Water, Governance and Sustainability:

A Case Study of Water Allocation in Whiteman's Creek Watershed, Ontario

by

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DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

This research focuses on the role of water governance in building resilience and fostering sustainability in socio-ecological systems (SES). Water governance refers to the structures, processes and actors – and the dynamic interactions among them – that facilitate and influence decisions affecting water resources and aquatic ecosystems in terms of their collective influence on sustainability of SES. As human water demands grow and the impacts of climate change set in, water governance regimes are increasingly challenged to provide sufficient water to support livelihood and economic activities while also protecting the life-supporting functions of freshwater ecosystems. The objective of this thesis was to understand and assess whether governance arrangements for water allocation in Ontario are effectively addressing this challenge.

A broad literature review focused on three overlapping bodies of literature – (1) sustainability, resilience and systems thinking, (2) governance and planning, and (3) water policy and management. From this review, a conceptual framework was developed to guide understanding and assessing the effectiveness of water governance arrangements to enhance resilience and foster sustainability. The framework includes seven criteria: socio-ecological system integrity; equity; efficiency; transparency and accountability; participation and collaboration; precaution and adaptation; and, integration.

A case study of water allocation was undertaken in Whiteman's Creek watershed, a sub-watershed of the Grand River in southwestern Ontario, where water scarcity is a persistent concern and where conditions are anticipated to worsen under climate change, posing problems for both human livelihoods and the integrity of the creek ecosystem. Data for the case study were collected through content analysis of documents, records and websites and through semi-structured interviews with key informants. The conceptual framework was used to synthesize the data into a narrative from which recommendations for strengthening water governance were proposed.

Water governance is increasingly taking on forms more distributed or polycentric in structure and more inclusive, collaborative and participatory than previous models built largely on top-down, centralized decision making. This shift is viewed by many as a critical element for building resilience and sustainability. While the governance regime for water allocation in Whiteman's Creek reflects these general trends, the case study findings suggest that Ontario's existing water governance system is not capable to deal effectively with more frequent and prolonged drought conditions anticipated in Whiteman's Creek as the climate changes.

Introduction of decentralized governance arrangements over the past decade, primarily the Ontario Low Water Response (OLWR) plan, has enhanced capacity in Whiteman's Creek to cope with recurring low water conditions. Yet when pressed with extreme drought conditions, as experienced during the period of field work for this thesis, the challenge of satisfying both instream water needs and withdrawal uses reveals weaknesses in the governance system, including unclear decision-making criteria (e.g., related to hydrological thresholds), uncertainty related to roles and responsibilities of various actors, and generally limited capacity for precaution and adaptation.

Recommendations are proposed for improving water governance in Whiteman's Creek, and in Ontario more broadly. Ecologically-based thresholds should be integrated into water management regimes to ensure sufficient water is secured to sustain aquatic ecosystem integrity and to provide clarity on limits to permitted allocation and OWLR thresholds. More broadly, a focus on building adaptive capacity and engaging in anticipatory planning will be central to building resilience and fostering sustainability in Whiteman's Creek.

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DEDICATION

For and because of Carol and Esrael

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Chapter 1: INTRODUCTION

1.1. Setting the context

Whiteman's Creek is a small tributary of the Grand River, located in the heart of southwestern Ontario. Despite its proximity to the world's largest freshwater lakes – the Laurentian Great Lakes – water scarcity is a persistent problem in Whiteman's Creek watershed. During late summer and early autumn, both precipitation and stream flow are at a minimum when water taking reaches a maximum. Providing sufficient water to support cash crop operations while at the same time sustaining the integrity of the creek ecosystem is a growing challenge (Grand River Conservation Authority, 2007b).

Evidence suggests that water scarcity may be worsening in Whiteman's Creek. Ivey's (2002) summary of climate change impacts for southern Ontario and the Grand River watershed points to declines in late summer and early autumn precipitation, annual surface runoff and discharge rates, and increased evaporation due to rising air temperatures. Observations for Whiteman's Creek watershed support these projections as summer low water conditions are becoming more frequent. The decade from 1995 to 2005 included five years of drought-level conditions, with critical low water levels experienced in 1999 and 2001 (Grand River Conservation Authority, 2005a). In 2007, the provincial Ministry of Natural Resources asked anglers in the region to voluntarily stop fishing in Whiteman's Creek because brook and brown trout were under stress from near-record low water levels and increased water temperatures (Ontario Ministry of Natural Resources, 2007).

The situation in Whiteman's Creek illustrates the some of the key challenges of water management in the 21st century. Growing human demands for water coupled with the impacts of climate change are altering the quality and availability of fresh water, which increases the difficulties of securing water to support economic activities such as agriculture and urban development while also protecting the life-supporting functions of freshwater ecosystems (Postel, 2000: 941). The situation in Whiteman's Creek also points to the important role of fresh water – and governance over it – as fundamental to building or maintaining resilience in socio-ecological systems (SES), which is viewed as a critical element of sustainability (Walker and Salt, 2006).

The 21st century water challenge is recognized largely as a governance problem (Kreutzwiser and de Loë, 2004; Brandes, Ferguson, M'Gonigle et al., 2005; UNESCO, 2006; United Nations Development Program, 2007). It is widely acknowledged that technological solutions and/or enhanced scientific understanding alone cannot solve mounting water challenges; rather, the problems – and the solutions required to address them – often relate more to social and institutional factors. Effectively addressing these challenges will require strengthening of existing organizations and institutions and developing new arrangements to reconcile the often conflicting needs, values and interests of various stakeholders without further compromising the integrity and productivity of ecological systems (de Loë and Kreutzwiser, 2007).

As with environmental issues more broadly, water governance and management *are* shifting in response to the challenges of the 21st century (Gleick, 2003; Pahl-Wostl, Craps, Dewulf et al., 2007). The tradition of state-led, command-and-control regimes is giving way to models based on decentralized decision making and participatory planning involving state and non-state actors, including water users, environmental organizations and citizens (Dale, 2001; Folke, 2003; de Loë, 2005; de Loë and Kreutzwiser, 2007). At the same time, the practice of water management is shifting from an emphasis on extraction of resources and manipulation of freshwater ecosystems towards more holistic approaches that seek to manage human water demands within the broader goal of protecting and restoring ecosystem integrity (Folke, 2003; Gleick, 2003; Pahl-Wostl, Craps et al., 2007).

The persistent water problems in Whiteman's Creek relate, at least in part, to problems with the Permit to Take Water (PTTW) program. The creek is, as a report in 2005 concluded, over-allocated.[1] The report states:

> It is clear that the permitted rates far exceed the availability of water in Whiteman's creek, and if they were extracted simultaneously at the maximum permitted rate, there

[1] The term over-allocated reflects permitted uses, which are for a specified volume and may be subject to additional criteria related to timing of use. Permitted takings do not necessarily equal actual water takings as users may not use their full permitted allocation in all or some years.

> would be nothing left for the aquatic environment (Grand River Conservation Authority, 2005a: 202).
>
> From an implementation perspective, the PTTW fails to effectively account for the cumulative impact of multiple water takings within a watershed or specific region. From a design perspective, the PTTW includes only discretionary consideration of the needs of the aquatic environment on a case-by-case basis; there is no overarching requirement in the PTTW program (or any other provincial law or policy in Ontario) that ensures sufficient water is secured to support ecosystem functions.

The response to the water allocation problem in Whiteman's Creek reflects a shift towards more decentralized and participatory water governance. In 2003, the provincial government introduced the Ontario Low Water Response (OLWR) program to facilitate effective local response in the event of a drought. Superimposing the OWLR program on the PTTW system shifted water governance towards a more decentralized regime focused on the local or sub-watershed scale, and on engaging a range of watershed actors and interests in decision making around water allocation. Around the same period, even more localized responses – Irrigation Advisory Committees (IAC) – emerged in agricultural areas in regions of Ontario experiencing increasingly severe and frequent low water conditions, including Whiteman's Creek. This reflects a further decentralization of water governance to the local scale and with some aspects of decision-making authority devolved to water users. The result is part of an evolution towards a nested set of institutions for water governance and a move towards more decentralized and participatory decision making.

1.2. Research scope and questions

Using Whiteman's Creek as a case study, this thesis seeks to understand whether and how this evolution in water governance in Ontario is building resilience and fostering sustainability in SES. The focus is on water allocation, broadly understood to mean the system of processes and institutions through which society enables and constrains the use of water, when and under what circumstances. The thesis is framed by the following questions:

1. What are appropriate criteria for assessing governance for sustainability in SES?

2. Is governance of water allocation in Ontario fostering sustainability in SES?

3. How might governance of water allocation in Ontario be modified to better foster sustainability in SES?

1.3. Conceptual perspective

In this thesis, water governance and sustainability are approached from a systems perspective, viewing Whiteman's Creek watershed as a SES. Berkes and Folke (1998) began using the term 'social-ecological systems' to denote the integrated elements of human and natural systems and to emphasize that the distinction between the two is artificial and arbitrary. Humans are part of, rather than separate from, nature. Our activities, particularly as collectives through our social and economic institutions, are major influences on ecological patterns and are in turn affected by them (Grumbine, 1994; Grumbine, 1997; Cortner and Moote, 1999; Kay, Regier, Boyle et al., 1999; Folke, 2003; Slocombe, 2010).

Anderies, Janssen and Ostrom (2004: 3) define an SES as "an ecological system intricately linked with and affected by one or more social systems." This perspective views linked social and ecological systems as nested hierarchies of complex, adaptive units; an SES consists of multiple subsystems that at the same time are embedded within multiple larger systems (Kay, Regier et al., 1999; Mitchell, 2002; Anderies, Janssen et al., 2004). Falkenmark et. al (Falkenmark and Folke, 2002; Falkenmark, 2003; Falkenmark and Rockstrom, 2004) have added an explicit hydrological dimension to the SES concept to reflect the fundamental importance of fresh water to sustainability, arriving at a conception of watersheds as integrated socio-eco*hydrological* systems.

Systems approaches and systems thinking underpin the concept of SES. Some argue that widespread adoption of a systems perspective in planning and natural resource management is central to directing society onto a sustainable trajectory (Trist, 1980; Kay, Regier et al., 1999; Ravetz, 1999; Folke, 2003). In the realm of fresh water, Falkenmark and Folke (2000: 351) suggest that there *is* an "ongoing shift from an impact-oriented to a true systems approach." Elsewhere, Folke (2003) proposes a shift in perspective for freshwater management from a command and control approach intended to stabilize 'optimal' production towards a complex systems perspective based on managing for social-ecological resilience (Table 1-1).

Table 1-1: Shift in thinking and perspective on freshwater management

From command-and-control	To complex systems
• Assume stability and seek to control change	• Accept change and manage for resilience
• Assume predictability and seek optimal control	• Acknowledge uncertainty and opt for risk spreading
• Manage resources for increased yield	• Manage diversity to cope with dynamic change
• View water as input to production	• View water as Earth's 'bloodstream'
• Rely on technological change to solve resource issues	• Rely on adaptive co-management to build resilience
• View society and nature as separate systems	• View society and nature as co-evolving systems

(Adapted from: Folke, 2003: 2033)

1.4. Justification

Governance and, more specifically, water governance is a relatively new field of inquiry. Imperial (1999) notes that the field is challenged by lack of consensus on approaches for studying governance networks, particularly regarding what constitutes successful performance and how it might be measured. In this thesis, I attempt to address this challenge by proposing a framework for assessing water governance as it relates to resilience and sustainability in SES.

The thesis focuses on how to approach the problem of governing water use in a manner that ensures human water demands do not undermine the integrity of aquatic ecosystems in order to secure and enhance resilience and sustainability in SES (Folke, 2003; Postel and Richter, 2003; Wallace, Acreman and Sullivan, 2003; Falkenmark and Rockstrom, 2004; Smakhtin, Revenga and Doll, 2004). It is anticipated that approaching the problem of water governance from a sustainability perspective and via a systems approach will identify means for delivering on or at least providing steps towards this primary focus. More pragmatically, given that water issues are anticipated to be an increasingly pressing challenge for parts of Ontario, this thesis aims to provide a sense of direction and recommendations for improving water governance in Whiteman's Creek watershed, and for Ontario more broadly, as steps towards sustainability.

1.5. Research approach

The research was conducted using a case study approach. In employing a case study approach, researchers seek in-depth understanding of a complex social phenomenon such as a program, an event, an activity, a process, or individual/group dynamics through intensively exploring a single or small number of examples (Rothe, 1994; Creswell, 2003). This research focuses on a single case – Whiteman's Creek watershed – to develop a 'thick' understanding of water governance by looking at the various decision-making arrangements at various ecological and institutional scales (Young, 2002; Adger, Brown, Fairbrass et al., 2003).

Qualitative strategies were used to collect, analyze and interpret case study data. Data were collected through content analysis of documents, records and websites and via semi-structured interviews with key informants. With the conceptual framework providing the structure, the data were synthesized into a narrative from which recommendations for strengthening water governance emerged. The focus on a single case limits the potential to generalize to other watersheds across the province; however, it does provide insights into the performance of policies that, in many cases, apply province-wide, and to similar low water challenges in other regions or contexts.

1.6. Thesis outline

This thesis includes six chapters. This introduction is followed by Chapter 2, which reviews the literature regarding resilience, sustainability and systems thinking, governance and planning, and water policy and management, and from this literature proposes a conceptual framework for assessing water governance. Chapter 3 discusses the research design, including the general methodology, methods for data collection and interpretation, and the research procedure and limitations related to the approach. Chapter 4 is the first of two chapters presenting the case study of water governance in Whiteman's Creek. It outlines the context, including the watershed environment and legal and institutional framework for water governance in the watershed. Chapter 5 builds on this context to assess water governance in Whiteman's Creek by applying the assessment criteria developed in Chapter 2. Chapter 6 presents conclusions and recommendations, limitations, as well as opportunities for further research.

Chapter 2: LITERATURE REVIEW

This chapter draws on three broad but overlapping bodies of literature – (1) sustainability, resilience and systems thinking, (2) governance and planning, and (3) water policy and management – and from this information creates a conceptual framework for understanding and assessing governance arrangements for water management to foster resilience and sustainability.

The first section of the chapter establishes the context for the thesis with discussions of sustainability, resilience and fresh water, the concept of SES as a systems-oriented approach to addressing sustainability problems, and the role of governance and planning as part of such responses. The second section draws on these literatures to develop the assessment criteria applied to the case study in Chapter 4 and 5.

2.1. Sustainability

In 1987, the World Commission on Environment and Development landmark publication *Our Common Future* defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987: 8). Since its introduction, the concept of sustainable development has influenced aspects of human development ranging from natural resource management and urban planning to policies and institutions dealing with environmental security, poverty and human health, and economic planning. It has been taken up, to varying degrees and under varying interpretations, by government bodies at national and sub-national levels, and by influential policy actors from the UN to non-government organizations.

Over the following 20-plus years since *Our Common Future* was published, the definition of sustainable development has been the subject of debate and criticism that typically has focused on the use of the word *development*. That word is often interpreted as synonymous with growth, implying a primarily physical or material expansion of production (Daly and Cobb, 1994; Mitchell, 2002). The problem with this perspective is that the biosphere has a limited capacity to sustain growth. Therefore, such a perspective fails to address the fact that, ultimately, ecological limits to physical and material expansion exist beyond which irreversible scarcity of resources and degradation of life-sustaining ecological processes begins to occur. Daly and Cobb (1994; 1996) distinguish growth, normally understood as quantitative expansion, from development, taken to mean qualitative improvement. The word ‘sustainability’ is now typically preferred to ‘sustainable development’, as it eliminates interpretation of ‘sustainable’ as an adjective for growth (Mitchell, 2002).

Recognition of limits to growth, while fundamental to defining sustainability, has also been one of the many challenges encountered in operationalizing the concept. Central to the challenge is that ecological limits to physical and material expansion are unlikely to be fixed or absolute, but are more likely to reflect conditions in a given time and at a particular place, including the operative technologies and associated practices (Mitchell, 2002: 78). As stated in *Our Common Future*, “ecological limits are not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities” (WCED, 1987: 8). However, as Dale (2001: 126) notes, despite the fact that limits are made more plastic through technology and human ingenuity, humans cannot escape the limits of a finite biosphere. In order to avoid abrupt global environmental change due to anthropogenic pressures on Earth, Rockstrom et al. (2009) suggest there is a need to define a “safe operating space for humanity”, and argue that staying within that space will require that, as a minimum, humanity not transgress one or more of seven ‘planetary boundaries’ related to: CO_2 concentration in the atmosphere, ocean acidification, stratospheric ozone concentration in the atmosphere, cycling of nitrogen and phosphorus, global freshwater use, land conversion, and loss of biodiversity.

As the sustainability literature evolved, the now-common ‘pillars’ conception emerged as the dominant framing. This evolution in the understanding and application of sustainability is commonly centred on three pillars – social, economic and ecological – and the balancing or at least accounting of considerations and values within these three categories. As Gibson et al. (2005: 94) indicate, these categories have proven useful in grouping relevant actors and interests in sustainability discussions and in organizing sustainability indicators but “…the pillars have proven more useful for categorizing and separating than for linking and integrating”. More pointedly, Gibson et al. (2005: 94) note that:

> The pillar categories reproduce the deeply entrenched divisions of policy mandates and research expertise that have long frustrated more integrated thinking. And they encourage a focus on conflicts, especially between economic and ecological pillars, which are often assumed to be the foundations of warring houses. As a result, pillars-based approaches to

> sustainability planning and evaluation tend to concentrate attention on competing objectives, rather than on opportunities for positive accommodations of interrelated human and ecological interests.

This thesis adopts a more comprehensive conception of sustainability that has emerged with the growing influence of systems concepts such as SES and resilience on policy, planning and management. The concept of resilience, first introduced by Holling (1973) to help understand the capacity of ecosystems to persist when subject to perturbations, has since been applied more broadly to include social elements of linked SES. Walker and Salt (2006: 37) assert that resilience is the "cornerstone of sustainability" and that any approach to or conception of sustainability that does not explicitly acknowledge a system's resilience is simply not going to deliver the goods and services we require to endure over the long term. Walker and Salt (2006: 37) describe a resilient SES as having "greater capacity to avoid unwelcome surprises (regime shifts) in the face of external disturbances, and so has a greater capacity to continue to provide us with the goods and services that support our quality of life." It is important to direct attention to cross-scale interactions in SES to remain cognisant of forces operating at broader systems scales, in particular the dominant global political economy that is driving humanity towards ever deeper unsustainability (Young, 2002; Gibson, Hassan et al., 2005).

This more comprehensive perspective places a greater emphasis on governance and planning as central to moving towards sustainability. Gibson et al. (2005: 95-114) present a set of sustainability requirements developed from an extensive review of the sustainability literature that reflect this comprehensive view. They are:

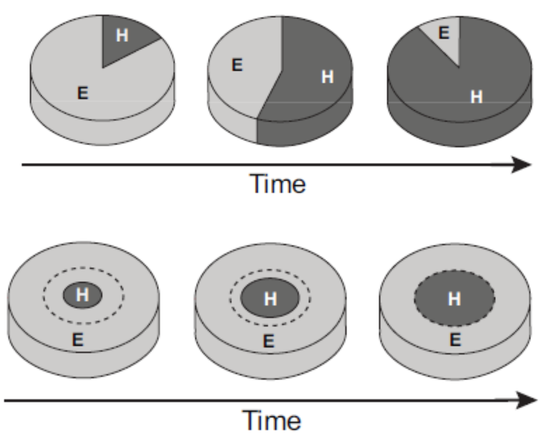
- **Socio-ecological system integrity –** Build human-ecological relations that establish and maintain the long-term integrity of socio-biophysical systems and protect the irreplaceable life support functions upon which human as well as ecological well-being depends.
- **Livelihood sufficiency and opportunity –** Ensure that everyone and every community have enough for a decent life and opportunities to seek improvements in ways that do not compromise future generations' possibilities for sufficiency and opportunity.

- **Intragenerational equity –** Ensure that sufficiency and effective choices for all are pursued in ways that reduce dangerous gaps in sufficiency and opportunity (and health, security, social recognition, political influence, etc.) between the rich and the poor.
- **Intergenerational equity –** Favour present options and actions most likely to preserve or enhance the opportunities and capabilities of future generations to live sustainably.
- **Efficiency –** Provide a larger base for ensuring sustainable livelihoods for all while reducing threats to the long-term integrity of socio-ecological systems by reducing extractive damage, avoiding waste and cutting overall material and energy use per unit of benefit.
- **Socio-ecological civility and democratic governance –** Build the capacity, motivation and habitual inclination of individuals, communities and other collective decision-making bodies to apply sustainability principles through more open and better informed deliberations, greater attention to fostering reciprocal awareness and collective responsibility, and more integrated use of administrative, market, customary, collective and personal decision-making practices.
- **Precaution and adaptation –** Respect uncertainty, avoid even poorly understood risks of serious or irreversible damage to the foundations for sustainability, plan to learn, design for surprise and manage for adaptation.
- **Immediate- and long-term integration –** Attempt to meet all requirements for sustainability together as a set of interdependent parts, seeking mutually supportive benefits.

2.1.1. Sustainability and fresh water

Sandra Postel, a leading global voice on freshwater issues, notes that "the sustainability of our water use will hinge on our finding ways to secure the water required to support human livelihoods while at the same time protecting the life-supporting functions of freshwater ecosystems" (Postel, 2000: 941). Consistent with the discussion above regarding limits to growth, Postel (2003: 91-92)[2] provides a useful approach to discussing ecological limits in the context of fresh water management (Figure 2-1) and uses it to illustrate the impacts of 'traditional' water management policies and to propose an alternative approach. The upper diagram is meant to illustrate the priority placed on economically productive human water uses (H) under traditional water management and planning and the concomitant decrease in water remaining in situ to secure ecosystem integrity (E). The proposed alternative illustrated in the lower diagram acknowledges that the human water economy is nested within and inextricably dependent on nature's water economy. It explicitly addresses ecosystem needs by placing a limit on human water use, which Postel and Richter (2003: 39) to as a "sustainability boundary."

Figure 2-1: Sustainability boundaries



As Postel (2003: 92) explains, the sustainability boundary concept illustrates limits on both the quantity of water available in a given watershed, and on the extent to which human activities can alter freshwater ecosystems before impairing the production of the goods and service they provide. It thus provides a framing for discussions of water scarcity that explicitly recognizes the needs of ecosystems in assessments of water scarcity (Smakhtin, Revenga et al., 2004).

Accurately identifying and establishing a sustainability boundary in a specific context is both theoretically and practically challenging, if even possible. This difficulty occurs in part because, under the conception discussed above, the sustainability boundary implies seeking limits that are static points or thresholds; yet, we are dealing with complex, dynamic SES, not to

[2] The diagrams included here, taken from Postel and Richter (2003: 39), originally appeared in Postel (2003).

mention the challenge of dealing with water management in the context of climate change, which is shaking foundational principles of hydrology. In a recent review of worldwide changes in streamflow, Milley et al. (2008) identified a global pattern in which anthropogenic climate forcing now dominates the influence of large-scale atmospheric cycles on hydrology. One of their conclusions is that, given the magnitude and ubiquity of hydroclimatic change apparently now under way, the foundational hydrological concept of stationarity – the notion that past trends can be used to predict future conditions – is no longer valid. As noted in the article, "we assert that stationarity is dead and should no longer serve as a central default assumption in water-resource risk assessment and planning" (Milley, Betancourt et al., 2008: 574).

2.1.2. Complexity, uncertainty and conflict

As water resources become scarcer and ecological impacts of growing water use more evident, complexity and uncertainty become more apparent in water management, often leading to increased potential for conflict among the many actors with interests in freshwater resources and ecosystems. These are defining characteristics of what Bardwell (1991: 603) refers to as 'environmental' problems, described as "complex, plagued with uncertainty and extremely political." Similarly, Booher and Innes (2010) note, the problems facing policy makers and planners in the 21st century often have the potential to overwhelm the organizations society depends upon on due to issues of uncertainty and complexity, fragmentation and diversity, interdependence and new spaces for and modes of decision making.

Human and ecological systems are dynamic; continuous change and surprise are inevitable. This change leads to uncertainty in natural resource and environmental planning and management (Holling, 1996; Mitchell, 2002). In the context of water governance, complexity, uncertainty and conflict arise from dynamic interactions among human, hydrological and ecological systems. As Slocombe (2010: 425) notes, "conflict and uncertainty in resource management emerge from many sources, some in the natural environment, some in the human, and more in the interaction of the two." Lack of knowledge due to limited availability of data is the best-known type of uncertainty, but equally important, but often less recognized, it the uncertainty related to the broader system. For example, historical trends and interactions among system elements such as non-linearities, feedback loops and delays create significant uncertainty for governance and management. In SES, uncertainty also arises from social elements – from the diversity of rules and institutions operating at various scales and the underlying mental models that influence stakeholder perceptions and actions (Pahl-Wostl, Sendzimir, Jeffrey et al., 2007). Mitchell (2002) suggests that rather than seeking to resolve the challenges posed by complexity, uncertainty and conflict, we should “recognize their importance and to determine how to function in their presence.” Table 2-1 outlines potential sources of complexity, uncertainty and conflict in water governance.

