides in urban centers (Bruneau et al., 2009; Sheelanere et al., 2013). The SSW is fed by three major tributaries: the Red Deer, Bow and Oldman rivers. Tributaries entering the main channels from the plains include the Battle River, which joins the North Saskatchewan River near Battleford, and Swift Current Creek, which joins the South Saskatchewan River (SSR) near Swift Current (SRB, 2009). The SSR flows east into Saskatchewan where it is stored in Lake Diefenbaker and has the total drainage area of 35,000 square kilometres in overall Saskatchewan (SWA, 2006).

There are over 20,000 water licences and registered uses in the SSR, and a few hundred of these are in the South Saskatchewan sub-basin in Alberta. Groundwater consumption in the SSW represents about 2.5 % of total consumption (SRB, 2009). Irrigated agriculture represents the most significant water use in the basin. Summer flows in the SSR have been reduced by 84% since the early 20th century, and its major tributaries have all been subjected to multiple impoundments and large withdrawals (Squires et al., 2010; Sheelanere et al., 2013). There are various factors that have led the water quantity and quality concerns of SSW, as well as the multijurisdictional boundary of the watershed, which make the SSW a valuable unit of study for advancing watershed CEAM (Sheelanere et al., 2013).

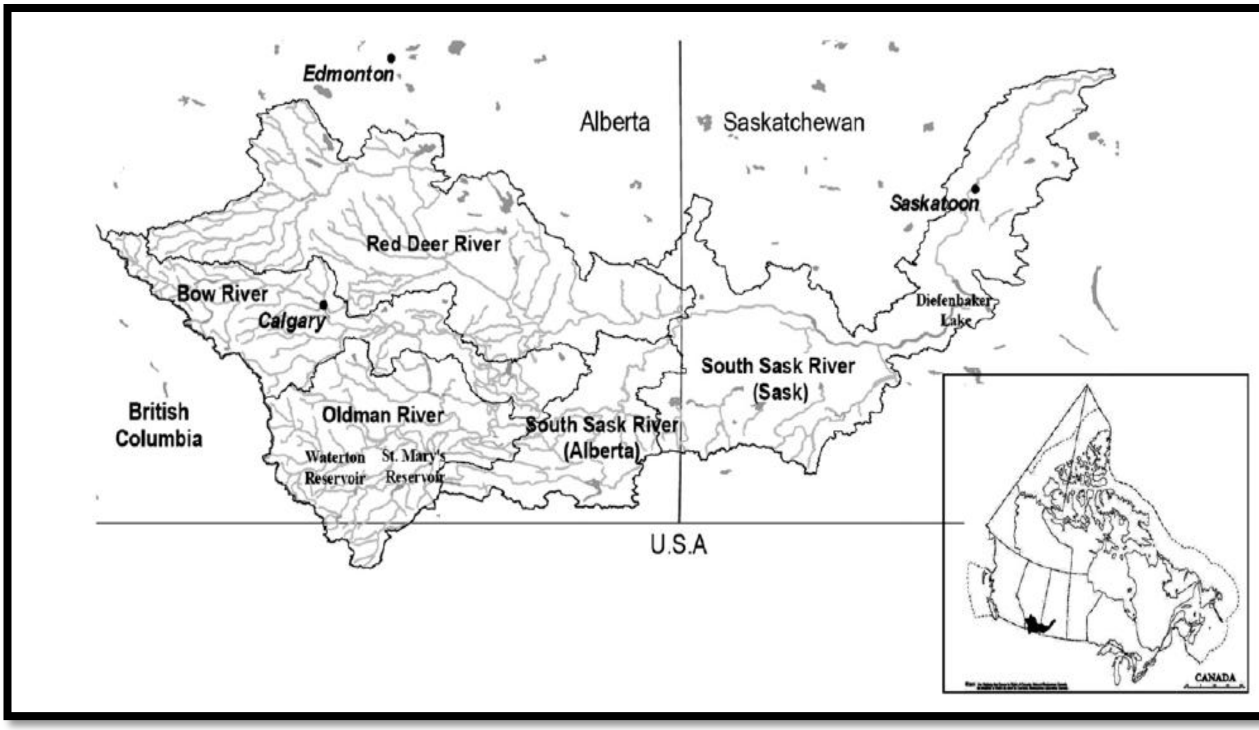

Figure 3.1 South Saskatchewan Watershed and sub-basins.
Map adapted from Martz et al. (2007); Sheelanere et al. (2013).

The Saskatchewan Water Security Agency (WSA) provides current water management in the South Saskatchewan River through forecasting inflow from Alberta, managing water levels on Lake Diefenbaker, and managing streamflow downstream of the Gardiner Dam and water allocations to various water users. The WSA operates all services and programs related to wastewater operations and municipal drinking water and affiliated surface and ground protection. Environment Canada currently monitors streamflow and water quality at the federal level for Alberta and Saskatchewan Border (SWA, 2006). The primary governance institutions and agencies responsible for land and water use management and assessment for SSW at the provincial and federal level are shown in Table 3.1.

Table 3.1 Primary water governance institutions in the South Saskatchewan Watershed

Federal	Inter Provincial	Provincial		Regional Organizations	
		Alberta	**Saskatchewan**	**Alberta**	**Saskatchewan**
Environ. Canada Fisheries & Oceans Agriculture Canada Cdn. Environ. Assess. Agency Natural Resources Canada Parks Canada Health Canada Transport Canada	Prairie Provinces Water Board Int. Joint Commission Agri-Environment Service Branch	Alberta Environ. Alberta Agriculture, Food & Rural Development Ministry of Sustainable Resource Development Natural Resource Cons. Board Alberta Health & Wellness	Saskatchewan Water Security Agency Sask Water Saskatchewan Agriculture & Food Saskatchewan Ministry of Environment Saskatchewan Health	Alberta Irrigation Project Association Sustainable Resource Development South East Alberta Watershed Alliance	SSW South West Development & Lake Diefenbaker Development Area Saskatchewan Soil Conservation Association Saskatchewan Urban Municipality Association Saskatchewan Municipal Government Saskatchewan Association of Watersheds

Source: Orrego, 2007; Patino and Gauthier, 2009; Sheelanere, 2010; Sheelanere et al., 2013

Requirement for the CEA of development projects is set out under sections 19(1)(a) of the *Canadian Environmental Assessment Act* (Canada, 2012), and 49(d) of the *Alberta Environmental Protection and Enhancement Act* (AEPEA) *(*Alberta, 1993). There is no specified requirement for CEA under Saskatchewan's *Environmental Assessment Act* (SEAA) (Saskatchewan, 1983) (Sheelanere et al., 2013). The Saskatchewan Ministry of Environment is responsible for reviewing the EAs of development projects, and the SEAA does require proponents to consider environmental effects of their projects but there are no requirements to undertake a CEA (Griffiths et al., 1998; Sheelanere, 2010) (Table 3.2). Cumulative effects, when assessed, are assessed largely on a project-by-project basis under all three EIA jurisdictions, and often limited to those 'larger' development projects (Noble et al., 2011). The problem, explains Noble et al. (2011), is that many of the non-point sources of stress that contribute to cumulative effects in the SSW are either deemed too insignificant to trigger an EIA or do not fall within the regulatory requirements of EIA.

Table 3.2 EIA requirements and provisions for CEA in the South Saskatchewan Watershed

Authority	Legislative instrument	Requirements for cumulative effects assessment	Responsible agency
Federal	*Canadian Environmental Assessment Act* Section 19(1)(a)	The environmental assessment of a designated project must take into account the environmental effects of the designated project, including the environmental effects of malfunctions or accidents that may occur in connection with the designated project and any cumulative environmental effects that are likely to result from the designated project in combination with other physical activities that have been or will be carried out.	Canadian Environment Assessment Agency
Alberta	*Environmental Protection and Enhancement Act* Section 49(d)	An environmental impact assessment report shall include a description of potential positive and negative environmental, social, economic and cultural impacts of the proposed activity, including cumulative, regional, temporal and spatial considerations.	Alberta Environment, Alberta Energy and Utility Board and Natural Resource Conservation Board
Saskatchewan	*Environmental Assessment Act* Draft guidelines for EA reports, Section 5.	No explicit legislated requirement. In an environmental impact statement, long-term and cumulative effects should be considered.	Saskatchewan Ministry of Environment

Source: CEAA, 2012; Alberta Environment, 1993; Saskatchewan Environment, 1979-80; Griffiths et al., 1998; Noble et al., 2011)

3.2 Capacity indicators for watershed CEAM

A common approach to the evaluation of capacity in any sector is the use of a set of indicator questions in an evaluative framework (Ivey et al., 2002). For example, the US EPA (1998) outlines a set of indicator questions to be used to assess the institutional capacity such as technical, managerial, and financial capacity of small public water systems, for compliance with the United States' *Safe Drinking Water Act* and these questions deal with technical knowledge and implementation, ownership accountability, staffing and organization, external linkages, and revenue sufficiency, among other issues (Ivey et al., 2002). From the 'institutional requirements' for watershed CEAM, based on Sheelanere et al. (2013), capacity indicator questions were developed for each institutional requirement (see Table 3.3). These indicator questions were developed based on a range of supporting literature in such fields as CEA, environmental assessment, strategic assessment, watershed planning and management, integrated water resource management, ecosystem-based management, and institutional arrangements for resource management.

Table 3.3 Institutional requirements for watershed CEAM and capacity indicators

Institutional Requirements[1]	Indicators	Source
Lead Agency	1. Clear goals and priorities have been set for the watershed, including those related to future land use and overall watershed health. 2. There is an agency or group of agencies in the watershed with a leadership role in the assessment and management of cumulative effects. 3. There is an agency or group of agencies in the watershed that has the ability (formal or informal) to influence decisions about land use and project development decisions. 4. There is an agency or group of agencies in the watershed that has formal authority to implement and/or enforce regulations across the watershed to support cumulative effects assessment and management activities (e.g., land use regulations, monitoring and reporting requirements). 5. There is an agency or group of agencies in the watershed that has formal authority to allocate technical and financial resources to support cumulative effects assessment initiatives (e.g., monitoring, data collection).	Parker and Cocklin, 1993; Reid, 1993; Grindle and Hilderbrand, 1995; Griffiths et al.,1998; Kennett,1999; Mitchell, 2005; Ivey, 2006, 2006a, 2006b; Canter and Ross, 2010; Seitz et al., 2011; Noble et al., 2011; Sheelanere et al., 2013
Multi stakeholder collaboration	1. There is a collaborative approach among provincial, watershed and municipal authorities in setting goals and priorities for the watershed concerning land and water use and development. 2. The roles and responsibilities of watershed stakeholders (e.g., industry, watershed agencies, land owners, government agencies) with respect to the assessment, management and monitoring of cumulative effects are clearly defined. 3. There is willingness amongst provincial, watershed, and municipal authorities to share data and knowledge and to coordinate activities related to monitoring watershed conditions and managing effects. 4. Industrial proponents operating in the watershed are willing to share their data (e.g., water quality, effluent discharge, water use) with other industries and non-industry stakeholders. 5. Local communities (e.g. municipalities, land owners) are sufficiently engaged in watershed or sub-watershed planning, monitoring, environmental assessment and related decision making processes.	Reid, 1993, 1998; Mitchell, 2005; de Loe, 2001; de Loe and Kreutzwiser, 2005; Heathcote , 2009; Canter and Ross, 2010; Noble, 2010; Connelly, 2011; Noble et al., 2011; Seitz et al., 2011
Watershed baselines, indicators and thresholds	1. There is adequate baseline data to identify past trends or changes in water quality across the watershed. 2. There is adequate baseline data to identify past trends or changes in water quantity / flow across the watershed. 3. There is adequate spatial baseline data to identify past land cover and land uses across the watershed. 4. There is agreement on the most appropriate indicators of watershed health. 5. There is a scientific understanding of thresholds (e.g. maximum	Reid, 1998; Davies and Hanley, 2010; Brinson and Eckles, 2011; Canter and Atkinson, 2011; Noble et al., 2011; Seitz et al., 2011

Institutional Requirements[1]	Indicators	Source
	loadings, minimum flows, etc.) at which river system functions are no longer ecologically viable.	
Multi-scaled monitoring	1. Monitoring programs under regulatory-based environmental impact assessment provide an understanding of a project's effects on watershed processes. 2. There are requirements for the monitoring of river system conditions (e.g. water quality, flow, loadings) across the watershed. 3. Current monitoring programs provide a sound understanding of, and allow for detection of changes in, water quality conditions across the watershed. 4. Current monitoring programs provide a sound understanding of, and allow for detection of changes in, water quantity/ flow conditions across the watershed. 5. Current monitoring programs provide a sound understanding of, and allow for detection of changes in, the dominant stressors to river system health (e.g., land use, disturbance patterns, buffers, effluent discharge, etc) across the watershed.	Squires et al., 2010; Noble et al., 2011; Seitz et al., 2011
Data management and coordination	1. There is a coordinated, watershed (or sub-watershed) approach to data collection/monitoring that ensures a standardized baseline establishment of watershed conditions. 2. Data concerning water quality and quantity are available in an easily accessible, up-to-date and electronic format to industry, to all levels of government and to all watershed stakeholders. 3. Spa tial data of current and past land uses, disturbance areas, or use patterns are available in an easily accessible, up-to-date and electronic format to industry, to all levels of government and to all watershed stakeholders. 4. There is consistency in project impact monitoring standards and indicators (used under environmental impact assessment or similar regulations/permits) for projects affecting similar components or for projects of a similar class (e.g. pulp mills, metal mines, agriculture, etc.). 5. Available data (water quality, quantity, and spatial land use data) are 'quality controlled', such that data gaps, uncertainties, errors, or assumptions are reported and known to data users.	Peterson et al., 1987; Braat, 2002; Hamdy et al., 1998; de Loe et al., 2002; Timmer et al., 2007; Canter and Ross, 2010; Noble, 2010; Seitz et al., 2011
Vertical and horizontal linkages	1. Watershed or sub-watershed management plans influence the terms and conditions (e.g., scope, monitoring requirements) of project-specific environmental impact assessments. 2. Watershed or sub-watershed management plans influence policy and other decisions concerning land and water use in the watershed. 3. There is consistency in watershed management goals and objectives across sub-basins in the watershed. 4. Results from project specific monitoring (under environmental impact assessment or other permitting requirements) are used to inform broader watershed assessment, evaluation and reporting processes. 5. Information generated from science programs or watershed monitoring and assessment programs is given due consideration in the development or implementation of watershed management plans.	Dubé and Munkittrick, 2001; Kennett, 2002; Duinker and Greig, 2006; Schindler and Donahue, 2006; Harriman & Noble, 2008 ; Noble et al., 2011; Seitz et al., 2011 Sheelanere et al., 2013

Institutional Requirements[1]	Indicators	Source
Enabling legislation	1. There is sufficient legislation or other regulatory means to establish a watershed-based framework for cumulative effects assessment, monitoring and management. 2. The 'terms of reference' developed for projects under regulatory-based environmental impact assessment provide clear direction for the selection of indicators for use in project assessment and monitoring actions. 3. There is sufficient legislation or other regulatory means to ensure that results generated from state-of-the-watershed assessments (e.g., monitoring programs, science studies) influence decisions about land use and development. 4. Current legislation and other regulatory instruments concerning land and water use are consistent across the watershed and between different levels of government in the watershed. 5. There is sufficient legislation or regulations to enable the protection of sensitive or vulnerable areas of the watershed from human disturbance.	de Loe et al., 2002; Ivey et al., 2006a; Dubé et al., 2007; Zhao et al., 2009; Noble et al., 2011;
Financial and human resources	1. The scientific and technical expertise to develop and implement tools for cumulative effects assessment is available in the watershed, either through government, the private sector, or academic institutions. 2. Funding is available for source water protection plans and projects. 3. Financial resources are available at the provincial level to support watershed-based cumulative effects assessment and monitoring programs (i.e., data collection, reporting, enforcement). 4. Financial resources are available at the sub-watershed level, to watershed agencies, regional government, and municipalities to participate in watershed cumulative effects programs. 5. Education and training opportunities on cumulative effects assessment tools and practice are available to members of government, watershed managers, land use planners, and other stakeholders responsible for planning and assessment.	de Loe et al., 2002; de Loe and Kreutzwiser, 2005; Timmer et al., 2007

[1]List of 'institutional requirements' is based on Sheelanere et al. (2013)

3.3 Data Collection

Data concerning the watershed CEAM capacity in the SSW were collected using an on-line, web-based survey using the tool Fluid Surveys. The survey consisted of four parts. Part one of the survey was focused on the participant profile, including questions such as the participant's area of residence/ work and professional affiliation and educational background or training. Part two of the survey was focused on participant's views about the current health of the SSW, specifically regarding water quality and quantity, and the primary threats to water quality and quantity in the SSW. Part three of the survey provided participants with a list of requisites (see Table 2.1), identified in the academic literature (see Sheelanere et al., 2013) as necessary to support watershed CEAM programs. Participants were asked to assign points to each requisite based on their importance to ensuring 'successful' watershed CEAM. Participants were asked to assign points generically, considering Canadian watersheds in general and not specific to the SSW context in order to get a brief overview of the participant's perspective on individual requisite.

Part four of the survey asked participants to assess current capacity in the SSW to implement and sustain watershed CEAM. For each of the 8 requisites, participants were presented with a set of indicators for assessment (see Table 3.3) that, collectively, provide an understanding of their perception of current capacity in the SSW to assess and manage cumulative effects. This section of the survey consisted of both closed-ended and open-ended questions. Closed ended questions, or the capacity indicator statement, were developed from the "institutional requirements" and "indicators" in Table 3.3. A nine-point response scale was used, whereby for each indicator statement participants were asked to rate on a scale ranging from 1 "strongly agree" to 9 "strongly disagree." Responses were evaluated collectively and the results used to generate an assessment of participant understanding of the common capacity needs and constraints for watershed CEAM in the SSW. After each "institutional requirement" section with closed-ended indicator questions, there was an open-ended question which provided an opportunity for participants to provide qualitative responses or examples that may serve to illustrate or explain their overall set of responses to the indicator questions.

3.4 Selection of participants

The intended survey participants were SSW watershed agencies, industry, cumulative effects practitioners, provincial regulators, academic researchers, and ENGOs. A letter of invitation containing a link to the survey was sent out to an initial list of key informants from the above groups, many of which whom were previously involved in watershed CEAM research in the SSW conducted by Noble et al. (2011). These participants were asked to forward the survey to others whom they thought might be interetsed in participating, using a snowball sampling design (see Valentine, 2005). In addition, the survey was advertised on various listserves and through the media with open access from May to September 2012. The objective was to capture the broadest range of participants possible.

3.5 Data analysis

Quantitative data collected on the capacity indicators were analyzed using the Statistical Package for the Social Sciences (SPSS), applying traditional non-parametric statistical techniques. Coding of the data was done in order to identity the differences across participant group and also the identification of primary areas in need of development, and areas where it seemed to be working fine regarding the watershed CEAM capacity.

Survey responses were exported weekly from Fluid Surveys during the time period when the survey platform was active and online for the participants. At first, descriptive statistics were carried out using SPSS for the whole of survey responses to understand the typical response for individual questions. In part one of the survey, the responses for participant's current affiliation were regrouped in three categories: government, NGOs and private sector. In part two of the survey, responses for effects to water quality and quantity were categorized into five different types or sources of stress, respectively (se Chapter 4).

Comparisons between participant groups and professional affiliation, in response to individual requisites in part four, were conducted using non-parametric statistical tests. In part three of the survey, mean evaluation of weights and distributions for individual requisites was used to identify and rank priority requisites, and traditional non-parametric statistical tests used to test for differences between participant groups. Analysis of open-ended responses was based on participant group and current affiliation.

Particular attention in data analysis was given to the identification of potential differences between participant groups, between provinces, identification of the primary requisites in need of capacity development, and areas where it seems to be sufficient to support watershed CEAM capacity in SSW.

3.6 Limitations to the research methods

There are advantages to using online, web-based surveys over traditional mail-out surveys; however, there are some limitations to this approach (Wright, 2005). A constraint in this research was, give the snowball sampling design and use of list serves, that the survey participation rate was not known. Participants were identified using snow ball sampling (see Valentine, 2005) which makes it difficult to determine the exact sample size and the population. As such, inferences about the population cannot be made based on the sample.

CHAPTER 4

RESULTS

4.1 Participant profile

A total of 73 people participated in the survey: 29 (39.7%) were from Alberta and 42 (57.5%) were from Saskatchewan. Two participants indicated that they were not from either Alberta or Saskatchewan, but either worked or conducted research in the SSW (Table 4.1). Of the 73 participants, the majority (n = 41) affiliated themselves with the South Saskatchewan River sub-basin (56.2%), followed by the Bow River (19.2%), Oldman River (9.6%), and Red Deer River (1.4%). Ten participants identified themselves as not currently residing in either of the above mentioned sub-basins; but were connected with the SSW in their past or current research and professional activities (Table 4.2).