Table 2-1: Complexity, Uncertainty and Conflict in Water Governance

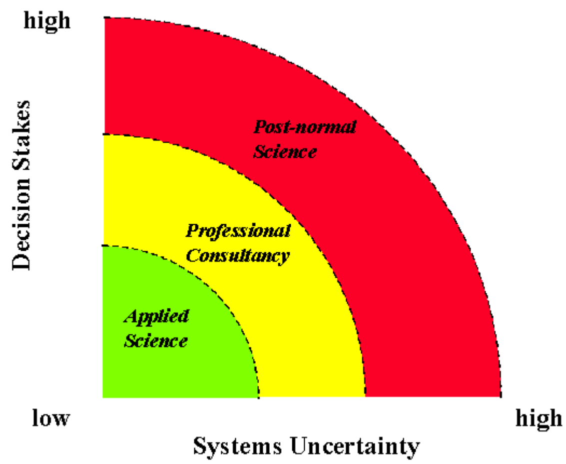
Complexity	Variability of ecological processes such as precipitation, runoff, infiltration. Changing economic uses for water, political priorities and social values. Many actors with interests in freshwater resources and ecosystems including industry, agriculture, municipal and recreational users, as spiritual and cultural values. Horizontal and vertical fragmentation in governance.
Uncertainty	Limited predictive ability for flood or drought Unreliability of future water supply due to climate change Unclear roles and responsibilities among various levels and agencies of government. Limited understanding of current and future water supply and demand. Unclear or inconsistent water use priorities. Limited understanding of ecological needs
Conflict	Human water demands vs. nature’s needs. Competing human demands and interests – upstream/downstream issues.

2.1.3. Systems thinking and resilience

Acting in concert, complexity, uncertainty and conflict constitute the context in which science, policy and planning must progress. As Trist (1980: 117) suggests, in the realm of environmental policy we are no longer dealing with problems but with “systems of problems” or “metaproblems”. Addressing these systems of problems, according to Trist, is beyond the problem-solving capabilities of centralized bureaucratic systems. Rather, an interactive mode of planning focused on collaboration, identifying shared values, continuous learning, and ongoing evaluation and modification is proposed to handle such turbulent conditions (Trist, 1980; Mitchell, 2002).

Funtowicz and Ravetz (1993; Ravetz, 1999) introduced the idea of post-normal science for analyzing and responding to complex problems and systems. Based on two key properties (uncertainty and decision stakes), they differentiated complex systems from simple and complicated systems, and suggested approaches appropriate for dealing with each. System uncertainties reflect the degree to which measurement and observation alter the system, as well as data limitations or incompleteness of information. Decision stakes reflect the various costs, benefits and values of stakeholders involved in the system. The relationships between the two – and the responses proposed by Funtowicz and Ravetz – are shown in Figure 2-2 and Table 2-2.

Figure 2-2: Typology of problem-solving strategies



(Source: Funtowicz and Ravetz, 1993)

Table 2-2: Typology of problem solving strategies explained

	System type	Response strategy
Applied Science	*Simple systems* in which the number of variables is such that they may be controlled or accounted for.	Normal science – the tradition of ‘objectively’ searching for factual knowledge through reductionism and rigorous application of scientific method.
Professional Consultancy	*Complicated systems* in which the number of variables needed to explain or deal with phenomenon	Decision stakes demand skill and judgment of the seasoned professional (e.g., surgeon,

	cannot be as easily controlled as in simple systems.	senior engineer or planner).
Post-normal Science	*Complex systems* in which uncertainty is irreducible, stakes are high, and values are in dispute.	Dialogue among legitimate actors or "extended peer communities".

(Adapted from: Funtowicz and Ravetz, 1993; Ravetz, 1999; Funtowicz and Ravetz, ND)

In post-normal science, "the quality of the decision-making process is absolutely critical for the achievement of an effective product in the decision" (Funtowicz and Ravetz, ND). This assurance of quality is achieved through dialogue among legitimate actors – what Funtowicz and Ravetz refer to as "extended peer communities". Post-normal science is not meant to do away with past scientific traditions but rather to build on them by democratizing science and placing it in its social context. It is meant to recognize that science alone cannot decide what are often value questions (Cortner and Moote, 1999) – or to quote Dubos (1968: 145), "Scientific knowledge per se cannot define or impose values to govern behaviour, but it provides facts on the basis of which choices can be made."

As discussed in the introduction to this chapter, a systems approach and the concept of SES are useful conceptual frames through which to tackle problems sharing characteristics of complexity, uncertainty and conflict. According to Flood and Carson (1993), the systems concept is used to represent an organized whole that consists of elements sharing some relationship(s). Similarly, Funtowicz and Ravetz (ND) describe a system as a collection of elements and subsystems, defined by their relations within some sort of hierarchy or hierarchies. The systems model is a heuristic aid used to understand the real world by structuring complex situations as an organized whole of interrelated elements (Flood and Carson, 1993; Bunch, 2002).

Systems thinking stands in contrast to the reductionist thinking that underpins most applied science. Rather than studying an entity by reducing it to a number of discrete components, a systems perspective focuses on the arrangements of and the relations between the parts that connect them into a whole (Heylighen and Joslyn, 1992). The systems mode of analysis brings attention to multiple levels of scale and patterns relationships – it focuses on all levels in a hierarchy, to horizontal and vertical connections, and, most importantly, to the connections among them. Analysis is holistic in the sense that it focuses on identifying and analyzing interrelationships and connections rather than linear causal chains.

The SES concept provides a framework for developing such a holistic picture of the structure and dynamics of interdependent social and ecological systems. This holistic picture draws together consideration of social systems, including issues such as governance, access to resources and property rights, as well as ecological systems, which involve issues of ecosystem function, structure and processes (Berkes, Colding and Folke, 2003). The understanding of SES as nested hierarchies or multiple subsystems that at the same time are embedded within multiple larger systems (Kay, Regier et al., 1999; Mitchell, 2002: 111; Anderies, Janssen et al., 2004) is consistent with the notion of nested basin, or nested watershed, perspectives common in freshwater management and governance such as integrated water resource management (IWRM) and integrated river basin management (IRBM) (Mitchell, 1990; Mitchell and Shrubsole, 1992; GWP, 2000; Plummer, Spiers, FitzGibbon et al., 2005).

The concept of resilience is closely linked to systems thinking (Gunderson and Holling, 2002). Indeed, Walker and Salt (2006: 31) assert that “Resilience thinking is *system thinking*.” Resilience thinking addresses the dynamics and development of complex SES. It is defined as the capacity of a SES to continually change and adapt, yet remain within critical thresholds. Adaptability and transformability are viewed as two key aspects of resilience (Walker, Holling, Carpenter et al., 2004; Folke, Carpenter, Walker et al., 2010). Adaptability (or adaptive capacity) refers to the capacity of a system to adjust responses to changing external forces and internal processes in order to maintain development within the existing system regime. Transformability refers to the capacity of a system to shift to a new system regime by crossing critical system thresholds. Transformation in SES can come about by making use of crises as windows of opportunity for novelty and innovation or by combining existing sources of knowledge and experience to shift the system on to new development trajectories (Folke, Carpenter et al., 2010).

Resilience thinking is posited as a challenge to, and replacement for, the basic conceptual framework underpinning environmental and natural resource governance and management. Traditionally, environmental and resource management has focused on maximizing specific outputs for short term economic gain. In some applications, this perspective has shifted to a greater emphasis on balancing supply and demand under the rubric of optimization. Walker and Salt (2006) discuss the paradox of focusing narrowly on optimization, which essentially means maximizing specific, desired outputs or products from a system (e.g., fish, timber, food yield) by controlling other elements. The goal of optimization is to lock a system into some optimal state based on the belief that doing so will ensure maximum sustained benefits in terms of outputs of goods and services.

The problem with an optimization approach is that it does not reflect how the world really works. As Walker and Salt (2006) note, "The systems we live in and depend on are usually configured and reconfigured by extreme events, not average conditions." Further, they assert that optimization does not match the way humanity places value on things – it emphasizes a simplified focus on a limited number of quantifiable values (e.g., timber, fish) with little attention directed to the value of the system as a whole, or the unquantifiable life support values. The paradox is that, the more you optimize a system for production of specific values, the more you diminish the overall resilience. By contrast, a resilience-based approach recognizes that SES are complex and continually adapting through cycles of change. The intent of managing and governing for resilience is to strengthen the ability of an SES to absorb shocks and respond to surprises in order to sustain a system regime that will continue to deliver desired goods and services; or conversely, preventing the system from moving into an undesirable regime from which it is either difficult or impossible to recover (Walker and Salt, 2006; Folke, Carpenter et al., 2010).

2.2. Governance, planning and fresh water

The 21st century water challenge is recognized primarily as a governance challenge (de Loë, 2005; Bakker, 2007; de Loë and Kreutzwiser, 2007; Pahl-Wostl, Craps et al., 2007). The issues and the solutions relate much more to social and institutional factors than to lack of basic scientific understanding or adequate technology (Kreutzwiser and de Loë, 2004). For example, changes in water availability resulting from global climate change, attention to the water needs of ecosystems, and growing human water demands increase the potential for conflict among various interests and actors. At the same time, fragmented governance – among orders of government, agencies within governments, and among public, private and civil society interests

– often impede effective management (Kreutzwiser, de Loë, Durley et al., 2004; Hill, Furlong, Bakker et al., 2008).

Effectively addressing water governance issues will require strengthening the interactive and collaborative capacities of institutions and engaging in participatory planning processes to reconcile the often conflicting needs, values and interests of various actors without compromising the integrity and productivity of ecological systems (de Loë and Kreutzwiser, 2007). Ultimately, this can lead to decisions about trade-offs and priorities among social and environmental objectives related to fresh water. Consistent with the discussion of post-normal science presented above, Goldman (2004) notes that such decisions are and should be political, and should not be left to experts and narrowly framed models. To this end, McCarthy (2003), drawing on the work of Funtowicz and Ravetz, introduced the notion of post normal governance as a counter-proposal to challenge and critique the top-down, command and control and bureaucratic nature of more traditional approaches to environmental decision making.

2.2.1. Defining water governance

Broadly defined, governance refers to processes and structures for social coordination and collective decision making. It deals with questions of who decides and how? – that is, in the context of a given issue, who are legitimate actors, what are their interests, and what is the process for resolving disparate views among these actors and interests? Governance deals with the roles and activities of various actors and institutions, and interactions among them, in terms of their collective influence on the trajectory and development of SES.

The emergence of the governance concept has been linked to various political and economic trends, including devolution of responsibilities from higher to lower levels of government, and a hollowing out the state that has led to such things as reduction in the size of governments, abandonment or curtailment of some traditional areas or activities (e.g., research), privatization of delivery of public services, and cuts to capacity for effective programming, regulation and enforcement (Francis, 1996; Stoker, 1998; McCarthy, 2003; de Loë, 2005). At the same time, demands for effective collective responses are rising to address growing challenges of globalization, climate change and a generally increasing pressure of human activities on biophysical systems. Consequently, governance focuses on establishing, clarifying and integrating the roles of multiple actors, including government authorities, private sector and not-for-profit organizations, in policy, planning and management across spatial scales (Sampford, 2002; McCarthy, 2003; Kemp, Parto and Gibson, 2005). As Kemp, Parto, and Gibson (2005: 17) note, governing for sustainability will require more coherently interrelated institutional structures and processes of planning, administration, markets, tradition and choice at every spatial scale.

Definitions of governance abound in the literature. Dale (2001: 178) provides a useful starting point for defining governance, suggesting that it "centres on the management of complex interdependencies among many different actors – individuals, corporations, interest groups, nation states – all of whom are involved in interactive decision making regarding issues that affect everyone's welfare." Governance involves the structures and processes by which societies share power and shapes individual and collective actions including laws, regulations, discursive debates, negotiation, mediation, conflict resolution, elections, public consultations, protests, and other decision-making processes (Lebel, Anderies, Campbell et al., 2006). More succinctly, governance refers to the "political, socio-economic and administrative systems that societies create to make decisions and manage resources" (de Loë, 2005: 1).

Over the past decade, a significant focus has emerged in the academic and gray literature on governance and fresh water – or "water governance." Bakker (2003: 5) defines water governance as "the range of political, organizational and administrative processes through which communities articulate their interest, their input is absorbed, decisions are made and implemented, and decision makers are held accountable in the development and management of water resources." Similarly de Loe and Bjornlund (2010) define it as "the ways in which decisions that affect water are made, who is involved in making those decisions, and how power is distributed in society." Bakker (2007: 16) distinguishes water governance from water management, while acknowledging the two are intimately linked: "*water governance* refers to the decision-making processes we follow, how we make decisions and who decides; *water management* refers to operational approaches we adopt, and the models, principles and information we use to make decisions." As applied in this thesis, water governance, includes the structures, processes and actors – and the dynamic interactions among them – that facilitate and influence decisions affecting water resources and aquatic ecosystems.

2.2.2. Planning – theory and practice

Fainstein and Fainstein (1996: 265) define planning as "future-oriented, public decision making directed toward attaining specific goals." Similarly, Hudson (1979: 387) defines it as "foresight in formulating and implementing programs and policies." This future orientation and explicit connection to public decision making and formulation and implementation of policy make clear the connections between governance and planning.

Like governance, planning is a challenging field of theory and inquiry to frame, due to its broad conceptual base that borrows from numerous social sciences. Indeed, in the introductory chapter of their reader on planning theory, Campbell and Fainstein (1996) note that "Planning theory is an elusive subject of study" and that "…the subject is slippery, and explanations are often frustratingly tautological or disappointingly pedestrian." Hudson's (1979) SITAR rubric is the most commonly cited framework for organizing and classifying planning theory. The acronym SITAR denotes five approaches in his classification system: Synoptic, Incremental, Transactive, Advocacy and Radical. According to Hudson (1979: 388), the latter four categories build from the synoptic approach – being either "modifications of synoptic rationality or reactions against it."

The *synoptic* approach, also referred to as a comprehensive rational model, typically follows a number of well-established steps: (1) defining the problem, (2) establishing goals and objectives, (3) identification of alternative means to achieve goals and objectives, (4) assessing the options against explicit criteria (5) choosing a preferred solution and implementing it, (6) monitoring and evaluation (Mitchell, 2002: 38). *Incremental* planning, as championed by Charles Lindblom, is based on a critique of the synoptic approach. Lindblom viewed the synoptic approach as unrealistic, reductionist and biased to central decision making and administrative control. Proponents of the incremental approach, also known as 'partisan mutual adjustment' or 'muddling through', stress that decisions are better understood and arrived at in terms of the "push and tug of established institutions" (Hudson, 1979: 389) working to accomplish objectives through means of decentralized bargaining processes (Lindblom, 1959; Hudson, 1979). Whereas a synoptic approach seeks to identify an optimum solution from among the many possibilities, incrementalism works within a 'bounded rationality' that simplifies the detail and complexity inherent in the real world into incremental decisions aimed at satisfying practically attainable goals and outcomes that are satisfactory rather than optimum.

Transactive planning is defined by its emphasis on process, and on personal and organizational development, rather than the more narrow focus of incremental and synoptic approaches on achieving specific objectives. It is more experiential, using “concrete experience and direct participation as the point of departure for problem solving…” rather than relying solely on expert input and data and centralized authority (Hudson, 1979: 392). *Advocacy* planning is a response to what its proponents see as power inequities in more traditional modes of planning. It is rooted in adversary procedures common to the legal profession that emerged in the 1960s movements aimed at defending ‘weak’ interests and marginalized causes, such as environmental protection and anti-poverty, against the established power of business and government. While successful in blocking particular projects and challenging traditional power dynamics, advocacy planning has been criticized for an inability to put forward and mobilize support for constructive alternatives (Hudson, 1979). Finally, Hudson’s tradition of *radical* planning is an ambiguous body defined primarily by a “critical and holistic look at large scale social processes” such as class structure, economic relationships and dynamics of social movements, alliances and confrontations.

Freidman’s (1987) classification of planning theory includes four traditions. *Social reform* is focused on role of the state in societal guidance and the use of the scientific approach. *Policy analysis* is essentially synonymous with the synoptic approach, focusing on analyses by technocrats aimed at social engineering. *Social learning*, under Freidman’s definition, is consistent with incrementalism in that it focuses on generation and accumulation of knowledge through social processes, and its application to facilitate action and change. Finally, *social mobilization* seeks to achieve goals through collective action from the ground up – it is consistent with advocacy planning.

Fainstein and Fainstein (1996) propose another four category typology of planning theory that includes traditional, democratic, equity and incremental approaches. The traditional approach is consistent with synoptic planning, with the planner prescribing both the goals and the means for attaining them. The democratic approach questions what is seen as the elitism of traditional planning, calling for greater participation by broader society in formulating both goals and solutions. Equity planning overlaps with democratic planning, but is less focused on process and more concerned with outcomes, with most attention directed at addressing who gets what and a defining goal being increasing equality. Finally, incremental planning, as in Hudson's description above, sees planning as moving forward through a series of "successive approximations".

There are no firm rules or criteria distinguishing if or when to use a particular approach under any of the classifications. Most commentators note that no single model or approach is perfect, and that the practice of planning often includes choosing among or integrating across models to suit particular circumstances. Planning theory is also likely best viewed as evolving, with a number of strands that intertwine and unravel with application and experience. One of the most defining elements in the evolution of planning theory is the move from an early spatial and physical focus – primarily on urban form – to an orientation more on the processes, quality and dynamics of decision making and on the social, political, economic and ecological context within which decision making occurs. This reorientation has many similarities – in terms of its focus and approach to inquiry – as changes in the field of governance.

Collaborative planning, which reflects Friedman's social learning tradition and Fainstein and Fainstein's democratic approach, focuses on discursive concepts and approaches to planning. Communication, interaction, and relationship-building among government, interest groups and other major sectors are at the heart of collaborative planning; these factors are viewed as means for improving policy development and implementation through social learning and consensus building (Margerum, 2002; Healey, 2003). This greater focus on multi-sector participation in decision making is a central element of what Healey (1992) refers to as the "communicative turn in planning theory". Drawing on Habermas' theory of communicative rationality, Healey's notion of "planning through debate" is a democratic mode of decision making based on collaborative, communicative processes of debating and deciding on matters of collective concern. The notion of planning through debate rejects the conception of rationality defined in terms of systematic application of logic and empirical science by autonomous individuals, proposing instead a communicative rationality whereby reasoning is achieved through inclusive, inter-subjective discourse aimed at mutual learning, shared understanding and development of collective courses for action (Braaten, 1991; Healey, 1992). Habermas' ideal of inclusiveness does not eliminate logic and science, but extends the knowledge base for reasoning to encompass all ways of knowing and many sources of knowledge; it may involve telling stories as well as doing analyses. In this way, the knowledge and principles that guide action are products of a collective understanding of the SES derived through open discourse (Healey, 1992).

In combing ideas from systems thinking with collaborative planning, Innes and Booher (2000) suggest a need for development of institutions with the capacity to recognize uncertainty, to manage crises and to deal with complex problems inherent in SES. It is argued that more traditional, mechanistic modes of planning and governance systems are poorly matched to the reality. What is needed is "a systems view of collaborative planning and governance that leads to policy making that is adaptive, innovative and intelligent" (Connick and Innes, 2003:180).

Goldstein (2009) discusses a coming together of the interests of resilience thinkers and communicative planners. Based on a symposium held in 2008 attended by members of both fields, Goldstein surmised that communicative planners' interest in resilience relates to broadening of the field beyond a traditional focus on dispute resolution and a growing appreciation for the notion of linked social and ecological systems, rather than approaching ecological concerns as simply another stakeholder claim. On the other hand, resilience thinkers' attention to collaborative and communicative planning stems from growing interest in voluntary coordination over hierarchical leadership in terms of the potential to build trust, manage conflict, link actors, initiate partnerships, enhance communication, foster innovation and mobilize support for change (Goldstein, 2009). Communicative planning is premised on the notion that collective deliberation can bring together different forms of knowledge and styles of reasoning to promote social learning and yield creative, mutually shared decisions. In the same way, resilience thinking, having evolved from an early focus on the 'policy as experimentation' thinking behind adaptive management, has broadened to an emphasis on exploring the potential for polycentric, self-organizing, participatory governance to cope with uncertainty and change in SES (Goldstein, 2009).

Given the discussion above, the planning model most relevant to this thesis is collaborative planning. The focus on communication and debate through participatory processes that are inclusive and aim to foster shared understanding and shared learning are consistent with the conception of water governance discussed in section 2.2.1. Integration of systems thinking with collaborative planning (as discussed above) reflects a growing appreciation for the concept of SES and increased focus on building resilience and fostering sustainability.

As with other approaches, collaborative, participatory and adaptive planning and governance models have limitations and constraints. One of the key criticisms of adaptive management and governance relates to costs, time and risk associated with implementation. Adaptive management is assumed to be an expensive undertaking requiring substantial and sustained financial resources, in particular, to develop reliable monitoring systems required to assess the impacts of policy and management interventions. Time is also an oft-cited concern. The notion of policy-as-experimentation that lies at the heart of adaptive management can take decades or even generations to produce discernable results, meaning that costs incurred in the present will result in benefits accruing to other interests well into the future. There is also a risk element associated with policy-as-experimentation; that is, there is a risk that experimental policies may not produce the anticipated or desired impacts, despite the fact that they do improve knowledge and understanding. This risk can create problems for political decision-makers whose careers may be threatened by openly admitting uncertainty relating to the implications of such policy interventions and by the reality of failed experiments (Holling, 1995; Walters, 1997; Gunderson and Holling, 2002). A key challenge in overcoming these limitations and constraints is to complement adaptive processes with institutions and organizations designed to recognize uncertainty, to manage crises and to deal with complex problems (Innes and Booher, 2000).

Collaborative planning models are also the subject of substantial criticisms that include inattention to power and equality (Huxley, 2000; Brand and Gaffikin, 2007) and an unbalanced focus on process at the expense of outcomes (Huxley, 2000). In a review of the theory and practice of collaborative planning, Gunton and Day (2003) discuss five weaknesses and challenges associated with the model. They are:

Unequal power relations: More powerful stakeholders may avoid or undermine collaborative planning, using their superior power and resources to delay processes or pursue alternative means to achieve their objectives. On the other hand, weaker stakeholders who are frustrated with the process may withdraw, reducing the likelihood of a mutually beneficial outcome.

Unequal stakeholder representation: Stakeholder groups willing and able to participate in collaborative planning may represent only narrow spectrum of interests, which can lead to exclusion of broader public interests not represented by organized groups.

Perverse outcomes of consensus rules: The focus on achieving consensus may lead stakeholders to settle for second-best solutions, or the lowest common denominator. Further, difficult or controversial issues such as recognition of ecological constraints may be ignored in an effort to achieve consensus and recommendations may be too vague to guide effective implementation.

Logistical challenges: Organizing and sustaining a planning process that includes a large group of often antagonistic participants requires substantial resources and time. Further, planning officials unaccustomed to or unfamiliar with collaborative planning may be unwilling to relinquish decision-making power to outside stakeholders.

Effectiveness in dealing with fundamental value differences: Some problems may simply be so intractable due to widely disparate values and worldviews that they are not amenable to collaborative planning approaches.

The authors caution against allowing these challenges to detract from applying and advancing collaborative planning; rather, they suggest it is important to consider whether these weaknesses are more or less challenging than those associated with other planning models. This speaks to the need to consider all planning models, and potentially hybrids of various models, to arrive at an approach best suited for the conditions and context of the problem being addressed.

2.2.3. Water governance and management evolving to a systems regime

According to some, the conceptual basis and practice of water governance, planning and management is in the midst of a paradigm shift (Cortner and Moote, 1999; Gleick, 2000; Gleick, 2003; Pahl-Wostl, Craps et al., 2007). This shift involves an evolution from a focus on optimizing resource efficiency and/or maximizing economic gain through top-down, centralized allocation of water resources towards systems oriented governance models and planning processes that view social and ecological systems as linked by the hydrologic cycle and that rely on a broader group of actors to participate in decision making related water resource management (Folke, 2003; Anderies, Walker and Kinzig, 2006).

Two key themes discussed in the literature regarding this shift are:

1. a broader view of the institutional context for water governance that is much more distributed or polycentric across a multiple scales and includes informal as well as formal institutional arrangements (McGinnis, 2000; Ostrom, 2001; Young, 2002; Adger, Brown et al., 2003; Plummer, Spiers et al., 2005; Crona and Hubacek, 2010; Nowlan and Bakker, 2010).

2. a mode of planning that strives to be inclusive, collaborative and participatory in nature, and is grounded in discursive decision making (Healey, 1992; Dale, 2001; Adger, Brown et al., 2003; Booher and Innes, 2010).

A central tenet of the governance concept is that it is about more than govern*ment*. Governance extends social coordination and decision making beyond the state to include non-state actors, including resource users, citizens, private-sector interests and non-government organizations in decision making and implementation (de Loë, 2005; Plummer, Spiers et al., 2005; de Loë and Kreutzwiser, 2007; Pahl-Wostl, Craps et al., 2007; Nowlan and Bakker, 2008). As Lebel et al. (2006: 2) state: "Governance is not the sole purview of the state through government, but rather emerges from the interactions of many actors, including the private sector and not-for-profit organizations. It can be formally institutionalized or expressed through subtle norms of interaction or even more indirectly by influencing the agendas and shaping the contexts in which actors contest decisions and determine access to resources." In the context of fresh water, de Loe (2005) notes that decisions about the use and management of water resources should – and, indeed, do – involve actors beyond the state. He further emphasizes that, given the complexity associated with interactions among ecological, hydrological and human systems and trends towards smaller governments, the state alone cannot do everything. Some functions are best handled by other actors.

The shift towards distributed governance is linked to systems and resilience thinking. In the domain of water and watershed management, such distributed governance is often discussed under the rubric of 'nested basin approaches' (Bruce and Mitchell, 1995; Plummer, Spiers et al., 2005). Ostrom (1995: 34) argues that centralized, hierarchical decision-making models "do not, and cannot, have the variety of response capabilities (and the incentives to use these capabilities) that complex, polycentric, multi-layered governance systems can have." Ostrom's thesis, which is based on Ashby's Law of Requisite Variety[3], is that "Any governance system that is designed to regulate complex biological systems must have as much variety in the actions that it can take as there exists in the system being regulated (Ostrom, 1995: 34)." Similarly, Francis (1988: 107) has referred to the hierarchical structure of agencies and institutions seeking to address ecological problems as "fundamentally unecological."

As Huitema (2009) notes, polycentric governance systems are those in which political authority is dispersed to separately constituted bodies with overlapping jurisdictions that do not stand in hierarchical relationship to each other. In polycentric governance systems, the capacity to deal with complex issues is typically widely dispersed across loosely connected actors functioning at different spatial scales and through a range of social networks with different centres of decision making (Imperial, 1999; McGinnis, 2000; Olsson, Folke and Berkes, 2004). The challenge is to coordinate capacities and relationships so that they come together on the ground in a coherent and ecologically sustainable way (Francis, 2005).

Booher and Innes (2010), in their case study of water planning and management processes in California (known as CALFED), argue that the CALFED process is an example of a self-organizing complex adaptive network in which collaboration is a central element of governance. They identify several innovations in water governance, including a distributed structure of information and decision making (i.e., polycentric structure), as well as nonlinear planning processes that are iterative and incorporate direct and indirect feedback, self-organization and adaptation. The tangible results of these innovations are a system of water allocation that protects 'environmental water' through an Environmental Water Account (EWA), while at the same time securing a reliable supply of agriculture and urban uses. The EWA creates a water supply for fishery needs by acquiring water through voluntary sales and contracts rather than regulatory means, and holds this water in reserve to use when it is needed most. Running the EWA is one of CALFED's most important activities and has buy-in from most stakeholders

[3] The law of requisite variety holds that any regulative system needs as much variety in the actions it can take as exists in the system it is regulating (Ostrom, 1995: 34).

because it was developed through a transparent, inclusive and collaborative process supported by extensive data gathering and modelling.

Nowlan and Bakker (2010) refer to distributed and collaborative governance as "shared water governance". They identify five key characteristics of shared water governance:

- Delegation by government of water governance to a council, committee, or basin organization;
- Rescaling decision making, often but not always, to the watershed scale;
- Greater participation by a wide variety of non-state actors;
- Collaborative decision-making processes, often emphasizing consensus and trust-building;
- Science-based decision making, often requiring extensive fact-finding.

Nowlan and Bakker (2010: 49) stress the importance of maintaining government's role in water governance, noting that "Shared water governance works best when governments are committed to educate and empower citizens, build trust and help build collective wisdom." They also note the importance of sustained capacity, noting that the benefits of shared water governance will only be realized in situations where financial and other resources are guaranteed and sustained over the long term.

While viewed by many as critical to dealing with sustainability issues and the complexity, uncertainty and conflict that underpin them, a shift towards distributed governance also poses challenges. Based on a review of the water governance literature, Huitema (2009) concluded that "There is little empirical evidence for the effectiveness of the river-basin approach, either in its monocentric form (unitary river-basin authorities) or its polycentric form (collaboration at the basin scale)". Dinar et al. (2005) suggest that basin-scale governance institutions are a necessary but insufficient condition for successful resource management. Their absence will lead to the failure of management but their presence does not necessarily lead to success. A fundamental challenge associated with such a shift towards distributed governance is to ensure governments establish clear lines of accountability so that they respond to and deliver on the mandates for which they are legally responsible. Obscuring of traditional jurisdictional and administrative boundaries and sharing of responsibilities among state and non-state actors requires increased attention to clarifying the roles of various governance actors to maintain transparency and accountability (Lundqvist, 2004; de Loë, 2005; Nowlan and Bakker, 2008).

Hill et al. (2008) discuss the relationship between harmonization and subsidiarity in water governance to assess differing degrees of and approaches to federal and provincial participation in water policy in Canada. Harmonization refers to the "process of achieving regulatory efficiency, effectiveness and clarity through standardization and centralization." Subsidiarity is "defined as the principle whereby a central authority does not take action (except in the areas which fall within its exclusive competence) unless it is more effective than action taken at lower levels" (Hill, Furlong et al., 2008: 317). Based on their analysis, the authors argue that it is not a matter of choosing one of two options (harmonization or subsidiary) but rather combining the two in ways that capture synergies to best deliver on objectives. So there is a need to explore which aspects of water governance would benefit from greater harmonization, and which from subsidiarity. While the analysis of Hill et al. (2008) focused on the relationship between federal and provincial legislative regimes, the notion of balancing subsidiary and harmonization is also relevant to relationships between federal and provincial governments and municipal governments, and in decentralized governance relationships and institutions involving a range of government and non-government actors.

2.2.4. Governance, planning and water allocation

Water allocation refers to the rules and procedures through which access to water is determined (Tarlock, 1988). Allocation systems establish availability and priority among a range of extractive and instream uses – including irrigation, municipal and industrial water supply, hydropower, recreation and environmental protection – thus influencing economic productivity, social and cultural well being and ecosystem integrity (de Loë and Bjornlund, 2010). Historically, allocation systems have focused primarily on efficient and equitable allocation of resources among human uses such as agriculture, power generation, and municipal water supply, with fresh water viewed primarily as an input to economic production (Folke, 2003; Richter, Matthews, Harrison et al., 2003). As human water demands continue to grow over the 21st century, existing allocation systems are coming up against ecological limits and are beginning to adapt to the need to secure water specifically for sustaining ecosystem integrity. The challenge for water governance thus expands beyond allocating among human uses to broader decisions regarding allocation of water to serve both direct human uses (i.e., for domestic needs, agriculture and industry) and requirements for maintenance of ecosystems and the many goods and services they provide (Acreman, 2001).

Various models exist for allocating water. Traditionally, the state has held the dominant decision-making role in water allocation, typically under administrative approaches and regulatory tools. Under such administrative allocation regimes, decisions are taken primarily through processes that emphasize bureaucratic expertise and state enforcement (Dinar, Rosegrant and Meinzen-Dick, 1997; Dryzek, 1997). Bjornlund (2000: 7) summarizes the nature of administrative water management, noting, "The traditional approach to water management is of a centralized nature, a command and control framework, where government regulations and central authorities define how water resources can be used and by whom – a top-down approach."

A water allocation model relying predominantly on administrative allocation often leads to waste and misallocation of water and fails to create incentives for users to conserve and improve efficiency of water use (Dinar, Rosegrant et al., 1997). Administrative allocation systems are often limited in terms of flexibility to respond to changing patterns of human water demand or the dynamic water needs of source ecosystems. Compliance with or adherence to decisions and rules occurs through a combination of regulatory enforcement and sanctions based on a broad societal acceptance of the legitimacy of legal frameworks and general desirability of the behaviours they guide or prescribe. Trends towards smaller, less interventionist governments typical of contemporary liberal democracies also pose challenges for monitoring and enforcing infractions of legal and regulatory frameworks and lead to a greater reliance on social norms and sanctions to guide appropriate behaviour (Dinar, Rosegrant et al., 1997).

One response to the limitations of administrative allocation is greater reliance on economic instruments, such as the trade and transfer of water rights. Under such an approach, decision making relies on market mechanisms to determine the value of resources, to allocate water to highest value uses, and to distribute costs and benefits efficiently among competing interests. According to Dinar et al. (1997), market-based systems are more responsive to change than centralized allocation of water; however, they also have limitations, particularly for addressing ecosystem needs for the water.

A significant challenge for market mechanisms arises from the nature of ecological systems. The integrity of ecological systems and many of the goods and services they provide are products of their value as wholes – a quality that is intractable for the reductionist and aggregative valuation techniques of neo-classical economics. When in an ecosystem (e.g., river, lake, wetland, aquifer), water is largely a public good. It provides benefits to multiple parties simultaneously and it is therefore difficult to exclude parties from enjoying these benefits regardless of whether or not they pay (i.e., water is "nonexcludable') (Postel and Carpenter, 1997). These characteristics make it difficult, if not impossible, to determine accurately an economic value for water when *in situ*. As a result, the price of water – or the fees charged to use water – rarely reflect its 'true' or 'full' social and ecological value (Postel, 2003).

A second, and for the purpose of this thesis, more critical issue is that markets do not ordinarily recognize biophysical limits on human water use. While markets may be satisfactory for allocating resources among competing users with the capacity to pay, markets are incapable of setting the overall scale of human water use. As Daly (2005: 104) notes:

> Economic theory has traditionally dealt mainly with allocation. It has not dealt with the issue of scale (the physical size of the economy relative to the ecosystem). Properly functioning markets allocate resources efficiently but they cannot determine the sustainable scale; that can be achieved only by government policy.

Thus, left unconstrained, market mechanisms are not likely to result in sustainable outcomes. Indeed, Bjornlund (2005: 7) suggests that without a process for setting limits on human water use, "water markets are likely to produce socially and ecologically undesirable outcomes." Using economic instruments therefore requires state-established rules for how they will function and parameters within which they will operate, including setting constraints on the markets by establishing limits on human water use (Syme, Nancarrow and McCreddin, 1999).

Regulatory and market-based approaches share this challenge of establishing limits on human water use: the former relates to limited potential of centralized and hierarchical modes of decision making to address cumulative effects and deal with complex systems challenges; the latter in the failure to recognize collective goods and internalize external costs. A central premise of this thesis is that establishing such a limit is a *planning problem*. Establishing the sustainability boundaries envisioned by Postel and colleagues rests in the realm of scientifically informed, democratic decision making. In this realm, social and environmental concerns can be separated from debates regarding the appropriateness or relative effectiveness of market-based or administrative water allocation systems. Rather, these higher level decisions regarding the sharing of water between instream environmental requirements and human demands are dealt with in collaborative planning processes where actors with legitimate concerns and interests come together to explore, and ideally reach consensus on and implement solutions (Bjornlund, 2005).

Water scarcity and growing pressure to secure water for ecosystems is resulting in increasingly complex and conflict-ridden decision making regarding allocation of water resources. No single approach to water allocation has been, or is likely to be, effective in dealing with such conditions. The solutions are much more likely to be found in combining aspects of various approaches to arrive at a model of water governance that provides the flexibility required to deal with change and surprise and enables collaborative, decentralized decision making, while also ensuring the higher level (i.e, government) oversight, authority and accountability required to maintain a credible and socially legitimate regime for managing a common resource.

2.3. Assessment framework

This section draws on concepts introduced and discussed above to develop a framework for assessing water governance in a SES. It begins with a brief explanation of how the SES concept is used descriptively – to frame the context of the case study presented in Chapters 4 and 5. It then sets out the assessment framework, which rests on seven criteria: socio-ecological system integrity; equity; efficiency; transparency and accountability; participation and collaboration; precaution and adaptation; and, integration.

There is a temptation in proposing such a framework to separate criteria into categories of ends and means, or outcomes and enabling conditions. However, through the literature review process, it became apparent that allocating criteria into such categories may not be useful because the means and ends are intertwined and some criteria could fall within either (or both) of the categories. Given this intertwining of means and ends, it is important to recognize that the aim is for all of the criteria to be met as well as possible, while appreciating that there can be tensions between and among them. Thus, in developing and applying the framework it is important to direct attention not only to the implications of specific criteria, but also to interacting effects among them in order to understand which ones may be mutually supportive and which may require attention trade-offs.

2.3.1. Describing an SES

Context refers to the interrelated conditions in which something exists, or in which phenomena occur. In systems terminology, establishing the context involves differentiating the system under observation from the external environment. According to Mitchell (1990: 8), describing the context within which a particular system functions involves consideration of some or all of: 1) the state of the natural environment; 2) prevailing ideologies; 3) economic conditions; and, 4) legal, administrative and financial arrangements.

This element of the conceptual framework provides an organizing structure to aid in the description of the case study using the SES concept. The SES description for Whiteman's Creek includes:

1. Biophysical conditions and trends, in this case with a particular focus on hydrological and ecological aspects of the watershed;
2. The institutional framework governing allocation and use in Ontario (i.e., relevant law, regulation, policy and jurisdictional distribution of responsibilities) as it relates to prevailing ideologies linked to more decentralized and participatory governance;
3. A history of socio-economic development in Whiteman's Creek;
4. Key actors (i.e., stakeholders, water managers) governing allocation and use of the waters of Whiteman's Creek, their interests and responsibilities; and
5. Financial capacity of the various actors and organizations involved in water governance and management.

2.3.2. Assessment Criteria

This section sets out criteria for assessing the effectiveness of water governance and sustainability. Assessing effectiveness means assessing the success of a process or initiative, with success defined by criteria or characteristics representative of progress in solving a particular problem, influencing a particular situation, or moving towards desired future conditions. In the realm of governance, effectiveness is typically defined as the extent to which a policy, plan, program or activity achieves its expressed objectives or desired outputs or outcomes (Adger, Brown et al., 2003; World Meteorological Organization, 2009).

Effectiveness can be interpreted in various ways. For example, an economic interpretation of effectiveness would focus on whether or not a policy or program resulted in greater wealth generation or economic efficiency. Similarly, where an outcome is important for public health, effectiveness might be assessed in terms of reduced instances of disease (Adger, Brown et al., 2003). These approaches are appropriate for assessments of specific programs or policies, but are unlikely to be useful in addressing broader concerns and considerations related to governance and sustainability in SES, which requires a more elaborate set of criteria against which the many institutions and processes that together form a governance system can be assessed (Young, 2005). The following sections discuss seven criteria against which this broader interpretation of effectiveness might be assessed. As noted previously, influences related to some criteria will be mutually supportive, while others may lead to tensions, requiring that attention be directed also to interactions between or among them, and to the system as a whole.

2.3.2.1. Socio-ecological system integrity

Gibson et al. (2005: 95) describe socio-ecological integrity as building "human-ecological relations that establish and maintain the long term integrity of socio-biophysical systems and protect the irreplaceable life support functions upon which human as well as ecological well-being depends." The concept builds from an earlier focus, rooted primarily in the natural sciences, on ecological integrity, a term that has a range of definitions and explanations and whose meaning has evolved.

Traditional interpretations of ecological integrity took a largely 'scientific' and 'objective' perspective, focusing on its value in describing the condition of an ecosystem relative to that of a natural or undisturbed system. For example, for Angermeier and Karr (1994), "Integrity implies an unimpaired condition or the quality or state of being complete or undivided; it implies correspondence with some original condition." Such definitions have been critiqued as narrow, rigid and even self-defeating because they tend to reinforce a discourse of conflict between economic development and environmental preservation as incompatible social objectives (Clark, Fluker and Risby, 2008).

System-oriented interpretations of ecological integrity take a broader view, looking beyond the focus on natural systems and objective measurement, recognizing the complex, dynamic nature of ecological systems and bridging the artificial gap between human and natural systems. For systems thinkers, ecological integrity encompasses ecosystem features such as resilience, elasticity and stress response that allow ecosystems to maintain function and structure under changing environmental conditions (Higgs, 2003: 122). Kay and Schneider (1994: 7) note that for an ecosystem to have integrity it must have the ability to operate under normal environmental conditions, cope with changes in environmental conditions (stress), and continue to evolve and develop (persist) in light of these stresses. Recognizing the 'stress' that is driving environmental change is largely the product of the nature and intensity of human activities, the integrity of an ecosystem has as much to do with human values and interventions in ecosystem dynamics as it does with the 'natural' functions and processes of ecosystems. "The traditional, objective scientific perspective on ecological integrity was thus a necessary but not sufficient foundation upon which to base environmental decisions" (McCarthy, 2006: 51).

Socio-ecological system integrity makes this human dimension in the ecosystem integrity discourse explicit. As noted by Clark et al. (2008: 161), "SES are dynamic, and have no 'pristine' or 'baseline' state to which the system should or could be restored or managed. When a system does, or is predicted to, enter a new state, an explicitly normative decision, informed, but not determined by science, must be made about which state is more desirable to manage for." Similarly, Gibson et al. (2005: 96) note that, "for sustainability, the objective [of socio-ecological system integrity] is not to prevent system change but to organize and manage our activities so that the changes we influence still preserve the system conditions and services upon which we rely."

Given the central role that fresh water plays in SES – in human health, livelihoods and economic development, and in sustaining the planet's biodiversity and life supporting functions – its governance and management are fundamental to maintaining and enhancing socio-ecological system integrity. Beyond basic human needs for drinking, hygiene and sanitation and subsistence diets, water is fundamental to economies and societies, serving as an input to industry, agriculture and urban development. At the same time, fresh water is also a foundation of the diversity of flora and fauna that comprise the biosphere we inhabit. As Falkenmark (2003: 2042) notes, "For any ecosystem function to be sustained, fresh water provides the foundation for the processes involved: a foundation that has largely been neglected in the past." Attention to ecosystem needs is now emerging as a significant focus of water governance and management globally (Folke, 2003; Postel and Richter, 2003; Wallace, Acreman et al., 2003; Falkenmark and Rockstrom, 2004; Smakhtin, Revenga et al., 2004; UNEP, 2010).

The sustainability boundary concept discussed in section 2.1.1 provides some direction for interpreting and assessing socio-ecological integrity in the context of water governance and management, as do concepts such as water security and sustainable water management. de Loe and Bjornlund (2010) indicate that "Water security exists when sufficient water of good quality is available for social, economic and cultural uses while, at the same time, adequate water is available to sustain and enhance important ecosystem functions." This view succinctly captures the importance of water to both human and natural systems; it does not, however, establish objectives for assessing socio-ecological integrity. definition of sustainable water management adds additional substance and direction. According to Richter's (in Galloway and Pentland, 2003: 9), sustainable water management requires that attention be directed to achieving four objectives simultaneously – those objectives, with some elaboration, are:

1. **Provide all humans with access to safe, clean water supplies to meet their basic needs.** Socio-ecological systems integrity depends in part on human health and well-being, both at the individual and community level, of those members of the SES in question. Ensuring reliable access to safe drinking water is thus critical to the overall effectiveness of water allocation systems. The generally accepted absolute minimum amount of fresh water required for human survival is approximately 5 litres per capita per day (lcd). To meet additional basic needs such as sanitation, food preparation and

bathing, 50 lcd is recommended (Gleick, 1996: 83). Consideration of what is sufficient in terms of access and availability will be coloured by context; so perspectives on what is 'sufficient' cannot be considered entirely objectively, and will depend on the affluence and degree of development of the society in question.

2. **Sustain healthy freshwater ecosystems that provide socially valued ecosystem services and products.** As noted above by Falkenmark, fresh water is fundamental to ecosystem function. In surface water systems, the water flow regime is now regarded as a 'master variable' that drives many other ecosystem processes, and is thus a useful, high-level indicator of overall ecosystem integrity (Poff, Allan, Bain et al., 1997; Richter, Matthews et al., 2003). Under natural conditions, flow regime varies over space and time according to local climatic conditions and surrounding landscape structure. If flow regimes are altered beyond critical limits, the ecological integrity and self-sustaining productivity of aquatic ecosystems become severely compromised, negatively affecting their ability to provide valued goods and services (Poff, Allan et al., 1997; Richter, Matthews et al., 2003). These benefits include such things as habitat for fish and other aquatic species that may be important to recreational or sport fisheries; natural flood attenuation in wetlands and side channels; cultural, aesthetic and spiritual values; and, conservation of biodiversity more broadly, which is a critical element of system integrity and resilience (Postel, 2005). The problem is that each system has unique water requirements within a range of quantity and variability, so there is no simple prescription for the 'correct' volume or variability of water flow required to sustain ecosystem integrity in a particular state. For water allocation, the goal is to manage patterns of water withdrawals in ways that emulate, as closely as possible, natural fluctuations in levels and flows (Brooks, 2005), and to monitor the impacts on key ecosystem functions and services as part of an adaptive management process.

3. **Enable the remaining water (after fully meeting objectives 1 and 2) to serve the broadest possible array of socially valued purposes.** Sustainability boundaries place constraints on the volume of water made available for extractive uses, thus setting the context within which livelihood and economic activities that depend on

withdrawals of water can function. Key considerations in addressing this objective are: whether sufficient water is available, at the right times, to support existing agriculture and industrial activities; whether such activities are limited or impaired by water scarcity; and, whether existing water users are maximizing efficiency and productivity (see section 2.3.2.3). Addressing this objective also requires consideration of deeper questions related to what are 'socially valued purposes'. Is water being used for the most socially desirable ends? Are existing water uses viewed as legitimate across local society? Will existing uses and levels of use impair opportunities for future generations (see objective 4 below)?

4. **Do all of this (i.e., addressing objectives 1-3) in a way that does not compromise the abilities of future generations to do the same.** Consideration of intergenerational equity is a core principle of sustainability. As discussed by Gibson et al. (2005), when considering the future as well as the present, there is a tension between the need to provide expanded economic and other goods to many people today without continued degradation of resource stocks and undermining of biophysical systems. Context is an important consideration when addressing this objective. In situations where material consumption and the resulting pressures on biophysical systems are disproportionately high, serious contributions to sustainability will require a shift in emphasis away from more material gain and a decoupling of well-being from material growth (Gibson, Hassan et al., 2005: 100). In other words, such situations require a shift away from efforts aimed solely at sustaining existing and expanded production of economic and other goods to consider alternative livelihood options that are less water intensive. Consideration of future generations is addressed in more detail as a separate criterion in section 2.3.2.2, which deals with both intra and inter-generational equity.

2.3.2.2. Equity

Ensuring equity requires that governance arrangements deal fairly with all those concerned with the outcomes of decisions and actions. Equity is multi-dimensional, requiring attention to both the *substantive* elements of governance – who gains and who loses – as well as *procedural* dimensions – who can and should participate in decision making (Syme, Nancarrow et al., 1999: 52; Young, 2002: 15). Sustainability requires consideration of intra- and inter-generational equity (Dale, 2001; Gibson, Hassan et al., 2005). The goal is to establish governance systems that ensure the costs and benefits of decision-making processes and their outcomes are distributed fairly among affected actors and interests, both within and among generations (Dale, 2001: 136). It is important to recognize the distinction between equity and equality. In the context of water management, equality would mean all parties have an equal share of the available resource, whereas equity demands that all parties should have the opportunity to access sufficient water for human health and livelihoods.

Satisfying procedural dimensions of the equity requirement means that governance arrangements must seek to include the plurality of interests with a stake in the conditions of a SES in decision making (Dale, 2001: 136). Engaging a diverse representation of actors and interests in governance ideally brings new ideas and diverse knowledge to decision making and strengthens ownership of proposed actions and outcomes (Dale, 2001; Sampford, 2002). In practice, the extent to which procedural equity is satisfied depends on the nature of planning processes and the openness of institutions – it thus relates closely to the notion of participation discussed in section 2.3.2.5 below.

Satisfying substantive equity requirements ensures that benefits and costs of policies and decisions are distributed fairly among affected actors and interests (World Meteorological Organization, 2009: 3-6). In the context of water governance, this criterion means addressing both who has access to water and in what quantities, and how the cost and benefits of water management and use are distributed among the various actors in a SES. This ideal is not to ensure actors and interests necessarily gain access to the same amount of water (that would be equal access), but that all should have the opportunity to access sufficient water for social and economic development, set within recognized limits required to sustain ecological integrity.

Furthermore, decisions to reduce or suspend access to water should reflect the broader social good and local context. For example, satisfying the equity requirement need not necessarily address questions of whether certain users (i.e., golf courses or water bottling plants) are good or bad *per se*, but rather should address the extent to which they infringe on other users and ecosystem needs for water now and in the future. This criterion demands a broadly understood and acknowledged set of priorities among various and often competing uses of water.

The above discussion on procedural and substantive equity addresses intra-generational equity in that it is couched in present terms. Satisfying a requirement of inter-generational equity entails consideration of the distribution of costs and benefits across generations. It requires that governance arrangements ensure present activities do not unreasonably compromise or eliminate options for future generations to enjoy similar or enhanced conditions of socio-ecological system integrity as present generations (Gibson, Hassan et al., 2005).

In the context of water allocation, questions of inter-generational equity relate to the degree to which existing water use is affecting socio-ecological integrity for future generations, either positively or negatively, and the degree to which governance arrangements consider those impacts. Assessing the extent to which governance arrangements are forward-looking in analysis and commitments provides an indication of the degree to which inter-generational equity is considered in governance. Evidence of future or inter-generational considerations may be found in the vision, goals and objectives of policies and plans. Given the complexity and uncertainty associated with any SES, it is difficult, if not impossible, to understand fully and thus assess the impact of present activities on future conditions. The best we can do is apply concepts such as post normal science to design governance arrangements that draw on best available science and expertise, under a precautionary, adaptive and participatory approach, to close off unsustainable activities and set limits and buffers to ensure present activities do not compromise socio-ecological integrity for future generations.

2.3.2.3. Efficiency

We live in a world of limited resources – financial, human and, increasingly, biophysical resources such as land and water – and socio-ecological systems have limited capacity for resilience. The efficiency of resource use thus must be an essential element of governance and sustainability. As defined by Young (2005), efficiency is a measure of the extent to which goals are achieved with minimum expenditure of resources. Satisfying the efficiency criterion requires use of biophysical, social and financial resources in ways that avoid waste and minimize overall use of material resources and energy use per unit of benefit (Gibson, Hassan et al., 2005).