Table 4.1 Study participants by province

Province	n[1]	(%)
Alberta	29	39.7
Saskatchewan	42	57.5

[1]n = 2 missing responses

Table 4.2 Study participants by sub-basin

Sub-basin	n	(%)
Bow River	14	19.2
Oldman River	7	9.6
Red Deer River	1	1.4
South Saskatchewan River	41	56.2
Other	10	13.7

Participants were asked to identify their current professional affiliation and educational background. Thirty individuals (41.1%) were affiliated with government departments and agencies; 39.7% (n = 29) were from NGOs; and 17.8% (n = 13) from the private sector (Table 4.3). One participant did not respond to this question.

Government departments and agencies included people from federal government, provincial government and municipal government. NGOs included organizations and agencies which are involved in watershed assessment and management in SSW, and the scientific community from academic organizations with the expertise on watershed management. The private sector included people who are consultants and are also practitioners and experts on environmental assessments in the watershed (Table 4.3).

Table 4.3 Study participants by professional affiliation

Current affiliation	n[1]	(%)	
Government sector	30	41.1	Federal Govt – 1.4
			Provincial Govt – 35.6
			Municipal Govt -4.1
NGOs and Academia	29	39.7	Watershed Agency – 4.1
			NGO's – 26.0
			Academia – 9.6
Private Sector	13	17.8	Consultant – 11.0
			Other – 6.8

[1] 1 missing response

Participants were from a variety of educational backgrounds, which were subsequently categorized as either the 'natural sciences' (75.3%) or 'social sciences' (24.7%). Natural sciences included people identifying a background in biology, engineering, agriculture and related fields or disciplines. Social sciences include people identifying education or training in business, planning, economics and related fields or disciplines (Table 4.4).

Table 4.4 Study participants by educational background or training

Category	n	(%)
Natural Sciences	55	75.3
Social Sciences	18	24.7

4.2 State of the South Saskatchewan Watershed

The second part of the survey focused on participant's views about the current health of SSW, specifically water quality and quantity, and the primary threats to water quality and quantity in the SSW.

4.2.1 Overall health of the South Saskatchewan Watershed

Participants were asked to evaluate the overall health of the SSW based on whether it was 'unhealthy', 'healthy but with problems', or 'healthy'. The majority of participants (84.9%) identified the overall health of SSW to be 'healthy but with problems'; 8.2% said it was 'unhealthy'; only 6.8% said it was 'healthy'. There was no significant difference in responses between Alberta and Saskatchewan participants (U = 613, p = 0.727)[1]. There were also no significant differences between participant groups, based on affiliation (H = 2.966, p = 0.227)[2].

Participants were also asked how the overall health of SSW has changed in past ten years, specifically whether it has 'declined', 'remained about the same' or 'improved'. The majority of the participants, 49.3%, said that the overall health of the SSW has declined; 42.5% said that it remained about the same; only 4.1% said that the health of the SSW has improved (Table 4.6). There was no significant difference between Alberta and Saskatchewan participants (U = 549, p = 0.896). There were also no significant differences between participant groups, based on affiliation (H = 3.848, p = 0.146).

Table 4.5 Current health of the South Saskatchewan Watershed[1]

Response category	n	(%)	Alberta $\bar{x}$	Saskatchewan $\bar{x}$	Overall $\bar{x}$	SD (σ_X)
Unhealthy	6	8.2	1.97	2.00	1.99	0.391
Healthy but with problems	62	84.9				
Healthy	5	6.8				

[1] Response scale: unhealthy = 1; healthy but with problems = 2; healthy = 3

Table 4.6 Change in health of South Saskatchewan Watershed over the past 10 years[1]

Response category	n	(%)	Alberta $\bar{x}$	Saskatchewan $\bar{x}$	Overall $\bar{x}$	SD (σ_X)
Declined	36	49.3	1.56	1.55	1.53	0.583
Remained about the same	31	42.5				
Improved	3	4.1				

[1] Response scale: declined = 1; remained about the same = 2; improved = 3

4.2.2 Cumulative effects threats to water quality and quantity in the sub-basins of the SSW

Participants were asked to identify whether the cumulative effects of human actions in the sub-basins of the SSW posed a current threat to water quality and quantity. The question was based on a nine point scale. From 1 'strongly disagree' to 9 'strongly agree' with the statements: the cumulative effects of human actions pose a current threat to water quality in the SSW; and the cumulative effects of human actions pose a current threat to water quantity in the SSW.

[1] Mann-Whitney U test statistic
[2] Kruskal-Wallis H test statistic

The mean response across all participants for water quality was 7.36, indicating that participants 'somewhat agreed' with the statement that cumulative effects pose a threat to water quality (Table 4.7). There were no significant differences between Alberta and Saskatchewan participants (U = 498, p = 0.235).

The mean response across all participants for water quantity was 7.34, indicating that participants 'somewhat agreed' that cumulative effects pose a threat to water quantity (Table 4.7). There were no significant differences between responses from Alberta and Saskatchewan participants (U = 522.500, p = 0.375).

There were also no significant differences between participant groups, based on affiliation, for either cumulative effects to water quality (H = 2.512, p = 0.285) or cumulative effects to water quantity (H = 1.966, p = 0.374).

Table 4.7 Perceived threat of cumulative effects to water quality and quantity in the South Saskatchewan Watershed[1]

	Province			**Groups (Current affiliation)**			
	Alberta $\bar{x}$	**Saskatchewan** $\bar{x}$	**Aggregate** $\bar{x}$	**Government** $\bar{x}$	**NGOs and academia** $\bar{x}$	**Private sector** $\bar{x}$	**Aggregate** $\bar{x}$
Water quality	7.62±1.522	7.17±1.657	7.36±1.606	7.00±1.912	7.76±1.300	7.54±1.330	7.40±1.607
Water quantity	7.55±1.804	7.20±1.860	7.34±1.833	7.07±2.196	7.79±1.521	7.31±1.494	7.40±1.836

[1]Responses scale of 1-9, where 1 = strongly disagree; 3 = somewhat disagree; 5 = neither agree nor disagree; 7 = somewhat agree; 9 = strongly agree; 2,4,6,8 = intermediate responses

Participants were then asked to list what they perceived to be the primary threats to water quality and quantity in the SSW. For effects to water quality, a total of 127 different responses were received, which could be categorized into five different types or sources of stress: agricultural activities, industrial activity, urban settlement, flow diversions, and other. Under the category agricultural activities, responses included such sources of stress as runoff from agricultural operations and intensive livestock operations, and pesticide and fertilizer use. Responses under the category 'industrial activity' included such sources of stress as pipelines and shoreline disturbance, disturbance to riparian habitat from industry operations, oil and gas development, and oil spills. Urban settlement stresses included runoff, sewage seepage, wastewater discharge, pharmaceuticals and other municipal activities. Flow diversions included activities such as dams and water withdrawals. Other types of sources of stress identified by participants included invasive species, policy ineffectiveness to control water use, and climate change.

Activities associated with agriculture were identified most frequently, identified by 43 participants and comprising 33.85% of all responses. This was followed by stresses from urban settlements, identified by 39 participants and comprising 30.7% of total responses and was also identified as a significant threat to the water quality. Participant's responses under the other categories included: industrial activity (14.96%), policy/climate change (11.02%), and flow diversion (9.44%) (Table 4.8).

Table 4.8 Primary threats to water quality in the South Saskatchewan Watershed

Primary Threat	AB (n) [1]	%	SK (n)	%	Total (n)	(%)
Agriculture/ ILO and runoff(pesticides, fertilizers)	15	31.9	28	35	43	33.85
Urban settlement (runoff, sewage, waste water discharge, pharmaceuticals)	15	31.91	24	30	39	30.70
Industrial activity (pipeline/shoreline distribution, riparian disruption, oil gas, spills)	5	10.63	14	17.5	19	14.96
Other (policy/ climate, invasive species)	5	10.63	9	11.25	14	11.02
Flow diversion (Dams, withdrawals)	7	14.89	5	6.25	12	9.44
Σ	47		80		127	

[1] number of times the threat was identified by study participants

For effects to water quantity, a total of 107 different responses were received, which could be categorized into five different types of sources or stress: agricultural activities, climate change and global warming, inefficient/poor planning and management practices, industrial use, and other. Under the category agricultural activities, the responses included such sources of stress as water withdrawal and use for intensive agriculture and livestock operations. Responses under the category climate change included such sources of stress as global warming, droughts, floods, glacier and snowpack loss. Poor planning and management practices included over allocation of water, lack of Source Water Protection Plan (SWP), and lack of information on groundwater and use. Under the category industrial use, responses included the water withdrawals and use for industrial purposes which are non-agricultural. Other types of sources of stress for water quantity identified by participants included municipal use, river diversion, and loss of critical recharge areas.

‘Climate change’ was identified most frequently, identified by 26 participants and comprising 24.29% of all responses. This was followed by stresses from agriculture/irrigation use, identified by 25 participants and comprising 23.36%; and poor planning and management practices, identified by 23 participants and comprising 21.49% of total responses. Participant’s responses under the ‘other’ category included: industrial use (16.82%); municipal use, river diversion and loss of critical recharge area (14.01%) (Table 4.9).

Table 4.9 Primary threats to water quantity in South Saskatchewan Watershed

Primary Threat	AB (n) [1]	%	SK (n)	%	Total (n)	(%)
Climate change (droughts, floods, glacier and snowpack loss)	11	26.19	15	23.07	26	24.29
Agriculture/ irrigation use (withdrawals, use)	8	19.04	17	26.15	25	23.36
Poor planning and management practices (over allocation, lack of SWP, lack of information on groundwater and use)	10	23.80	13	20	23	21.49
Industrial use (non-agriculture)	6	14.28	12	18.46	18	16.82
Other (municipal use, river diversion, loss of critical recharge areas)	7	16.66	8	12.30	15	14.01
Σ	42		65		107	

[1] number of times the threat was identified by study participants

4.3 Relative importance of the requisites for watershed CEAM

In the third part of the survey participants were provided with a list of requisites, identified in the academic literature (see Sheelanere et al., 2013) as necessary to support watershed CEAM programs. The requisites were as follows: lead agency; multi-stakeholder collaboration; watershed baselines, indicators and thresholds; multi-scaled monitoring; data management and coordination; vertical and horizontal linkages; enabling legislation; and financial and human resources.

Participants were asked to assign points to each requisite based on its importance to ensuring ‘successful’ watershed CEAM. Participants were asked to assign points generically, considering Canadian watersheds in general, and not specific to the SSW context. Participants could assign a total of 80 points across the set of 8 requisites. The more important they perceived particular requisite in ensuring successful watershed CEAM, the more points they could assign to it. If all eight requisites were considered equally important, then 10 points could be assigned to each requisite.

Overall, participants identified 'multi-stakeholder collaboration' as the primary requisite to ensure successful watershed CEAM, with highest total points assigned (832), followed by 'lead agency' (771) and 'financial and human resources' (754). Other requisites were scored as follows: 'watershed baselines, indicators and thresholds' (742); 'multi-scaled monitoring' (655); 'data management and coordination' (663); 'vertical and horizontal linkages' (480); and 'enabling legislation' (692) (Table 4.10).

There were no significant differences between Alberta and Saskatchewan participants based on the perceived importance of the requisites, with the exception of 'lead agency'. Participants from Saskatchewan assigned significantly more weight (importance) to the presence of a lead agency as a requisite for watershed CEAM than did Alberta participants (U = 728.000, p = 0.039). The total weight assignment distribution across all 8 requisites, by percentage, for Alberta and Saskatchewan participants, is shown in Figure 4.1. The highest % weight distribution (16.19%) was to 'multi-stakeholder collaboration' by Alberta participants, and lowest weight distribution (8.01%) was to 'vertical and horizontal linkages' also by Alberta participants.

Table 4.10 Mean weight/points assigned to requisites for watershed CEAM[1]

Indicators / **Province**	**Lead Agency**	**Multi-stakeholder collaboration**	**Watershed baselines, indicators and thresholds**	**Multi-scaled monitoring**	**Data management and coordination**	**Vertical and horizontal linkages**	**Enabling legislation**	**Financial and human resources**
AB $\bar{x}$	10.03	12.90	11.86	9.88	10.52	7.71	10.70	11.00
SD(σX)	±4.338	±8.772	±5.282	±4.013	±6.192	±2.274	±5.757	±3.563
Total points (AB)	291	374	332	257	284	185	289	297
SK $\bar{x}$	12.31	11.17	10.51	9.95	9.47	7.56	9.83	11.15
SD(σX)	±4.780	±7.797	±3.227	±2.961	±2.679	±2.511	±4.068	±4.234
Total points (SK)	480	458	410	398	379	295	403	457
Overall $\bar{x}$ SD(σX)	11.34 ±4.702	11.89 ±8.198	11.07 ±4.226	9.92 ±3.385	9.90 ±4.428	7.62 ±2.406	10.18 ±4.788	11.09 ±3.954
Total points	771	832	742	655	663	480	692	754
p-value	0.039*	0.390	0.383	0.682	0.989	0.970	0.767	0.793

[1]AB = Alberta, SK = Saskatchewan; $\bar{x}$ = mean, SD (σX) = standard deviation; p-value = significance level;
* indicates significance difference between AB and SK based on Mann-Whitney U test statistic

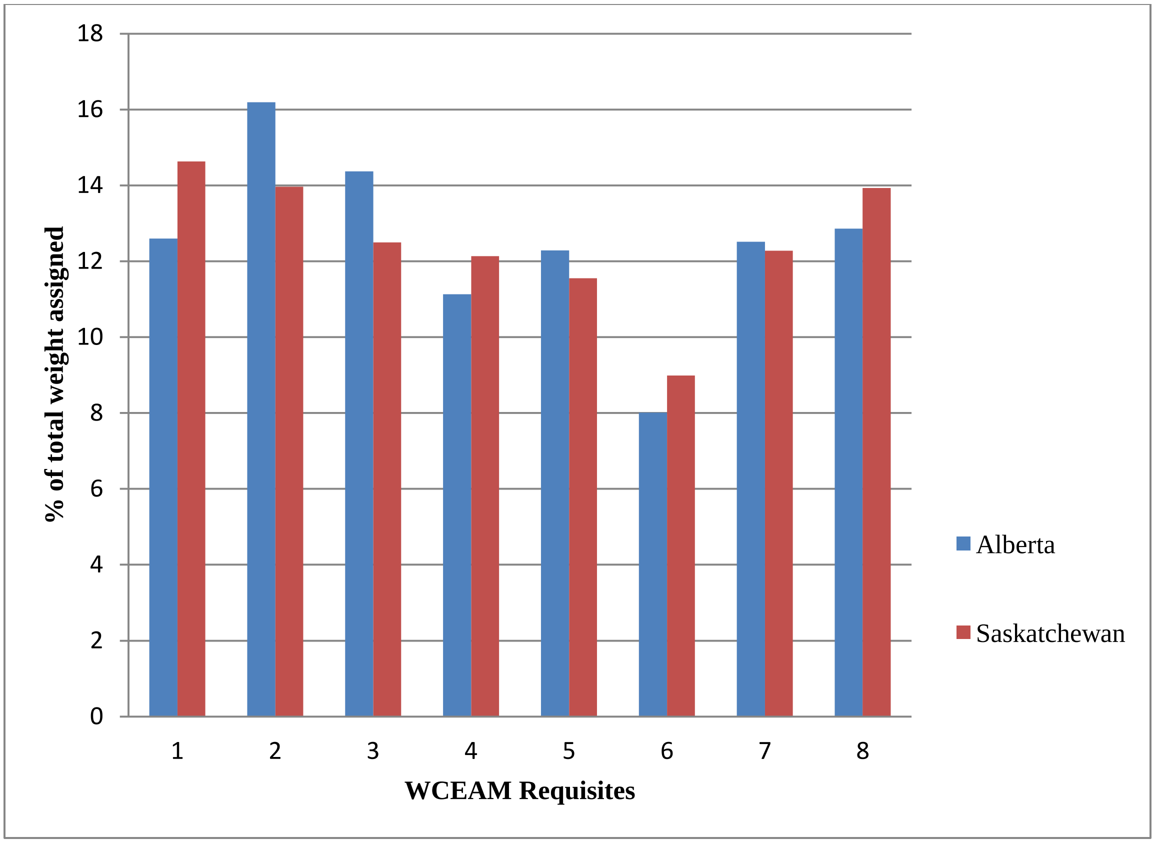

Figure 4.1. Total weight assignment distribution across all 8 requisites by percentage.

Notes: 1 = lead agency; 2 = multi-stakeholder collaboration; 3 = watershed baselines, indicators and thresholds; 4 = multi-scaled monitoring; 5 = data management and coordination; 6 = vertical and horizontal linkages; 7 = enabling legislation; 8 = financial and human resources

4.4 Evaluation of watershed CEAM capacity

The fourth part of the survey asked participants to assess the current capacity in the SSW to implement and sustain watershed CEAM. The focus was on surface water and the watershed boundaries included the Red Deer River, Bow River, Oldman River, and South Saskatchewan River sub-basins. For each of the 8 requisites identified above, participants were presented with a set of indicators for assessment that, collectively, provide an understanding of their perception of current capacity in the SSW to assess and manage cumulative effects. Participants were asked to identify their level of agreement with each indicator statement from 1 ‘strongly disagree’ to 9 ‘strongly agree’, based on their knowledge and experience with water, land, and governance issues or management practices in the SSW.

4.4.1 Lead Agency

Under the requisite ‘lead agency’, participants were asked to assess the following indicators: i) Clear goals and priorities have been set for the watershed, including those related to future land use and overall watershed health; ii) There is an agency or group of agencies in the watershed with a leadership role in the assessment and management of cumulative effects; iii) There is an agency or group of agencies in the watershed that has the ability (formal or informal) to influence decisions about land use and project development decisions; iv) There is an agency or group of agencies in the watershed that has formal authority to implement and/or enforce regulations across the watershed to support cumulative effects assessment and management activities (e.g., land use regulations, monitoring and reporting requirements); v) There is an agency or group of agencies in the watershed that has formal authority to allocate technical and financial resources to support cumulative effects assessment initiatives (e.g., monitoring, data collection).

The median response was relatively neutral on all 5 indicators and, based on the distribution of responses across categories, there was little consensus amongst participants (Table 4.11). On indicator 1, for example, 39.4% of participants (n = 26) agreed that clear goals and priorities had been established for the watershed, and an approximately equal percentage of participants (37.9%, n = 25) disagreed. The median response was only slightly higher for indicator 5, with 50% (n = 33) of respondents agreeing that there is an agency or groups of agencies in the watershed with authority to allocate resources for CEA.

There were no significant differences between Alberta and Saskatchewan participants on any of the 5 indicators ($p \geq 0.05$ for all Mann-Whitney U test statistics), and no significant differences based on participant affiliation ($p \geq 0.05$ for all Kruskal-Wallis H test statistics).

Table 4.11 Participant responses for requisite - ‘lead agency’[1]

Indicators	Disagree[2] (1-3)	Neutral (4-6)	Agree (7-9)	Mean ($\bar{x}$)	Median
1. Clear goals and priorities have been set for the watershed, including those related to future land use and overall watershed health.	25 (37.9%)	15 (22.7%)	26 (39.4%)	5.09±2.56	5.0
2. There is an agency or group of agencies in the watershed with a leadership role in the assessment	16 (24.2%)	20 (30.3%)	30 (45.5%)	5.58±2.38	6.0

Indicators	Disagree[2] (1-3)	Neutral (4-6)	Agree (7-9)	Mean ($\bar{x}$)	Median
and management of cumulative effects.					
3. There is an agency or group of agencies in the watershed that has the ability (formal or informal) to influence decisions about land use and project development decisions.	13 (19.7%)	21 (31.8%)	32 (48.5%)	5.79±2.36	6.0
4. There is an agency or group of agencies in the watershed that has formal authority to implement and/or enforce regulations across the watershed to support cumulative effects assessment and management activities (e.g., land use regulations, monitoring and reporting requirements).	17 (25.7%)	20 (30.3%)	29 (44%)	5.42±2.54	6.0
5. There is an agency or group of agencies in the watershed that has formal authority to allocate technical and financial resources to support cumulative effects assessment initiatives (e.g., monitoring, data collection).	15 (22.7%)	18 (27.3%)	33 (50%)	5.70±2.47	6.5

[1]n = 66 respondents
[2]Response scale of 1-9, where 1 = strongly disagree; 3 = somewhat disagree; 5 = neither agree nor disagree; 7 = somewhat agree; 9 = strongly agree; 2,4,6,8 = intermediate responses. For ease of presentation, after completion of all statistical analysis the response scale was condensed to three categories: disagree (1-3); neutral (4-6); agree (7-9).

Several Alberta participants, who provided qualitative responses on this topic, commented that there are number of agencies working on watershed management in the SSW, but they lack common and clear goals needed to efficiently and effectively work together collaboratively within the watershed and sub watersheds. Participants specifically focused on a need of an agency to monitor, enforce, and implement goals to improve watershed health, along with the creation of coherent legislation to ensure realization of common goals for better land-use management and watershed health, and the commitment of adequate resources to monitor and enforce thresholds to reach those goals. Many participants, for example, said that Alberta Environment and Sustainable Resource Development do have a defined leadership role in these regards, but on the ground action was lacking.

One participant from the private sector said that leadership that was not directly linked to government or industry would be best for effective cumulative effects management in the watershed. A participant from a NGO said that Alberta does have several quasi-judicial bodies that make public interest determinations that involve water, such as the Energy Resource Conservation Board (ERCB) and Alberta Utilities Commission (AUC) and in making such public interest determinations for development projects both defer to existing policies or regulation; however, both are also removed from the implementation and monitoring of projects as well as cumulative effects management. Participants noted that other departments and agencies of Alberta government do share responsibility for monitoring and cumulative effects, but these departments lack the resources, expertise, and budgets to ensure effective cumulative effects management.

Saskatchewan participants also commented that there was no governance structure or water strategy to address cumulative effects. One participant from government noted that Alberta has its Water for Life strategy document and planning process that is well underway, but Saskatchewan "is not even in the game." Saskatchewan participants across all participant groups reported that CEA was simply not a current priority of governments and that this is why there is currently little leadership in this area in the SSW. Participants reported that the Saskatchewan Watershed Authority lacked the mandate, sufficient budget and authority to drive a watershed CEAM process – including the needed means to integrate across provincial agencies and then build the capacity to actually deliver on CEA and overall watershed monitoring and management. One government participant mentioned that the formation of the Global Institute for Water Security at the University of Saskatchewan has brought these concerns to the forefront for regulatory agencies. However, one NGO participant said that any lead agency for watershed CEAM should be a non-partisan entity, and have the enforcement ability of government regulators.

4.4.2 Multi-stakeholder Collaboration

Under the requisite 'multi-stakeholder collaboration', participants were asked to assess the following indicators: i) There is a collaborative approach among provincial, watershed and municipal authorities in setting goals and priorities for the watershed concerning land and water use and development; ii) The roles and responsibilities of watershed stakeholders (e.g., industry, watershed agencies, land owners, government agencies) with respect to the assessment, management and monitoring of cumulative effects are clearly defined; iii) There is willingness amongst provincial, watershed, and municipal authorities to share data and knowledge and to coordinate activities related to monitoring watershed conditions and managing effects; iv) Industrial proponents operating in the watershed are willing to share their data (e.g., water quality, effluent discharge, water use) with other industries and non-industry stakeholders; v) Local communities (e.g. municipalities, land owners) are sufficiently engaged in watershed or sub-watershed planning, monitoring, environmental assessment and related decision making processes.

For most of the indicators the majority of responses were neutral to disagree (Table 4.12). On indicator 5, for example, the median response was 4.0, with 43.7% (n = 28) of participants disagreeing that local communities are sufficiently engaged in watershed activities and only 20.3% (n = 13) agreeing with the statement. The median response on indicator 2 was only 3.0, with 53.1% (n = 34) of participants disagreeing with the statement 'the roles of watershed stakeholders are well-defined' and only 21.9% (n = 14) agreeing.

There were no significant differences between Alberta and Saskatchewan participants, with the exception of indicator 5 ($U = 259$; $p = 0.005$). Participants from Alberta were relatively neutral on whether local communities were sufficiently engaged in watershed planning and assessment activities in the watershed ($\bar{x} = 5.32$); whereas Saskatchewan participants disagreed that local communities were sufficiently engaged in watershed planning and assessment activities in the watershed ($\bar{x} = 3.72$).

Table 4.12 Participant responses for requisite - 'multi-stakeholder collaboration'[1]

Indicators	Disagree[2] (1-3)	Neutral (4-6)	Agree (7-9)	Mean ($\bar{x}$)	Median
1. There is a collaborative approach among provincial, watershed and municipal authorities in setting goals and priorities for the watershed concerning land and water use and development.	25 (39.1%)	16 (25%)	23 (36%)	4.98±2.53	5.5
2. The roles and responsibilities of watershed stakeholders (e.g., industry, watershed agencies, land owners, government agencies) with respect to the assessment, management and monitoring of cumulative effects are clearly defined.	34 (53.1%)	16 (25%)	14 (21.9%)	4.19±2.534	3.0
3. There is willingness amongst provincial, watershed, and municipal authorities to share data and knowledge and to coordinate activities related to monitoring watershed conditions and managing effects.	21 (32.8%)	23 (35.9%)	20 (31.3%)	5.03±2.46	5.0

Indicators	Disagree[2] (1-3)	Neutral (4-6)	Agree (7-9)	Mean ($\bar{x}$)	Median
4. Industrial proponents operating in the watershed are willing to share their data (e.g., water quality, effluent discharge, water use) with other industries and non-industry stakeholders.	25 (39.1%)	25 (39.1%)	14 (21.9%)	4.56±2.42	4.5
5. Local communities (e.g. municipalities, land owners) are sufficiently engaged in watershed or sub-watershed planning, monitoring, environmental assessment and related decision making processes.	28 (43.7%)	23 (35.9%)	13 (20.3%)	4.36±2.37	4.0

[1]n = 64 respondents
[2]Response scale of 1-9, where 1 = strongly disagree; 3 = somewhat disagree; 5 = neither agree nor disagree; 7 = somewhat agree; 9 = strongly agree; 2,4,6,8 = intermediate responses. For ease of presentation, after completion of all statistical analysis the response scale was condensed to three categories: disagree (1-3); neutral (4-6); agree (7-9).

There were no differences in responses based on participant's professional affiliation, with the exception of indicator 4 (H = 6.896, p = 0.032), and indicator 5 (H = 6.220, p = 0.045). On indicator 4, there was a significant difference in responses between NGOs and private sector participants (U = 227.500, p = 0.020),where participants from NGOs disagreed that industrial proponents operating in the watershed are willing to share their data with other industries and non-industry stakeholders ($\bar{x}$ = 3.82); whereas participants from private sector were relatively neutral on whether industrial proponents operating in the watershed are willing to share their data with other industries and non-industry stakeholders ($\bar{x}$ = 5.91). On indicator 5, there was a significant difference in responses between government and private sector participants (U = 202.500, p = 0.011), and also between NGOs and private sector participants (U = 218.500, p = 0.043). Here, participants from government disagreed that local communities were sufficiently engaged in watershed planning and assessment activities in the watershed ($\bar{x}$ = 3.92); participants from NGOs disagreed with the statement ($\bar{x}$ = 4.04); whereas participants from private sector were relatively neutral on whether local communities were sufficiently engaged in watershed planning and assessment activities in the watershed ($\bar{x}$ = 5.91).

A number of Alberta participants, who provided qualitative responses on this topic, commented that there is collaboration going on in the SSW but not to the degree needed – there remain issues with trust amongst some parties, clarity around common goals, and a lack of transparency in sharing data. Participants identified multi-stakeholder involvement in watershed planning, but also noted that those plans and the stakeholder input doesn't always lead to changes in policy and regulation that actually govern how land use happens in the watershed. Provincial government agencies were criticized for not sharing data on water and land use, particularly those provincial agencies whose mandate is associated with facilitating industrial development. One NGO participant, for example, said that "everyone talks about multi-stakeholder collaboration but the reality is that projects/programs are typically led by the stakeholder with the most to gain or lose in that instance. Still uneven representation amongst stakeholders; some are very hard to engage." Communities in the headwaters were said to be more engaged in watershed improvement than those in the lower parts of the watershed, where water quantity and quality issues were said to be of even greater concern. A participant from the private sector said that the variability within different watershed groups and stakeholders makes it difficult to answer these questions – those concerning the effectiveness of multi-stakeholder collaboration. The participant noted that some groups are relatively well resourced and have years of experience, while others are not as well off.

Saskatchewan participants commented that there has not yet been a sufficient opportunity for significant collaboration regarding watershed CEAM, and industries operating in the watershed are rarely willing to share their data. Another major concern identified by one participant from NGO was that the provincial government and stakeholders do get together to assess their portion of the watershed and determine where the quality and quantity risks or problems occur and they do come up with plans to address the issues through collaboration and communication, but then the system falls apart because the agencies often not have the capacity and resources to actually deliver on the entire plan. One of NGO participant, however, noted that environmental groups and the general public are often left out of such planning processes.

4.4.3 Watershed baselines, indicators and thresholds

Under the requisite 'watershed baselines, indicators and thresholds', participants were asked to assess the following indicators: i) There is adequate baseline data to identify past trends or changes in water quality across the watershed; ii) There is adequate baseline data to identify past trends or changes in water quantity / flow across the watershed; iii) There is adequate spatial baseline data to identify past land cover and land uses across the watershed; iv) There is agreement on the most appropriate indicators of watershed health; v) There is a scientific understanding of thresholds (e.g. maximum loadings, minimum flows, etc.) at which river system functions are no longer ecologically viable.

For most of the indicators the majority of the responses were neutral to disagree, except on indicator 2 and indicator 3, where the majority of the responses were neutral to agree (Table 4.13). On indicator 4, for example, the median response was 4.0 with 43.8% (n = 28) of participants disagreeing that there is agreement on the most appropriate indicators of watershed health and only 20.3% (n = 13) agreeing with the statement. The median response on indicator 2 was 6.0, with 40.6% (n = 26) of participants agreeing that there is adequate baseline data to identify past trends or changes in water quantity / flow across the watershed and only 25% (n = 16) disagreeing with the statement. The median response for indicator 3 was 5.0, with 39.1% (n = 25) of participants agreeing that there is adequate spatial baseline data to identify past land cover and land uses across the watershed and only 23.4% (n = 15) disagreeing with the statement.

There were no significant differences between Alberta and Saskatchewan participants, with the exception of indicator 1 ($U = 294.500$, $p = 0.021$). Participants from Alberta were relatively neutral on whether there is adequate baseline data to identify past trends or changes in water quality across the watershed ($\bar{x} = 5.32$); whereas Saskatchewan participants disagreed that there is adequate baseline data to identify past trends or changes in water quality across the watershed ($\bar{x} = 3.89$). There were no significant differences based on participant affiliation ($p \geq 0.05$ for all Kruskal-Wallis H test statistics).

Table 4.13 Participant responses for requisite - 'watershed baselines, indicators and thresholds'[1]

Indicators	Disagree[2] (1-3)	Neutral (4-6)	Agree (7-9)	Mean ($\bar{x}$)	Median
1. There is adequate baseline data to identify past trends or changes in water quality across the watershed.	27 (42.2%)	20 (31.3%)	17 (26.5%)	4.45±2.45	4.0
2. There is adequate baseline data to identify past trends or changes in water quantity / flow across the watershed.	16 (25%)	22 (34.4%)	26 (40.6%)	5.48±2.38	6.0
3. There is adequate spatial baseline data to identify past land cover and land uses across the watershed.	15 (23.4%)	24 (37.5%)	25 (39.1%)	5.36±2.31	5.0
4. There is agreement on the most appropriate indicators of watershed health.	28 (43.8%)	23 (36%)	13 (20.3%)	4.41±2.23	4.0

Indicators	Disagree[2] (1-3)	Neutral (4-6)	Agree (7-9)	Mean ($\bar{x}$)	Median
5. There is a scientific understanding of thresholds (e.g. maximum loadings, minimum flows, etc.) at which river system functions are no longer ecologically viable.	25 (39.1%)	17 (26.5%)	22 (34.4%)	4.81±2.61	4.0

[1]n = 64 respondents
[2]Response scale of 1-9, where 1 = strongly disagree; 3 = somewhat disagree; 5 = neither agree nor disagree; 7 = somewhat agree; 9 = strongly agree; 2,4,6,8 = intermediate responses. For ease of presentation, after completion of all statistical analysis the response scale was condensed to three categories: disagree (1-3); neutral (4-6); agree (7-9).

A participant from government, who provided qualitative responses on this topic, commented that there is less understanding in variability of known thresholds in SSW due to interconnection and cumulative effects. One participant from private sector said that thresholds are often only detected after they have been crossed, and it is often difficult biologically and politically to return to a less intrusive state. The participant went on to further note that the idea of pushing things to their limit and then backing off slightly does not lead to a productive aquatic system. Still, many participants said that there is enough data to make land use planning decisions that will have positive impacts on overall watershed health. But, it was also noted that such data exists for some locations, particularly for the main rivers themselves, but not many of the contributing tributary systems. Further, a participant from government said that many of the indicators used seem dependent on either the jurisdiction or the existing monitoring programs; they are not necessarily the best indicator or agreed-upon indicator.

Participants from Saskatchewan reported that data are limited regarding historical water quality in the South Saskatchewan River watershed and monitoring data have significant gaps and challenges in terms of consistency. An NGO participant, for example, reported that sufficient baseline information is often not available because it was never funded or a never priority and, and a result, “there is nothing to compare things with, which will make it difficult to quantify what happened or the extent of change.” The participant went on to explain that baseline data is critical for future assessment and other projects that might occur in the watershed. That said, another NGO participant reported that there is considerable data available in old government document and from printed maps and published reports that simply have never been converted to digital format, and that such data, particularly historical land use data (e.g., roads, railways, utilities, waterway crossings, etc).

4.4.4 Multi-scaled monitoring

Under the requisite 'multi-scaled monitoring', participants were asked to assess the following indicator: i) Monitoring programs under regulatory-based environmental impact assessment provide an understanding of a project's effects on watershed processes; ii) There are requirements for the monitoring of river system conditions (e.g. water quality, flow, loadings) across the watershed; iii) Current monitoring programs provide a sound understanding of, and allow for detection of changes in, water quality conditions across the watershed; iv) Current monitoring programs provide a sound understanding of, and allow for detection of changes in, water quantity/ flow conditions across the watershed; v) Current monitoring programs provide a sound understanding of, and allow for detection of changes in, the dominant stressors to river system health (e.g., land use, disturbance patterns, buffers, effluent discharge, etc) across the watershed.

For most of the indicators the majority of responses were neutral to disagree (Table 4.14). On indicator 5, for example, the median response was 3.0, with 58.7% (n = 37) of participants disagreeing that current monitoring programs provide a sound understanding of, and allow for detection of changes in, the dominant stressors to river system health across the watershed. Only 12.7% (n = 8) of the participants agreed with this statement. The median response on indicator 3 was only 3.0, with 54% (n = 34) of participants disagreeing that current monitoring programs provide a sound understanding of, and allow for detection of changes in, water quality conditions across the watershed and only 11.1% (n = 7) agreeing. The median response on indicator 2 was 5.0, with 44.4% (n = 28) of participants remaining neutral with the statement that there are requirements for the monitoring of river system conditions across the watershed.

There were no significant differences between Alberta and Saskatchewan participants on any of the 5 indicators ($p \geq 0.05$ for all Mann-Whitney U test statistics), and no significant differences based on participant affiliation ($p \geq 0.05$ for all Kruskal-Wallis H test statistics).

Table 4.14 Participant responses for requisite - 'multi-scaled monitoring'[1]

Indicators	Disagree[2] (1-3)	Neutral (4-6)	Agree (7-9)	Mean ($\bar{x}$)	Median
1. Monitoring programs under regulatory-based environmental impact assessment provide an understanding of a project's effects on watershed processes.	22 (34.9%)	20 (31.8%)	21 (33.3%)	5.05±2.50	5.0
2. There are requirements for the monitoring of river system conditions (e.g. water quality, flow, loadings) across the watershed.	14 (22.2%)	28 (44.4%)	21 (33.3%)	5.52±2.14	5.0
3. Current monitoring programs provide a sound understanding of, and allow for detection of changes in, water quality conditions across the watershed.	34 (54%)	22 (34.9%)	7 (11.1%)	3.84±1.97	3.0
4. Current monitoring programs provide a sound understanding of, and allow for detection of changes in, water quantity/ flow conditions across the watershed.	26 (41.3%)	24 (38.1%)	13 (20.6%)	4.37±2.05	4.0
5. Current monitoring programs provide a sound understanding of, and allow for detection of changes in, the dominant stressors to river system health (e.g., land use, disturbance patterns, buffers, effluent discharge, etc) across the watershed.	37 (58.7%)	18 (28.8%)	8 (12.7%)	3.56±1.98	3.0

[1]n = 63 respondents
[2]Response scale of 1-9, where 1 = strongly disagree; 3 = somewhat disagree; 5 = neither agree nor disagree; 7 = somewhat agree; 9 = strongly agree; 2,4,6,8 = intermediate responses. For ease of presentation, after completion of all statistical analysis the response scale was condensed to three categories: disagree (1-3); neutral (4-6); agree (7-9).

Several Alberta participants, who provided qualitative responses on this topic, noted that their current monitoring systems are not working at all to support watershed CEAM. An – NGO participant reported that most monitoring currently focuses on main river systems; but that tributaries should be monitored more than mainstreams because they are the first to suffer from the cumulative impacts of land use and have less capacity to respond to change. A participant from government, for example, commented: "I don't think we have a monitoring system in the South Saskatchewan River watershed that provides the science base needed to understand where we are currently at and what we need to know to address future threats. We monitor water quality and flows, but not the aquatic biota or stressors adequately. Stressors may be both natural (precipitation, fire, mountain pine beetle, etc.) and human caused (land use, effluent, etc.) and have not done a good job of defining relationships between the stressors and the conditions of the aquatic environment". Other participants commented on the importance of monitoring in the adaptive management process for managing cumulative effects. A participant from NGO noted that "we are attempting to do adaptive management, on paper, but monitoring is rarely followed up with funding or capacity. We are not actually completing adaptive management loops because management plans are not altered based on results from monitoring because monitoring is rarely completed."

Saskatchewan participants similarly reported inadequate monitoring programs to support CEAM. One government participant noted that most of the monitoring processes are project-specific, but that monitoring for individual projects may not be that relevant when considering impacts from multiple non-project related activities. The participant explained that "some larger projects can have obvious impacts on water quality and quantity and monitoring and reporting is essential, but to be truly effective this monitoring and reporting should be assessed against a watershed data set."

4.4.5 Data management and coordination

Under the requisite 'data management and coordination', participants were asked to assess the following indicators: i) There is a coordinated, watershed (or sub-watershed) approach to data collection/monitoring that ensures a standardized baseline establishment of watershed conditions; ii) Data concerning water quality and quantity are available in an easily accessible, up-to-date and electronic format to industry, to all levels of government and to all watershed stakeholders; iii) Spatial data of current and past land uses, disturbance areas, or use patterns are available in an easily accessible, up-to-date and electronic format to industry, to all levels of government and to all watershed stakeholders; iv) There is consistency in project impact monitoring standards and indicators (used under environmental impact assessment or similar regulations/permits) for projects affecting similar components or for projects of a similar class (e.g. pulp mills, metal mines, agriculture, etc.); v) Available data (water quality, quantity, and spatial land use data) are 'quality controlled', such that data gaps, uncertainties, errors, or assumptions are reported and known to data users.

For most of the indicators the majority of responses were neutral to disagree (Table 4.15). On indicator 3, for example, the median response was 3.0, with 59.7% (n = 37) of participants disagreeing that spatial data of current and past land uses, disturbance areas, or use patterns are available in an easily accessible, up-to-date and electronic format to industry, to all levels of government and to all watershed stakeholders. Only 8.1% (n = 5) of the participants agreed with this statement. The median response on indicator 2 was only 3.0, with 59.7% (n = 37) participants disagreeing with the statement that data concerning water quality and quantity are available in an easily accessible, up-to-date and electronic format to industry, to all levels of government and to all watershed stakeholders. Only 16.1% (n = 10) of the participants agreed with this statement.

There were no significant differences between Alberta and Saskatchewan participants, with the exception of indicator 2 (U = 288.500, p = 0.034). Participants from Alberta somewhat disagreed that there is consistency in project impact monitoring standards and indicators for projects affecting similar components or for projects of a similar class ($\bar{x}$ = 4.40); whereas Saskatchewan participants strongly disagreed that there is consistency in project impact monitoring standards and indicators for projects affecting similar components or for projects of a similar class ($\bar{x}$ = 2.91).

There were no differences in responses based on participant's professional affiliation, with the exception of indicator 1 (H = 7.783, p = 0.020), and indicator 2 (H = 7.297, p = 0.026). On indicator 1, there was a significant difference in responses between government and private sector participants (U =185.500, p = 0.012), and also between NGOs and private sector participants (U = 210, p = 0.009). Here, participants from government disagreed that there is a coordinated, watershed approach to data collection/monitoring that ensures a standardized baseline establishment of watershed conditions ($\bar{x}$ = 3.38); participants from NGOs also disagreed with the statement ($\bar{x}$ = 3.37); whereas participants from private sector were relatively neutral on whether there is a coordinated, watershed approach to data collection/monitoring that ensures a standardized baseline establishment of watershed conditions ($\bar{x}$ = 5.50).