The efficiency and productivity[4] of water use are important considerations for sustainability and resilience in SES. The 'supply-side' approach has been the basic paradigm of water management throughout the industrialized world for much of the 20th century (Gleick, 2000). The primary concern of the supply-side approach is to secure sufficient water to meet forecast demand. There is a growing recognition of the need to shift from exploitation of water resources to strategies aimed at managing human activities to curb water demand. According to Brooks and Peters (1988: 10), demand management includes "any measure which reduces or reschedules average or peak withdrawals from surface or groundwater sources while maintaining or mitigating the extent to which return flows are degraded." Demand management strategies include economic, socio-political and physical measures that change behaviour and practices to increase water use efficiency and productivity (Tate, 1990). This can include changes in technology, production practices and the products or commodities produced, and policies or programs to encourage such changes.

A soft path approach to water planning and management (Brooks, Brandes and Gurman, 2009) looks beyond demand management as a means to simply improve efficiency and productivity of water use to consider questions related to if and why water is used to achieve particular ends – for example, why in the developed world is water of drinking water quality used to flush human wastes away when options such as recycled grey water or composting toilets can provide the same service. Traditional approaches to demand management are typically seen as a means for delaying 'inevitable' supply side developments to meet growing water needs. Soft path approaches start by first considering a desired future state for water use, ideally based on defined ecological limits to local water use. Soft path water planning works backwards from this desired state or ecological limit to determine what range of demand management tools can be implemented, together, to connect that desired future to the present. The soft path approach is thus consistent with the sustainability boundary concept. Four key principles underpin the soft path approach: (1) treating water as a service provider rather than an end in itself; (2) making ecological sustainability a fundamental criterion of water management; (3) matching the quality

[4] Water productivity is defined as the amount of measurable output per unit of water used; for example, tonnes of grain or the dollar value of the good or service produced per unit of water.

of water delivered to that needed for the end use; and, (4) planning from the future back to the present (i.e., backcasting) (Brandes, Brooks and Gurman, 2009: 11).

In theory, establishing limits or constraints on water use (i.e., establishing sustainability boundaries) will encourage efficiency initiatives and drive up water productivity. In water stressed systems, for improvements in water efficiency or productivity to enhance ecological integrity and sustainability, gains in efficiency and productivity would be returned to and retained in the aquatic ecosystem rather than be passed down stream to the next extractive water user. By nesting demand management strategies within a broader goal of working within ecological limits, the soft path approach seeks to minimize or eliminate so-called 'rebound effects' that can occur when improvements in efficiencies by one user free up water for others, potentially resulting in an overall increase in water demand. Without explicit attention to overall limits, efficiency gains may not deliver on ecological objectives.

In the context of decision making, efficiency means using social and institutional resources such as money, time and energy required in decision making as efficiently as possible. The goal of institutional efficiency is to ensure that decision-making processes produce the desired outcomes without waste of resources (World Meteorological Organization, 2009: 3-6). Key indicators of decision-making efficiency include: how long it takes to arrive at a decision; the amount of time, effort and money required on the part of various actors to make decisions; and, the degree to which unnecessary overlap and redundancies in the roles of actors and functions of institutions is minimized.

The latter indicator above requires some elaboration. A key element of assessing the efficiency of a governance system is to understand the degree of overlap and redundancies in the mandates and actions of various actors and the functions of different institutions. The primary concern is that two or more elements of a governance system may duplicate efforts or perform the same or similar functions. However, some overlap and redundancy may be desirable, and indeed, maybe necessary to respond effectively to surprises posed by unexpected or unanticipated events typical of complex SES (Dale, 2001: 134). Consequently, satisfying the efficiency goal is not as straight-forward as reducing overlap and redundancy.

Taken in the context of complex systems where surprise and uncertainty are inevitable, the challenge is to understand not only if redundancies and overlap exist, but also to assess the degree to which they are necessary and beneficial in terms of maintaining and improving socio-ecological integrity (Walker and Salt, 2006). Dale (2001) suggests that efficiency related to institutional overlap and redundancy can be improved through integration (discussed in section 2.3.2.7); specifically via "integrated decision making and the development and continual refinement of a guiding framework for governance" (Dale, 2001: 134). Similarly, Walker and Salt (2006) suggest that a resilient world requires institutions that include deliberate redundancy in their governance systems in order to enhance diversity and flexibility of an SES.

There is also potential for tension related to the timeframes within which efficiency is judged. From a short-term perspective, the time, money and effort required for broad consultation and social learning processes may seem to be an inefficient use of scarce resources; however, investment of these resources in the near term to facilitate collaboration and participation and embed social learning and adaptive management may lead to a more efficient governance regime over the long term as actors are more likely to be better informed and have greater capacities for collaborative decision making and flexibility to respond. As Walker and Salt (2006: 148) note "Totally top-down governance structures with no redundancy in roles may be efficient (in the short term), but tend to fail when the circumstances under which they were developed suddenly change." Thus, long-term efficiency is compromised.

2.3.2.4. Accountability and Transparency

According to Merriam-Webster Online (2008), to be transparent is to be clear – free from pretence or deceit, readily understood and characterized by visibility and accessibility of information. Accountability, again from Merriam-Webster Online (2008), is defined as an obligation or willingness to accept responsibility for one's actions. Together, achieving transparency and accountability ensures that all actors in a SES understand how decisions are made and how resources are allocated (World Meteorological Organization, 2009: 3-6). Criteria for assessing transparency and accountability include clearly defined terms of authority and responsibility; defined decision-making rules; adherence to those rules (i.e., respecting rule of law), effective sanctions for instances of abuse; and, convenient and timely access to information (Dale, 2001; Lundqvist, 2004; Capistrano, Samper, Lee et al., 2005)

While improved transparency and greater accountability are among the purported benefits of more distributed or decentralized governance, that result is not guaranteed. As Cohen and Davidson (2011: 523) note, "Outside of elected officials, the challenges surrounding accountability speak to the question of delegating decision-making authority to non-elected parties, as a watershed approach typically includes extra-governmental participation. Accountability concerns – particularly with respect to extra-governmental participation in decision-making processes – are often related to the broader question of legitimacy." Indeed, water governance researchers raise a number of questions regarding transparency and accountability in distributed governance systems, including (Lundqvist, 2004; de Loë, 2005; Nowlan and Bakker, 2008):

1. Are responsibilities being devolved that should properly be undertaken by state agencies?
2. Is it possible to connect decisions and actions taken at local levels to higher level (provincial and federal) institutions and democratically elected officials (i.e., responsible Ministers)?
3. Are decisions and actions adhering to statutory requirements (i.e., rule of law)?
4. Where multiple state and non-state actors are involved in collaborative decision making, is it clear who has responsibility for what?

In analyzing decentralized, multi-layered water governance in Sweden, Lundquist (2004: 421) observed both lack of clearly defined terms of authority and responsibility, and concerns related to democratic accountability, particularly at the 'super-local' sub-catchment level. These observations are not an argument against decentralization but rather evidence that local governance must be compatible with and bounded by authority and power at higher jurisdictional levels (Lundqvist, 2004: 414). This perspective is consistent with the discussion of relationship between harmonization and subsidiarity in water governance discussed in Section 2.2.3.

Transparency and accountability require that information be readily available to and directly accessible by those affected by decisions and, ideally, in forms easily understood by non-experts (UNESCO, 2003; Capistrano, Samper et al., 2005). The information being used in decision making often goes beyond 'expert science' to include other forms of knowledge, such as local and traditional knowledge (Sampford, 2002; Schofield and Burt, 2003; Capistrano, Samper et al., 2005). Transparency and accountability are thus enhanced by opening governance to encompass not only the claims of conventionally trained experts, but also the insights of those with experiential knowledge of their environment. This approach is consistent with the notion of 'extended peer communities' and the broader concept of post-normal science discussed in section 2.1.3. Given the complexity inherent to SES, information about uncertainty and risk is an important input to good governance (Capistrano, Samper et al., 2005: 181). According to Schofield et al. (2003: 86), good decision making requires information to be available at a range of scales and level of details; explicit understanding of the certainty/uncertainty of information being used; and, use of local knowledge without compromising independence and rigour.

Key considerations when assessing availability and accessibility of information include (Capistrano, Samper et al., 2005):

- Whether the information is even available (i.e., does it exist?)
- If not, is the capacity to collect the required information developed?
- Is the information of the highest quality and from collectively conceived legitimate sources?
- Is the information in a useable form?
- Have uncertainties, related both to facts and values, been described and explained?
- Is there a plan to resolve those uncertainties we are capable of addressing, given current problem-solving capacities?

Satisfying transparency and accountability criteria is enhanced through participatory decision making (section 2.3.2.5), which can improve collective understanding of roles and responsibilities and sharing information and bring new knowledge to the table. Transparency and accountability may also be enhanced by integration (section 2.3.2.7), which aims to coordinate the activities of various actors in a governance system and to maintain clear roles and responsibilities, particularly as relates to legally responsible authorities (i.e., governments).

2.3.2.5. Participation and Collaboration

Increased participation by non-state actors and by the public in policy development, planning processes, and day-to-day management is a fundamental element of decentralized, polycentric governance systems, and a core theme in the literature on shared or collaborative governance (Nowlan and Bakker, 2008; Booher and Innes, 2010). Participation is one means of satisfying equity issues (section 2.3.2.2) by seeking to ensure that all those affected by decisions and the resulting outcomes have a say. Effective participation requires that all affected parties have a voice, either through intermediate organizations that legitimately represent their interests or via direct participation, and that all interests are represented within a governance system (Costanza, 1998; Syme, Nancarrow et al., 1999: 60; UNESCO, 2006). Governance should provide opportunities for all affected parties to be represented in processes, decisions and actions, and further, for individuals and groups representing different interests to cooperate in decision making and take actions that affect their future while sharing responsibility for outcomes (Dale, 2001: 136).

Participation can take many forms, and can mean different things to different people (Huitema, Mostert et al., 2009; von Korff, d'Aquino, Daniell et al., 2010). Similarly, Booher and Innes (2010) note that *collaboration* can encompasses many types of cooperative efforts among two or more groups of individuals or organizations. Making the connection between the two, Huitema et al. (2009: 5) use the term 'public participation' to describe collaboration between governmental and non-governmental stakeholders. Booher and Innes (2010: 4) provide a more elaborate explanation of collaboration, which they refer to as processes in which "individuals representing differing interests engage in long-term, face-to-face dialog, seeking agreement on strategy, plans, policies, or actions." Collaborative processes may be established in an number of ways: by government agencies or legislative bodies seeking to address often intractable problems; by developers, environmentalists, and other private actors frustrated by conflict or stalled decisions; or by community or group of resource users seeking to better manage use of a limited, common resource, such as a local water users association (Booher and Innes, 2010).

It is important to look beyond the presence or absence of participatory and collaborative structures to consider also the quality of participation. Arnstein's (1969) ladder of citizen participation (Table 2-3) presents the nature of involvement and quality of participation in decision making in terms of degree of power sharing. Mostert (2003) proposes an alternative framework organized around levels of participation and relevant methods (Table 2-4).

Table 2-3: Arnstein's Ladder of Citizen Participation

Rung on the ladder	Nature of involvement	Degree of power sharing
Manipulation	Rubberstamp committees	Non-participation
Therapy	Power holders educate or cure citizens	
Informing	Citizens' rights and options are identified	Degrees of tokenism
Consultation	Citizens heard but not necessarily heeded	
Placation	Advice is received from citizens but not acted upon	
Partnership	Trade-offs negotiated	Degrees of citizen power
Delegated power	Citizens are given management power for selected or all parts of programmes	
Citizen control		

Table 2-4: Mostert's Public Participation Levels and Methods

Level of participation	Methods of participation and engagement
Information ▪ public gets/has access to information	Leaflets, mailings, use of media, information centres, internet, etc.
Consultation ▪ views of the pubic are sought	Opportunities to comment, public hearings, opinion polls, advisory committees, etc.
Discussion ▪ real interaction between government and public	Small group meetings (e.g., charettes, workshops) Large group meetings (e.g., working groups)
Co-designing ▪ public takes active role in policy development or project design	Small group meetings (e.g., charettes, workshops) Large group meetings (e.g., working groups)
Co-decision making ▪ public shares decision-making powers with government	Negotiations resulting in voluntary agreements, public representation in governing bodies, referenda
Decision making ▪ public performs tasks independently	Resource users and NGOs performing public functions (e.g., water users associations)

Generally speaking, participation is a desired and beneficial element of good governance; however, it can present problems. Table 2-5 from (Mostert, 2003) outlines some benefits and problems.

Table 2-5: Potential Benefits and Problems of Public Participation

Potential benefits	Potential problems
▪ Better informed and more creative decision making ▪ Greater acceptance of decisions and fewer implementation problems ▪ Social learning by all involved ▪ More open and integrated government ▪ Enhanced democracy	▪ Reluctant government that gives no serious follow-up, resulting in less public acceptance of decisions ▪ Limited and unrepresentative response ▪ Low quality response ▪ Inconsistent decision making ▪ Costs and time

The benefits discussed in Table 2-5 are echoed by von Korff et al. (2010), who note that realizing these benefits depends heavily on well-designed participation processes. Instances where processes are poorly designed can lead to stakeholder disillusionment and lost trust; relaxed environmental legislation or lopsided decisions regarding environmental protection; reluctance to participate, increased conflict or reluctance to adopt decisions; and, lost time and money (von Korff, d'Aquino et al., 2010). Mitchell (2002), after Smith (1982: 561-3), discusses three potential stages of planning at which to engage the public in participation – normative (determining what ought to be done); strategic (determining what can be done) or operational (determining what will be done). These stages are often iterative rather than following a sequential, one-way path. While most often participation occurs at the operational stage, it is widely agreed that participation should be encouraged at the earlier strategic and normative stages to avoid perception that participation is merely tokenism (Mitchell, 2002: 190). According to Cortner and Moote (1999), including broad perspectives at the goal definition stage will increase the legitimacy and acceptability of both the process and outcomes.

von Korff et al. (2010) propose seven overarching design principles for participatory decision-making processes:

1. See the participation process as an opportunity for effective decision making and not as a constraining obligation;
2. Consider the input of the stakeholders during design and implementation;
3. Encourage inclusive and appropriate stakeholder involvement, seeking balance between inclusiveness and efficiency of the process;
4. Clearly define the roles and responsibilities of the lead agency and of the participants.
5. Respect political realities – the main decision makers, which may not necessarily be the lead agency, need to be identified and must remain responsible for the final decision even if they choose to delegate this responsibility.
6. Meet the needs of the stakeholders and context by including stakeholders in problem framing and design participation mechanisms (e.g., meetings, conference calls, discussion forums) to meet the needs of participants, and providing participants with the means (e.g., knowledge, financial resources, opportunities) to engage effectively; and,
7. Always remain open to adjusting the process design to respond to changes in context, new knowledge, or uneasiness among stakeholders.

2.3.2.6. Precaution and Adaptation

Precautionary and adaptive approaches to governance are proposed as a means for addressing the complexity and uncertainty inherent in socio-ecological systems. In 1992, the Rio Declaration (United Nations Environment Programme, 1992) introduced the precautionary principle. It states: “Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.” That definition is now viewed as a narrow interpretation of precaution (Gibson, Hassan et al., 2005: 112). A more elaborate view of a precautionary approach builds on anticipatory and proactive planning, flexible institutional arrangements and organizations, and processes for interpreting and responding to ecological and social feedback. Such approaches rely on and foster social learning, applying continuous observation of system dynamics and adjustment of responses as a means for dealing with inevitable uncertainties (Gibson, Hassan et al., 2005).

Proactive and anticipatory planning builds capacity to respond to inevitable surprise when it does occur, and where possible, seeks to prevent serious or irreversible damage. The intent is to establish a system of governance that is proactive – that is always looking for and preparing for both present and future opportunities and challenges and is therefore capable of addressing both short-term crisis while planning for the long term. Yet, as Gibson (2005: 60) notes, while efforts to anticipate and avoid problems are desirable and potentially effective, overconfidence in such efforts is perilous; a more robust form of precaution seeks to proactively build resilience and adaptive capacity and also includes strategies such as back up plans, avoidance of unnecessary risk, and planning for reversibility.

Flexible, dynamic institutional and governance structures are a key element of adaptive governance and management (Anderies, Walker et al., 2006: 9). The adaptive management paradigm emerged in response to the limitations, and often failures, of traditional approaches to resource and environmental management and planning – in particular, the conflict, gridlock and vulnerability to unanticipated upsets that often occurs due to rigid management programs and piecemeal policy frameworks (Lee, 1993; Holling, 1995; Berkes and Folke, 1998). Conventional approaches to planning and management assume that with enough data it will be possible to understand, and thus control, a system. Rather than seeking to control the uncontrollable, adaptive approaches accept uncertainty, plan for surprise and aim to develop a better, albeit incomplete, understanding of the system in question by treating management as a learning experience designed to develop social-ecological systems capable of dealing with surprise and uncertainty (Lee, 1993; Holling, 1995; Berkes and Folke, 1998; Folke, Carpenter, Elmqvist et al., 2002). Adaptive management has been described as an integrated, interdisciplinary and systematic approach to improving management and accommodating change by learning from the outcomes of management policies and practices (Holling, 1978).

Adaptive approaches, based on continuous learning, are flexible enough to respond to fluctuating ecological conditions (Olsson, Folke et al., 2004: 94). Dryzek (1987: 46-54) describes flexibility as the ability of a mechanism to adjust to its own structural parameters as demanded by changing environmental conditions. It is argued that moving from centralized to polycentric governance leads to greater flexibility in dealing with uncertainty and surprise. As Francis (1990: 195) has observed for governance in the Great Lakes Basin, "With more organizational centres and networks available, there is greater inherent flexibility within the overall system of governance to respond to surprise."

Ongoing monitoring is fundamental to the adaptive management process, providing information on social and environmental feedbacks as resources are used and systems are managed (Lee, 1993; Berkes and Folke, 1998). Monitoring ecosystem processes and dynamics is essential for increasing the ability to respond to change and to shape institutions and management practices in order to realize and sustain a desirable socio-ecological system state (Berkes and Folke, 1998). As Olsson et al. (2004: 77) note, "such a process of social learning is linked to the ability of management to respond to environmental feedback and direct the coupled social–ecological system into sustainable trajectories."

Bouwen and Taillieu (2004: 143) define social learning as "a process through which communities, stakeholders, or societies learn how to innovate and adapt to changing social-environmental conditions." According to Schusler, Decker and Pfeffer (2003: 311), social learning occurs when "people engage with one another, sharing diverse perspectives and experiences to develop a common understanding and basis for joint action." It is an ongoing process involving feedback between the learner and the environment that changes social practice and interpretation of the environment – the learner changes the environment, which in turn affects the learner (Pahl-Wostl and Hare, 2004). Precaution and adaptation – through social learning processes – are therefore linked to participation in governance (Section 2.3.2.5).

Effectively embedding precaution and adaptation into water governance also requires avoidance of strategies aimed at optimizing water productivity up to some ecological limit because these limits are poorly understood due to ecosystem complexity and uncertainty. Maximizing water productivity up to an ecological limit represents a risky form brinkmanship and poses serious risks to socio-ecological integrity in systems where limits to resilience are difficult to define and surprise is common (Gibson, Hassan et al., 2005; Walker and Salt, 2006). Precautionary and adaptive criteria such as diversity of responses and inclusion of back-up alternatives; buffers around ecological limits; reversibility of decisions and solutions; and mechanisms for effective monitoring, feedback and response should be identified and applied in designing and choosing among policies, plans and programs of water governance (Gibson, Hassan et al., 2005).

2.3.2.7. Integration

The concept of integration is applied in two ways in this thesis. As it relates to water governance specifically, integration can serve as a means for addressing fragmentation among many policies, programs, actors and institutions involved in decision making. As discussed by Gibson et al. (2005: 118), integration is also required to ensure all criteria included in an assessment framework are applied together as a set of interdependent parts in order to identify and capture mutually supportive benefits.

Fragmentation of policies, programs and management activities and separate attention to social, economic and biophysical concerns present a persistent challenge in water governance. Central to the problem is the ‘silos’ approach and mentality associated with the narrowly specialized mandates and expertise of most government bureaucracies (and other large organizations) and their policies. This silo effect refers to the tendency of bureaucracies to organize around individual line agencies or departments. Agencies participate in decision making primarily with regard to their own mandates and authority, and without serious consideration of those of other agencies or organizations, and with little attention to designing policy and administration to address overlaps and inconsistencies or to seek multiple, mutually reinforcing benefits (Dale, 2001; World Meteorological Organization, 2009). In multi-layered and decentralized governance regimes, this silo effect may be exacerbated by responsibilities and authority being distributed across orders of government and a number of agencies within each order, and increasingly among non-government organizations. The result can be a gridlock in governance whereby structural barriers and interlocking values and ideologies produce a sort of paralysis, or as Dale (2001: 100) remarks, an “overwhelming inability to respond.”

With the diversity of actors and institutions – both state and non-state – sharing interests in, and responsibilities for, water governance and management in Canada, the fragmentation, silo effects and gridlock discussed above present an ongoing challenge. The concept of integration provides a frame for understanding the relationships among these various elements of a water governance system, and, more importantly, a means for reconciling fragmentation and overcoming the resulting gridlock through frameworks such as Integrated Water Management (IWM), Integrated River Basin Management (IRBM), and Integrated Water Resources Management (IWRM).

Integration is defined as “having all parts combined into a harmonious whole” (World Meteorological Organization, 2009). It does not mean consolidation under a central authority, but rather, coordination and coherence among actors and institutions and across temporal and spatial scales (Dryzek, 1987). *Coordination* entails arranging properly the order and relationships among various initiatives and those responsible for their implementation to ensure a SES functions in a harmonious manner. *Coherence* ensures a logical connection among various actors and their initiatives in terms of being “united in principles, relationships, or interests” (Merriam-Webster, 2008; World Meteorological Organization, 2009). In a coordinated and coherent governance system, each part recognizes linkages with others and seeks to harmonize all participants’ activities to promote an efficient, effective and equitable approach to achieving overall goals and objectives (Dale, 2001: 134).

Kemp et al. (2005: 19) note that the goal of integration is not to create a single body or a single policy dealing with everything; rather, “effective integration for practical decision making centres on acceptance of common overall objectives, coordinated selection of policy options, and cooperative implementation designed for reasonable consistency.” Evidence of integration includes coordination among government policies and initiatives of other governance actors, coherence defined in terms of broadly common goals, objectives, rules and priorities, and clarity in terms of spatial boundaries, authority, roles and responsibilities (Lundqvist, 2004; Kemp, Parto et al., 2005). A key means of achieving effective integration is building or enhancing capacity through partnerships and networks that create horizontal and vertical linkages among agencies and organizations (de Loë, 2005).

Mitchell (2009: 7) stresses that “*Integration* is a means to an end, not an end to itself. As a result, use of integration in water management should be preceded by a vision of a desired future condition or state. Without such direction, it is difficult to determine which parts need to made into a whole, who should be working together to arrange proper order and relationships, and what logical connections need to be realized.” It is also important to realize that integrated approaches do not necessarily come without costs in terms of financial, human and other resources; thus, there may trade-offs including ones between integration and efficiency in governance (Young, 2002).

Because the seven criteria included in the assessment framework overlap and are interdependent, integration among them is required to seek out mutually supporting benefits and to identify areas of conflict and, potentially, trade-offs among them. As Gibson et al. (2005: 114) note, in relation to their sustainability assessment requirements outlined in section 2.1, that such criteria "are not mere targets for the long run; they are a package of obligatory considerations for all decisions along the way. And in all of these decisions, consideration of the interconnections will be as important as attention to the individual requirements." Attention to mutually supportive benefits and the potential for tensions among the criteria are discussed further in section 2.4.

2.4. Summary: Synergies and Trade-offs

Together, the literature review and the conceptual framework provide the foundations and a set of criteria for assessing governance of water allocation in a 'real world' case study, and using that assessment to propose recommendations for strengthening governance of water allocation to foster sustainability in the case study watershed, and in Ontario more broadly.

Two challenges were experienced in developing the assessment framework: (1) choosing a manageable and useful set of criteria from among a large number of potential options discussed in the literature on governance and planning, sustainability and systems thinking; and, (2) organizing the criteria and maintaining coherence of the framework as a whole, given the tensions and synergies among them.

As discussed in section 1.4, there is a lack of consensus in the academic and grey literature on approaches for studying governance systems, particularly regarding what constitutes successful performance and how it might be measured (Imperial, 1999). This means that there was no widely accepted or tested 'off the shelf' framework to apply to a case study, which in turn required a review of a large volume of literature to derive a set of criteria. For many of the criteria presented above, similar but often nuanced definitions were found in the literature, requiring a synthesis of various discussions to develop both working definitions and indications of what would constitute evidence that a criterion is or is not being met, and to what degree. In the end, the resulting seven criteria provide a defensible and useful framework for assessing governance as is relates to water allocation and likely to other water issues and to environmental governance more broadly. However, they are not put forward as a set of criteria that would address Imperial's concerns regarding a consistent approach for assessing and measuring governance performance. The criteria proposed here are aimed primarily at assessing what existing governments deliver rather than to assess the quality of governance *per se*.