Table 4.15 Participant responses for requisite - 'data management and coordination'[1]

Indicators	Disagree[2] (1-3)	Neutral (4-6)	Agree (7-9)	Mean ($\bar{x}$)	Median
1. There is a coordinated, watershed (or sub-watershed) approach to data collection/monitoring that ensures a standardized baseline establishment of	31 (50%)	24 (38.7%)	7 (11.3%)	3.71±2.03	3.5

Indicators	Disagree[2] (1-3)	Neutral (4-6)	Agree (7-9)	Mean ($\bar{x}$)	Median
watershed conditions.					
2. Data concerning water quality and quantity are available in an easily accessible, up-to-date and electronic format to industry, to all levels of government and to all watershed stakeholders.	37 (59.7%)	15 (24.2%)	10 (16.1%)	3.63±2.37	3.0
3. Spatial data of current and past land uses, disturbance areas, or use patterns are available in an easily accessible, up-to-date and electronic format to industry, to all levels of government and to all watershed stakeholders.	37 (59.7%)	20 (32.3%)	5 (8.1%)	3.39±2.18	3.0
4. There is consistency in project impact monitoring standards and indicators (used under environmental impact assessment or similar regulations/permits) for projects affecting similar components or for projects of a similar class (e.g. pulp mills, metal mines, agriculture, etc.).	31 (50%)	24 (38.7%)	7 (11.3%)	3.69±2.21	3.5
5. Available data (water quality, quantity, and spatial land use data) are 'quality controlled', such that data gaps, uncertainties, errors, or assumptions are reported and known to data users.	29 (46.8%)	26 (41.9%)	7 (11.3%)	3.79±2.10	4.0

[1]n = 62 respondents

[2]Response scale of 1-9, where 1 = strongly disagree; 3 = somewhat disagree; 5 = neither agree nor disagree; 7 = somewhat agree; 9 = strongly agree; 2,4,6,8 = intermediate responses. For ease of presentation, after completion of all statistical analysis the response scale was condensed to three categories: disagree (1-3); neutral (4-6); agree (7-9).

On indicator 2, there was a significant difference in responses between government and private sector participants (U =194.500, p = 0.004), and also between NGOs and private sector participants (U =195, p = 0.04). In this case, participants from government disagreed that data concerning water quality and quantity are available in an easily accessible, up-to-date and electronic format to industry, to all levels of government and to all watershed stakeholders ($\bar{x}$ = 2.96); participants from NGOs also disagreed with the statement ($\bar{x}$ = 3.52); whereas participants from private sector were relatively neutral on whether data concerning water quality and quantity are available in an easily accessible, up-to-date and electronic format to industry, to all levels of government and to all watershed stakeholders ($\bar{x}$ = 5.50).

A number of participants from Alberta, who provided qualitative responses on this topic, said that data management and coordination was one of the biggest problems when it comes to watershed planning and management for CEAM. It was emphasized that there was a wide range of data that could potentially be used for watershed CEAM, but it needs to be better coordinated and accessible from a single point. A larger problem identified, however, was that many stakeholders are still not willing to share their data.

In Saskatchewan, one of the government participants commented that Saskatchewan is “way behind other jurisdiction in data management and coordination and puts very little resources towards it.” Another participant from the NGO group said that data are “all over the place with no consistency, aside from what is required for reporting under different permitting requirements.” The participant went on to note that “for the data that are available, it's simply not easily available. You have to know exactly where to go to get it, and it's often old by the time it is released.”

4.4.6 Vertical and horizontal linkages

Under the requisite ‘vertical and horizontal linkages’, participants were asked to assess the following indicators: i) Watershed or sub-watershed management plans influence the terms and conditions (e.g., scope, monitoring requirements) of project-specific environmental impact assessments; ii) Watershed or sub-watershed management plans influence policy and other decisions concerning land and water use in the watershed; iii) There is consistency in watershed management goals and objectives across sub-basins in the watershed; iv) Results from project specific monitoring (under environmental impact assessment or other permitting requirements) are used to inform broader watershed assessment, evaluation and reporting processes; v) Information generated from science programs or watershed monitoring and assessment programs is given due consideration in the development or implementation of watershed management plans.

The median response was relatively neutral on all 5 indicators and, based on the distribution of responses across categories, there was little consensus amongst participants (Table 4.16). On indicator 3, for example, the median response was 5.0, with 42.4% (n = 25) of participants remaining neutral with the statement ‘there is consistency in watershed management goals and objectives across sub-basins in the watershed’. On indicator 1, 35% of participants (n = 21) agreed that watershed or sub-watershed management plans influence the terms and conditions of project-specific environmental impact assessments, and an approximately equal percentage of participants (35%, n = 21) disagreed.

There were no significant differences between Alberta and Saskatchewan participants, with the exception of indicator 4 (U = 272.500, p = 0.043). Participants from Alberta were relatively neutral on whether results from project specific monitoring are used to inform broader watershed assessment, evaluation and reporting processes ($\bar{x}$ = 5.17); whereas Saskatchewan participants disagreed that results from project specific monitoring are used to inform broader watershed assessment, evaluation and reporting processes ($\bar{x}$ = 3.94).

There were no differences in responses based on participant's professional affiliation, with the exception on indicator 4 (H = 6.568, p = 0.037). On indicator 4, there was a significant difference in responses between NGOs and private sector participants (U = 189, p = 0.012); where participants from NGOs disagreed that results from project specific are used to inform broader watershed assessment, evaluation and reporting processes ($\bar{x}$ = 3.89); whereas participants from private sector were relatively neutral on whether results from project specific are used to inform broader watershed assessment, evaluation and reporting processes ($\bar{x}$ = 6.00).

Table 4.16 Participant responses for requisite - 'vertical and horizontal linkages'[1]

Indicators	Disagree[2] (1-3)	Neutral (4-6)	Agree (7-9)	Mean ($\bar{x}$)	Median
1. Watershed or sub-watershed management plans influence the terms and conditions (e.g., scope, monitoring requirements) of project-specific environmental impact assessments.	21 (35%)	18 (30%)	21 (35%)	4.93±2.36	5.0
2. Watershed or sub-watershed management plans influence policy and other decisions concerning land and water use in the watershed.	17 (28.3%)	22 (36.6%)	21 (35%)	5.05±2.27	5.0
3. There is consistency in watershed management goals and objectives across sub-basins in the watershed.[3]	22 (37.3%)	25 (42.4%)	12 (20.3%)	4.36±2.14	5.0
4. Results from project specific monitoring (under environmental impact assessment or other permitting requirements) are used to inform broader watershed assessment,	21 (35%)	27 (45%)	12 (20%)	4.45±2.10	5.0

evaluation and reporting processes.					
5. Information generated from science programs or watershed monitoring and assessment programs is given due consideration in the development or implementation of watershed management plans.	14 (23.3%)	27 (45%)	19 (31.6%)	5.02±2.04	5.0

[1]n = 60 respondents; [3]n = 59 respondents
[2]Response scale of 1-9, where 1 = strongly disagree; 3 = somewhat disagree; 5 = neither agree nor disagree; 7 = somewhat agree; 9 = strongly agree; 2,4,6,8 = intermediate responses. For ease of presentation, after completion of all statistical analysis the response scale was condensed to three categories: disagree (1-3); neutral (4-6); agree (7-9).

One of the participants from Alberta, affiliated with government, who provided qualitative responses on this topic, reported that science information will and has been used in the development of watershed management plans, but only when the science is known and shared. The participant went on to explain that this often is conducted in an ad hoc manner so there is no consistency or ability to use it for the long term. Another participant, affiliated with NGO group, said that there is a huge disconnect from policy to regulation to management plans.

In Saskatchewan, a participant from government, for example, said that watershed or sub-watershed management plans can provide direction for project-specific impact assessments, however, additional effort in data collection and monitoring is necessary to understand the degree of impacts that may occur from a project. A participant from NGO group reported that there is little linkage between initiatives at the watershed scale and decisions about projects at the local scale, and vice versa, because these are two completely different processes - and often ones with contradictory objectives. Another NGO participant noted that there will inherently be inconsistency in watershed management goals and objective across sub-basins in the watershed, since there are different groups and stakeholders involved. The participant went on to note that "this might be okay as long as the right information is influencing those goals and objectives, like risks or proper baseline information, because one area might influence decisions due to economic reasons like oil and gas/agriculture as compared to another with more environmental priorities or influences." The participant noted that ideally there needs to be similar management goals and objectives across sub-basins, better use of project specific monitoring to inform broader watershed assessment, evaluation and reporting processes, and better consideration of information generated from science programs or watershed monitoring and assessment programs by all stakeholders in the development or implementation of watershed management plans.

4.4.7 Enabling Legislation

Under the requisite 'enabling legislation', participants were asked to assess the following indicators: i) There is sufficient legislation or other regulatory means to establish a watershed-based framework for cumulative effects assessment, monitoring and management; ii) The 'terms of reference' developed for projects under regulatory-based environmental impact assessment provide clear direction for the selection of indicators for use in project assessment and monitoring actions; iii) There is sufficient legislation or other regulatory means to ensure that results generated from state-of-the-watershed assessments (e.g., monitoring programs, science studies) influence decisions about land use and development; iv) Current legislation and other regulatory instruments concerning land and water use are consistent across the watershed and between different levels of government in the watershed; v) There is sufficient legislation or regulations to enable the protection of sensitive or vulnerable areas of the watershed from human disturbance.

For most of the indicators the majority of responses were neutral to disagree (Table 4.17). On indicator 1, for example, the median response was 5.0, with 62.3% (n = 38) of participants remaining neutral with the statement 'there is sufficient legislation or other regulatory means to establish a watershed-based framework for CEA, monitoring and management'; 21.3% (n = 13) disagreeing; and only 16.4% (n = 10) agreeing.

There were no significant differences between Alberta and Saskatchewan participants on any of the 5 indicators ($p \geq 0.05$ for all Mann-Whitney U test statistics). There were no differences in responses based on participant's professional affiliation, with the exception of indicator 3 (H = 6.907, p = 0.032). On indicator 3, there was a significant difference in responses between NGOs and private sector participants (U = 183.500, p = 0.022), where participants from NGOs disagreed that there is sufficient legislation or other regulatory means to ensure that results generated from state-of-the-watershed assessments influence decisions about land use and development ($\overline{x}$ = 3.22); whereas participants from private sector were relatively neutral with the statement.

Table 4.17 Participant responses for requisite - 'enabling legislation'[1]

Indicators	Disagree[2] (1-3)	Neutral (4-6)	Agree (7-9)	Mean ($\bar{x}$)	Median
1. There is sufficient legislation or other regulatory means to establish a watershed-based framework for cumulative effects assessment, monitoring and management.	13 (21.3%)	38 (62.3%)	10 (16.4%)	4.89±1.83	5.0
2. The 'terms of reference' developed for projects under regulatory-based environmental impact assessment provide clear direction for the selection of indicators for use in project assessment and monitoring actions.	29 (47.5%)	24 (39.3%)	8 (13.1%)	3.90±2.15	4.0
3. There is sufficient legislation or other regulatory means to ensure that results generated from state-of-the-watershed assessments (e.g., monitoring programs, science studies) influence decisions about land use and development.	29 (47.5%)	19 (31.1%)	13 (21.3%)	3.97±2.49	4.0
4. Current legislation and other regulatory instruments concerning land and water use are consistent across the watershed and between different levels of government in the watershed.	30 (49.2%)	17 (27.9%)	14 (22.9%)	3.93±2.55	4.0
5. There is sufficient legislation or regulations to enable the protection of sensitive or vulnerable areas of the watershed from human disturbance.	24 (39.3%)	22 (36.01%)	15 (24.6%)	4.33±2.59	4.0

[1]n = 61 respondents
[2]Response scale of 1-9, where 1 = strongly disagree; 3 = somewhat disagree; 5 = neither agree nor disagree; 7 = somewhat agree; 9 = strongly agree; 2,4,6,8 = intermediate responses. For ease of presentation, after completion of all statistical analysis the response scale was condensed to three categories: disagree (1-3); neutral (4-6); agree (7-9).

A participant from Alberta, affiliated with government, who provided qualitative responses on this topic, reported that EIA under regulatory programs in the SSW provides clear direction for cumulative effects and there is the legislation and regulatory means to ensure the protection of the most sensitive or vulnerable areas of the watershed – the problem is that there is absence of the political will to use it most of the time. Other participants, from NGO and private sector, similarly said that legislation and regulatory means exist, but are discretionary and there are limited resources or political desire to enforce the laws and regulations. The watershed advisory committees were reported to not have any authority needed to enforce the policies that they develop.

Enabling legislation was reported to be similarly problematic in Saskatchewan. One participant, affiliated with government, said that the province has no water strategy and Saskatchewan Watershed Authority's "State of The Watershed Report" is an unscientific, misleading document for the purpose of supporting any sort of CEAM initiative. Another participant, affiliated with a NGO, said that current legislation is complicated, fractured into too many areas of legislation, and does not seem comprehensive enough to support CEAM – particularly with regard to ensuring protection of sensitive habitat in a watershed.

4.4.8 Financial and Human Resources

Under the requisite 'financial and human resources ', participants were asked to assess the following indicators: i) The scientific and technical expertise to develop and implement tools for cumulative effects assessment is available in the watershed, either through government, the private sector, or academic institutions; ii) Funding is available for source water protection plans and projects; iii) Financial resources are available at the provincial level to support watershed-based cumulative effects assessment and monitoring programs (i.e., data collection, reporting, and enforcement); iv) Financial resources are available at the sub-watershed level, to watershed agencies, regional government, and municipalities to participate in watershed cumulative effects programs; v) Education and training opportunities on cumulative effects assessment tools and practice are available to members of government, watershed managers, land use planners, and other stakeholders responsible for planning and assessment.

For most of the indicators the majority of responses were neutral to disagree, except on indicator 1, where 66.1% (n = 39) of participants, with the median response 8.0, agreed that the scientific and technical expertise to develop and implement tools for CEA is available in the watershed, either through government, the private sector, or academic institutions (Table 4.18). On indicator 2, for example, the median response was 3.0, with 63.3% (n = 38) of participants disagreeing that funding is available for source water protection plans and projects and only 15% (n = 9) agreeing with the statement.

Table 4.18 Participant responses for requisite 'financial and human resources'[1]

Indicators		Disagree[2] (1-3)	Neutral (4-6)	Agree (7-9)	Mean ($\bar{x}$)	Median
1.	The scientific and technical expertise to develop and implement tools for cumulative effects assessment is available in the watershed, either through government, the private sector, or academic institutions.[3]	8 (13.6%)	12 (20.3%)	39 (66.1%)	7.08±1.99	8.0
2.	Funding is available for source water protection plans and projects.	38 (63.3%)	13 (21.7%)	9 (15%)	3.19±2.24	3.0
3.	Financial resources are available at the provincial level to support watershed-based cumulative effects assessment and monitoring programs (i.e., data collection, reporting, and enforcement).	36 (60%)	16 (26.6%)	8 (13.3%)	3.33±2.17	3.0
4.	Financial resources are available at the sub-watershed level, to watershed agencies, regional government, and municipalities to participate in watershed cumulative effects programs.	33 (55%)	20 (33.3%)	7 (11.7%)	3.44±2.31	3.0
5.	Education and training opportunities on cumulative effects assessment tools and practice are available to members of government, watershed managers, land use planners, and other stakeholders responsible for planning and assessment.[3]	29 (49.2%)	19 (32.2%)	11 (18.6%)	3.83±2.26	3.5

[1]n = 60 respondents; [3]n = 59 respondents
[2]Response scale of 1-9, where 1 = strongly disagree; 3 = somewhat disagree; 5 = neither agree nor disagree; 7 = somewhat agree; 9 = strongly agree; 2,4,6,8 = intermediate responses. For ease of presentation, after completion of all statistical analysis the response scale was condensed to three categories: disagree (1-3); neutral (4-6); agree (7-9).

There were no significant differences between Alberta and Saskatchewan participants on any of the 5 indicators ($p \geq 0.05$ for all Mann-Whitney U test statistics). There were no differences in responses based on participant's professional affiliation, with exception of indicator 1 (H = 6.250, p = 0.044). On indicator 1, there was a significant difference in responses between government and NGOs participants (U = 416.500, p = 0.014), where participants from government were relatively neutral on whether the scientific and technical expertise to develop and implement tools for CEA is available in the watershed, either through government, the private sector, or academic institutions ($\bar{x}$ = 5.95); whereas participants from NGOs agreed with the statement ($\bar{x}$ = 7.26).

A number of Alberta participants, who provided qualitative responses on this topic, commented that responsibilities for CEAM should not be downloaded onto municipalities, without proper funding to allow them to do a good job. A participant from the private sector, for example, mentioned that much of the necessary expertise is available for CEAM, particularly at the provincial level, but in limited amounts due to competing priorities elsewhere.

Participants from Saskatchewan similarly commented that expertise is available for CEA, but lacks organization and financial resources. An NGO participant said that the "scientific and technical expertise for WCEA is steadily growing in both AB and SK, along with the recognition that it is important for long term watershed management." The participant went on to note that the scientific and technical expertise is available in addition to education and training opportunities on CEA tools and practices, but there are insufficient financial resources available for source water protection plans and projects, at the provincial level to support watershed-based CEA and monitoring programs (i.e., data collection, reporting, enforcement) and at the sub-watershed level for watershed agencies, regional government, and municipalities to participate in watershed cumulative effects programs."

CHAPTER 5
DISCUSSION

5.1 Introduction

There is a need to shift from local, project-scale assessments to broader, regional assessments to effectively assess cumulative effects to watershed processes and manage river system condition (Duinker and Greig, 2006; Squires et al., 2010; Seitz et al., 2011). Project-specific assessments do not provide the necessary expertise, resources, or leadership to assess the potential for cumulative impacts to occur in the entire watershed (Squires and Dubé, 2012). Watershed CEAM examines the interactions between landscape changes that accumulate over time and space and river system response, and also looks for the outcomes of these interactions under different futures of growth and development (Seitz et al., 2011). The science of watershed CEAM is advancing, but much less is known about the capacity to implement and sustain it. Literature at present focuses on the scientific and technical knowledge required to implement watershed CEAM, but mentions relatively little about the capacity to undertake effective watershed CEAM (Noble et al., 2011). This research focused on identification of current capacity needs and constraints to undertake watershed CEAM in South Saskatchewan Watershed, a trans-boundary watershed. The research findings are summarized and discussed in the following sections. Results concerning the eight requisites for watershed CEAM, and related capacity issues are also discussed.

5.2 Cumulative effects and their assessment in the South Saskatchewan Watershed

The condition of the South Saskatchewan Watershed was identified by study participants to be healthy, but with problems (see Table 4.5, Chapter 4). Literature suggests that reduced water availability and deteriorating water quality are the consequences of increased landscape disturbance caused by human development activities and climate change (Schindler, 2001; Cooley and Gleick, 2011; Schindler and Donahue, 2006; Noble et al., 2011; Seitz et al., 2011). Such landscape disturbances include urban settlement, recreational development, and industrial activity, combined with increasing water withdrawals and the large-scale development of water resource infrastructures such as dams, pipelines, and irrigation. These are also the major factors contributing to current river-system health problems in the South Saskatchewan, as identified by study participants. Participants also reported that the health of the SSW over the past 10 years has declined due, in part, to industrial development and landscape disturbances (see Table 4.6, Chapter 4). This view is consistent with Seitz et al. (2011) who argued that river system health is largely a function of the types of interactions and processes that occur on the landscape within the boundary of the watershed.

Activities associated with agriculture and stresses from urban settlements were identified by study participants as the primary threats to water *quality* in the South Saskatchewan Watershed (see Table 4.8, Chapter 4). Surface runoff with pesticides and fertilizers from vast agricultural land, including intensive livestock operations were identified as directly affecting water quality in the South Saskatchewan River system. Municipal discharge, pharmaceutical waste and sewage were also identified as significant threats. Major urban centers like Calgary, Edmonton and Saskatoon discharge effluent from sewage treatment plants and industrial sources to the rivers along with runoff from urban surfaces, which results in the transfer of contaminants to the river system (Pomeroy et al., 2005).

Climate change, along with irrigation, were identified as the primary threats to water *quantity* in the South Saskatchewan Watershed (see Table 4.9, Chapter 4). Climate change plays a vital role in affecting the health of SSW, with increasing rates of droughts and floods in recent years. The South Saskatchewan River basin is considered to be very sensitive to climate change. It is largely fed by snow from the eastern slopes of the Rocky Mountains; small changes in climate can alter the hydrology of the river basin and affect both flood and drought frequency and severity (Pomeroy et al., 2005). The alteration of river hydrology directly impacts the aquatic ecology of the river system. The sources of such stress as climate change may originate in the watershed itself, but still has the potential to adversely affect water quality or quantity (Noble et al., 2011).

There are both direct and indirect links between water quantity and quality issues (see Pomeroy et al., 2005) that are of concern for the assessment and management of cumulative effects. For example, human activity frequently results in the deterioration of water quality, and the degree of deterioration generally increases during periods of water shortages when lower discharges results in less dilution. Given the complexity of pathways that lead to cumulative effects to both water quality and quantity, there is a need for watershed-based approaches to CEAM. Currently, project-based EIA is the primary tool for assessing and managing the cumulative effects of human actions in the SSW. Environmental impact assessment is performed as part of applications for the approval of individual project developments, provides information on how such developments may affect the environment and can be mitigated, and examines potential effects in the context of past and existing development (Hegmann and Yarranton, 2011).

However, consideration of cumulative effects under project-specific EIA is limited in spatial and temporal scale, often lacks a sound specific basis and does not fully encompass the interacting effects of multiple stressors over space and time (Baxter et al., 2001; Therivel and Ross, 2007; Seitz et al., 2011). Quinn et al. (2004) also note that project-based EIA is narrowly focused on a proposed development action, which makes it difficult to understand the multiplicity of pathways of human activities and land use changes in a watershed that stress river systems. Numerous scholars have argued that current approach to assessing cumulative effects under EIA-based framework is not strong and is fraught with a number of problems that compromise the ability to provide useful information with which to anticipate the possible cumulative effects of proposed developments (Baxter et al., 2001; Greig and Duinker, 2006a; Duinker and Greig, 2007).

Although project-based EIA is necessary for assessing and managing individual development actions, the primary threats to water quality and quantity in the SSW, as identified by study participants, are broad-scale stress – for example, agricultural runoff, effluent, urban settlement, climate change. Most of these broad-scale stresses are not subject to project-specific EIA regulation (Noble et al., 2011). Project-based EIA lacks the methodological approach to assess the effects associated with multiple projects over space and time (Dubé and Munkittrick, 2001). Participant's responses regarding the absence of mechanism to support watershed CEAM activities in the SSW was consistent with the academic literature, which notes that despite the importance of watershed CEAM regional-based approaches have not yet become the cornerstone of CEA practice because there is not a mechanism in place to sustain it (see Dubé, 2003; Noble, 2010).

5.3 Requisites for watershed CEAM in the South Saskatchewan Watershed

Sheelanere et al. (2013) identified eight requisites that have helped to understand the institutional requirements for watershed CEAM, addressing such matter as technological, scientific, institutional, political, organizational, and financial and human resources. Sheelanere et al. (2013) proposed that successful watershed CEAM requires, at a minimum, government leadership; complementary monitoring programs at the project and watershed scale; a means to ensure the sharing of monitoring data across watershed stakeholders; and a nested planning framework to coordinate watershed planning objectives with individual project impact assessment and decision making. These requisites (see Table 2.1, Chapter 2) were adopted in this research as a basis for evaluation and assessment of the capacity needs and constraints to watershed CEAM in the SSW. Lead agency, multi-stakeholder collaboration, and financial and human resources were identified as the most important requisites for implementing and sustaining watershed CEAM programs (see Table 4.10, Chapter 4).

Saskatchewan participants identified lead agency as the most important requisite for implementing and sustaining CEAM in SSW (see Figure 4.1, Chapter 4).This is consistent with Noble et al. (2011), in that without an agency or group of agencies with the mandate to implement watershed CEAM programs, allocate resources, and enforce monitoring requirements, there is likely to be little direct influence on watershed CEAM on regulatory decisions about land and water use allocation. The results suggests that efforts by other organizations to advance watershed CEAM in the SSW, at least in Saskatchewan, will likely serve only to raise awareness until there is a lead agency with a clear mandate by the province to address cumulative effects at the watershed scale and act accordingly. There are benefits from increased awareness, such as changes in some individual practices; however, key decision making on such CEAM issues, particularly those that concern land use plans, project licensing, and water withdrawals usually rests with government. Arguably, watershed CEAM cannot be driven solely ‘bottom-up’ and government must lead watershed CEAM activities (Griffiths et al., 1998; Kennett, 1999; Noble, 2010; Seitz et al., 2011; Sheelanere et al., 2013).

Multi-stakeholder collaboration was identified as the next most important requisite for sustaining CEAM in SSW, and identified as the most important by the majority of Alberta participants (see Figure 4.1, Chapter 4). CEAM requires the collaboration of governments, stakeholders and proponents as such initiatives are beyond the responsibility and capabilities of a single proponent to establish environmental objectives and manage development on a regional basis, guided by broader environmental planning and sustainability goals (Noble, 2010; Connelly, 2011). The results revealed that there is collaboration going on in the SSW to meet CEAM objectives but it is very limited. Some major issues involved are the lack of clarity around common goals for watershed and sub-watershed management, and a lack of transparency in sharing data. Unclear mandates, duplication of responsibilities, and conflicting missions regarding watershed management among watershed stakeholders can inhibit the success of the watershed assessment (Conservation Ontario, 2001). Therefore, linkages between agencies and authorities responsible for managing different aspects of surface water and groundwater quality and quantity, as well as between land use and terrestrial and aquatic ecosystems must be made explicit (Ivey et al., 2002).

The third most important requisite identified was financial and human resources, identified by Saskatchewan participants to be slightly more important than identified by Alberta participants (Figure 4.1, Chapter 4). Many participants commented that expertise is available for CEA, but there is a lack of organizational and financial resources to develop successful plans and actions. This is consistent with the literature, which notes that a major constraint to water resources development and protection is the limited capacity of the institutions in many countries to absorb financial resources and convert them into worthwhile and sustainable actions and projects (Hamdy et al., 1998). In particular, participants noted that there are insufficient financial resources available for monitoring programs (i.e., data collection, reporting, and enforcement) and at the sub- watershed level for watershed agencies, regional government, and municipalities to participate in watershed cumulative effects programs. Ivey et al. (2002) identified that there is the need for an adequate financial, technical, and staff resources to assume responsibility for water management activities.

5.4 Watershed CEAM Capacity

Building capacity for water management is a complex and multi-dimensional challenge and focusing narrowly on one aspect only, for example, more financial resources or more technical knowledge may prove to be ineffective if other aspects are neglected and overlooked (Ivey et al., 2002). A similar argument could be made for watershed CEAM, in that science capacity and generating new data through monitoring are essential to advancing CEAM initiatives, but science capacity and data are of little use if there is limited institutional or management capacity to implement and sustain CEAM initiatives (Sheelanere et al., 2013). The lack of institutional capacity, related to the management of water resources, directly affects water quality and quantity (Hamdy et al., 1998).

As noted at the outset of this thesis, efforts to advance watershed CEAM over the past fifteen years and across a range of jurisdictions have achieved only mixed success in Canada (Dubé et al., 2006; Schindler and Donahue, 2006; Noble and Patrick, 2008). Noble et al. (2011) report that part of the problem is that the science of how to do watershed CEAM is advancing, but there remains limited understanding of the institutional arrangements and capacity needed necessary to implement and sustain it. From the results of this research, limited capacity for watershed CEAM was identified across all 8 requisites; however, two areas were deemed particularly weak in terms of current capacity to support watershed CEAM, namely data management and coordination (see Table 4.15, Chapter 4), and financial and human resources (see Table 4.18, Chapter 4). In the sections that follow each of the 8 requisites is discussed in terms of the key findings and areas in need of capacity development.

5.4.1 Lead Agency

Responses under the requisite ‘lead agency’ were relatively neutral across all indicators (see Table 4.11, Chapter 4) indicating that some capacity does exist in terms of a lead agency to support watershed CEAM, but there is considerable room for improvement. Notwithstanding the recent history in Alberta with CEAM programs and initiatives, for example, Land-use Framework (LUF), Lower Athabasca Regional Plan (LARP), Water for life Action Plan, Regional Aquatics Monitoring Program (RAMP), there were surprisingly no differences in responses between Alberta and Saskatchewan participants on the assessment criteria for a lead agency.

A positive factor identified by study participants was that the various agencies and authorities do exist in the SSW to support CEAM, including watershed organizations and government agencies with formal authority to implement and/or enforce the necessary regulations across the watershed to support CEAM activities (e.g., land use regulations, monitoring and reporting requirements) (see Table 4.11, Chapter 4). A lead agency is essential for the coordination and communication of the information regarding watershed health that is necessary for watershed CEAM (Parker and Cocklin, 1993).

However, there were two overarching challenges. First, watershed agencies at present lack common and clear goals (including those related to future land use and overall watershed health) needed to efficiently and effectively work together collaboratively within the watershed and sub watersheds to support CEAM. Saskatchewan participants indicated that the Saskatchewan Water Security Agency, previously known as Saskatchewan Watershed Authority, lacked the mandate, sufficient budget and authority to drive a watershed CEAM process - including the needed means to integrate across provincial agencies and then build the capacity to actually deliver on CEA and overall watershed monitoring and management. Second, there appears to be a lack of clarity in terms of the roles and responsibilities across agencies to support watershed CEAM. Alberta participants noted that Alberta Environment and Sustainable Resource Development does have a defined leadership role in these regards, but on-the-ground action was lacking. The Prairie Provincial Water Board could potentially advance leadership in CEAM across the South Saskatchewan Watershed. However, the board is focused currently primarily on water quantity as opposed to both quantity and quality. The Board also does not address land use planning or development decisions in the watershed – aspects that are critical to watershed CEAM leadership. A lead agency for watershed CEAM must be able to influence decisions about land use and project development with watershed goals and objectives in mind (see Griffiths et al., 1998; Noble, 2010; Seitz et al., 2011; Sheelanere et al., 2013).

Sheelanere et al. (2013) and Seitz et al. (2011) argue that provincial government agencies, or a government-led consortium, must serve as the lead agency to oversee, and ensure the proper resourcing of, all aspects of watershed CEAM, since only government has the capacity and regulatory authority to ensure CEAM implementation and compliance and allocate resources. However, result from this research suggest that watershed CEAM in the SSW has not been within the purview of provincial or regulatory authorities (see Noble et al., 2011), and there is a need to modify current institutional arrangements to ensure leadership for watershed CEAM and for watershed planning and management generally (Carter et al., 2005). Watershed CEAM must be regulated and authorities (federal and/or provincial governments) who have access to the amount of data and expertise required must take on a leadership role to ensure its successful implementation (Squires and Dubé, 2012).

5.4.2 Multi-stakeholder Collaboration

Responses under the requisite 'multi-stakeholder collaboration' were again neutral across all indicators (see Table 4.12, Chapter 4). One of the major challenges to CEAM is to achieve effective collaboration among developers, proponents and regulatory agencies, and multiple stakeholder groups regarding mitigation and management of cumulative effects (Canter and Ross, 2010). Several authors note the importance of multi-stakeholder and collaborative approaches to CEAM. Therivel and Ross (2007), for example, argue that cumulative effects require cumulative solutions that involve the combined actions of multiple stakeholders. Canter and Ross (2010) similarly note the importance of multi-stakeholder collaboration to develop joint cumulative effects management initiatives, either locally or regionally, or both, if significant cumulative effects are anticipated on any VEC or its indicators.

The recognized importance of multi-stakeholder and collaborative approaches to watershed CEAM amongst Alberta participants was not surprising. Alberta has had a range of experiences in CEA and monitoring programs, including: the Cumulative Environmental Management Association (CEMA) – a multi-stakeholder group formed to produce recommendations and management frameworks for managing the cumulative impacts of oil sands development established in 2000 (see www.cemaonline.ca); and the Regional Aquatics Monitoring Program (RAMP) – a multi-stakeholder monitoring program focused on understanding the effects of oil sands on aquatic systems established in 1997(see www.ramp-alberta.org). These two organizations play important roles in CEAM framework development in Alberta. Further, Alberta's emerging Land Use Framework (LUF) is premised on multi-stakeholder collaboration for the development of regional plans that will adopt a cumulative effects approach (see www.landusealberta.ca).

Saskatchewan does not have a similar history of multi-stakeholder CEAM initiatives. It was identified that local communities (e.g. municipalities, land owners) are not sufficiently engaged in watershed or sub-watershed planning, monitoring, environmental assessment and related decision making processes. In this regard, Lawe et al. (2005) note that stakeholder input has generally improved in Canada in the last decade, emphasizing more of the shared decision-making approach, but true meaningful involvement is difficult, and has not frequently occurred from a community/ First Nations perspective and they have limited influence over EIA follow-up including long-term monitoring programs that determines effectiveness of mitigation.

Overall, the results indicated that the roles and responsibilities of watershed stakeholders (e.g., industry, watershed agencies, land owners, government agencies) are not clearly defined with respect to the assessment, management and monitoring of cumulative effects in SSW. For an effective watershed CEAM, collaboration amongst government agencies and regional stakeholders is necessary to develop shared visions and responsibilities for regional assessment and implementation, with a clear delineation of roles and responsibilities to achieve a common goal (Noble, 2008).

5.4.3 Watershed Baselines, Indicators and Thresholds

Responses were neutral across all indicators under the requisite 'watershed baselines, indicators and thresholds' (see Table 4.13, Chapter 4). This indicates that there is some capacity in terms of existing indicators, baselines and thresholds for watershed CEAM; but there is still significant room for improvement. Baseline assessment plays an important role in establishing knowledge of the key assessment components and characteristics of watershed that can be monitored over space and time for the purposes of change assessment, projected forward as part of a trends analysis or impact prediction, and used as the future conditions against which future scenarios can be assessed and managed accordingly (Harriman and Noble, 2008; Seitz et al., 2011). However, study participants noted that there is no adequate baseline data to identify past trends or changes in water *quality* across the SSW; whereas for water *quantity* there is considerable amount of data (see Table 4.13, Chapter 4).

Baseline data are often expensive and time consuming to gather (Connelly, 2011), and most environmental evaluations cover only a short period of time, generating data that are almost always insufficient to identify trends or trajectories of change until the impact is larger or has been occurring for some time (Ziemer, 1994). Constructing a CEA baseline for river systems involves two fundamental components: the scientific understanding of the river system and identifying appropriate CEA indicators, and determining changes in landscape patterns and processes in the watershed that can be related to conditions of the aquatic environment (Seitz et al., 2011). In this regard, Ball et al. (2012b) suggest that if data on water quality and aquatic biota are limited, there is potential to use surrogate assessment components, such as data on land use and land cover that can be gathered over large and small areas and at regular temporal intervals via remote sensing and GIS (i.e., satellite and aircraft) and then related to water quality and water quantity data. For example, a GIS analysis can calculate the percentage of vegetation present next to lotic waters. For example, potentially providing an indication of riparian health as well as potential impacts to water quality where it can be a useful indirect indicator that quantifies one complicating relationship between stressor (agricultural run-off) and river condition (water quality and aquatic biota) (Ball et al., 2012b). However, participants also noted that land use surveys are expensive; there are very few existing historically and only recently (in the last 10 years or so) has satellite and GIS technology made it feasible to do land use classification based on remote sensing.

Greater consistency in the use of VECs and indicators is also required to support good watershed CEAM, and in turn good EIA (Ball et al., 2012a). The results indicate that there is not an agreement on the most appropriate indicators and thresholds of watershed health in the SSW because many of the indicators and thresholds used seem dependent on either the jurisdiction (Alberta and Saskatchewan) or the existing monitoring programs and are not necessarily the best indicators or agreed-upon indicators. In their review of EIA practice in the SSW, for example, Ball et al. (2012a) identified a sample of 35 project EIAs that identified potential impacts to the aquatic environment, but found no common set of indicators for which data could be shared across EIAs or scaled up to the watershed to support CEAM. Ball et al. (2012a) suggest the identification of a few, ecologically based parameters that are useful for understanding cumulative effects at multiple scales and across projects, which may be watershed specific, but they must be ‘‘non-negotiable’’ for proponents seeking development authorizations in those watersheds, and must be a mandatory part of monitoring programs.

The lack of data and unclear thresholds for assessing cumulative effects limits the capacity of any development proponent operating in a watershed to determine the cumulative effects of their project on broader watershed processes (Noble et al., 2011). Establishing objectives and thresholds should be based on sound scientific guidance for an effective watershed CEAM (Dubé, 2003; Seitz et al., 2011). However, participants noted that Alberta does have a comparatively good and consistent record of water quality data from the SSW; whereas in Saskatchewan, participants noted that monitoring data, for a variety of reasons (mostly having to do with changing provincial and federal priorities), has significant gaps and challenges in terms of consistency (several time periods where no monitoring data was collected, for example), and location (monitoring locations selected in terms of ease of access instead of being selected on the basis of scientific rationale).

The development of thresholds in CEAM is required to determine the point at which environmental change has occurred, is close to occurrence, may no longer be acceptable, and may require management action; and thresholds have to be linked to a decision-making process so that if a threshold is approached or exceeded, decision makers know the action they have to take for an adaptive management (Squires and Dubé, 2012). Climate change is one of the major factors that must be considered in CEAM, because baselines, indicators and thresholds will likely need continual adjustment over the coming decades due to variability into watershed ecology and hydrology. Global climate change will pose a wide range of challenges to freshwater resources, altering water quantity, quality, and system operations (Cooley and Gleick, 2011). Study participants suggest that an analytical tool should be developed to suggest causes, remedies and predictors, particularly in regard to climate change and uncertainty (draughts, floods, and biological changes). In this regard, Canter et al. (2011) note that indicators, indices, and habitat suitability models can be useful in CEAM activities, planning follow-up monitoring, and adaptive management programs.

5.4.4 Multi-scaled Monitoring

Study participants identified that current monitoring in the SSW is not comprehensive enough. Participants suggested that there should be common monitoring standards maintained all over the major tributaries and river basins. Common data collection and monitoring programs for individual development actions affecting river systems should be ensured (Ball, 2011; Sheelanere et al., 2013). It is necessary to ensure that point-specific project-based EIAs are relevant for evaluating and monitoring cumulative effects at the broader watershed scale; and that sufficient direction is provided to project specific EIAs through terms of reference set based on knowledge gained from broader watershed CEAM programs (Dubé, 2003; Seitz et al., 2011; Sheelanere et al., 2013). Stronger monitoring programs and watershed-based data management will allow for the development of a common approach to WCEA, and provide greater certainty in the management and regulation of water resources (Ball et al., 2012b).

Study participants identified that current monitoring programs do not provide enough sound understanding of, and allow for detection of changes in, the dominant stressors to river system health (e.g., land use, disturbance patterns, buffers, effluent discharge, etc) across the SSW (see Table 4.14, Chapter 4). In Canada, the lack of long-term water quality, water quantity, and biological monitoring data is the major factor impeding the effective assessment of landscape change in a watershed and its relation to aquatic ecosystems (Ball et al., 2012b). Noble (2008) notes that a multi-scaled approach is essential to gaining a true understanding of cumulative effects to devise and inform the practices to effectively manage them. However, financial do play a major role when it comes to watershed monitoring programs. Budgetary constraints and shifting programs priorities often result in reduced collection of viable long-term data (Ball et al., 2012b). It was identified by study participants that monitoring has been cut back when it needs to be increased substantially, and there is very little monitoring and communication of the drivers of change. To ensure successful CEA monitoring, long term commitments are needed from watershed stakeholders. As such, project proponents engaged in development in the watershed not only should work to meet their EIA obligations but also must be engaged in broader cumulative effect long term monitoring programs (Seitz et al., 2011).

The lack of long-term monitoring data and data inconsistencies limit the advancement of watershed CEAM science and the application of watershed CEAM (Ball et al., 2012b). Monitoring is important for understanding a system and effects to that system. Satellite-based monitoring could also be used to uncover trends even over a comparatively short time-horizon where remotely sensed data can provide sufficient information to help identify the significance issues surrounding cumulative change (Lein, 2002). Monitoring programs must be designed to match the scale of assessment (in space and time) with the particular stressors and assessment components appropriate to the watershed, and that such work requires the establishment of a regulatory framework for watershed-based monitoring and assessment (Ball et al., 2012b). Study participants noted that establishment of Global Institute for Water Security (GIWS) in Saskatchewan, launched in 2011, is a positive step towards water resources management and expected to improve the monitoring and management of the SSW.