As discussed when introducing the assessment framework in section 2.3.2, the criteria are in general mutually supportive and synergistic, meaning that when an effort is focused on improving performance of one criterion, then performance of others, or of the system as a whole, is improved. For example, improving participation and collaboration can lead to improved accountability and transparency, equity (in terms of access to decision making) and integration among various actors and interests. In some instances, addressing criteria may reveal tensions among them; that is, reducing focus and attention on satisfying one or a few criteria in order to improve the performance of others, or of the system as a whole. For example, improving participation by engaging more actors in decision making or enhancing socio-ecological integrity by maintaining some degree of redundancy and overlap in governance arrangements and responsibilities and activities of various actors would likely increase the overall societal resources required to take and act on decisions. These additional resource requirements can create challenges in terms of satisfying decision-making efficiency objectives. In part, this can be addressed by considering the implications for efficiency over a longer time horizon: a longer process that leads to strong results and sustained action is more efficient than a short process that leaves problems unaddressed. In this sense, it is important to remain focused on the ultimate purpose of to ensure all of the criteria are met as well as possible in order to improve performance of the system as a whole.

Chapter 3: RESEARCH DESIGN

This chapter describes the research design. It discusses the epistemological underpinnings of the research, the qualitative methodology employed and the specific methods used to collect and interpret data. It then presents the five-step research procedure used to undertake the research and ends with a discussion of research standards and limitations of the design.

3.1. Framing: Policy Research

This thesis falls within the realm of 'policy research', a broad field of social research that Majchrzak (1984: 12) defines as "a process of conducting research on, or analysis of, a fundamental social problem in order to provide policy makers with pragmatic, action-oriented recommendations for alleviating the problem." In discussing policy research, Michaels (2003: 16) suggests it is useful to distinguish between research *of* policy and research *for* policy (emphasis in original). Research *of* policy typically entails investigations focused on identifying and explaining the causes and effects particular policies or programs, or what Majchrzak (1984: 12-14) refers to as evaluative research. Research *for* policy is a more fundamental and applied endeavour that begins with a particular social problem and seeks to enhance the capacity of decision makers to address it with specific recommendations and strategies. Since this work focuses on a social problem rather than a particular policy or program, it is consistent with Michaels' notion of research *for* policy.

3.2. Epistemology

Translated from its Greek origins, *episteme* (knowledge) and *logos* (to study), epistemology is the branch of philosophy that deals with the study of knowledge. Epistemology is described as a particular 'way of knowing' or as Crotty (1998: 8) suggests, "a way of understanding and explaining how we know what we know." Epistemology deals with fundamental questions of how claims to knowledge are justified and legitimized. Three common epistemological schools, each with particular defining characteristics, are objectivism, subjectivism and constructivism.

Objectivism or realism sees knowledge as being 'out there' in the world awaiting discovery; realists assert that things exist as meaningful entities independently of human consciousness and experience (Crotty, 1998: 5; Neuman, 2000: 67). The focus is on deterministic or cause and effect relationships; human behaviour is understood to be determined by causal and immutable laws and mechanisms over which we have little control. The objectivist researcher is the 'disinterested scientist' whose work proceeds uninfluenced by personal values and independently of the social and cultural forces affecting human activity. Repeatability of results through controlled experimentation is the primary means of validating, justifying and legitimizing knowledge claims (Neuman, 2000: 69; Creswell, 2003).

Subjectivism also views knowledge as 'out there' awaiting discovery but sees it as obscured by human values and our varied understandings of situations and phenomena**.** To the subjectivist, meaning and human behaviour are not locked in by causal or natural laws; rather, reality is being constantly shaped and reshaped by social, political and cultural factors. While human behaviour is understood to be constrained by material conditions and cultural context, the subjectivists sees these relationships or laws as changeable. Knowledge claims are validated, justified and legitimized through social interactions aimed at understanding and changing social conditions (Neuman, 2000: 76 - 80).

Constructivism sees knowledge as being socially constructed – a perception of what people understand as truth (Patton, 2002). Knowledge is not 'out there' but rather constructed out of social interaction and purposeful action. Constructivism is a form of relativism in which meaning as well as human beliefs and behaviours have no absolute reference – everything is relative. Researchers do not seek to be value free – in fact, the constructionist questions the very possibility of value-free research as it sees values infused everywhere in everything. It is the meaningfulness of knowledge to those being studied that validates, justifies and legitimizes knowledge claims (Neuman, 2000: 72-79).

A hybrid of these perspectives underpins this research. The approach adopted here recognizes: (1) the need to identify broadly applicable objectives in order to establish a defensible working understanding of how the world works, what concerns are pressing, and what actions should be taken to respond to those concerns; (2) that there are inevitable uncertainties associated with any understanding of how the world works because of complex system behaviour and because of the influence of diverse human constructions of such understandings; and, (3) the need to specify assessment criteria for particular contexts and cases that can be used to draw conclusions and recommendations based on the complex views of those most closely associated with the SES being studied.

3.3. Methodology: Qualitative, Case Study Research

Crotty (1998) describes methodology as the strategy or plan of action that links methods to outcomes and findings. The methodology is governed by the epistemological tradition, and in turn, guides the methods used to collect and interpret information and data. This thesis employs a qualitative, exploratory methodology using a case study approach.

3.3.1. Qualitative research

Qualitative research involves discovery of knowledge and development of meaning through data and measurement that are primarily non-numerical. Qualitative researchers explore and develop concepts and theories by observing and making sense of patterns and relationships in social (or socio-ecological) phenomena. Qualitative research thus differs both in its goal and approach from quantitative research, which seeks to test laws and theories by collecting and analyzing primarily numeric data and statistical analysis (Creswell, 2003). The following list highlights some common defining features of qualitative research (Miles and Huberman, 1994; Neuman, 2000; Creswell, 2003):

- It is conducted through intense and/or prolonged contact with a 'field' situation;
- The researcher's role is to gain a holistic (i.e., systemic, encompassing, integrated) understanding of the logic, the arrangements and the explicit and implicit rules of the situation under study;
- Is interpretive and often inductive; concepts are supported and meaning discovered when the researcher is immersed in the data;
- Data are most often words drawn from documents, observation, interviews and transcripts; and,
- Analysis proceeds by extracting themes or generalizations from the evidence and organizing data to present a coherent, consistent picture of the phenomena.

This qualitative research is *exploratory* in that it seeks to apply the concept of governance in an evaluative mode to develop a rich and synthetic but preliminary understanding of the structure and dynamics of decision making. As Imperial (1999) notes, there is a lack of consensus on approaches for studying governance networks, particularly regarding what constitutes successful performance and how it might be measured. Lebel et al. (2006: 14) also identify measurement as a relatively unexplored and challenging area in applying the governance concept in SES, noting that "The capacities of individual actors or institutionalized relationships among them are not straightforward to assess." Exploratory research differs from descriptive research, which focuses on accurate and systematic description of a phenomena or situation, and from explanatory research which seeks to develop or reinforce cause and affect relationships among specific, typically limited numbers of variables (Palys, 2003).

3.3.2. Case Studies

Case studies are prominent in the social sciences, and are particularly popular with policy researchers because they are fast, cost effective, and provide a richer understanding of situations than do statistical methods (Majchrzak, 1984: 63). It is also argued that case studies are the most appropriate strategy for exploratory research (Robson, 1993).

Stake (1995) defines a case as a bounded system that has both boundaries and working parts, and notes that researchers pay close attention to how cases function within their broader context. Cases thus provide researchers with a definable unit of analysis through which to undertake an empirical inquiry of social situations. In employing a case study approach, researchers seek in-depth understanding of a program, an event, an activity, a process, or individual/group dynamics through intensively exploring a single or small number of examples (Rothe, 1994; Creswell, 2003; Warren and Karner, 2005; Yin, 2009). Yin (2009: 19) suggests case studies are most appropriate when:

- Explaining the links in real-life interventions that are too complex for survey or experimental strategies;
- Describing the real-life context in which an intervention has occurred;
- Illustrating or describing an intervention itself; and
- Exploring situations in which the intervention being evaluated has no clear single set of outcomes.

3.4. Methods

(Crotty, 1998) describes methods as the specific techniques and procedures to collect, organize and interpret research information. Qualitative researchers rely on content analysis of documents, records and images and archival records; content analysis of interviews; and observation of social interaction as methods for collecting information (Robson, 1993; Rothe, 1994; Creswell, 2003; Yin, 2009). Content analysis of documents and interviews were the primary data collection and analysis techniques employed in this research.

In analyzing and interpreting information, researchers look for patterns in language and activities, common perspectives and recurring themes to construct a rich description of a social situation. Constructivists view the research process to be influenced by personal values and social contexts, analysis and interpretation, guided by a conceptual framework grounded in academic literature, and therefore viewed as subjective. In qualitative research, information is, as Creswell (2003: 182) notes, "filtered through a personal lens that is situated in a specific socio-political and historical moment."

3.5. Research procedure

The research procedure involved a series of five steps; each is described below in a separate sub-section. The steps are presented in logical sequence; however in application the procedure followed a much more tortuous path than the sequence of steps would suggest. In practice, the procedure involved a number of iterations through some or all of the steps, and not always in the order presented below, to arrive at the final thesis document. The five steps were:

1. Review academic and grey literature to develop a conceptual framework;
2. Select an appropriate case study to explore the phenomenon of interest;
3. Review content of documents to collect data;
4. Select informants and conduct semi-structured interviews;
5. Analyze and interpret data from document review and interviews, and synthesize into a narrative organized around the conceptual framework.

3.5.1. Developing the Conceptual Framework

It has been argued that theory and concept underpin all research endeavours, whether conducted in an academic setting or other research environments. For example, Hedrick, Bickman and Rog (1993) suggest that "all studies, whether acknowledged or not, are based on a conceptual framework." They guide a researcher in asking and answering research questions by drawing on academic literature to create structure from concepts and theories for application in empirical study of the 'real world'.

The relationship between theory and concept requires clarification. For Neuman (2000: 42-44), concepts are "the building blocks of theory." Concepts, he explains, are expressions of ideas through words or symbols. They are seldom used in isolation, but rather in groups, or in what Neuman refers to as "concept clusters." Miles and Huberman (2002: 1) refer to concepts as "a set of classifications that vie for our attention because they are compelling, coherent and elegant. They are maps for generating and revising a research design, and in the best case, for broadening our understanding of a situation." Theories, according to Neuman (2000), consist of clusters of concepts that are consistent and mutually reinforcing. Based on this conception, Neuman (2000: 40) defines social theory as "a system of interconnected abstractions or ideas that condenses and organizes knowledge about the social world." While instructive, Neuman's distinction between theory and concept lacks clarity in terms of when and how to use these ideas. Here, Mitchell (2004) provides a distinction that hinges on the power *to describe, explain and predict*. A theoretical framework "would have established general application to describe, explain and predict." By contrast, "a conceptual framework simply characterizes what are believed to be the key components and relationships of a problem or a system, without any expectation that the framework has the capacity to describe, explain or predict – but it is used to see whether one or more of those will be possible."

Stoker (1998) has noted that the value of the governance concept lies not in its ability to explain causal relationships. Nor does it provide a new normative theory; rather, its value is as an organizing framework, directing attention to the many forces influencing social decision making. The conceptual framework for this thesis builds from this understanding of governance. It draws most heavily on the governance literature, drawing it together with that from systems thinking, planning, environmental and natural resource management, and sustainability. The conceptual framework was developed by identifying and defining criteria and characteristics that help give structure to the exploration of governance of water allocation in a SES.

3.5.2. Selecting an Appropriate Case

In selecting an appropriate case study, Stake (1995) suggests that researchers consider two different options:

1. ***The Intrinsic Case*** is selected when a researcher is curious about that particular situation (i.e., individual, program, organization) and the focus of learning is on this one situation, not others or some general problem of interest; and

2. ***The Instrumental Case*** is selected as an instrument for understanding something other than the particular case, such as a general concept or a broader policy issue that reaches beyond, but is well represented by, this particular situation.

The case selected for this research is was chosen as an instrumental case – one to aid in understanding the dynamics of water governance in the broader context of Ontario's water policy framework.

In selecting a case, it is important to have defined criteria to ensure that the case provides sufficient insight into the phenomena of interest. The goal is to identify groups, settings and individuals where the processes being studied are most likely to occur (Silverman, 2005). Seeking out extreme or unique cases is one approach to ensuring the research provides evidence to observe and comment on conceptual propositions or validate proposed concerns (Eisenhardt, 2002; Yin, 2009). Thus, a representative case is one that is meaningful because it builds in criteria which help the researcher to develop an explanation based on the conceptual propositions underpinning the study (Silverman, 2005). Researchers must also consider pragmatic questions in selecting an appropriate case. The following criteria were used in selecting an appropriate case for this research:

- Evidence of human development placing significant pressure on water resources and ecosystem integrity;

- Existence or potential for conflict between human demands and ecosystem needs for water;
- Decision making regarding water allocation occurring in a multi-actor, multi-layered governance system;
- Accessibility for fieldwork, considering both proximity to the researcher and access to participants; and,
- Sufficient documentation and access to it.

Based on these criteria, Whiteman's Creek was identified as an appropriate case. Its water is recognized to be over-allocated, resulting in significant pressure on water resources and impacts on the integrity of the creek ecosystem, which is, in turn, leading to heightened potential for conflict among governance actors. Also, governance arrangements for water allocation in Whiteman's Creek are evolving to include more decentralized and participatory decision making in the form of Low Water Response teams and Irrigation Advisory Committees. The case also satisfies pragmatic criteria of accessibility to interview participants and documentation.

3.5.3. Document review

Documentation can provide a rich source of information for qualitative research. Most documents provide secondary information generated by others and are thus subject to values and perspectives different from those of the researcher. Documentation is particularly useful because it provides a low cost data source that can be collected unobtrusively. It does, however, present some challenges. Pragmatically, limited availability and access to documents can hamper research. More importantly, some documents can be overly inferential, which poses challenges for legitimizing evidence and meaning (Rothe, 1994; Creswell, 2003; Yin, 2009). As Silverman (2005: 160) notes, "while documents provide 'social facts', since they are produced, shared and used in socially organized ways they cannot be considered accurate, transparent representations of day-to-day activities such as organizational routines or decision making, no matter how comprehensive or official."

This research drew on a range of documentation relevant to water planning, management and policy for Whiteman's Creek, in the Grand River watershed and in the Province of Ontario. This documentation included policy statements and planning documents, scientific reports and policy analyses, academic journal articles, websites of key actors and institutions of water governance, legislation and regulation, newspaper articles, archival records and conference proceedings. In the end, a limited number of key documents (approximately 20) provided the bulk of evidence for this research.

3.5.4. Semi-structured interviews

Interviewing is one of the most common means of collecting primary information in qualitative research. The purpose of interviews is to elicit narrative stories from respondents (Warren and Karner, 2005). Interviews can take a number of forms: open-ended, where questions are not pre-specified and the researcher provides little or no direction to informants; semi-structured, where researchers use a guide (often a series of questions) to focus the interview, but that also allows informants to elaborate or focus in specific areas; and, structured, where the interviews proceed according to a standardized, ordered set of questions (Rothe, 1994; Creswell, 2003; Yin, 2009).

Semi-structured interviewing was used in this research in order to maintain the conceptual focus of the study while allowing informants the freedom to move away from the research guide, thus providing opportunities for new insights with respect to both the conceptual framework and the detailed evidence provided. The interview guide is included as Appendix A.

A total of 13 interviews were completed over a four month period from July to October 2007. The informants were identified through the document review, by internet searches, and via snowballing, whereby one informant recommended others as valuable informants. Informants represented a range of sectors, perspectives and interests relevant to water governance in Whiteman's Creek, including local and provincial governments, the GRCA, environmental, conservation and faith groups, First Nations, academic experts and the agricultural sector.

Interviews were dyadic – with one researcher and one participant involved in each (Warren and Karner, 2005). Each interview lasted from 45 to 75 minutes. All were tape-recorded with the consent of interviewees. Twelve of the 13 interviews were conducted face-to-face, with the remaining interview conducted via telephone due to travel constraints. Most were conducted in the office settings of the informants, with a few conducted in alternative settings such as conferences and in one instance, beside the creek.

The research procedure was reviewed and approved by the University of Waterloo Office of Research Ethics (ORE), which requires that all researchers undertaking studies that involve human participants be consistent with University of Waterloo guidelines. Those guidelines ensure that the rights and welfare of human participants are respected and that participation is secured through a transparent consent process that is fully informed and voluntary (Office of Research Ethics University of Waterloo, 2005). The procedures discussed above received approval from the ORE under file number 12909.

3.5.5. Analysis, interpretation and synthesis

Upon completion of interviews, the taped sessions were reviewed in their entirety. Complete transcriptions of the interviews were not produced; rather, attention was focused on extracting key evidence, including general observations and inferences by the researcher, as well as specific statements of informants that provided particularly compelling or unexpected data. This information was brought together in an interview analysis document organized according to the seven elements of the conceptual framework. By reviewing this document in an ongoing and iterative way, key observations and interpretations were developed, drawing out common perspectives and comments, and noting particularly extreme perspectives and points of agreement and disagreement among the respondents.

The interview data were then synthesized with the data generated through the document review to develop a narrative of the situation, framed according to the conceptual framework. In synthesizing the research data, key themes were drawn out, providing the basis for the conclusions and recommendations of the thesis.

3.6. Research limitations, validity and reliability

Several factors related to the research design and its implementation could have limited the value and relevance of the study. First, the study would have benefited from a greater number of informants to provide a more diverse and rich picture of the perspectives on water governance in Whiteman's Creek. However, due to time constraints and inability to access some informants over the research period the study was limited to 13 informants. The informants accessed were, for the most part, knowledgeable on the dynamics of water governance in Whiteman's Creek and thus the information provided was deemed sufficient to meet the goals of the research.

Second, the methods employed in conducting the research, particularly the approach used to analyze and interpret the data, can allow for what Yin (2009: 14) refers to as "equivocal evidence" or "biased views" of the researcher which can influence the direction of findings and conclusions of the study. As noted previously, under a constructivist epistemology, a researcher's values are recognized as an influence on the overall research process, and can at best be managed and acknowledge by stating those values and applying research standards.

Finally, case study research is often criticized as providing a poor basis for generalization. Since each case comprises unique biophysical and socio-political elements, some question the plausibility of comparing results to other cases and generalizing findings to society more broadly. However, the matter is one of the level of generalization possible; that case studies can be generalized to theoretical and conceptual propositions (i.e., analytic generalization) not populations or universes (i.e., statistical generalizations) (Silverman, 2005; Yin, 2009). And as Flyvberg (2006) notes, while limitations regarding generalization are valid, exploratory studies have an important role in academic research because of their potential to look beyond understanding symptoms and frequencies of problems, to exposing meanings and patterns in complex social phenomena.

Validity and reliability of qualitative research methods rely heavily on triangulation. This research relies on a technique known as methodological triangulation whereby more than one method is used to gather data (Stake, 1995). In this research, literature review, semi-structured interviews and document review provided the methods to address validity and reliability. The literature review provides a legitimized base of information to create the conceptual framework, and the use of document review and interviews provides two data collection techniques for triangulation. Validity and reliability are enhanced when documentation and interviews reinforce similar concepts, perspectives and meanings; this is further enhanced when the input of multiple informants results in similar data.

Chapter 4: CONTEXT: WHITEMAN'S CREEK SOCIO-ECOLOGICAL SYSTEM

Many of the sources and aspects of complexity, uncertainty and conflict often encountered in water governance outlined in section 2.1.2 are present in Whiteman's Creek SES. The ecological and hydrological context in the watershed, in particular the close connections between regional groundwater and the creek in the Norfolk Sand Plain and the impacts of landscape transformation, are the basis for significant ecosystem complexity. Since the mid 20th century, frequent and prolonged low water conditions in the creek have added to this complexity, and when combined with heavy water takings by multiple users and sectors has led to significant uncertainty regarding availability of water to meet human demands while also securing water instream to sustain the integrity of creek ecosystem. The potential of more frequent and extreme low water events anticipated due to climate change is likely to compound the complexity and uncertainty of water management in Whiteman's Creek. The system of water governance is equally complex as it includes a growing number of institutional arrangements at different spatial scales and a range of actors and interests using water and active in decision making.

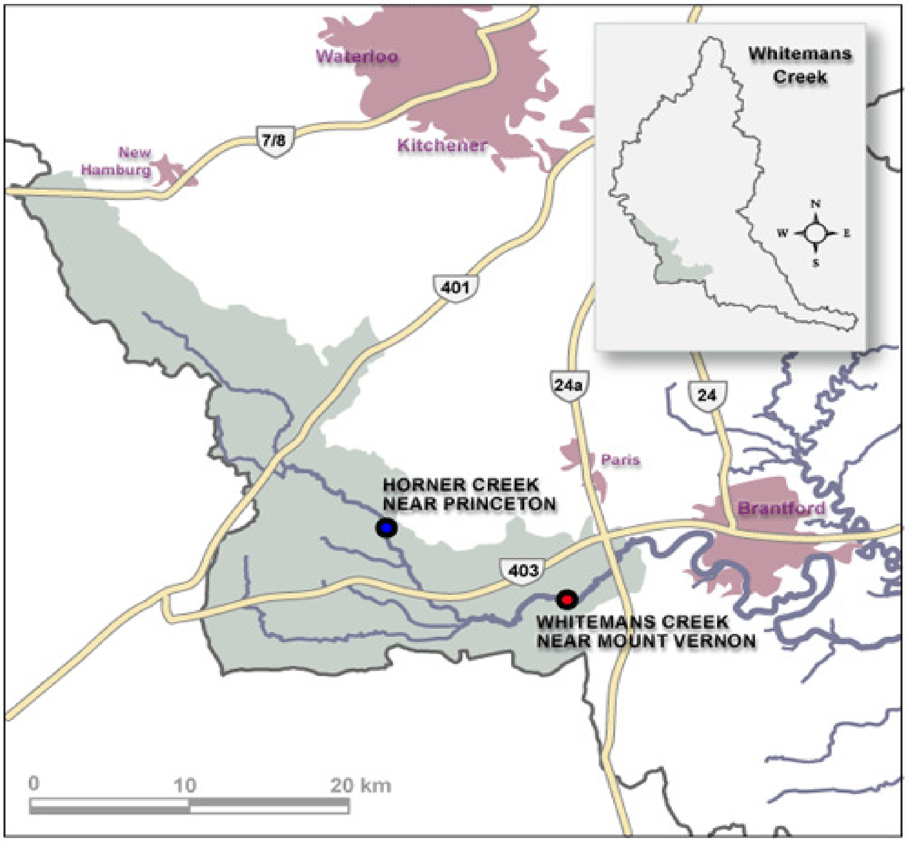
The net result is heightened potential for *conflict*: among various extractive water users; between extractive water uses and instream values; and between withdrawals for socio-economic development and the ecological integrity of the creek. The complexity, uncertainty and potential for conflict may increase with the more frequent and extreme low water events anticipated under global climate change.

This chapter is divided into three sections. Section 4.1 describes the watershed environment. Section 4.2 describes the water governance system, especially the roles and responsibilities of various levels of government, quasi-government organizations, multi-stakeholder entities and civil society. Section 4.3 summarizes the chapter, reflecting on the dynamics of the Whiteman's Creek SES.

4.1. The watershed environment

Whiteman's Creek watershed is primarily rural in character with a number of small settlements within its boundaries. Water resources are critical to sustaining agricultural productivity, including some of the largest cash crop operations in Southern Ontario, as well as other water-dependent economic activities including aquaculture, recreation and aggregate mining (Grand River Conservation Authority, 2007b). The creek also supports a valued sport fishery with thriving populations of smallmouth bass, walleye, northern pike, brown trout and a unique resident population of rainbow trout, and is home to several species at risk, including the black redhorse and river redhorse (Grand River Conservation Authority, 2005a; Marion, 2006).

Figure 4-1: Map of Whiteman's Creek watershed



Source: Grand River Conservation Authority

The watershed lies in the lower, southwestern portion of the Grand River basin. Its two main tributaries, Horner and Kenny Creeks, converge west of the community of Burford before merging with the main stem of the Grand River just north of the City of Brantford (Grand River Conservation Authority, 2007b).[5] The watershed is small, with an area of 414 km^2 (Grand River

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[5] According to the 1962 Whiteman (Horner) Creek Conservation Report, Horner is the common name for the water course, but locally is only applied to the section above the confluence with Kenny Creek. That report, and most studies since, follow the precedent set in the 1954 Grand Valley Report which uses the name Whiteman (or Whiteman's) for the entire watershed system (Province of Ontario - Conservation Authorities Branch, 1962: 5).

Conservation Authority, 2005a). Horner Creek is the larger of the two tributaries; it runs from its headwaters near the community of Shakespeare in a south-easterly direction for 40 km before merging with Kenny Creek near Burford. Kenny Creek, a slow moving and meandering watercourse, begins in the eastern portion of the Township of Norwich to the west of the City of Woodstock. From there it flows in a generally easterly direction for approximately 15 km to reach the confluence with Horner Creek. Beyond this point, Whiteman's Creek continues in a easterly direction for approximately 13 km before merging with the main stem of the Grand River (Richardson, 1954; Province of Ontario - Conservation Authorities Branch, 1962; Province of Ontario - Conservation Authorities Branch, 1972).

The physiography of the watershed is dominated by a till and sand plain interspersed with till moraine, and smaller segments of kame moraine and wetland areas. Till plain dominates the headwaters of both tributaries; the soils, comprising generally fine, silty clay loam soils, are described as well to imperfectly drained (Province of Ontario - Conservation Authorities Branch, 1962; Province of Ontario - Conservation Authorities Branch, 1966; Grand River Conservation Authority, 2005a). Much of the south-central portion of the watershed is part of the formation known as the Norfolk Sand Plain. In this area well-drained, high permeability soils comprise a shallow sand aquifer, which is an important hydrologic feature for both irrigation water supply and for the integrity of the creek ecosystem (Grand River Conservation Authority, 2005a; Grand River Conservation Authority, 2007b).