5.4.5 Data Management and Coordination

Of all 8 requisites, 'data management and coordination' was scored the lowest across all indicators (see Table 4.15, Chapter 4), meaning that participants mostly disagreed with all five indicators under this requisite. Participants perceived this particular requisite as one of the biggest challenges to supporting watershed CEAM. Both spatial and temporal data need to be made available to all stakeholders to support watershed CEAM (Squires et al., 2010); and if there is inefficiency in data management and coordination it can create significant obstacles to CEAM (Piper, 2000). Study participants identified that data required for watershed CEAM, including data on water quality and quantity, where available, was not easily accessible. Further, in other cases many stakeholders were said to be unwilling to share their data, which is consistent with the literature which note that where the science does exist, data sharing has significant challenges (Kilgour et al., 2007; Seitz et al., 2011; Ball et al., 2012a; Sheelanere et al., 2013). This is not a problem that is unique to watershed CEAM, or to the SSW. This issue of data sharing and accessibility is a persistent problem which may create obstacles for watershed assessments (Therivel, 2004). For example, in Canada, aquatic data is collected, managed, and assessed by different jurisdictions and by different programs within each jurisdiction which has resulted in fragmentation, a lack of consistency, and limited data access (Dubé, 2003).Inter-jurisdictional and multi-project communication must be improved with regards to sampling design, analytical methods, and data management for data to be consistent and comparable in future studies (Ball et al., 2012b).

Data availability itself may not be totally resolvable, but data access could be better coordinated and data converted to standard formats generally accessible to all from a single point. The EU water framework is one example where data and information on water are reported to the European Environment Agency (EEA) through the EuroWaternet information system, which is extensively based on voluntary co-operation and provision of information from all stakeholders (WFD, 2001). Environment Canada does have a national water data archive, known as HYDAT, which is available to the public. However, this data archive provides data that addresses water quality and quantity in parts of the watershed, focused more on water quality, and it is not spatially comprehensive. HYDAT also do not house spatial land use data, which is important for the proper assessment of cumulative environmental effects at the watershed scale (see Seitz et al. 2011). Participants also identified a lack of coordination of watershed (or sub-watershed) approaches to data collection/monitoring that ensures a standardized baseline of watershed conditions (see Table 4.15, Chapter 4). Collaboration is essential amongst governments at the national, sub-national, regional and local levels due to shared responsibilities for the environment and shared data bases for effective watershed assessments (Connelly, 2011). This will ensure that data collected for assessment and management actions and decisions at one scale (e.g. local project developments) are useful for river system and watershed monitoring, planning and management, and vice versa.

Sheelanere et al. (2013) suggest that a centrally managed information repository is needed to support watershed CEAM and that shared accessibility and standardized data is essential. Participants suggest that a scientific body with authority and mandate could coordinate overall data collection, monitoring, and data analysis for watershed CEAM in the SSW, which may help to control the quality of data (water quality, quantity, and spatial land use data) and data gaps, uncertainties, errors, or assumptions are reported to data users. For this, a provincial integrated water policy should be developed that supports the improvement, maintenance and accessibility of resource data for effective local watershed management, where province itself should establish database standards, facilitate data sharing mechanisms and, where necessary, provide support for database development and maintenance (see Conservation Ontario, 2001).

5.4.6 Vertical and Horizontal Linkages

Responses were relatively neutral across all indicators under the requisite ‘vertical and horizontal linkages’ (see Table 4.16, Chapter 4). Of all 8 requisites, ‘vertical and horizontal linkages’ was given the lowest weight by study participants (see Table 4.10 and Figure 4.1Chapter 4), which shows that participants perceive this particular requisite as least important component among other requisite in ensuring successful watershed CEAM. A major factor behind this could be lack of formal tiering mechanisms, where there is an absence of a formal tiered system of policy, plan, and program assessment to effectively carry regional CEAM forward from the watershed to the project scale (Noble, 2008).

Good CEAM, at minimum, is multi-tiered and informed by, and informs, other existing or proposed policies and plans influencing the region, and is deliberately tiered toward downstream development assessment and decision making process Noble (2010). In this regard, participants emphasized the need for similar watershed management goals and objectives across sub-basins; and better use of project specific monitoring programs to inform broader watershed assessment, evaluation and reporting processes. Arguably, a watershed approach can set the context needed for scoping, assessing and managing cumulative effects attributable to individual projects, and project-specific assessment could build on the regional understanding and suggest in some detail how to manage the cumulative effects (Baxter et al., 2001). Watershed or sub-watershed management plans should influence the terms and conditions (e.g., scope, monitoring requirements) of project-specific environmental impact assessments, and be guided by policy concerning land and water use in the watershed. For this, Noble (2010) notes that solving the cumulative effects problem and the tyranny of the small decisions requires a much more integrative and strategic framework – a framework that can operate at the regional scale, both informing and informed by higher level policies and plans and lower level developmental projects.

Participants also identified the need for better consideration of information generated from science programs or watershed monitoring and assessment programs by all stakeholders in the development or implementation of watershed management plans. Project-based EA must supply information to watershed-based CEAM, and that assessing cumulative effects under project-based EA is useful only if it is done within a broader context and with a link to analysis at a watershed level. On the other hand, cumulative effect information from project-based assessment could be used to help determine effects at a larger scale (Harriman and Noble, 2008; Sheelanere et al., 2013).

5.4.7 Enabling Legislation

Current legislation and other regulatory instruments concerning land and water use are not consistent across the watershed and between different levels of government in the watershed (see Table 4.17, Chapter 4). Weak legislation can undermine implementation of watershed management (i.e., inadequate penalties for environmental violations, lack of national water quality standards and guidelines; and lack of environmental operating standards for industry) (Conservation Ontario, 2001). In order to achieve institutional adaptation for successful implementation of any new management action plans, development of new legislation and enabling it is an essential factor (Cortner and Moote, 1994). However, participants noted that currently legislation exists but is discretionary and not used, has contradicting policies and there is no enforcement.

It was identified that the laws are not the problem - rather, the lack of desire by politicians to put enough money into the departments that are required to enforce laws and the lack of enthusiasm by bureaucrats to enforce the laws and regulations is the problem. There is excessive bureaucracy and politics at government level because of the decentralized nature of watershed management, that makes it difficult to co-ordinate activities, respond to development pressures, secure funding and partnerships throughout the various levels of bureaucracy and the private sector without strong national (and sometimes international) leadership, support and direction (Conservation Ontario, 2001). This could be the main reason why watershed advisory committees such as Saskatchewan Water Security Agency do not have any authority to enforce the policies that they develop.

Some initiative has recently been shown in regard to strengthening and updating of the environmental assessments procedures in Saskatchewan. In 2012, the Saskatchewan Ministry of the Environment developed a new environmental code and updated its Environmental Assessment Act to focus on a 'results based approach' to impact management. It is intended that this new environmental code, which is the first of its kind in Canada, will provide guidance on designing an effective environmental management system for development in the province. To enhance environmental protection and management, financial penalties for non-compliance under the new Environmental Assessment Act have been substantially increased, and potential for incarceration has been included as a strong deterrent (Government of Saskatchewan, 2012b). Various stakeholders were involved in consultation processes for the development of the code including companies, associations, provincial and federal government agencies, environmental non-governmental organizations, municipalities, First Nations and Métis communities, academia and knowledgeable private individuals (Government of Saskatchewan, 2012a). That said, whether and how the new code and act will facilitate CEAM beyond the scale of the individual development project remains unclear.

In Alberta, the provincial government's Land Use Framework refers explicitly to the need for a cumulative effects management approach. Through its emerging Land Use Framework the Alberta government has expressed its commitment to manage the cumulative effects originating from multiple development stressors at the regional level, with shared responsibility for action and improved integration of economic, environmental and social considerations (Alberta Environment and Sustainable Resource Development, 2013). There are various regional plans that have already been approved by cabinet and are becoming government land-use policies for the region, which largely supports a cumulative effects approach (Alberta Environment and Sustainable Resource Development, 2013).

Study participants identified that there is need of sufficient legislation or other regulatory means to ensure that results generated from state-of-the-watershed assessments (e.g., monitoring programs, science studies) influence decisions about land use and development, and to enable the protection of sensitive or vulnerable areas of the watershed from human disturbance (see Table 4.17, Chapter 4). For this, land-use planners and managers must give due consideration to cumulative effects, and the implications of CEA science, when developing broad policies and plans, and these policies and plans must be sufficiently informative to guide decisions about the nature and acceptability of future land use and project-specific developments (Noble, 2010). Responses were relatively neutral as to whether there is sufficient legislation or other regulatory means to establish a watershed-based framework for CEA, monitoring and management (see Table 4.17, Chapter 4). This is perhaps not surprising, given that regional-scale CEAM should be legislated or otherwise implemented is still contested in the academic literature (Sheelanere et al., 2013). However, at a minimum there is a need for 'terms of reference' developed for projects under regulatory-based EIA to clearer direction for the selection of indicators for use in project assessment and monitoring actions that support CEAM (see Table 4.17, Chapter 4). Canter and Ross (2010) identified that 'terms of reference' for consultants preparing CEAM documentation have been vague and have not provided necessary direction. This would provide a much stronger legal requirement for cumulative effects management (e.g. not being granted necessary authorizations until mitigation has been put in place), and informed and proactive decision makers (Therivel and Ross, 2007).

5.4.8 Financial and Human Resources

Study participants gave low scores across all indicators under the requisite 'financial and human resources'. Majority of Saskatchewan participants identified this particular requisite as the most important requisite for sustaining CEAM in SSW (see Figure 4.1, Chapter 4) and (see Table 4.10 and Table 4.18, Chapter 4). This particular requisite was identified as weakly present in terms of supporting watershed CEAM. Sheelanere et al. (2013) noted that in order to implement and sustain, over the long term, CEAM programs and requirements (e.g. monitoring programs, landscape modeling, reporting, communication and data management and coordination), sufficient financial and human resources need to be available. However, it was identified by study participants that expertise for CEAM is available but there is absence of organizational and financial resources to support and utilize this expertise and knowledge. It was also identified that the capacity constraint in this case is the lack of financial commitment and support to implement watershed CEAM activities. With the lack of financial resources, capacity of watershed agencies, organizations, and citizens to implement an effective watershed management is limited (Litke and Day, 1998; Timmer et al., 2007).

Participants identified a lack of funding for source water protection plans and projects in SSW. To improve financial capacity at the local level for source water protection plans, one such effective step could be charging the customers rates that cover not only the costs associated with operating and maintaining water system infrastructure, but also the costs of protecting source water supplies (Timmer et al., 2007). Study participants also identified that education and training opportunities on CEA tools and practice is necessary and an important asset to members of government, watershed managers, land use planners, and other stakeholders responsible for planning and assessment. Connelly (2011) note that continued training and the sharing of practical experiences among various watershed stakeholders is needed for a successful watershed level CEAM. Parkins (2011) noted that in order to advance the watershed CEAM, a focus on longterm investment in the science and technology of CEA is necessary.

In order to secure a sustainable financial base to support activities related to watershed CEAM for a longer term, there are various programs that could be tested. One such program could be a “user pay” approach, where industries or government agencies requiring baseline data when submitting project EIAs or any other regulatory applications, are required to pay a fee to access the information needed to support their project application or licensing. Another option is an arm’s length foundation of government, which could be an effective measure to direct government, industry, ENGO and other sources of funding on a continuous basis to support CEAM research, data management and distribution. Conservation Ontario (2001) mentions several financing options for watershed management, which could also be effective in terms of supporting and sustaining watershed CEAM activities. These include cost sharing incentives, which is an effective option whes the enforcement of desirable actions is not possible either because it involves high cost, is not authorized or unpopular (Conservation Ontario, 2001). The report also proposes financing from senior government to local government (for example, municipal government), which could be effective in supplying seed money for new programming initiatives such as CEAM at the local level where the local tax base cannot fund such programs and initiatives. Conservation Ontario (2001) also recommends that an equitable user pay approach be applied to all the users of water resources regardless of how much water they use, which includes not only the operating and distribution cost but also cost which are involved in conservation and assessment of the water resources.

CHAPTER 6

CONCLUSION

6.1 Research contributions

Over the past fifteen years, efforts to advance watershed CEAM initiatives in Canada have achieved only mixed success across a range of jurisdictions (Dubé et al., 2006; Schindler and Donahue, 2006; Noble et al., 2011). There is a limited understanding of the institutional arrangements and capacity needs to implement and sustain watershed CEAM, although, the science of watershed CEAM is advancing (Noble et al., 2011; Chilima et al., 2013; Sheelanere et al., 2013). Qualitative study focusing on the policy, capacity needs and practices of watershed CEAM in Canadian watersheds have been conducted in the past; therefore, to develop more understanding of the current institutional arrangements for CEAM in the SSW, this research focused on a systematic and quantitative evaluation of the watershed CEAM capacity in SSW.

The overall purpose of this research was to develop and apply a framework to assess regional capacity to support watershed CEAM requisites. A set of indicator questions were developed to evaluate the degree to which specific requisites to support watershed CEAM in the SSW were present. This research contributed towards the evaluation of watershed CEAM capacity in the SSW. It also identified the current capacity needs and constraints to watershed CEAM in the SSW. Indicators for each watershed CEAM requisite will be beneficial for watershed planners and managers to assess and evaluate watershed CEAM capacity in other Canadian watersheds.

6.2 Lessons learned and opportunities

Overall, from the results of this research, limited watershed CEAM capacity was identified across all 8 requisites. The primary tool for assessing and managing the cumulative effects of human actions in the SSW is the project-based EIA; however, the primary threats to water quality and quantity in the SSW, as identified by study participants, are broad-scale stress – for example, agricultural runoff, effluent, urban settlement, climate change. Most of these broad-scale stresses are not subject to project-specific EIA regulations (Noble et al., 2011). Clearly, there is a need to shift from solely local, project-scale assessments to include also broader, regional assessments to effectively assess cumulative effects to watershed processes and manage river system condition (Duinker and Greig, 2006; Squires et al., 2010; Seitz et al., 2011; Sheelanere et al., 2013). Results from this research indicate the need for similar watershed management goals and objectives across sub-basins; and better use of project-specific monitoring programs to inform broader watershed assessment, evaluation and reporting processes. The assessment of cumulative effects under project-specific EIA is required in some jurisdictions, but it is useful only if it is done within a broader context and with a link to analysis at a watershed level. The result also shows that institutional arrangements to support watershed CEAM activities in the SSW need to be developed. In this regard, the academic literature also notes that despite the importance of watershed CEAM, regional-based approaches are not yet the primary focus of CEA practice because there is not a mechanism in place to sustain it (see Dubé, 2003; Noble, 2010).

Another lesson learned from this research is that efforts by other organizations; for example, South Saskatchewan River Watershed Stewards Inc., and CEMA, will likely serve only to raise awareness to advance watershed CEAM in the SSW, at least in Saskatchewan, until there is a lead agency with a clear mandate by the province to address cumulative effects at the watershed scale. Alberta participants noted that Alberta Environment and Sustainable Resource Development does have a defined leadership role in these regards, but on-the-ground action is lacking. Squires and Dubé (2012) noted that in order to be effective, watershed CEAM must be regulated and authorities (federal and/or provincial governments) who have access to the amount of data and expertise required must take on a leadership role to ensure its successful implementation. This confirms that government only has the key decision making power on CEAM issues concerning land use plans, project licensing, and water withdrawals. This is well supported by the literature which note that governments need to play a major role and take the leadership for watershed CEAM by: establishing objectives and thresholds based on sound scientific guidance; ensuring that point-specific project-based EIAs are relevant to evaluating and monitoring cumulative effects at the broader watershed scale; and providing direction to project specific EIAs through terms of reference set based on knowledge gained from broader watershed CEAM programs (Noble, 2010; Seitz et al., 2011; Sheelanere et al., 2013).

Among all requisites for watershed CEAM in the survey, multi-stakeholder collaboration was identified as one of the most important for sustaining CEAM in the SSW. This is aligned with the literature, which notes that CEAM requires the collaboration of governments, stakeholders and proponents as such initiatives are beyond the responsibility and capabilities of a single proponent to establish environmental objectives and manage development on a regional basis, (see Noble, 2010; Connelly, 2011). Alberta has had a range of experience in CEAM programs, including: CEMA, RAMP and LUF. However, the lack of clarity around common goals for watershed and sub-watershed management, and a lack of transparency in sharing data among watershed stakeholders pose major challenges to watershed CEAM. Collaboration and cooperation amongst government agencies and regional stakeholders is necessary to develop shared visions and responsibilities for regional assessment and implementation, with a clear delineation of roles and responsibilities to achieve a common goal (Noble, 2008).

The next major challenge to watershed CEAM is the lack of organizational and financial resources to develop and implement, over the long-term, successful plans and actions for watershed CEAM. Saskatchewan participants indicated that the Saskatchewan WSA lacked the sufficient budget and authority to drive a watershed CEAM process - including the needed means to integrate across provincial agencies and then build the capacity to actually deliver on CEA. This is aligned with recent literature on watershed-based approaches, which notes that effective execution of water management activities needs an adequate financial, technical and human resources (Ivey et al., 2002; Parkins, 2011; Sheelanere et al., 2013). It was also identified that sufficient financial resources need to be available for monitoring programs and at the sub-watershed level for watershed agencies, regional government, and municipalities to participate in watershed CEAM programs. A rigid financial commitment is required to support and execute watershed CEAM activities appropriately.

There is also a need for the continued development of science-based tool that are appropriate for watershed CEAM. Squires et al. (2010), for example, note that although effects-based approaches are conducted at the appropriate scale for CEA and are effective for determining the health of a system, the development of predictive models to understand how a river system may respond to future development pressures has not occurred. Analytical tools need to be developed to suggest causes, remedies and predictors, particularly in regard to climate change and uncertainty for watershed CEAM. For an in-depth study of the cumulative effects from developmental activities; designing of indicators, indices, and habitat suitability models can be useful in CEAM programs, planning follow-up monitoring, and adaptive management programs (Canter et al., 2011). There is a need to adopt more future-based tools for watershed CEAM because it is all about uncertainties related to environmental conditions in future. Most of what we have focused on to date has been retrospective analysis or change assessment of the accumulated state of watershed. Therefore, tools are needed to facilitate scenario-based analysis of potential future conditions and resource pressures in the watershed. These tools should relate to both internally driven scenarios linked directly to land use and local drivers of change within the watershed, and also to externally driven change, such as climate change and changes to economic conditions (see Seitz et al., 2011). For this, Geographic information system (GIS) is one of the important tools as it has the ability for assessing spatial overlaps, spatial distributions of environmental change, and manipulation of 'what-if' scenarios to prepare for a number of potential alternate environmental consequences (Noble, 2008; Seitz et al., 2011; Ball et al., 2012b).

A major challenge in supporting predictive approaches for watershed CEAM, however, is that monitoring has been cut back when it needs to be increased substantially, and there is very little understanding of the drivers of change. Long term commitments are needed from watershed stakeholders to ensure successful CEA monitoring. These short-term bursts of activity and short-lived organizational commitments continue to come up short in meeting the growing demands and expectations for land-use planning and CEA in Canada (Parkins, 2011). Compounding the problem is that the data required for watershed CEAM, including data on water quality and quantity, where available, is not easily accessible. Many watershed stakeholders, particularly industry, were said to be unwilling to share their data. Despite that data availability itself may not be totally resolvable, due to proprietary data, it is recommended that data access be better coordinated for those data that can be shared and data converted to standard formats and be accessible to all from a single point. The European Union water framework is one example where data and information on water are reported to the European Environment Agency (EEA) through the EuroWaternet information system, which is extensively based on voluntary co-operation and provision of information from all stakeholders (WFD, 2001). There is a need for such type of framework in the SSW, where there is a single portal for data. Alberta Environment and Sustainable Resource Development, and Saskatchewan WSA could collaborate and work together for the development of such type of framework, where online data on water could be retrieved from a single portal and available to all watershed stakeholders in these two jurisdictions.

In order to ensure that the state-of-the science developments are well communicated to address gaps in CEA practice; linkages between CEA research, environmental monitoring programs, and front-line EA practice, need to be strengthened (Dubé, 2003). Provincial level campaigns and workshops need to be organized, focusing on advancing watershed CEAM as a major agenda, incorporating key watershed stakeholders, including local communities. Financial commitment should be given, regardless the government in power, to organize such activities. This research also identified that sufficient legislation or other regulatory means is necessary to ensure that results generated from monitoring programs and science studies influence decisions about land use and development, and to enable the protection of sensitive or vulnerable areas of the watershed from human disturbance. At a minimum there is a need for 'terms of reference' developed for projects under regulatory-based EIA to clearer direction for the selection of indicators for use in project assessment and monitoring actions that support watershed CEAM (Dubé, 2003; Seitz et al., 2011; Sheelanere et al., 2013).