Flows in lower Whiteman's Creek depend highly on groundwater discharged from the high water table of the Norfolk Sand Plain. According to the GRCA, "the shallow unconfined aquifer is so well connected to the surface water that any water takings from groundwater can be assumed to have an impact on the surface water levels" (Grand River Conservation Authority, 2005a). This groundwater discharge is particularly important during dry summer months when the aquifer slowly and continuously releases cold, clear water critical to the trout and other cold-water fishes found in the lower reaches of the creek (Ivey, 2002; Grand River Conservation Authority, 2005a; Grand River Conservation Authority, 2007b). The warmer, upper reaches support healthy populations of northern pike and smallmouth bass (Grand River Conservation Authority, 2005a).

Since settlement by Europeans began towards the end of the 18th century, human development has significantly altered the landscape and hydrology of Whiteman's Creek watershed. In 1794, lands purchased from the Mississauga First Nations were opened up by settlers who began clearing the dense mixed forests of maple, elm, hemlock, cherry, and high grade white pine, converting the land to agricultural uses. This same year Thomas Horner opened the first sawmill on the creek: 55 years later at least 26 sawmills were active in the region (Dreger, 1932; Richardson, 1954). Within a century, Whiteman's Creek watershed was almost 90% cleared of forest cover due to the high agricultural land value (Richardson, 1954). A 1962 conservation study found that only 8% of the watershed remained forested, with 46% of the land in grain, corn and other row crops, 7% in tobacco and 25% in hay and pasture (Province of Ontario - Conservation Authorities Branch, 1962; Province of Ontario - Conservation Authorities Branch, 1966).

In 1954, the Grand River Conservation study reported that Kenny Creek may dry up in very dry summers (Richardson, 1954). Similarly, stream flow data collected over a 12-year period from 1953 to 1965 showed a dramatic variability in flows on Horner Creek, with a maximum of 2268 cfs at one extreme, and "zero flow recorded on several occasions" (Province of Ontario - Conservation Authorities Branch, 1966). The 1962 Conservation Report also makes reference to inadequate supplies that "may fail entirely", as well as "drying of streams" by heavy pumping during low flow periods (Province of Ontario - Conservation Authorities Branch, 1962: 21-3).

According to the GRCA (2005b), approximately 165 Permits to Take Water (PTTW) have been issued for Whiteman's Creek watershed – a large number for this relatively small watershed. Of these, 148 are for agriculture. Water takings are from both ground and surface water sources, with permitted groundwater takings representing a greater volume than takings from the creek (Grand River Conservation Authority, 2005a). Table 4-1 and Table 4-2 (adapted from: Grand River Conservation Authority, 2005a: 115) summarize permitted surface and ground water takings, respectively, in the Whiteman's Creek watershed. Agriculture accounts for approximately 91% of surface water takings and 92% of groundwater takings.

Table 4-1: Surface Water Takings Upstream of Mt. Vernon Reach on Whiteman's Creek, 2005

General Purpose	Specific Purpose	Takings as flow (m3/s)	% of total surface water takings
Agriculture	Other agriculture[6]	1.111	74.38
	Tobacco	0.253	16.97
	Market gardens / flowers	0.004	0.53
	Nursery	0.008	0.25
Commercial	Aquaculture	0.008	0.53
Construction	Other construction	0.013	0.88
	Road building	0.002	0.11
Miscellaneous	Wildlife Conservation	0.095	6.34
Total		**1.49**	**100.00**

(Adapted from: Grand River Conservation Authority, 2005a: 115)

Table 4-2: Groundwater Takings Upstream of Whiteman's Creek, 2005

General Purpose	Specific Purpose	Takings as flow (m3/s)	% of total ground-water takings
Agriculture	Other agriculture[7]	1.590	74.91
	Tobacco	0.355	16.71
	Field & pasture crops	0.063	2.97
	Market gardens / flowers	0.023	1.10
	Nursery	0.008	0.39
Commercial	Golf course irrigation	0.021	0.99
	Aquaculture	0.011	0.50
	Other commercial	0.005	0.26
Dewatering		0.019	0.90
Industrial	Food processing	0.001	0.03
Miscellaneous	Other miscellaneous	0.020	0.97
Water supply	Municipal	0.006	0.27
Total		**2.123**	**100.00**

(Adapted from: Grand River Conservation Authority, 2005a: 116)

The majority of water takings occur in the Norfolk Sand Plain region, the same region in which the creek is considered a pristine watercourse, including sections designated as a fish sanctuary with special fishing regulations to sustain fish populations and protect habitat. During late summer months (i.e., August, September), flows in this region of the creek reach critically low levels in many years that pose threats to the aquatic ecosystem. This has occurred four years within the past decade: 2001, 2002, 2005 and 2007. Reports indicate that in 2001 "the creek

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6 "Other" agriculture in IFN study refers to irrigated crops not specified in the list

7 "Other agriculture" includes such crops as potatoes, ginseng, vegetable crops, sod and nursery and garden flowers that have specific, and often significant, water requirements to ensure product that meets the standards for high value on the market.

almost stopped flowing" (Bauslaugh, 2002). These conditions may intensify in the future since climate change impacts are expected to result in reduced water availability and increased water demand during summers months due to declines in precipitation and stream flow and increases in evaporation, adding further complexity and uncertainty to water management (Ivey, 2002).

4.2. The Water Governance System

By tracing the chronology of water resource issues and institutional responses in the Grand River watershed between the late 1800's and the present, Plummer et al. (2005) illustrate the polycentric nature of governance in the watershed, and a shift from centralized authority towards decentralized planning and management. This polycentric and decentralized form is evident in the governance system for water allocation in Whiteman's Creek, which includes a mix of government and non-government actors and an institutional framework consisting of federal, provincial and municipal legal mechanisms, ministries, departments and agencies and collaborative arrangements that include both state and non-state actors. The governance system for water allocation in Whiteman's Creek can be described as a blend of the public (administrative) allocation and user-based allocation systems discussed in section 2.2.4, with significant development of collaborative, local and watershed-based arrangements. Discussion of the governance system is separated into two main sections: one that describes the roles and functions of the various actors in water governance, and the other that deals with decentralized, collaborative governance arrangements related to water allocation in Whiteman's Creek.

4.2.1. Actors, roles and responsibilities

Federal and provincial governments share constitutional responsibility for water management in Canada in an arrangement described as a "complex and confusing allocation of water management powers" (Saunders and Wenig, 2007: 121). Under the *Constitution Act, 1867*, provincial governments hold the majority of power to create laws and policy for management of natural resources – including water (Rueggeberg and Thompson, 1984; de Loë and Kreutzwiser, 2007; Saunders and Wenig, 2007). Specifically, section 109 grants proprietary rights of ownership to provinces, and section 92(5) grants provincial legislatures the power to make laws governing the sale and management of water (Rueggeberg and Thompson, 1984: 16).

4.2.1.1. Federal government

The federal government's constitutional authority for water includes coastal and inland fisheries, navigation and shipping, and residual powers to create laws for the peace, order and good government of Canada (Rueggeberg and Thompson, 1984; Boyd, 2003; Saunders and Wenig, 2007). Specific legislation provides for federal jurisdiction over pollution prevention, interprovincial and international shared waters, and waters on federal lands (Boyd, 2003; Bakker, 2007).

The *Fisheries Act* is the most significant federal legal instrument for maintaining or enhancing the ecological integrity of freshwater ecosystems in Canada. Section 35 of the Act prohibits the harmful alteration, disruption or destruction (HADD) of fish habitat, unless authorized by the Minister of Fisheries and Oceans. According to DFO Policy, authorizations are not issued where the HADD is considered "unacceptable". Where the HADD is considered acceptable, habitat compensation for habitat loss will be required ("Fisheries Act," 1985). According to DFO's Standard Operating Policies, determining what is acceptable regarding HADD relates to critical fish habitat. This determination is based on factors that include that habitat's importance in sustaining valuable fisheries (including commercial, recreational or Aboriginal fisheries), its rareness, its high productive capacity, and the sensitivity of certain life stages (of fish) it supports (Fisheries and Oceans Canada, 2010).

According the DFO's *Decision Framework for the Determination and Authorization of HADD of Fish Habitat*, "Types of projects to likely result in HADD are those that cause any degree of habitat alteration, disruption or destruction such that adverse effects to habitat attributes are likely to occur, and this would be expected to reduce the habitat's capacity to support one or more life processes of fish." Relevant to the conditions in Whiteman's Creek, this may include (among other things) "…change in the hydrology, hydraulics or geomorphology of a water course including …water withdrawal where the remaining flow may be below that required for successful utilisation of the habitat" (Fisheries and Oceans Canada, 1998: 11). Thus, negative impacts on fish habitat resulting from excessive water taking could be considered a HADD, and the activities causing or threatening to cause these impacts would require authorization under the Act.

The challenge of applying the HADD provision to the situation in Whiteman's Creek is that impact on fish habitat due to changes in hydrology relate to the cumulative impacts of many small water takings rather than one or two major takings. While recognizing the potential for cumulative impacts to fish habitat from a large number of individually insignificant projects, HADD authorization is typically applied on a project-by-project basis. The *Decision Framework for the Determination and Authorization of HADD of Fish Habitat* indicates that "cumulative impacts are best addressed through habitat or integrated resource management plans", including "regional/watershed management plans which establish the expected threshold(s) of development consistent with avoiding cumulative effects" (Fisheries and Oceans Canada, 1998: 13-16).

In an effort to improve the effectiveness of the Habitat Management Program, DFO has developed a risk management framework, which provides a structured approach to decision making under the habitat protection provisions of the *Fisheries Act.* The framework is intended to categorize risks to fish and fish habitat associated with development proposals, to communicate these risks to proponents and to identify appropriate management options to reduce risks to acceptable levels as determined by DFO fisheries staff or designated authorities in provincial governments or CAs (Fisheries and Oceans Canada, no date).

While the Fisheries Act provides the legal impetus for securing water to maintain or improve the integrity of the creek, the active role of the federal government in decisions involving water allocation and use in Whiteman's Creek is limited largely to setting the policy framework according to its responsibilities under the Fisheries Act, and participating in and funding collaborative water planning and management initiatives that are led primarily by the Grand River Conservation Authority discussed below in section 4.2.1.4.

The federal government is also responsible for water management on federal lands (such as national parks) and with respect to First Nations and their reserve lands. Issues related to First Nations and Aboriginal water rights are addressed in section 4.2.1.5.

4.2.1.2. Provincial government

Canada's Constitution Act assigns primary jurisdiction over "property and civil rights" and "the management and sale of public lands" to provincial governments. Since water is traditionally regarded as a form of property and common interpretation of the term 'public lands' includes water, provinces take the lead in most aspects of Canadian water management, including policy development, planning, allocation and ecosystem and source water protection (Pearse, Bertrand and MacLaren, 1985; FitzGibbon, Mitchell and Veale, 2006; Bakker, 2007). In Ontario, unlike other Canadian provinces, ownership of water is not vested in the Crown; rather, water resources are considered a public good that is used and managed through application of provincial laws, policies, regulation and stewardship initiatives (Conservation Ontario, 2003).

Responsibilities for water management in Ontario are shared primarily among Ministries of Environment, Natural Resources, Municipal Affairs and Housing and Agriculture, Food and Rural Affairs. Table 4-3 outlines significant provincial legislation with implications for governance of water allocation in Whiteman's Creek.

Table 4-3: Significant provincial legislation related to water management

Legislation & Lead Agency	Details
Clean Water Act (2006)	**Intent:** Ensure communities protect municipal drinking water supplies **Lead Agency:** Ministry of the Environment
Ontario Water Resources Act (1990)	**Intent:** Protect and manage Ontario's water resources **Lead Agency:** Ministry of the Environment
Conservation Authorities Act	**Intent:** Establishes a statutory framework for the creation, funding and operation of Conservation Authorities within Ontario and established their mandate to "further the conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals." **Lead Agency:** Ministry of Natural Resources
Lakes and Rivers Improvement Act	**Intent:** Regulate management, protection, preservation and use of the waters of the lakes and rivers of Ontario. **Lead Agency:** Ministry of Natural Resources

According to Kreutzwiser et al. (2004: 136), "Water allocation in Ontario takes place under a complex combination of common law, statutory law and policy." The legal framework is founded on the common law doctrine of riparian rights, which do not constitute ownership rights, but rather are rights of access to water flow in its natural quantity and quality, and limited rights to use that water for domestic purposes such as drinking and bathing, and purposes such as irrigation and manufacturing. A key constraint on these rights is that a landowner must not infringe on the rights of other users either by diminishing water quality or decreasing the quantity available downstream (Rueggeberg and Thompson, 1984; Percy, 1988; Lucas, 1990; Christensen and Lintner, 2007).

Over time, these common law foundations have been modified by statute law. The *Ontario Water Resources Commission Act, 1956* created the Ontario Water Resources Commission – a body established with broad powers to "develop and make available supplies of water" – in order to finance, construct and operate water supply and sewage treatment works (Milner, 1957; Mitchell and Shrubsole, 1992). An amendment to the Act in 1961 authorized the regulation of water takings in Ontario. This amendment, now designated as Section 34 of the Ontario Water Resources Act (OWRA),[8] requires that users obtain a permit to take water (PTTW) if they intend to withdraw more than 50,000 litres of per day from ground or surface water sources. Exceptions include water for fire fighting, livestock watering, or private domestic use, regardless of the volume taken, as well as those permits issued prior to the March 29, 1961 when the amendment took effect. The OWRA also gives the Minister of Environment the power to refuse or cancel permits, and to include specific terms and conditions. Terms and conditions may include specified volumes or rates of taking, purposes for which the water can be used and durations of the permit; conditions limiting timing of takings to particular seasons have also been included in permits (Gartner Lee Limited, 2002; Kreutzwiser, de Loë et al., 2004; Christensen and Lintner, 2007).

Kreutzwiser et al. (2004: 136) note that "the PTTW program has remained largely unchanged since its introduction in 1961." A notable exception was the introduction of Ontario Regulation 285/99 in 1999, commonly referred to as the 'water taking and water transfer regulation', which, among other things, established protection of the natural functions of the ecosystem and interference between ground and surface water takings as explicit considerations for government staff assessing permit applications.

Various reviews have identified significant problems with the PTTW program, including a failure to consider the impact of takings on ecosystem health, poor information management

[8] (Revised Statutes of Ontario [RSO] 1990, Chapter O 40)

and other issues related to administrative processes, which have resulted in over-allocation of some water sources. Table 4-4 identifies and explains major problems identified in reviews of the PTTW program.

Table 4-4: Issues with water allocation in Ontario

Problem	Explanation
Unclear priorities and inconsistent decision making	• Unclear priorities among various water uses – in particular, what priority ecosystems have relative to human demands. • OWRA does not include priorities in use or legal protection of ecosystem needs for water. • Technical assessments and use of scientific information on permit approvals are highly discretionary and inconsistent.
Incomplete information and knowledge gaps	• Lack of data on water supply and demand, requiring regulatory agencies and water users make decisions in the absence of essential information on water availability, current levels of use, and future demands. • Issue of permits for new takings without access to accurate information on existing takings may threaten ecosystem integrity.
Fragmented administration	• Responsibilities for assessments and the required information are spread across many actors, including the MNR, MOE, Conservation Authorities, DFO and municipal governments that vary in their approach to assessing impacts of water takings.
Short-term perspective and piecemeal approach	• Little attention is directed to the cumulative impacts of water takings on ecosystem function which, in some cases, has led to over-use and negative impacts on ecosystem integrity.
Reactive to conflict and enforcement and inflexible	• PTTW relies on primarily on voluntary compliance, with enforcement topically triggered by conflict (i.e., complaint of interference). • Permit duration (typically 10+ yrs) provides little opportunity for transfer of allocations among users and is therefore poorly equipped to adapt to changing economic, social and hydrological conditions.
Limited stakeholder participation	• Opportunities for public involvement are limited to commenting on permit applications posted on the provincial environmental registry under the Environmental Bill of Rights (EBR). • The 30-day comment period under the EBR is too short to allow for meaningful public input.

(Sources: ECO, 2001: 8; Gartner Lee Limited, 2002; Conservation Ontario, 2003: 40; Government of Ontario, 2004; Kreutzwiser, de Loë et al., 2004; Sierra Legal Defence Fund, 2004)

Responding to these and other problems, the government of Ontario revoked O. Reg 285/99 in 2005, replacing it with O. Reg. 387/04 and establishing new guidelines for assessing permit applications. Permits are now subject to a screening process that classifies them into three categories based on the risk of environmental impact and of interference with other users. Category 1 takings have low risk of causing adverse environmental impacts or interference with other uses; categories 2 and 3 have greater potential to cause environmental impacts or interference. Category 1 applications are subject to technical screening and evaluation by MOE staff; category 2 takings require applicants to include a scientific evaluation of the application by a qualified professional; category 3 takings must be accompanied by a scientific study prepared by a qualified professional. PTTWs are approved by Regional Directors with the MOE, with input from municipalities with respect to issues of concern to municipalities; CAs with respect to screening for DFO and watershed information; and MNR with respect to fisheries management, wetlands, habitat and dams (Government of Ontario, 2005b).

The revised PTTW process also identifies high and medium risk watersheds as another screening mechanism to assist Ministry staff in assessing water availability as part of the permit evaluation considerations. The PTTW manual includes two maps identifying high and medium use watersheds: one for watersheds classified as high or medium use during 'average annual conditions', and a second for watersheds classified as high or medium use during 'summer low flow conditions'. The summer low flow period is the six-week period that starts on August 1st and ends on September 11 of each year; the duration and timing of the period can be extended at the Director's discretion. Permit applications for high or medium use watersheds may be subject to additional requirements, including: demonstrating whether the volume of the taking can be reduced through more efficient use of water; conducting environmental effects monitoring under a short permit period in order to assess impacts before issuing a longer-term permit; and may cause the Director to initiate an assessment process to better understand or assess cumulative impacts of existing and proposed new takings on the watershed or water source. The PTTW manual states that, in high use watersheds, the Director will refuse permit applications for new or expanding water takings that remove water from the watershed, including beverage manufacturing, fruit or vegetable canning or pickling, ready-mix concrete manufacturing, and aggregate processing. The Grand River watershed is classified as medium use during average annual conditions and high use during summer low flow conditions (Government of Ontario, 2005b).

The revised PTTW process also aims to encourage greater efficiency in use and conservation of water resources. For new permits or requests for increased takings, applicants may be required to demonstrate that increased demand could not be reduced or avoided by changing to more efficient water use practices. Permit applications must also include goals for increasing efficiency or reducing loss of water, and must identify water efficiency practices to be undertaken and timelines for their implementation. The new process also requires users to keep track of the volume of water taken each day and to report these amounts annually (Government of Ontario, 2005a; Government of Ontario, 2005b).

On paper, changes to the PTTW program suggest improvements to water governance for Whiteman's Creek and for the province generally; however, the actual implications for water governance and water use in Whiteman's Creek are less apparent. The addition of screening mechanisms suggests improvements in assessing the relative importance of ecosystem water needs versus human withdrawals; however, despite the 2005 revisions to the PTTW program, new permits have been issued in Whiteman's Creek watershed. The screening processes also suggest improvements in the amount and quality of information accessed or developed to evaluate permits, as an application for category 2 and 3 watersheds requires scientific studies assessing the potential impacts of the proposed water taking on the environment and on other users. Where adhered to, this change may increase the understanding of water availability relative to a proposed water taking; however, as will be discussed in section 5.2, for some users this requirement acts as a deterrent to use the permit system due to the cost of providing the information. There is no evidence that changes to the PTTW have improved participation in decisions regarding water use in Whiteman's Creek. Worse, one interviewee with intimate knowledge of agricultural water use indicated that many in the agricultural community, which accounts for the greatest withdrawals of water, are not even aware of the PTTW program, suggesting a need for greater education and awareness in that community.

4.2.1.3. Local governments

Local governments have no explicit jurisdiction over water under Canada's *Constitution Act, 1867*. As 'creatures of the provinces', local and regional municipalities have power and responsibility only over those aspects of water management assigned to them by provincial governments (de Loë and Kreutzwiser, 2007). In Ontario, provincial allocation of powers to local governments occurs under the *Municipal Act*, which empowers municipalities to enact bylaws to impose constraints on water use (e.g., outdoor water use by-laws) and impose fees and charges for water services. In many cases, particularly in the densely populated areas of southern Ontario, two-tier municipal governments exist (i.e., Regional and local governments). In these instances, the various aspects of urban water management are shared among regional bodies and local governments, each with its own elected council and administrative structures. Despite reliance on delegated provincial authority, municipal governments, and in particular elected officials, are an important influence on water governance via their roles in Ontario's Conservation Authorities; this is discussed in further detail in the following section (4.2.1.4).

Local governments, under provincial legislation, are generally responsible for delivering treated water to local residents. In the context of Whiteman's Creek, the population of the County of Brant, and in particular the urban community of Paris, is expected to increase significantly in the coming decades. The most recent official plan includes a 'conservative estimate' of population growth in the County that would see numbers rise from 29,790 persons in 1996 to over 36,700 by 2021 (County of Brant, 2000: 8). The 2006 Canada Census reports a population of 34,415 persons – an increase of 8.7% from the 31,669 reported in 2001 (Statistics Canada, 2006). The population is growing more quickly than estimated in the 2000 official plan. The *Growth Plan for the Greater Golden Horseshoe* released in 2006 by the Ontario Ministry of Public Infrastructure Renewal projects a population of 39,000 for Brant County by 2011, with further growth out to 2031 (separate estimates are not provided for Brant beyond 2011, but are presented together with estimates for the City of Brantford) (Ministry of Public Infrastructure Renewal, 2006: Schedule 3).

The community of Paris, with a population of approximately 11,000 persons, is the largest population centre in the County of Brant. Paris, and more specifically, the Southwest Paris Urban Settlement Area, was identified in the Official Plan as a focus for new urban development (County of Brant, 2004). Two groundwater wells have been developed in this area that, while not yet in service, are in place to support future demand for municipal water supply. These wells are located in the vicinity of small tributaries that feed the lower reaches of Whiteman's Creek (County of Brant, 2010b; County of Brant, 2010a:12).

4.2.1.4. Conservation Authorities

Established under the *Conservation Authorities Act (1946),* Ontario's 36 Conservation Authorities (CAs) are local, watershed-based organizations created through partnerships between municipal and provincial governments (Mitchell and Shrubsole, 1992). Introduction of CAs signalled a significant, province-wide move towards more collaborative, decentralized and ecosystem-based water governance in Ontario. Section 20 of the Conservation Authorities Act establishes their mandate to "further the conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals." The website of Conservation Ontario, the umbrella organization that supports the network of CAs, describes the mandate slightly differently as ensuring the "conservation, restoration and responsible management of Ontario's water, land and natural habitats through programs that balance human, environmental and economic needs" (Conservation Ontario, 2009).

Unique in that they operate at a watershed scale rather than according to political boundaries, the CAs facilitate coordinated resource management, including management of water resources. Collaboration and cooperation are central the CAs efforts to integrate the activities of municipal and provincial ministries, federal agencies, Aboriginal, land owners and non-government organizations (Mitchell and Shrubsole, 1992; Carter, 2006). While the early activities of CAs focused largely on flood damage reduction and low flow augmentation (i.e., operation of dams and reservoirs), individual CAs, as well as their umbrella organization Conservation Ontario, have assumed a growing role and influence in Ontario water governance and management. For example, where they exist, CAs are the primary implementing agencies for the Province of Ontario's Drinking Water Source Protection Program and the Ontario Low Water Response Program. CAs also play a critical, and often leadership, role in fisheries management, research studies, monitoring, water management planning and recreation and education (Grand River Conservation Authority, 2010). The GRCA is also responsible for the implementation of the DFO Risk Management Framework under a formal partnership agreement with Fisheries and Oceans Canada.

CAs are not-for-profit corporate bodies governed by a Board of Directors whose members are appointed by local and/or regional municipalities. The majority of Board members are elected municipal officials. Boards are responsible for electing a chair and one or more vicechairs on an annual basis. Decisions are taken via vote, with each member entitled to one vote. Funding for CAs is derived from a combination of self-generated revenues (e.g., campground fees, planning fees, and hydroelectric generation), municipal levies, and grants and project funding from provincial and federal governments.

The GRCA and its predecessor organizations (the Grand River Improvement Association, the Grand River Valley Boards of Trade, and the Grand River Conservation Commission) were very much the foundations for Ontario's CAs (Mitchell and Shrubsole, 1992). Today, the GRCA is one of Ontario's best resourced and most effective CA's, managing water and other natural resources on behalf of almost one million residents within the Grand River basin.

The GRCA Board includes 26 members representing the 38 municipalities in the Grand River watershed. Representation is based on population, with larger municipalities having multiple representatives, and smaller municipalities having only one, or in some cases, one representative for a number of rural municipalities grouped together. In 2010, the GRCA's approximately $33 million budget included $10 million (32%) from municipal levies, $8 million (25%) from provincial and federal governments, and $13.4 million (43%) from self-generated revenue. Budgeted expenditures in 2010 break down as follows:

- Base operating budget: $18.6 million (57%);
- Special programs (one-time or ongoing projects such as sub-watershed studies, land purchases, etc.): $2.1 million (6%);
- Conservation Area operations: $8.2 million (25%); and,
- Source Water Protection program (covered entirely by provincial grants under the Clean Water Act): $4.1 million (12%).

Dependable revenues are critical to sustaining and enhancing the important functions of the CAs. In the mid-1990s, deep and rapid cuts to the budgets of the Province of Ontario's environmental agencies, including CAs, caught many CAs off guard and required that they react quickly to refocus their efforts and become more proactive in setting their own organizational agendas (Michaels, Goucher and McCarthy, 2006). The GRCA has a diverse revenues base, with significant funds generated through the municipalities that are active and engaged partners in CA, and through self-generated revenues. However, a significant portion of the annual budget (25% in 2010) still depends on transfers or grants from provincial and federal governments –

resources that are vulnerable in light of changing priorities or changing governing parties at higher levels of government (Grand River Conservation Authority, 2010).

4.2.1.5. Aboriginal government

As noted above, the federal government, under Aboriginal Affairs and Northern Development Canada (AANDC), is responsible for water management on First Nations reserves. However, the rights and roles of Aboriginal peoples in Canadian water governance extend beyond those related to reserve lands. In Canada, Aboriginal title, Aboriginal rights and treaty rights are protected under section 35 of the Constitution Act of 1982 (Walkem, 2007). The Supreme Court's protection of Aboriginal rights is based on the idea of a demonstrated connection to the land by the Indigenous Peoples claiming that right.

For Indigenous Peoples, territorial rights are inherent rights that originate from their own existence residing and from governing in these areas – their rights flow from occupation of their traditional territories before European colonization. Inherent rights do not require Canadian legal or political recognition to exist (Walkem, 2007: 306; Phare, 2009: 35). As Phare (2009: 36) notes:

> The difference is not just about terminology. There is a fine but important distinction between the two approaches. Canada considers these rights as valid once they are acknowledged by a court or the government itself (for example, through agreement). Indigenous Peoples, however, refer to their rights as being inherent to their Nations, given and limited by the Creator's laws and responsibilities, including the laws of stewardship and reciprocity with nature.

Treaty rights are another category of Aboriginal rights. These are rights laid out in nation-to-nation agreements between Indigenous Nations and representatives of Canada that reflect the mutual intentions of the parties at the time when the treaty was entered into. Treaties can include rights to resources such as hunting and fishing that pre-existed the treaty process, or granted rights such as the right to receive annual per capita financial payments, education and medical care (Walkem, 2007).

How this rather complicated system of Aboriginal rights relates to water is not fully clear. One argument is that Indigenous Peoples had inherent rights to water before Canada and the provinces were formed. However, the position of Canadian provinces is that, as a result of transfer of land and resource rights from the federal government when they were created, they possess the rights to the use of all water within their borders. All provinces, except Ontario and Prince Edward Island, have asserted ownership over and rights to water through legislation. As discussed in section 4.2.1.2 above, in Ontario ownership of water is not vested in the Crown but rather is considered a public good. It is commonly held by Canadian governments that Indigenous Nations gave up all rights to water through treaties addressing land rights – yet the treaties are silent on the issue of water rights (Phare, 2009). As Phare (2009: 51) notes, "…federal and provincial governments still have to prove (and it is their onus to do so) that First Nations peoples surrendered their water rights at any time in Canadian history."

This lack of clarity on Aboriginal water rights (and Aboriginal rights and title more generally) may have implications for water governance in the Grand River watershed, including Whiteman's Creek. Specifically, issues relate to the land rights of the Six Nations of the Grand River Territory. The Haldimand Proclamation of 1784, which granted land to the Iroquois who had served with the British during the American Revolution, allotted to the Six Nations lands "six miles deep from each side of the river beginning at Lake Erie and extending in that proportion to the head of the said river…" (Six Nations Lands and Resources, 2008). In 1798, Mohawk Chief Joseph Brant sold the lands opening them to settlement by Europeans, yet still today the Six Nations continue to lay claim to the bed and banks of the Grand River, leaving open questions of future land (and potentially water rights) claims. In a report in the Kitchener-Waterloo Record, then chief of the Six Nations elected council, David General, noted that "To say definitively today that there won't be a claim in that area is a bit premature…" (Outhit, 2006).

The elected council is the recognized governing body of the Six Nations under the *Indian Act*. However, adding to the uncertainty related to land claims in the Haldimand tract is the existence of a rival council, the Haudenosaunee Confederacy council, which represents the traditional Aboriginal leadership and is hoping to displace the elected council. According to then chief of the traditional council, Alan MacNaughton, despite sale of lands along the river, "In none of those agreements or sales or leases was the river or the river bed ever mentioned…" (Outhit, 2006). Thus, issues of Aboriginal land and water rights remain an open question as relates to water governance in the Grand River watershed.

4.2.1.6. Non-governmental actors and interests

Local conservation and stewardship organizations have a long history of fish stocking and habitat maintenance and restoration projects in Whiteman's Creek, and thus have significant concerns related to securing water for ecosystem integrity. The Brant Rod and Gun Club is a central actor regarding stewardship and restoration activities in the catchment. For over half a century, the group has worked through partnerships with the MNR, GRCA and community groups to protect and restore fish and fish habitat in Whiteman's Creek. The club, and others including Trout Unlimited and Friends of Grand, are partners with DFO, MNR and the GRCA in fisheries management planning for the Grand River, including Whiteman's Creek.

The Brant Federation of Agriculture, which is the local chapter of the Ontario Federation of Agriculture, engages in water governance and management via the Irrigation Advisory Committee and Ontario Low Water Response programs discussed below in section 4.2.2.

4.2.2. Decentralized, collaborative governance arrangements

Operational aspects of water management and governance related to water allocation in Whiteman's Creek occur to a large degree through decentralized and collaborative arrangements involving the various actors and institutional arrangements discussed above. Two key arrangements are discussed in this section.

4.2.2.1. Ontario Low Water Response Plan

Water shortages are increasingly common occurrences in parts of southern Ontario. Gabriel and Kreutzwiser (1993) documented seven significant dry spells from 1960 to 1989 that resulted in negative impacts on the agricultural sector. A dry spell in 1988 resulted in $55 million in crop insurance payments, and another $12 million paid in compensation to livestock producers (Ivey, Smithers, de Loë et al., 2001; Durley, de Loë and Kreutzwiser, 2003).

In 2003, the province introduced the Ontario Low Water Response (OLWR) plan, responding to a number of factors, including widespread drought in 1999, general increases in water demand, and changing climate patterns leading to more frequent low water conditions (Ontario Ministry of Natural Resources, Ontario Ministry of Environment, Ontario Ministry of Agriculture and Food et al., 2003; de Loë and Kreutzwiser, 2007). The OLWR was developed to ensure provincial preparedness and coordination and to support local response in the event of a drought through clear processes for information flow, establishing roles and responsibilities and outlining communication strategies (Ontario Ministry of Natural Resources, Ontario Ministry of Environment et al., 2003). The plan applies to all water users who hold a PTTW.

The OLWR defines three levels of low water conditions, each with associated responses intended to bring about reductions in water use in the event of drought or drought-like conditions. Precipitation and stream flow (surface water flow) are the variables for defining low water levels and triggering responses. Table 4-5 summarizes the thresholds and responses.

Table 4-5: OLWR conditions, thresholds and responses

Condition	Indicators and Thresholds		Response
	Precipitation	Streamflow	
Level 1	< 80% of average	**Spring**: monthly flow < 100% lowest average summer month flow **Other times:** monthly flow < 70% of lowest average summer month flow	**Voluntary Conservation** **Target:** 10% voluntary reduction by all sectors
Level 2	<60% of average weeks with <7.6mm	**Spring:** monthly flow < 70% of lowest average summer month flow **Other times:** monthly flow < 50% of lowest average summer month flow	**Conservation & Restrictions on Non-Essential Use** **Target:** 20% voluntary reduction by all sectors
Level 3	<40% of average	**Spring:** monthly flow < 50% of lowest average summer month flow **Other times:** monthly flow < 30% of lowest average summer month flow	**Conservation, Restriction & Regulation** **Target:** Reduce and manage water use demands to the maximum extent

(Source: Ontario Ministry of Natural Resources, Ontario Ministry of Environment et al., 2003)

The OLWR plan can be viewed as an addition to Ontario's governance system for water allocation designed to address the shortcomings of the PTTW program in dealing with allocation of water during periods of low water conditions. The plan provides general guidance on prioritizing water uses, but suggests that decisions regarding prioritization and low water response are best made with the support of local water managers and users. The basic prioritization model divides water uses into three classes (Government of Ontario, 2003: 13):

- **Essential uses** of water deal with human life and health: a reasonable supply of water for drinking and sanitation, water for health care, water for public institutions and public protection (e.g., wastewater treatment, some fire protection, schools) and water necessary for basic ecological functions.

- **Important uses** are those important for the social and economic well being of a particular area. This includes activities critical to industrial processes, commercial facilities such as hotels and restaurants and key agricultural crops. This category poses the most difficulty, as it may be necessary to rank priorities between activities and between groups within the same activity (e.g., between farm irrigation and a local car manufacturing plant or between food or non-food agriculture irrigation).
- **Non-essential uses** are those that can be interrupted for the short term without significant impact. These include private swimming pools, lawn watering, public and private fountains and vehicle washing.

Under the OLWR plan, decisions regarding if and when to move between levels and implement responses occur under two distinct but connected bodies: the provincial scale Ontario Water Directors Committee (OWDC) Low Water Committee, and watershed-based, multi-stakeholder Water Response Teams (WRTs). WRTs are the most active decision-making body, with the OWDC Low Water Committee providing general oversight and engaging in decisions and responses when Level 3 conditions occur.

Conservation Authorities (where they exist) take the lead in establishing WRTs. WRTs have no unique legislative authority, and do not replace existing agencies' policies or statutes; rather, they are intended to facilitate coordination of water management agencies, non-government groups and water users. WRTs are formed so that local interests in water resources (i.e., users, managers and other stakeholders) can collectively make decisions about water use during low water conditions (Government of Ontario, no date). They have decision-making authority delegated from the provincial government. Membership of WRTs is established by the lead organization (typically a Conservation Authority) according to guidance in the OLWR Plan which suggests teams should include Provincial government staff (MNR, MOE, OMAFRA), Conservation Authority staff, Municipal government staff, and representatives of local interests including: agriculture, business, recreation, non-government groups, and Aboriginals Peoples (Government of Ontario, 2003; Government of Ontario, no date).

The OWDC Low Water Committee includes two representatives (one Policy Director and one Field Director) from each of the Ontario Ministries of Natural Resources; Environment; Agriculture, Food and Rural Affairs, and Municipal Affairs and Housing. The committee is co-chaired by Water Policy Directors from the Ministries of Natural Resources and Environment (Government of Ontario, 2003; Government of Ontario, no date). Coordination and communication between the OWDC and local WRTs is addressed later in section 5.7 that assesses integration.

The Grand River WRT includes decision-making and non-decision-making members and a chair and secretary elected from the membership; GRCA staff currently serve as chair and secretary. Table 4-6 identifies the team membership. The team's mandate is established at the scale of the overall Grand River watershed, but it has identified 'areas of concern' to which special attention is directed to monitor and respond to low water conditions. Whiteman's Creek is one of the six areas of concern identified in the Grand River watershed.

Table 4-6: Grand River Low Water Response Team

Decision-making member organizations	GRCA (Chair, Secretary) Six Nations (Aboriginal) Municipalities: • Centre Wellington • City of Guelph • Region of Waterloo • County of Brant • City of Brantford • Haldimand County Sectors: • Agriculture • Golf course operation • Aggregate production • Landscaping • Commercial bottlers • Anglers & hunters • Environmentalists
Non-decision-making member organizations	Federal Government: • Environment Canada • Fisheries & Oceans Provincial Government:

	• Min. of Environment • Min. of Natural Resources • Min. of Agriculture, Food & Rural Affairs Technical support: • Trout Unlimited • GRCA (Fisheries expert)

(Source: Grand River Conservation Authority, 2007a)

4.2.2.2. Irrigation Advisory Committees

Whiteman's Creek is one of a few areas in Ontario for which Irrigation Advisory Committees (IAC) have been established. IACs are user-based bodies, nested under the WRTs, which promote irrigation efficiency, facilitate water sharing and deal with conflicts over competing demands for water at the local level in times of low water. First introduced in Norfolk County in the Big Creek watershed in 2000, IACs are a relatively new mechanism for water governance and management in Ontario that emerged partly in response to the agricultural sector's dissatisfaction with the PTTW program. Durley et al. (2003) and Kreutzwiser et al. (2004: 141) suggest IACs represent a potentially valuable evolution in water governance for promoting demand management and wise use of scarce water resources. The IAC in Whiteman's Creek, which is organized through the Brant County chapter of the Ontario Federation of Agriculture, focuses on the lower portions of the sub-watershed on the Norfolk Sand Plain.

IAC membership is voluntary and consists of 10-12 farmers with interests in a common water source; a chair and secretary are elected from the membership. The membership identifies local 'captains' whose role is to coordinate water-taking schedules in times of low water conditions with the goal of staggering water takings to manage the cumulative impacts of water takings on the creek ecosystem. In a well functioning IAC, should conflict arise, the captain is to contact the IAC chair and call on a resolution team (a sub-set of the broader committee trained in conflict resolution) to work with the taker who issued the complaint to mediate the problem through group discussion.

The IAC in Whiteman's Creek was initially formed by the Brant Federation of Agriculture in the summer of 2002. With an initial (one year) budget of $12,000 contributed by DFO, GRCA and the Brant Stewardship Council, the members of the IAC underwent mediation training; however, since that time the IAC has played only a minor role in water governance in

Whiteman's Creek. For example, Agnew (2004: 7) noted that no mediation exercises were conducted by the Whiteman's Creek IAC as of August 2003 despite episodes of low water in the summers of 2001 and 2002, and interviews with key informants for this research conducted during the summer of 2007, during extreme low water conditions, indicated that the IAC had not been active apart from limited communications regarding changes in levels under the OLWR plan.

4.2.3. Summary of the governance system

The governance system for water allocation in Whiteman's Creek takes a polycentric, multi-scalar form that includes a combination of arrangements for ecosystem protection, water allocation and water use management. Some arrangements provide legal authority and mandate and guidance for decision making, while others are functional, collaborative bodies that facilitate decision making and act on decisions.

Federal and provincial legal frameworks, specifically the Fisheries Act and regulations under the Ontario Water Resources Act that form the basis of the PTTW program, establish the overarching structure for governance of water allocation in Ontario. Actual involvement of the federal government in water allocation and use in Whiteman's Creek is limited to oversight of the policy framework for fish habitat protection, and participating in and funding collaborative water planning and management initiatives. The province maintains the bulk of the power over water allocation as administrator of water rights through the PTTW program.

Functional aspects of water governance – where actual decisions and actions are taken, for example, regarding priorities for water use and ecosystem protection – take place through delegated arrangements and collaborative decision making, specifically the OLWR program and the IACs. The GRCA is the most active and significant body influencing operational aspects of water governance and management in Whiteman's Creek. The legislative authority of the GRCA regarding water allocation and ecosystem protection has not changed significantly over time, but its functions and responsibilities have. The GRCA plays a central integrating and convening role in a polycentric, collaborative water governance regime, leading much of the operational decision making, planning and management regarding water resources in the Grand River watershed through delegated responsibility and partnerships. The GRCA also develops and manages much of the information central to water resource management in the watershed. Local conservation and stewardship organizations are also active partners in water governance in Whiteman's Creek, in particular, via the WRT.

The combination of governance arrangements for water allocation in Whiteman's Creek can be viewed as a set of nested institutions, with an overarching legal framework developed and operating at national and provincial scales, the OLWR at the river basin scale (in this case, Grand River) and the IAC constituted at local, sub-watershed scale. Establishing legal regimes and policy guidance at national and provincial scales is appropriate given the constitutional division of powers over water resources in Canada. In principle, delegation of functional decision making to collaborative bodies and operating at the watershed and sub-watershed scales (i. e., OLWR and IAC) seems an effective means for governing water allocation and use effectively. However, the effectiveness of the overall system is contingent on delegated authorities having access to sufficient resources to have capacity for facilitating implementation. For example, the IAC, while a promising model that has been effective in other regions, is of limited influence on water management in Whiteman's Creek due in part to a lack of sustained financial resources. What is an appropriate level of financial resources, and what mechanisms are available to generate those resources, are key questions for the future success of the IACs.

One significant question arising from this review of the water governance system in Whiteman's Creek relates to administration of the PTTW system. Over-allocation of water resources in Whiteman's Creek calls into question whether the administration of the PTTW by the province's regional water managers is effective and efficient. Given its central integrating role in water governance, the GRCA may be better positioned, although not currently appropriately resourced, to assume a stronger role in water allocation to ensure that cumulative impacts of water takings are managed within the ecological capacity of the watershed, and to better integrate the PTTW system with the OLWR and IAC. This matter, and the overall effectiveness of the water governance system in Whiteman's Creek, is explored in greater depth in Chapter 5.

Chapter 5: ASSESSING WATER GOVERNANCE IN WHITEMAN'S CREEK

The discussion in Chapter 4 described the SES, with a primary focus on the governance system. With this context established, Chapter 5 focuses on assessing water governance in Whiteman's Creek watershed by applying the assessment criteria developed in section 2.3.2.

Primary data for this thesis were collected during the summer of 2007 – a summer that local media reported to be one of the driest on record in the Grand River watershed (Aulakh, 2007). Water users in Whiteman's Creek were under pressure to reduce water demands, and the Ontario MNR requested that anglers voluntarily stop fishing in the creek because brook and brown trout were under stress due to the near-record low water levels and increased water temperatures (Ontario Ministry of Natural Resources, 2007). These extreme conditions provided a unique opportunity to observe and assess how existing water governance arrangements in Ontario respond to a water-stressed SES. It is important to note that these extreme conditions instigated some changes to water management and governance in Whiteman's Creek over the months following the data collection period; while attempts were made to understand those changes, they and their impacts on water governance may not be fully captured in this thesis, given time and resource constraints.

5.1. Socio-ecological system integrity

Frequent low water conditions in Whiteman's Creek watershed have implications both for livelihood and economic activities dependent on extractive water use and for the integrity of the creek ecosystem. Low water conditions are most prominent from May to October, which coincides with the irrigation season when water takings are highest. Cash crops such as potatoes, vegetables, tobacco and sod, fundamental to the region's agricultural economy, create particularly heavy demand for water in the late summer and early fall (during harvest time) when supplemental water is required to ensure high quality products and economically viable yields. Extended 'within year' dry spells exacerbate problems since soil moisture is lost to evapo-transpiration, in turn leading to increased irrigation demand (Grand River Conservation Authority, 2005a: 201; Grand River Conservation Authority, 2007b).

The combination of low water conditions and heavy water takings threaten habitat and the productivity of the ecosystem in the lower reaches of Whiteman's Creek, minimizing food sources for fish and other wildlife. This area is critical to the highly valued, and valuable, sport and recreational fishery in the Grand River watershed; indeed, fly-fishing alone contributes more than $1 million to the local economy each year (Grand River Conservation Authority, 2005a; Grand River Conservation Authority, 2007b; Grand River Conservation Authority, 2009).

During the summer of 2007, Whiteman's Creek was listed in OLWR Level 2 condition for over three months in the period from July 25 to November 30. During this time, streamflow had actually reached the Level 3 thresholds, since monthly flows were less than 30% of lowest average summer month flow, although Level 3 conditions were never declared (Grand River Conservation Authority, 2007d; Grand River Conservation Authority, 2008). The situation prompted the Ministry of Natural Resources to take unprecedented action of imposing fishing restrictions to protect fish stocks in the creek (Grand River Conservation Authority, 2007b).

The challenges experienced in 2007 led to more in-depth study of water use and management in Whiteman's Creek. Following the field research for this thesis, and as a result of the extreme low water conditions experienced in 2007, the GRCA, at the request of MNR, conducted a two-phase pilot study on recommending OLWR Level 3 conditions on Whiteman's Creek. That study included a review of precipitation and streamflow data for the period from 1961 to 2007, which revealed 19 annual occurrences of daily streamflow values reaching or crossing Level 3 thresholds with multiple annual occurrences of such low flow conditions (Grand River Conservation Authority, 2008).

The problems related to water management in Whiteman's Creek occur in part because – at least on paper – water resources in the system are over-allocated to extractive water uses. A 2005 study exploring instream flow needs (IFN or environmental flows) for various locations in the Grand River watershed (referred to hereafter as the 'IFN study') provides a comprehensive scientific assessment of water use, availability and ecosystem needs for water in Whiteman's Creek. By comparing mean daily streamflow data to the total value of permits for surface and groundwater takings (expressed as flow rates), the IFN study found that permitted allocations exceed locally available supplies, leading to the following conclusion:

> …permitted rates far exceed the availability of water in Whiteman's creek, and if they were extracted simultaneously at the maximum permitted rate, there would be nothing left for the aquatic environment. (Grand River Conservation Authority, 2005a: 202)

Table 5-1 summarizes the results of the demand-supply analysis of the IFN study. The analysis focused on the period from May to October to assess the impact of the water takings on the streamflow in Whiteman's Creek during the most water-stressed time of year. 'Normal' streamflow (or supply) was determined by calculating the average daily streamflow for the period from 1961 to 2002. Normal streamflow for the period from May to October at the Mount Vernon monitoring gauge was determined to range from 1.2 to 2.5 m^3/s, with a mean of 1.7 m^3/s.

Analysis of the demand-supply relationship was conducted for two different periods: (1) from 1961 to 2002, to assess long-term trends; and, (2) from 1995 to 2002, to focus on what appears to be a period of increasing frequency of low water events. While the results of the analysis indicate that the stream has been over-allocated, the authors of the IFN study indicate complete drying of the creek has not been observed in this lower section (Grand River Conservation Authority, 2005a: 115, 201).

Table 5-1: Permitted water takings and streamflow in Whiteman's Creek[9]

Permitted takings (m3/s)		Implications for streamflow based on 1961- 2002 data	Implications for streamflow based on 1995- 2002 data
Surface water takings	1.49 m^3/s	Creek over-allocated on four different occasions during July and August for several days in a row. Streamflow for the remainder of July and August, and into October, also low, never surpassing 1.0 m3/s.	Creek over-allocated almost all of August and first half of September, as well as a 5-day period in July Flows also critically low in October
Ground Water takings	2.12 m^3/s	Creek over-allocated in period from July through September except for a few days.	No comments in IFN report
Combined water takings	3.62 m^3/s	Would put remainder of taking season after mid-May into over-allocated condition.	Almost all of July to October in negative flows.

The IFN study indicates that the creek does not dry completely because the shallow, regional groundwater aquifer surrounding it serves as a buffer or reservoir that slowly releases

[9] In Table 5-1 the term 'over-allocated' refers to excessive allocations in permits issued under the PTTW program. Permitted takings to do not necessarily equal actual water takings as users may not use their full permitted allocation.

water to maintain some minimal flow during periods of low precipitation. However, there is evidence that the buffering capacity of the groundwater aquifer is being compromised. Increasing frequency of drought is affecting aquifer recharge, and thus flow in the creek during low water conditions. Groundwater levels are described as having "dropped significantly in the last few years" (D. Shultz quoted in Littleton, 2003; Grand River Conservation Authority, 2005a; Grand River Conservation Authority, 2007b). According to the IFN study, "The past decade has also been detrimental to the groundwater supply due to lack of recharge to the aquifers. The ability of the system to buffer the impacts of over-takings in Whiteman's Creek is lessened when the groundwater supply is also being depleted faster than it is recharged" (Grand River Conservation Authority, 2005a: 203).

Over allocation, frequent low water conditions and changes to the buffering capacity of the aquifer pose significant threats to the integrity of the creek ecosystem. The IFN study determined that, at streamflow below 0.80 m^3/s, loss of hydraulic connectivity negatively affects fish, limiting their passage between pools and preventing them from locating food sources and finding refuge from predators (Grand River Conservation Authority, 2005a: 204-5).[10] This 0.80 m^3/s value – referred to in the report as a minimum or cut-off flow – is important for two reasons. First, daily average flows below this cut-off have been observed on at least one occasion in 31 of the 41 years in the period of 1961 to 2002, and have been observed over 50 times in 14 of those 41 years. Second, the cut-off flow is just slightly lower than the OLWR Level 2 streamflow threshold (0.86 m^3/s) and well above the Level 3 streamflow threshold (0.52 m^3/s).[11]

Key findings of the IFN study are that the agricultural sector is facing insufficient supply to meet its needs, while at the same time observed flows in the creek routinely fall below the cut-off flow that results in loss of connectivity of fish habitat in the creek. The report suggest that, because streamflow below the 0.80 m^3/s cut-off threshold was observed frequently (i.e., in 31 of the 41 years analyzed in the study), implementing the cut-off threshold would be impractical as it would adversely impact water users, particularly the irrigation sector. A sensitivity analysis

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[10] Elsewhere, the study suggests that connectivity for fish migration is "first lost" at 1.0 m^3/s (Grand River Conservation Authority, 2005a: 163).