6.3 Future research

It is suggested through this research that GIS is a tool which can facilitate scenario-based analysis of potential future conditions and resource pressures in the watershed. Therefore, further research is now required to analyze the change in environment and the study of different scenarios to predict and suggest various environmental conditions, particularly in regard to climate change and uncertainty for watershed CEAM, using GIS techniques. Additional research is also required to understand and identify the watershed baselines and indicators, based on sound scientific guidance, for use in project-based assessment and monitoring programs, which later will support watershed CEAM activities. It will also be worthwhile to have a look at the watershed CEAM practices in other developed countries and do comparisons on the techniques and various approaches to have a more insight and different perspective on the approaches for watershed CEAM. The framework for watershed CEAM requisites developed in this research has significantly contributed towards the evaluation and investigation of the current capacity to do CEAM in the SSW. Having said that, further application of this framework could be done in other Canadian watersheds through which a common capacity needs and constrains could be identified that prevails throughout the nation regarding the watershed CEAM. Every watershed have different capacity needs and constraints, however application of this framework could help to get an overall perspective on watershed CEAM.

REFERENCES

Alberta Environment 1993. Alberta Environmental Protection and Enhancement Act 1993, as amended by Alberta regulations 254/2007. Government of Alberta, Canada.

Alberta Environment. 2007. Towards environmental sustainability: proposed regulatory framework for managing environmental cumulative effects. Edmonton, Alberta, Canada.

Alberta Environment and Sustainable Resource Development, 2013. Cumulative Effects Management. Retrieved form https://landuse.alberta.ca/CumulativeEffects/CumulativeEffectsManagement/Pages/default.aspx

Ball MA. 2011. Scaling-up Valued Ecosystem Components for Use in Watershed Cumulative Effects Assessment [Master's Thesis]. Saskatoon, SK: University of Saskatchewan

Ball MA, Noble BF, and Dube MG. 2012a. Valued ecosystem components for watershed cumulative effects: An analysis of environmental impact assessments in the South Saskatchewan River Watershed, Canada. *Integr Environ Assess and Manag* DOI: 10.1002/ieam.1333

Ball MA, Somers G, Wilson JE, Tanna R, Chung C, Duro DC, Seitz N. 2012b. Scale, assessment components, and reference conditions: issues for cumulative effects assessment in Canadian watersheds. *Integr Environ Assess Manage* DOI: 10.1002/ieam.1332

Baxter W, Ross WA, Spaling. H 2001. Improving the practice of cumulative effects assessment in Canada. *Impact Assess Project Appraisal*; 19(4):253–62.

Braat T. 2002. *Regional Cumulative Effects Management Framework for Cold Lake, Alberta.* (Ottawa, ON): Canadian Environmental Assessment Agency.

Brinson MM and SD Eckles. 2011. U.S. Department of Agriculture conservation program and practice effects on wetland ecosystem services: a synthesis. Ecological Applications 21(Sp1): S116-S127.

Brismar A. 2004. Attention to impact pathways in EISs of large dam projects. *Environmental Impact Assessment Review*, 24:59–87.

Bruneau, J., D. R. Corkal, E. Pietroniro, B. Toth & G. Van der Kamp (2009) Human activities and water use in the south Saskatchewan river basin. *Prairie Forum* 34**,** 129-152.

Canada 1992. The Canadian Environment Assessment Act. S.C. 1992, c. 37. Last amended on 2010-07-12. Ottawa, ON: Her Majesty the Queen in Right of Canada.

Canada 2012. The Canadian Environmental Assessment Act, S.C. 2012, c. 19, s. 52. Canadian Environmental Assessment Agency 2012.

Canadian Council of Ministers of the Environment. 2009. *Regional strategic environmental assessment in Canada: Principles and Guidance*. Canadian Council of ministers of the Environment. Winnipeg, MB. 27 p.

Canadian Environmental Assessment Agency (1999) Operational Policy Statement: Addressing cumulative environmental effects under the Canadian Environmental Assessment Act. Online: http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=1F77F3C2-1

Canadian Plains Research Center (CPRC), 2012. *The Encyclopedia of Saskatchewan.* http://esask.uregina.ca/entry/south_saskatchewan_river.html

Canter L and B Ross. 2010. State of practice of cumulative effects assessment and management: the good, the bad and the ugly. *Impact Assessment and Project Appraisal* 28(4): 261-268.

Canter L and Atkinson F. 2011. Multiple uses of indicators and indices in cumulative effects assessment and management. *Environmental Impact Assessment Review* 31(5):491-501

Carter N, Kreutzwiser RD, de Loë RC. 2005. Closing the circle: Linking land use planning and water management at the local level. *Land Use Policy* 22: 115–127.

Chilima J. 2011. Institutional capacity and regional community participation for CEA in the Grand River watershed, Ontario, Canada**.** M.E.S Thesis. School of Environment and Sustainability. University of Saskatchewan, Saskatchewan, 2011.

Chilima JS, Gunn JAE, Noble BF, Patrick RJ 2013. Institutional considerations in watershed cumulative effects assessment and management. *Impact Assessment and project Appraisal* 31(1): 74-84

Cocklin C, Parker S and Hay J. 1992. Notes on cumulative environmental change I: concepts and issues. *Journal of Environmental Management* 35: 51-67.

Connelly R. 2011. Canadian and international EIA frameworks as they apply to cumulative effects. *Environmental Impact Assessment Review* 31 (2011) 453–456.

Conservation Ontario. 2001. The Importance Of Watershed Management In Protecting Ontario's Drinking Water Supplies. Unpublished submission to the Walkerton Inquiry.

Cooley H and Gleick PH. 2011. Climate-proofing transboundary water agreements. *Hydrological Sciences Journal*, 56:4, 711-718

Cortner, H and Moote M. 1994. Trends and issues in land and water resources management: Setting the agenda for change. *Environmental Management,*18: 167 173.

Culp J, Cash KJ and Wrona FJ. 2000. Cumulative effects assessment for the Northern River Basins Study. *Journal of Aquatic Ecosystem Stress and Recovery (Formerly Journal of Aquatic Ecosystem Health)*, 8, 87-94.

Davies H, and Hanley PT. 2010. *2010 State of the Watershed Report*. Saskatchewan Watershed Authority. 39 pp.

de Loë R, Di Giantomasso S, and Kreutzwiser R. (2002). Local capacity for groundwater protection in Ontario. *Environmental Management* 29(2): 217-233.

de Loë R and Kreutzwiser R. 2005. Closing the groundwater protection implementation gap. *GeoForum* 36(2): 241-256.

Dube MG. 2003. Cumulative effect assessment in Canada: a regional framework for aquatic ecosystems. *Environmental Impact Assessment Review* 23: 723-745.

Dube M, Johnson B, Dunn G, Culp J, Cash K, Munkittrick K, Wong I, Hedley K, Booty W, Lam D, Resler O and Storey A. 2006. Development of a new approach to cumulative effects assessment: a northern river ecosystem example. *Environmental Monitoring and Assessment,* 113, 87-115.

Dube MG, Muldoon B, Wilson J, and Bryan KM. 2012a. Accumulated State of the Yukon River Watershed: Part I Critical Review of Literature. *Integrated Environmental Assessment and Management* Volume 9999, Number 00—pp. 1–13

Dube MG, Munkittrick KR. 2001. Integration of effects-based and stressor-based approaches into a holistic framework for cumulative effects assessment in aquatic ecosystems. *Human Ecological Risk Assessment*; 7:247 – 58

Dube M, Munkittrick K, Jackson L, Noble B, Schreier H, Duinker P, Westbrook C, and McMaster M. 2007. *Development of the Healthy River Ecosystem Assessment System (THREATS) for assessing and adaptively managing the cumulative effects of manmade developments on Canadian freshwaters*. Research proposal accepted for funding by the Canada Water Network.

Duinker P and Greig L. 2006. The impotence of cumulative effects assessment in Canada: Ailments and ideas for redeployment. *Environmental Management* 37(2): 153-161.

Dumaresq C, Hedley K, Michelutti R. 2002. Overview of the metal mining environmental effects monitoring program. *Water Qual Res J Can*;37:213–8.

Environment Canada. 1998. Pulp and paper technical guidance for aquatic environmental effects monitoring. EEM/1998/1, National EEM Office, Science Policy and Environmental Quality Branch, Ottawa, ON, Canada

Environment Canada. 2001b. Metal mining guidance document for aquatic environmental effects monitoring. http://www.ec.gc.ca/eem, National EEM Office, Science Policy and Environmental Quality Branch, Ottawa, ON, Canada

German L, Hussein M, Alemu G, Mazengia W, Amede T, Stroud A. 2007. Participatory integrated watershed management: Evolution of concepts and methods in an ecoregional program of the eastern African highlands. *Agricultural Systems* 94 (2007) 189–204.

Gibson RB. 2002. From Wreck Cove to Voiseys Bay: the evolution of federal environmental assessment in Canada. *Impact Assessment and Project Appraisal,* 20, 151-159.

Gleick PH. 2003. Global freshwater resources: Soft-path solutions for the 21st century. *Science,* 302, 1524-1528.

Government of Saskatchewan, 2012a. Public Review of Saskatchewan's Draft Environmental Code. Retrieved from http://www.gov.sk.ca/news?newsId=138368bb-bb2d-40cd-97cd-653c614ea895

Government of Saskatchewan, 2012b. Amendments to the Environmental Assessment Act Support Saskatchewan's Growth Plan. Retrieved from http://www.gov.sk.ca/news?newsId=5e8ec3b9-0cb8-42c2-98f1-82f50d64d3c3

Greig L and Duinker PN. 2007. Scenarios of Future Developments in Cumulative Effects Assessment: Approaches for the Mackenzie Gas Project. Prepared by ESSA Technologies Ltd., Richmond Hill, ON for the Joint Review Panel for the Mackenzie Gas Project, [Inuvik, NT], 32 pp.

Grindle MS and Hilderbrand ME. 1995. Building sustainable capacity in the public sector: What can be done?. Public Admin. Dev., 15: 441–463. Doi: 10.1002/pad.4230150502.

Griffiths A, McCoy E, Green J and Hegmann G. 1998. Cumulative Effects Assessment: Current Practices and Future Options. Calgary: Macleod Institute.

Hamdy, Atef, Abu-Zeid, Mahmoud and Lacirignola C. 1998. Institutional Capacity Building for Water Sector Development. *Water International*, 23:3,126 — 133

Harriman J and Noble B. 2009. Integrating cumulative effects in regional strategic environmental assessment frameworks: lessons from practice. *Journal of Environmental Assessment Policy and Management*. 11(3): 267-290

Harriman J and Noble B. 2008. Characterizing project and strategic approaches to regional cumulative effects assessment in Canada. *Journal of Environmental Assessment Policy & Management,* 10(1): 25-50.

Heathcote IW. 2009. *Integrated Watershed Management: Principles And Practice*. New York: John Wiley and Sons, Inc. Second edition. ISBN 978-0-470-37625-6

Hegmann G and Yarranton GA. 2011. Alchemy to reason: Effective use of Cumulative Effects Assessment in resource management. *Environmental Impact Assessment Review* 31 (2011) 484–490.

Ivey, J. L., R. de Loë, and R. Kreutzwiser. 2006a. Planning for Source water protection in Ontario. *Applied Geography* 26:192-209.

Ivey JL, de Loë R, and Kreutzwiser R. 2002. Groundwater management by watershed agencies: an evaluation of the capacity of Ontario's conservation authorities. *Journal of Environmental Management* 64: 311-331.

Ivey JL, de Loë R, Kreutzwiser R, and Ferreyra C. 2006b. An institutional perspective on local capacity for source water protection. *Geoforum* 37: 944-957.

Johnson, LB, C Richards, GE Host and JW Arthur (1997). Landscape influences on water chemistry in Midwestern stream ecosystems. *Freshwater Biology*, 37:193–208.

Kennett S. 2002. Lessons from Cheviot: Redefining government's role in cumulative effects assessment. In A. Kennedy (ed.), *Cumulative Effects Assessment in Canada: From Concept to Practice*. Calgary, AB: Alberta Society of Professional Biologists.

Kennett SA. 1999. Towards a New Paradigm for Cumulative Effects Management. *CIRL Occasional paper #8*. (Calgary, AB): Canadian Institute of Resources Law, University of Calgary.

Kilgour B, Dube M, Hedley K, Portt C, Munkittrick K. 2006. Aquatic environmental effects monitoring guidance for environmental assessment practitioners. *Environ. Monit. Assess*. 130, 423–436.

Kristensen S. 2011. Capacity for cumulative effects assessment in Lower Fraser watershed, British Columbia, Canada. M.Sc. Thesis. Dept. of Geography and Planning. University of Saskatchewan, Saskatchewan, 2011.

Kristensen S, Noble BF, Patrick RJ 2013. Capacity for watershed cumulative effects assessment and management: lessons from the Lower Fraser River Basin, Canada. *Environmental Management*. Forthcoming.

LARP. Framework Surface water quality 2012. Lower Athabasca Region - Surface Water Quality Management Framework for the Lower Athabasca River, 2012. ISBN: 978-1-4601-0529-0 (PrintedVersion)

Lawe LB, Wells J, and Mikisew Cree First Nations Industry Relations Corporation. 2005. Cumulative effects assessment and EIA follow-up: a proposed community-base monitoring program in the Oil sands Region, northeastern Alberta. *Impact Assessment and Project Appraisal* 23(3): 205-209.

Lein JK. 2002. New Directions in the Use of Remotely Sensed Data for Cumulative Impact Assessment. *Environmental Practice* 4:220-235 (2002)

Litke S, Day JC. 1998. Building local capacity for stewardship and sustainability: the role of community-based watershed management in Chilliwack, British Columbia. *Environments* 25 (2 3), 91–109.

Technical Report of the RAMP Review Panel, Integrated Water Management Program, Alberta Innovates— Technology Futures. Calgary (AB): Alberta Innovates Technology Futures. 20 p.

Meinzen-Dick R, Knox A, Place F, Swallow B. 2002. Innovation in Natural Resource Management: The Role of Property Rights and Collective Action in Developing Countries. IFPRI, Washington, DC, 317 pp.

Mitchell B. 2005. Integrated water resource management, institutional arrangements, and land-use planning. *Environment and Planning A* (37): 1335-1352.

Munkittrick KR, McMaster ME, Van Der Kraak GJ, Portt C, Gibbons WN, Farwell A, Gray M. 2000. Development of methods for effects-driven cumulative effects assessment using fish populations: Moose River project. Pensacola (FL): Society of Environmental Toxicology and Chemistry. 236 p.

Noble B and Patrick R. 2008. Institutional arrangements for watershed-based cumulative effects assessment and management. Research proposal to the Social Sciences and Humanities Research Council of Canada.

Noble B. 2010. Cumulative Environmental Effects and the Tyranny of Small Decisions: Towards Meaningful Cumulative Effects Assessment and Management. Natural Resources and Environmental Studies Institute Occasional Paper No. 8, University of North British Columbia, Prince George, B.C., Canada.

Noble B. 2008. Strategic approaches to regional cumulative effects assessment: a case study of the Great Sand Hills, Canada. *Impact Assessment and Project Appraisal* 26(2): 78-90.

Noble B, Sheelanere P, Patrick R. 2011. Advancing watershed cumulative effects assessment and management: lessons from the South Saskatchewan River Watershed, Canada. *Journal of Environmental Assessment Policy and Management.*13 (4):567-590

Noble BF, Skwaruk J, Patrick RJ. 2013. Toward cumulative effects assessment and management in the Athabasca watershed, Alberta, Canada. The Canadian Geographer. Forthcoming

NWT CIMP, 2012. Aboriginal Affairs and Northern Development Canada. www.aandc-aadnc.gc.ca

Odum W. 1982. Environmental degradation and the tyranny of small decisions. BioScience 32(9): 728-729.

Orrego E. 2007. Water Governance Institutions in the South Saskatchewan River Basin. In *Institutional Adaptations to Climate Change Project*, 74. Regina: University of Regina.

Parker S and Cocklin C. 1993. The use of geographical information systems for cumulative environmental effects assessment. *Computers, Environment and Urban Systems*, 17, 393-407.

Parkins JR. 2011. Deliberative democracy, institution building, and the pragmatics of cumulative effects assessment. *Ecology and Society* 16(3): 20.

Patino L and Gauthier DA. 2009. A Participatory mapping approach to climate change in the Canadian Prairies. In A dry oasis: Institutional adaptation to climate on the Canadian Plains, ed. G. P Marchildon, 318. Regina: Canadian Plains Research Centre, University of Regina.

Pattanayak SK. 2004. Valuing watershed services: concepts and empirics from Southeast Asia. *Agriculture, Ecosystems and Environment* 104 (2004) 171–184.

Peterson EB, Chan YH, Peterson NM, Constable GA, Caton RB, Davis CS, Wallace RR, and Yarranton GA. 1987. *Cumulative effects assessment in Canada: An agenda for action and research.* Canadian Environmental Assessment Research Council, Hull, QC. 70 pp.

Piper JM. 2000. Cumulative effects assessment on the middle Humber: Barriers overcome, benefits derived. *Journal of Environmental Planning and Management* 43(3): 369-387.

Pomeroy JW, Boer D de, Martz LW. 2005. Hydrology and Water Resources of Saskatchewan, Centre for Hydrology Report #1. Centre for Hydrology, University of Saskatchewan, Saskatoon, Saskatchewan.

Quinn MS, Greenaway G, Duke D and Lee T. 2004. A Collaborative Approach to Assessing Regional Cumulative Effects in the Trans-boundary Crown of the Continent. In *Research and Development Monograph Series, 2002*. Ottawa: Canadian Environmental Assessment Agency.

Reid LM. 1993. Research and cumulative watershed effects. U.S. Department of Agriculture Forest Service, Pacific Southwest Research Station, Berkeley, Calif. General Technical Report PSW-GTR-141.

Reid LM. 1998. Cumulative watershed effects and watershed analysis. In *River ecology and management: Lessons from the Pacific coastal ecoregion.* R.J. Naiman and R.E. Bilby (editors). Springer-Verlag, New York, N.Y. pp. 476–501.

Reid LM. 2010. Understanding and evaluating cumulative watershed impacts. In Cumulative watershed effects of fuel management in the western United States. USDA Forest Service RMRS-GTR-231. 2010.

Reiter LM and Beschta RL. 1995. Effects of forest practices on water. In: Cumulative effects of forest practices in Oregon: Literature and synthesis. R.L. Beschta, J.R. Boyle, C.C. Chambers, W.P. Gibson, S.V. Gregory, J. Grizzel, J.C. Hagar, J.L. Li, W.C. McComb, T.W. Parzybok, M.L. Reiter, G.H. Taylor, and J.E. Warila (compilers). Oregon Department of Forestry, Salem, Oreg.

Ross WA. 1994. Assessing cumulative environmental effects: Both impossible and essential. Keynote address, in *Conference on Cumulative Effects Assessment in Canada: From Concept to Practice,* A Kennedy (ed.), Calgary, AB: Alberta Society of Professional Biologists

Saskatchewan 1979-80. The Environmental Assessment Act. S.S.1979-80 (effective 25 August 1980), as amended by S.S1983 c. 77: 1988-89 c. 42 and c. 55: 1996 c.19.1: and 2002 c. C- 11.1. The Queen‟s Printer, Regina, Saskatchewan.

Saskatchewan River Basin (SRB) 2009. From the Mountain to the sea. *Summary of the state of the Saskatchewan River Basin*. Partners for the Saskatchewan River Basin. ISBN 978-0-9730693-7-2.

Saskatchewan Watershed Authority (SWA), 2006. Background Report South Saskatchewan River Watershed.

Scherer R. 2011. Cumulative Effects: A primer for watershed managers. *Streamline, Watershed Management Bulletin* 14(2)14-20

Schindler D. 2001. The cumulative effects assessment of climate warming and other human stresses on Canadian freshwaters in the new millennium. *Canadian Journal of Fisheries and Aquatic Sciences* 58: 18-29.

Schindler D and Donahue W. 2006. An impending water crisis in Canada's western prairie provinces. *Proceedings of the National Academy of Sciences,* 103, 7210-7216.

Seitz N, Noble B, Westbrook C. 2011. Bringing science into river systems cumulative effects assessment practice. *Environmental Impact Assessment Review* 31 (2011) 172–179.

Shannon, M (1998). Social Organizations and Institutions, In: Naiman, R and R. Bilby (Eds), River Ecology and Management: Lessons from the Pacific Coastal Ecoregion, Springer Verlag, NY, 529-552pp.

Sheelanere P. 2010**.** Institutional requirements for watershed cumulative effects assessment in the south Saskatchewan watershed. M.E.S Thesis. University of Saskatchewan, Saskatchewan, 2010. Dissertation and Theses. Web.

Sheelanere, P., Noble, B.F. and R. Patrick 2013. Institutional requirements for watershed cumulative effects assessment and management: lessons from a Canadian trans-boundary watershed. *Land Use Policy*. 30: 67-75.

Sidle R and Hombeck JW. 1991. Cumulative effects: Broadening the approach to water quality research. *Journal of Soil and Water Research* 46:268–271.

Skwaruk J. 2011. Capacity to support cumulative effects assessment and management in the Athabasca watershed, Alberta, Canada.[Master's Thesis]. Saskatoon, SK: University of Saskatchewan

Squires AJ, Dube MG. 2012. Development of an Effects- Based Approach for Watershed Scale Aquatic Cumulative Effects Assessment. *Integrated Environmental Assessment and Management* — Volume 9999, Number 00—pp. 1–12

Squires AJ, Westbrook CJ, Dube M. 2010. *Integrated Environmental Assessment and Management* — Volume 6, Number 1—pp. 119–134

Therivel R and Ross W. 2007. Cumulative effects assessment: does scale matter? *Environmental Impact Assessment Rev*iew 2007; 27:365–85.

Therivel R. 2004. *Strategic Environmental Assessment in Action*. (London, UK): Earthscan Publications.

Timmer DK, de Loë RC and Kreutzwiser RD. 2007. Source water protection in the Annapolis Valley, Nova Scotia: Lessons for building local capacity. *Land Use Policy* 24:187–198.

United States Environmental Protection Agency (1998). *Guidance on Implementing the Capacity Development Provisions of the Safe DrinkingWater Act Amendments of 1996*. Washington, DC: United States Environmental Protection Agency, Office of Water.

Valentine G. 2005. Tell Me About using Interviews as a Research Methodology. In Flowerdew, R. and D. Martin (Eds.), *Methods in Human Geography*. (London, UK): Pearson Education Limited.

Walker SL, Hedley K, Porter E. 2002. Pulp and paper environmental effects monitoring in Canada: an overview. *Water Qual Res J Canada* 2002; 37:7– 19.

WFD. 2001. Common Implementation Strategy For The Water Framework Directive 2001. Strategic Document as Agreed By The Water Directors Under Swedish Presidency 2 May 2001.

Wright, K. B. (2005), Researching Internet-Based Populations: Advantages and Disadvantages of Online Survey Research, Online Questionnaire Authoring Software Packages, and Web Survey Services. Journal of Computer-Mediated Communication, 10: 00. doi: 10.1111/j.1083-6101.2005.tb00259.x

Zhao M, Becker DR and Kilgore MA. 2009. Assessing cumulative impacts within state environmental review frameworks in the United States *Environmental Impact Assessment Review* 29 (2009) 390–398

Ziemer, R. 1994. Cumulative effects assessment impact thresholds: Myths and realities. Pages 319–326 in A. J. Kennedy (ed.), Cumulative effects assessment in Canada: From concept to practice. Alberta Society of Professional Biologists, Edmonton, Alberta.

Appendix A: Data Collection Instrument

Note: The survey was designed and administered on-line using Fluid Surveys. The survey is copied below with descriptive text to explain the participant response categories available in pull-down menues on the on-line version.

[Letter of invitation sent by Email, posted to listserves, etc]

UNIVERSITY OF SASKATCHEWAN

Watershed Cumulative Effects Assessment and Management

- Capacity Assessment in the South Saskatchewan Watershed -

Over the past two years researchers at the University of Saskatchewan have been working to identify the basic requirements for assessing and managing cumulative effects to watersheds, and the capacity requirements to implement watershed cumulative effects assessment programs. You may have been involved in this research, or are aware of other science-related assessment and monitoring programs in this area.

The health of a river system is largely a function of the cumulative effects of in-stream use, allocation and interactions and processes that occur on the landscape within the boundary of the watershed. There has been much discussion about the need to assess and manage cumulative effects to watersheds, and there are several science-based programs focused on river system modeling and monitoring of watershed health. Much less is known about the capacity to implement and sustain programs designed to assess, monitor, and manage cumulative effects to watersheds.

Based on our research across several watersheds in Canada we have developed a set of indicators for assessing the capacity to implement and sustain watershed cumulative effects and management programs. We would like to invite you to participate in an on-line survey designed to assess the capacity for cumulative effects assessment and management in the South Saskatchewan Watershed. You need not be an expert in watershed cumulative effects. We are looking for your perspective on a variety of issues related to watershed planning, management and science in the South Saskatchewan

A link to the on-line survey and participant information can be found here:

http://www.usask.ca/~bfn571/Watershed_Cumulative_Effects.html

We would ask that you please forward this invitation to others whom you know may be interested in this work.

Thank you in advance for your participation. Should you have any questions please feel free to contact us at b.noble@usask.ca or robert.patrick@usask.ca

Sincerely,

Bram Noble, Ph.D., Professor
Environmental Assessment & Management
Department of Geography & Planning
University of Saskatchewan

Robert Patrick, Ph.D., Assistant Professor
Watershed Planning & Management
Department of Geography & Planning
University of Saskatchewan

[This is the first page of the survey on the Fluid Survey tool]

Watershed Cumulative Effects Assessment and Management

- Capacity Assessment in the South Saskatchewan Watershed -

Thank you for participating in this project.

This survey consists of **3 parts**. Please complete each section before proceeding to the next. Information cannot be saved, so if you exit the survey without completing you will need to start over.

The focus of the survey is on the capacity for cumulative effects assessment and management in the South Saskatchewan Watershed. The boundaries of the watershed study area include the Red Deer River, Bow River, Oldman River, and South Saskatchewan River sub-basins. Our focus is on surface water.

[Page 2 of the survey]

PART A – Background Information

Please provide us with the following background information:

1. Province of current residence: *[Pull down menu options: SK, AB]*

2. Sub-basin in which you currently reside: *[Pull down menu options: Bow River, Old Man River, Red Deer River, South Saskatchewan River, Not Sure]*

3. The category that best describes your current affiliation: *[Pull down menu options: federal government; provincial government; municipal government; watershed agency/authority; environmental non-government organization; academia; consultant-private sector; industry; agricultural producer; other –specify]*

4. How would you best describe your educational background or training? *[Pull down menu options: Natural sciences and technology (e.g. biology, engineering, chemistry, etc); Social sciences (e.g. planning, political studies, commerce, etc); Other – please specify]*

5. How would you describe the overall health of the South Saskatchewan watershed? *[3 point scale response: 1 = unhealthy; 2 = healthy but with problem; 3 = healthy]*

6. In the past 10 years would you say that the overall health of the South Saskatchewan river system and its tributaries has : *[9 point scale response: 1 = gotten considerably worse; 3 = gotten slightly worse; 5 = remained about the same; 7 = gotten slightly better; 9 = gotten considerably better]*

7. Cumulative effects are a threat to water quality in sub-basins of the South Saskatchewan watershed *[9 point scale response: 1 = strongly disagree; 3 = somewhat disagree; 5 = neither agree nor disagree; 7 = somewhat agree; 9 = strongly agree]*

8. Cumulative effects are a threat to water quantity in the sub-basins of the South Saskatchewan watershed *[9 point scale response: 1 = strongly disagree; 3 = somewhat disagree; 5 = neither agree nor disagree; 7 = somewhat agree; 9 = strongly agree]*

9. What would you identify as the primary threats to the overall health of the South Saskatchewan watershed and its river systems? *[Open ended, with 5 cells to list threats]*

10. Please provide your email address if you would like us to send you a copy of the study results. *[Email form]*

11. Would you like to be contacted about, or involved in, future research on watersheds or river systems management and assessment? *[Pull down menu options: yes/no]*

[Page 3 of the survey]

PART B – Priorities for Cumulative Effects Assessment & Management

Below is a list of components that we have identified as necessary to support watershed cumulative effects assessment and management programs. You are asked to indicate the importance of each component in ensuring *successful* watershed cumulative effects assessment and management. **In other words, which ones are the most important 'ingredients' for cumulative effects assessment in watersheds?** Your assessment should be generic, considering Canadian watersheds in general. Part C of this survey will focus specifically on the South Saskatchewan context.

Instructions:

i. Review the components and definitions.

ii. Assign points to indicate importance of each component. You have 80 points in total. The more important a component, the more points you assign to it. If all 8 are equally important, assign 10 points to each.

Component	Definition	***Points***
1. Lead Agency	A clearly identified, overarching agency with the authority, mandate and the capacity for cumulative effects assessment and management, including the means to direct monitoring programs and influence decisions about land use and project development.	[Web survey tool contains a 'weight assignment' set. Participants have 80 points that can be distributed across the set of 8 criteria. – CONSTANT SUM]
2. Multi stakeholder collaboration	Roles and responsibilities of various stakeholders in watershed management and sciences are well defined and stakeholders are represented in impact assessment and decision making about development.	
3. Watershed baselines, indicators and thresholds	The state of the watershed needs to be known and agreed upon science-based indicators and thresholds for impact assessment and monitoring are required at both the project and watershed scale.	
4. Multi-scaled monitoring	Monitoring programs are mandated at both the individual project and watershed scales, focused on water quantity and quality across the watershed, site specific actions, and land use changes that affect watershed processes.	
5. Data management and coordination	Monitoring data, both spatial and aspatial, that are needed for assessing and understanding watershed cumulative effects must be made available and in common data formats to all watershed stakeholders.	
6. Vertical and horizontal linkages	These are formal management and science linkages across watershed management policies and plans are well as between watershed cumulative effects assessment and management and project-based assessment, monitoring and decision-making.	
7. Enabling legislation	There is a means to implement watershed cumulative effects assessment and management initiatives, enforce monitoring programs and compliance and ensure influence over development decisions taken at the individual project level.	
8. Financial and human resources	Sufficient financial and human resources are available to implement and sustain, over the long term, cumulative effects assessment and management programs and requirements (e.g. monitoring programs, landscape modeling, reporting, communication and data management and coordination)	

PART C – Capacity for Cumulative Effects Assessment in the South Saskatchewan

In Part C you are asked to assess the current capacity in the South Saskatchewan watershed to implement and sustain watershed-based cumulative effects assessment and management. The watershed boundaries are depicted in the map below and include the Red Deer River, Bow River, Oldman River, and South Saskatchewan River sub-basins. The focus is on surface water

For each component from Part II of the survey we have identified a set of indicators. Collectively, these indicators will provide us an understanding of your views on the current capacity in the South Saskatchewan to assess and manage cumulative effects, and identify priority areas for capacity building.

Based on your knowledge and experience with water, land, and governance issues or management practices in the South Saskatchewan, identify your level of agreement with each indicator statement from 'strongly disagree' to 'strongly agree'.

There are **8 sections** to this final part of the survey, sections A to H.

[Page 5 of the survey]

Section 1 of 8

Lead Agency: A clearly identified, overarching agency with the authority, mandate and the capacity for cumulative effects assessment and management, including the means to direct monitoring programs and influence decisions about land use and project development.

Statement	Strongly disagree				Neutral				Strongly agree
1. Clear goals and priorities have been set for the watershed, including those related to future land use and overall watershed health.	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. There is an agency or group of agencies in the watershed with a leadership role in the assessment and management of cumulative effects.	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. There is an agency or group of agencies in the watershed that has the ability (formal or informal) to influence decisions about land use and project development decisions.	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. There is an agency or group of agencies in the watershed that has formal authority to implement and/or enforce regulations across the watershed to support cumulative effects assessment and management activities (e.g., land use regulations, monitoring and reporting requirements).	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. There is an agency or group of agencies in the watershed that has formal authority to allocate technical and financial resources to support cumulative effects assessment initiatives (e.g., monitoring, data collection).	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. *Are there any comments or observations that you wish to share with regard to 'leadership' for cumulative effects assessment and management in the South Saskatchewan watershed?* [open-ended text box/ qualitative response]									

Response scale for each of statements a to e should be a 9-point Likert scale:

1 = strongly disagree

2

3 = disagree

4

5 = neither agree nor disagree

6

7 = agree

8

9 = strongly agree

[Page 6 of the survey]

Section 2 of 8

Multi-stakeholder collaboration: Roles and responsibilities of various stakeholders in watershed management and sciences are well defined and stakeholders are represented in impact assessment and decision making about development.

Statement	Strongly disagree				Neutral				Strongly agree
1. There is a collaborative approach among provincial, watershed and municipal authorities in setting goals and priorities for the watershed concerning land and water use and development.	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. The roles and responsibilities of watershed stakeholders (e.g., industry, watershed agencies, land owners, government agencies) with respect to the assessment, management and monitoring of cumulative effects are clearly defined.	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. There is willingness amongst provincial, watershed, and municipal authorities to share data and knowledge and to coordinate activities related to monitoring watershed conditions and managing effects.	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Industrial proponents operating in the watershed are willing to share their data (e.g., water quality, effluent discharge, water use) with other industries and non-industry stakeholders.	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Local communities (e.g. municipalities, land owners) are sufficiently engaged in watershed or sub-watershed planning, monitoring, environmental assessment and related decision making processes.	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. *Are there any comments or observations that you wish to share with regard to 'multi-stakeholder collaboration' for cumulative effects assessment and management in the South Saskatchewan watershed?* [open-ended text box/ qualitative response]									

Response scale for each of statements a to e should be a 9-point Likert scale:

1 = strongly disagree

2

3 = disagree

4

5 = neither agree nor disagree

6

7 = agree

8

9 = strongly agree

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Section 3 of 8

Watershed baselines, indicators and thresholds: The state of the watershed needs to be known and agreed upon science-based indicators and thresholds for impact assessment and monitoring are required at both the project and watershed scale.

Statement	Strongly disagree				Neutral				Strongly agree
1. There is adequate baseline data to identify past trends or changes in water quality across the watershed.	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. There is adequate baseline data to identify past trends or changes in water quantity / flow across the watershed.	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. There is adequate spatial baseline data to identify past land cover and land uses across the watershed.	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. There is agreement on the most appropriate indicators of watershed health.	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. There is a scientific understanding of thresholds (e.g. maximum loadings, minimum flows, etc.) at which river system functions are no longer ecologically viable.	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. *Are there any comments or observations that you wish to share with regard to 'watershed baselines, indicators and thresholds' for cumulative effects assessment and management in the South Saskatchewan watershed?* [open-ended text box/ qualitative response]									

Response scale for each of statements a to e should be a 9-point Likert scale:

1 = strongly disagree

2

3 = disagree

4

5 = neither agree nor disagree

6

7 = agree

8

9 = strongly agree

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Section 4 of 8

Multi-scaled monitoring: Monitoring programs are mandated at both the individual project and watershed scales, focused on water quantity and quality across the watershed, site specific actions, and land use changes that affect watershed processes.

Statement	Strongly disagree			Neutral			Strongly agree		
1. Monitoring programs under regulatory-based environmental impact assessment provide an understanding of a project's effects on watershed processes.	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. There are requirements for the monitoring of river system conditions (e.g. water quality, flow, loadings) across the watershed.	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Current monitoring programs provide a sound understanding of, and allow for detection of changes in, water quality conditions across the watershed.	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Current monitoring programs provide a sound understanding of, and allow for detection of changes in, water quantity/ flow conditions across the watershed.	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Current monitoring programs provide a sound understanding of, and allow for detection of changes in, the dominant stressors to river system health (e.g., land use, disturbance patterns, buffers, effluent discharge, etc) across the watershed.	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. *Are there any comments or observations that you wish to share with regard to 'multi-scaled monitoring' for cumulative effects assessment and management in the South Saskatchewan watershed?* [open-ended text box/ qualitative response]									

Response scale for each of statements a to e should be a 9-point Likert scale:

1 = strongly disagree

2

3 = disagree

4

5 = neither agree nor disagree

6

7 = agree

8

9 = strongly agree

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Section 5 of 8

Data management and coordination: Monitoring data, both spatial and aspatial, that are needed for assessing and understanding watershed cumulative effects must be made available and in common data formats to all watershed stakeholders.

Statement	Strongly disagree			Neutral			Strongly agree		
1. There is a coordinated, watershed (or sub-watershed) approach to data collection/monitoring that ensures a standardized baseline establishment of watershed conditions.	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Data concerning water quality and quantity are available in an easily accessible, up-to-date and electronic format to industry, to all levels of government and to all watershed stakeholders.	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Spatial data of current and past land uses, disturbance areas, or use patterns are available in an easily accessible, up-to-date and electronic format to industry, to all levels of government and to all watershed stakeholders.	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. There is consistency in project impact monitoring standards and indicators (used under environmental impact assessment or similar regulations/permits) for projects affecting similar components or for projects of a similar class (e.g. pulp mills, metal mines, agriculture, etc.).	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Available data (water quality, quantity, and spatial land use data) are 'quality controlled', such that data gaps, uncertainties, errors, or assumptions are reported and known to data users.	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. Are there any comments or observations that you wish to share with regard to data management and coordination for cumulative effects assessment and management in the South Saskatchewan watershed? [open-ended text box/ qualitative response]									

Response scale for each of statements a to e should be a 9-point Likert scale:

1 = strongly disagree

2

3 = disagree

4

5 = neither agree nor disagree

6

7 = agree

8

9 = strongly agree

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Section 6 of 8

Vertical and horizontal linkages: These are formal management and science linkages across watershed management policies and plans are well as between watershed cumulative effects assessment and management and project-based assessment, monitoring and decision-making.

Statement	Strongly disagree				Neutral				Strongly agree
1. Watershed or sub-watershed management plans influence the terms and conditions (e.g., scope, monitoring requirements) of project-specific environmental impact assessments.	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Watershed or sub-watershed management plans influence policy and other decisions concerning land and water use in the watershed.	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. There is consistency in watershed management goals and objectives across sub-basins in the watershed.	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Results from project specific monitoring (under environmental impact assessment or other permitting requirements) are used to inform broader watershed assessment, evaluation and reporting processes.	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Information generated from science programs or watershed monitoring and assessment programs is given due consideration in the development or implementation of watershed management plans.	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. Are there any comments or observations that you wish to share with regard to vertical and horizontal linkages for cumulative effects assessment and management in the South Saskatchewan watershed? [open-ended text box/ qualitative response]									

Response scale for each of statements a to e should be a 9-point Likert scale:

1 = strongly disagree

2

3 = disagree

4

5 = neither agree nor disagree

6

7 = agree

8

9 = strongly agree

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Section 7 of 8

Enabling legislation: There is a means to implement watershed cumulative effects assessment and management initiatives, enforce monitoring programs and compliance and ensure influence over development decisions taken at the individual project level.

Statement	Strongly disagree			Neutral			Strongly agree		
1. There is sufficient legislation or other regulatory means to establish a watershed-based framework for cumulative effects assessment, monitoring and management.	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. The ‘terms of reference’ developed for projects under regulatory-based environmental impact assessment provide clear direction for the selection of indicators for use in project assessment and monitoring actions.	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. There is sufficient legislation or other regulatory means to ensure that results generated from state-of-the-watershed assessments (e.g., monitoring programs, science studies) influence decisions about land use and development.	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Current legislation and other regulatory instruments concerning land and water use are consistent across the watershed and between different levels of government in the watershed.	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. There is sufficient legislation or regulations to enable the protection of sensitive or vulnerable areas of the watershed from human disturbance.	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. *Are there any comments or observations that you wish to share with regard to enabling legislation for cumulative effects assessment and management in the South Saskatchewan watershed?* [open-ended text box/ qualitative response]									

Response scale for each of statements a to e should be a 9-point Likert scale:

1 = strongly disagree

2

3 = disagree

4

5 = neither agree nor disagree

6

7 = agree

8

9 = strongly agree

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Financial and Human Resources: Sufficient financial and human resources are available to implement and sustain, over the long term, cumulative effects assessment and management programs and requirements (e.g. monitoring programs, landscape modeling, reporting, communication and data management and coordination)

Statement	Strongly disagree				Neutral				Strongly agree
1. The scientific and technical expertise to develop and implement tools for cumulative effects assessment is available in the watershed, either through government, the private sector, or academic institutions.	☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Funding is available for source water protection plans and projects.	☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Financial resources are available at the provincial level to support watershed-based cumulative effects assessment and monitoring programs (i.e., data collection, reporting, enforcement).	☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Financial resources are available at the sub-watershed level, to watershed agencies, regional government, and municipalities to participate in watershed cumulative effects programs.	☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Education and training opportunities on cumulative effects assessment tools and practice are available to members of government, watershed managers, land use planners, and other stakeholders responsible for planning and assessment.	☐	☐	☐	☐	☐	☐	☐	☐	☐
6. *Are there any comments or observations that you wish to share with regard to financial and human resources for cumulative effects assessment and management in the South Saskatchewan watershed?* [open-ended text box/ qualitative response]									

Response scale for each of statements a to e should be a 9-point Likert scale:

1 = strongly disagree

2

3 = disagree

4

5 = neither agree nor disagree

6

7 = agree

8

9 = strongly agree

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Thank you for your participation!

You will receive a copy of the survey results at the email address provided at the start of the survey. If you did not provide your email address, a summary report will be made available on the project website at

http://www.usask.ca/~bfn571/Watershed_Cumulative_Effects.html

Meanwhile, should you have any questions or concerns please do not hesitate to contact b.noble@usask.ca