[11] OLWR streamflow thresholds are based on historic data. As part of the OLWR Level 3 pilot study, thresholds were recalculated to include data from the most recent two years. The resulting thresholds were as follows: Level 1 - 1.12 m^3/s; Level 2 - 0.80 m^3/s; and, Level 3 – 0.48 m^3/s (Grand River Conservation Authority, 2008).

determined that changing the cut-off threshold to 0.60 m^3/s would reduce the number of days below cut-off by 68%; a reduction of the cut-off threshold to this level would benefit agricultural water users. However, the report also notes that further ecological study is necessary to determine the severity of the ecological consequences of reducing the cut-off threshold to 0.60 m^3/s (Grand River Conservation Authority, 2005a). The study's final recommendations include:

- Increasing the OLWR Level 3 threshold to above 0.80 m^3/s (p. 163)
- Increasing the OLWR Level 2 threshold to 1.0 m^3/s (p. 164)
- Developing a water management plan to "balance human and environmental needs for water."

All informants acknowledged that managing water to meet both the demands for extractive users and instream needs to maintain ecological integrity is an ongoing challenge in Whiteman's Creek. Those with the greatest concerns for the integrity of the creek and values such as fish and fish habitat held strong opinions that existing extractive water uses were placing major stresses on the creek ecosystem and that existing thresholds in the OLWR system are not sufficient to maintain or enhance ecological integrity. In the words of one informant "when you get to [OLWR] Level 3, the system is trashed" (WC5). Another informant (WC1), who discussed an experience of having to rescue stranded fish during an extreme low flow event, noted that "the low water thresholds are in no way protective enough, I have been saying that for years." Finally, an informant with the GRCA (WC3) noted that "in setting up the low water response levels we know that if we are down to flows of 0.50 or 0.60 [m^3/s], that's pretty bad. We're just on the threshold of stranding fish."

It was also widely recognized among informants that the implications of securing more water instream during drought conditions would have consequences for local livelihoods, particularly in the agricultural sector. These views were not limited to representatives of the agricultural sector. For example, informant WC5, whose primary interest was fish habitat protection, noted "You can't blame the farmers; they are trying to make a living." Similarly, informant WC8, who also represented interests outside of the agricultural sector, notes, "there is certainly a need to take look at the [OLWR] thresholds and changing them. Whether that means no more golf courses or they need to use less water, I don't know. But we have to remember that when we are fooling around with the environment we are fooling around with our general health. On the other hand, we also need to be pragmatic and recognize that when you make these decisions [to constrain water use] you are affecting people's livelihoods."

Interestingly, apart from views of informants with the greatest interest in the integrity of the creek ecosystem noted above, there was a perception among remaining informants that conditions with respect to management of water for extractive uses and provision of water for instream needs are improving. These perceptions are not supported by the information on supply, demand and ecosystem needs for water presented above. Two key reasons were given for these perceived improvements: introduction of new water governance mechanisms, discussed below; and improvements in the efficiency of water use, discussed in section 5.3.

A majority of informants attribute improvements in water allocation to the introduction of the OLWR program. Over half of the informants pointed directly to the increased awareness and local engagement in decisions through the OLWR as the reason for the improvements. Several informants also attributed improvements to the IAC, despite its limited engagement in water governance in Whiteman's Creek. Even those informants noted above (WC5 and WC1), who held strong views about the inadequacy of existing thresholds to protect ecological integrity of the creek, acknowledged the OLWR and IAC mechanisms as important improvements to water governance and management. So while for some the thresholds are not viewed as protective enough of the aquatic ecosystem, there was general consensus among informants that the introduction of these decentralized and participatory governance mechanisms are important to improving the management of water resources in Whiteman's Creek. These mechanisms will be discussed in greater detail in following sections.

5.2. Equity

The conceptual framework presented in section 2.3 discusses two dimensions of equity – procedural and substantive. The procedural dimension addresses the question of who can and should participate in decision making, which has overlaps with section 5.5 on participation; the substantive dimension of equity, which asks if the benefits and costs of policies and decisions are fairly distributed. In the context of sustainability, consideration must be given not only to equity in the present (i.e., intra-generational equity) but also to inter-generational equity to ensure that decisions and actions taken today do not unreasonably compromise opportunities for future generations.

The Grand River WRT (i.e., the response team constituted under the OLWR plan) is the primary governance mechanism through which various interests and actors can and do engage in ‘active’ decision making; the IAC also provides engagement opportunities, but as has been noted, is largely inactive in Whiteman’s Creek. Access to decision making through the PTTW program is largely passive, with opportunities limited to commenting on permit applications via the Province of Ontario’s environmental registry or by issuing an official complaint of interference in the event of suspicion that one user is adversely affecting another.

As Table 4-6 in section 4.2.2.1 illustrates, the WRT in the Grand River watershed includes a diverse representation of actors and interests. However, not all actors and interests feel their voices are being heard or that their perspectives are having a real influence on water governance. Focusing on these ‘marginalized’ perspectives is useful for assessing the procedural dimension of equity. One such perspective comes from an informant of the local angling community (WC1) who notes that despite their efforts as members of the OLWR to bring attention to situations where low water conditions pose visible threats to fish and fish habitat (i.e., extreme low flows in the creek), their input is not given the same weight in terms of triggering responses (i.e., a shift in Levels to reduce water demand) as that of extractive water users (e.g., agricultural irrigator, golf course operator). In this informant’s words, “we are told, more than asked.” Another such perspective comes from an informant representing the local First Nation (WC8) who suggested that, while mechanisms such as the OLWR provide space for participation, the impact of their perspective on decisions and outcomes is minimal. To quote informant WC8, “access to decision making is not equitable; sure under the low water response we participate, but in terms of impacting a decision whether this guy can put his hose in the water and this guy can't, no, we're not involved.” And further, “I wouldn’t be far off the mark to say we are not well represented. It would be nice if there was a First Nations Low Water Response team, an equal body working alongside the existing WRT; that would be equitable.”

Assessing the substantive dimension of equity requires consideration of both benefits in terms of access to water, and costs associated with allocating water through various governance mechanisms. One of the key challenges to addressing equity concerns is a lack of clear priorities regarding water use. As noted in section 4.2.1.2, the OWRA does not require permits to take water for fire fighting, private domestic use, or livestock watering, regardless of the volume taken, which implies such uses are high priority. The exemptions are based on both the essential nature of these uses to society, and on an assumption that such takings would not amount to significant volumes in terms of overall water takings. However, beyond these implied priorities, the PTTW and supporting legislation do not establish clear priorities; indeed, unclear priorities have been noted as a key problem in a review of the PTTW program, again, as already noted in section 4.2.1.2. In practice, extractive uses commonly have priority over non-extractive uses.

As discussed in section 4.2.2.1, the OLWR does provide a basic prioritization model that divides water uses into three categories: (1) essential (i.e., requirements for human health and ecological functions); (2) important (i.e., for social and economic well-being); and, (3) non-essential (i.e., can be interrupted without significant impact). However, in practice this model provides little clarity in terms of priorities when in extreme low water conditions – this was quite apparent during the field research for this thesis as representatives from MNR, MOE and GRCA, along with other interested actors, were unwilling to respond to Level 3 conditions by restricting extractive uses despite evidence that conditions were nearing, or had passed, relevant Level 3 thresholds. The team was challenged in large part because no agreed upon response to a Level 3 condition had been developed.

Under a more decentralized governance system, water users and the broader non-government community associated with water allocation bear a greater proportion of the costs associated with taking and acting on decisions. Under the PTTW program, the costs associated with providing information for permit applications have increased under the most recent modification to the program; specifically, the costs associated with hydrological studies required for moderate and high use watersheds. A number of respondents raised concern that the increased costs resulted in inequities between farming operations and commercial enterprises when considering the technical studies and increased paperwork required to acquire or renew a permit. As one informant (WC13) representing a government agency noted, “the PTTW program is becoming more complicated. For a water-bottling company that has one taking point, and has an engineer with the right expertise, the process makes sense. If you are looking at an individual agricultural producer, they may have two or three or 10 water taking points, so managing the paperwork and the various conditions becomes very difficult. The PTTW has become difficult to the extent that it is a barrier to farmers participating in managing water – they may not even apply, or they may have a permit but not abide by it." This view was, not surprisingly, echoed by a representative from the agriculture community: "the PTTW is a boiler plate application for all users, and farmers are different – they are individuals rather than corporations and don't always have the information needed, or the ability to generate the information."

Under the OLWR, the costs of decision making are borne by society more broadly through participation in the WRT, which relies on public (i.e., government) resources as well as the efforts of water users and groups such as ENGOs. The OLWR, at least in levels 1 and 2, requires that all water users share the burden of reducing water demand by voluntarily reducing water use by the same degree (i.e., the same percentage reduction). One problem with this approach is that it seeks the same level of reduction from highly efficient users as inefficient users, which provides little incentive for inefficient users to adopt better practices. This is recognized in the OLWR Level 3 pilot study, which notes, "Some farmers, particularly in the vegetable growing sector, have already invested in water efficiency technologies to minimize their water taking impact. Therefore recognition should be given to water efficient practices by considering reductions in water taking for spray irrigation methods (i.e., less efficient) before reducing water takings for drip irrigation (i.e., more efficient)" (Grand River Conservation Authority, 2008: 18). Thus, inclusion of all users may appear on the surface to enhance equity, but asking all users to reduce water use by the same percentage does not necessarily ensure all interests have the opportunity to access sufficient water to meet their needs.

It is not until Level 3 is reached that prioritization among sectors may be required under the OLWR. No established response existed when the field research for this thesis was conducted, so, not surprisingly, the majority of informants indicated that priorities were unclear if and when OLWR Level 3 is reached. Recommendations made to the OWDC in the OLWR Level 3 pilot study provide some clarification of priorities and also address inequities among efficient and inefficient irrigators. The recommendations include: banning all aesthetic outdoor water use; eliminating gun irrigation during heat of day or high wind conditions; ensuring water management best practices are being maximized (e.g., minimizing leaks); mandatory (rather than voluntary) 20% reductions in water use by all permit holders, with the exception of efficient irrigators, who are only required to reduce by 10%; and, ongoing and intensive monitoring of instream conditions to assess impact of mandatory restrictions (Grand River Conservation Authority, 2008).

The agricultural sector is the most concerned with the costs of participating in governance. Under the IAC framework, members are to be compensated for attending meetings, for engaging in mediation exercises, and for mileage and phone calls. However, the agricultural community views the level of compensation to be minimal compared to the effort, and a lack of adequate and long-term funding for the IAC program makes assurance of such compensation a challenge; together these problems result in a disincentive for farmers to participate (Agnew, 2004: 8). This perspective is reinforced by an informant representing the agricultural sector, who notes that "The biggest problem with getting the IAC to work is funding. This has been the major challenge in getting it off the ground in Brant County. We are asking people to give up their time, to leave their own farm where they are valued at $2000 or $3000 per hour during this time of year to go somewhere else to talk with another farmer" (WC11). While this value is somewhat speculative and may be biased as it comes from a member of the agricultural community, it does reflect the impact that financial compensation for members of the IAC may have on enhancing participation. More research is required to determine just what level of compensation would be required to enhance and sustain participation in the IAC in Whiteman's Creek.

Informant WC11 also noted concerns regarding the impacts on livelihoods and economic productivity should regulators constrain water taking in order to retain more water in the creek consistent with recommendations in the IFN study. This individual also indicated that it may indeed be the case that water taking should be constrained to protect the creek ecosystem, but noted that "this should not happen without some compensation to agricultural producers should they face economic losses to improve environmental conditions, the benefits of which accrue to society more broadly." Concerns regarding compensation were also raised by the agricultural community in the OLWR Level 3 pilot study; one of the study reports indicates that "Additional dialogue is needed to address the issue of compensation for revenues losses resulting from mandatory water use reductions"(Grand River Conservation Authority, 2008: 27).

These challenges related to issuing and responding to a Level 3 condition highlight a key issue for water governance in Whiteman's Creek: a lack of clarity about when actions will be taken in situations where ecosystem needs for water are, according to policy, to take precedence over extractive human uses. This opens up issues of inter-generational inattention to equity. As an informant representing one of the local angling community noted, "Water should be a limiting factor [in development], but it's not. People are short-sighted. They don't look to where their children are going to be" (WC1). The implications for fish populations in Whiteman's Creek reinforce this perspective. As one study notes, "The impacts of low water and potential loss of fish biomass could be prevalent in the success of future generations. The current young-of-the-year or juvenile fish suffer during low water conditions due to predation in isolated pools, which reduced the number of fish from this generation that will survive to adulthood. The loss of the young fish limits the numbers of spawning adults in future years and subsequently the young produced for future generations is also limited" (Grand River Conservation Authority, 2007c: 17).

5.3. Efficiency

Assessing efficiency in water governance requires attention to both the use of water resources and the human and institutional resources required to take and implement decisions regarding water allocation.

While a comprehensive assessment of the technological aspects of water use efficiency was not undertaken for this thesis, both documentation and interview evidence suggest that improvements to the water productivity of existing commodities through technological means is well underway. Informants with intimate knowledge of agricultural water use, including an agricultural sector representative and representatives of OMAFRA and the GRCA, indicated that agricultural water users are shifting towards more efficient systems and practices, for example by moving to more efficient irrigation (e.g., pivots for field crops, drip for vegetable crops), using tarps or covers over crops such as ginseng, or irrigating later in the day to reduce evaporative loss of water. This insight is supported by interviews and surveys conducted with farmers as part of the OLWR Level 3 pilot study. A study report notes that "Of the other half of respondents, 53% of them stated that they already employ water conservation practices …" (Grand River Conservation Authority, 2008: 8). The report also notes that "farmers, particularly in the vegetable growing sector, have already invested in water efficiency technologies to minimize their water taking impact"; and that "Irrigation at night with less wind effect is already a consideration for many farmers when scheduling irrigation" (Grand River Conservation Authority, 2008: 18, 9).

Evidence indicates that forces other than water availability contribute significantly to the irrigation practices of farmers. Contextual factors, specifically the costs of fuel and the challenge of remaining competitive in a global marketplace, were noted in both interviews and documentation, as significant forces driving irrigation efficiency. An informant representing the agricultural community (WC11) noted, "farmers don't over-irrigate, it simply costs too much to pump that water." Similar views were reflected in the OLWR Level 3 pilot study. Commenting on a workshop held with farmers as part of that study, one report notes, "Two participants commented that irrigation is not based on water availability but fuel costs. They both limit their irrigation as the investment in fuel is not worth the return on crops…" and, "the farmers indicated that they typically do not irrigate unless necessary as it is expensive and stressful to consider fuel costs, chemical applications, equipment needs and labour"(Grand River Conservation Authority, 2008: 9, 11). This view was further supported by the results of a survey of irrigators conducted as part of the study. From the survey results, report authors concluded that, "Water availability was not a deciding factor in the irrigation activity of farmers... Factors of cost and personal stress may be deterring farmers from irrigating until absolutely necessary. Fuel costs were the main preventive factor listed in terms of cost and return for value" (Grand River Conservation Authority, 2008: 9). This is not to say that all irrigators have fully adopted efficient irrigation practices. As discussed in section 5.2, one of the recommendations put forward in the Level 3 pilot study was to eliminate gun irrigation during heat of day or during high wind conditions, implying that this practice is, to some degree, still employed.

Evidence of a shift in agricultural crops in Whiteman's Creek was also established in both interviews and documentation. The most cited example was the shift away from tobacco production towards potatoes, vegetables and sod. This shift is again due to contextual factors (i.e., declining demand for tobacco) rather than water availability or improved water efficiency; indeed, according to the OLWR Level 3 pilot study reports, the crops many farmers are turning to require the same amount or even more irrigation. According to one study report, "this change [from tobacco] is not expected to significantly reduce irrigation requirements due to the water needs of fruit, vegetable and root crops like potatoes and ginseng" (Grand River Conservation Authority, 2008: 15).

The IAC was proposed by a number of informants as a potentially effective approach to enhance demand management, yet as noted in section 4.2.2.2, the IAC in Whiteman's Creek is not effectively developed into a functional governance mechanism. Based on the findings of the OLWR Level 3 pilot study, the potential for self-organization by irrigators in Whiteman's Creek to create a functional IAC remains limited. According to results of the survey conducted as part of the study, despite a general sense among participating farmers that "the reactive measures employed to reduce water consumption during low flow conditions come too late to avoid social and economic impacts, suggesting that proactive measures would be more appropriate. The timing and commitment to being involved in an irrigation advisory committee come during the busiest times for irrigators, who consider themselves to be too busy at that time of year to participate" (Grand River Conservation Authority, 2008: 23). The report concludes by noting that resistance to participation in an IAC "will continue to aggravate the Low Water conditions in the Whiteman's Creek watershed" (Grand River Conservation Authority, 2008: 27).

Turning to the efficiency of decision-making processes, evidence indicates that significant resources – of government, water users and other organizations – are directed to water allocation in Whiteman's Creek, and that the amount of resources has increased over time as a result of changes to the PTTW and addition of the OLWR program. The key question is whether these additional resources dedicated to taking and acting on decisions is resulting in improvements to the governance system and to resilience of the SES.

Revisions to the PTTW program made in 2005, specifically the introduction of screening of applications based on classification of watershed into low, medium and high use, has increased the information requirements for permit applications. The amount and sophistication of information depends on the screening level (i.e., low, medium, high risk watersheds), with applications for Category 2 and 3 watersheds requiring scientific studies assessing the potential impacts of the proposed water taking on the environment and on other users. Information requirements for permit holders have also increased, as permit holders are required to collect and record data on the volume of water taken daily and report these data annually to the MOE (Government of Ontario, 2005b).

A number of informants felt these changes created unnecessary time and energy, and one indicated that they may in fact be a deterrent to participation in the PTTW program. An informant representing the agricultural sector (WC11) noted that "it needs to be streamlined. Producers find the process invasive. They are very frustrated with all the paperwork and don't know where to get the information to include in the application." An informant representing the GRCA (WC3) shared this perspective, noting that "the approvals, and pre-approvals, have really become onerous, especially on the agricultural community." On the other hand, informant WC8 noted that "it is cumbersome, but that may not be unnecessary; it maybe shouldn't be as easy as some would like it to be to acquire permits to take water." According to a key informant (WC13) with knowledge of the agricultural sector, the added effort required is a deterrent to participation in the PTTW program by some in the agricultural community who "may not even apply, or they may have a permit but not abide by it." This same informant noted, "The PTTW is useful as a record keeping and reporting function, but in terms of allocating water I'm not sure there isn't a better process." An informant representing MOE (WC7) noted, "there is still additional information we would like to know on applications, but this makes it more cumbersome on applicants, so it is a matter of balancing these things...between having enough information to make an informed decision, and making the application so cumbersome that they will just cheat."

The addition of the OLWR to the Ontario's governance system for water allocation has also resulted in additional demand on the resources of government agencies (GRCA, MOE, MNR), non-government organisations and civil society, and water users. In terms of process, informants generally agreed that the WRT is efficient in making decisions; as one informant (WC8) noted: "it works smoothly and quickly". This is at least the case with respect to Levels 1 and 2 of the OLWR. But as witnessed during the field research, the information required to make the decision to shift to a Level 3 condition was substantial, including assessment of social, economic and environmental impacts of the conditions, and responses to those conditions. By the end of the OLWR Level 3 pilot study, two reports were developed based on technical analyses, a survey of water users and a workshop with agricultural producers, to provide recommendations on a process for responding to Level 3 conditions. This suggests that the costs to society of the

OLWR, at least in Whiteman's Creek, are significant; however, the broad support among informants for the program suggests that these costs are worth the benefits associated with more participatory decision making and the improved capacity to respond to low water conditions. As one informant (WC13) noted, "the OLWR makes a lot of sense and is a good process. It is really democratic, which means that it isn't necessarily quick or without difficulties, but that is what consensus building is like."

5.4. Accountability and Transparency

Accountability and transparency in water governance in Whiteman's Creek watershed are addressed through both traditional command-and-control mechanisms (i.e., the PTTW) administered at the provincial level, and through collaborative approaches, specifically the OLWR and IAC. How the two relate and interact is important when considering accountability and transparency in the governance system as a whole. As one informant (WC6) noted, "The province needs to set standards, broad vision, and ensure consistency. Local interests look out for what is happening on their property and in their communities – the OLWR and IACs may be successful because they marry these broad provincial interests with local interests and responses."

The PTTW program takes a more traditional regulate-and-enforce approach to ensuring accountability through terms and conditions on permits, and monitoring and enforcement of those terms and conditions. The legitimacy of decisions to allocate water comes through the legislated powers of the Ministry of Environment (MOE) and its staff. In Whiteman's Creek, it is difficult to determine if water users who do hold permits are violating the terms and conditions, or if water is being taken without the permits. Violations are detected through complaints to MOE by other water takers or interests or if MOE staff are in the region monitoring. According to a representative of the MOE (WC7), "there is some non-compliance in Whiteman's Creek, as there is everywhere, but we don't have a good handle on how much. Compliance depends in part on how active the MOE has been in the area – if they have been out enforcing, receiving complaints, or out working with stakeholders there is increased compliance."

Evidence indicates that monitoring and enforcement activities are limited in Whiteman's Creek. According to a report prepared for the OLWR Level 3 pilot study, "Unsolicited inspections by the MOE do not generally occur if they were not already scheduled from an Inspection List set at the beginning of the year. No inspections were scheduled for Whiteman's Creek in 2006 or 2007. However, in the past, Whiteman's Creek has been inspected and generally two weeks are set aside to complete these inspections" (Grand River Conservation Authority, 2007c: 10). This limited monitoring and enforcement activity appear to be, at least in part, due to capacity issues. According to an informant with MOE (WC7), "capacity is a big issue with MOE, with new regulations and responsibilities but no new resources...the message is 'do more with less'." This perspective is reinforced by an informant with the local angling community (WC1) who noted that, "I'm not saying that the people in those ministries can't do it or don't want to enforce the rules – they just don't have the staff to do it because they don't have the money to do their jobs anymore."

Under OLWR, accountability and transparency are satisfied largely through deliberative decision making. While some concerns exist, there is broad support for and engagement in the OLWR mechanism. Evidence indicates that support for decentralized and collaborative governance in Whiteman's Creek is in part a product of a sense of shared responsibility for water management. When asked explicitly: "Who is responsible for sustainable water management in Whiteman's Creek?", most informants pointed first to the legally established responsibilities of federal and provincial governments, but the majority also acknowledged their own responsibility and the shared responsibility of all actors. These views span a range of actors, including conservationists, First Nations, government agencies and the agricultural community. Specific comments in this regard included: "All parties involved share responsibility. We have always taken on our responsibility for looking after the environment as a whole" (WC8); "It is a shared responsibility – we should all play a role" (WC12); and, "we all need to do our bit" (WC5).

This shared responsibility enhances the social legitimacy of and engagement in the OLWR. In the words of an informant representing the GRCA (WC3), "the program has been developed to ensure that everyone is responsible. It is the province's responsibility to keep tabs on the overall program, and they delegate to the Conservation Authority to manage it at the local level, and then we involve various sectors to make sure that we have a good cross section of input to the decision making. Those sector representatives are empowered to not only bring feedback, but to take the message out to their groups to ensure everyone is participating."

Some challenges and concerns lie at the interface between the command-and-control and decentralized approaches. Until the prolonged low water conditions experienced in Whiteman's Creek during the summer of 2007, it was not immediately clear under what legal mechanism(s) the OLWR is administered, leading to a lack of clarity regarding the lead government ministry and agency (and ultimately Minister) responsible and accountable for outcomes. The OLWR terms of reference indicates that the plan is "based on existing legislation and regulations" and further, that "It can be implemented under established legal authorities such as the *Municipal Act*, the *Lakes and Rivers Improvement Act* and the *Ontario Water Resources Act*" (Government of Ontario, 2003: 1). The lead agency for administration of each of these Acts is different.

It was not until the extreme conditions of 2007 spurred rapid reaction to Level 3 conditions that the legal grounding of the OLWR was clarified. A posting on the EBR announcing proposed policy changes related to this review and the pilot projects states, "The Ministry of Natural Resources is designated as the lead Ministry under the Emergency Management and Civil Protection Act in cases of drought emergencies and has implemented Ontario Low Water Response successfully since 2000" (Government of Ontario, 2010). This clarification is reflected in a revised 'draft' of the OLWR plan. The 2003 version of the plan states: MNR is listed as the lead agency for large-scale flooding, fire and drought emergencies (Government of Ontario, 2003). The revised 2009 draft states that MNR is the Designated lead agency responsible for Low Water and Drought Management under the *Emergency Management and Civil Protection Act* (Government of Ontario, 2009).

Finally, two informants raised issues regarding the delegation of significant decision-making responsibility for water allocation to the GRCA in the absence of a clear legal mandate. As an informant (WC12) with the GRCA noted, "changing from one level to another is very political and very subjective...it is up to the response team under our coordination to basically decide who should or should not be using water, but we have no jurisdiction to make these decisions." An informant representing a conservation organization (WC5), but with past experience as a member of a provincial government agency, puts a finer point on this point, noting that "the provincial government should ultimately be accountable, which is not to say that they need to do all the day-to-day management, but there needs to be a clear line of accountability. Some of what Conservation Authorities are doing, they are doing by default.

They don't have legislation behind them for activities beyond what is in the Conservation Authorities Act – so Conservation Authorities mandate compared to what they do is not clear. Maybe we need to revisit Conservation Authorities Act to give them real responsibility. If Conservation Authorities are already doing much of this additional work, maybe legislation should be rewritten to give them the authority."

5.5. Participation and Collaboration

Participation and collaboration vary under the nested suite of arrangements governing water allocation in Whiteman's Creek. Opportunities to participate, the diversity of interests represented, and the influence over decisions and their implementation are different when looking at the provincial scale PTTW, the watershed-based WRT, or the local IAC.

The primary mechanism for participation in relation to the PTTW is the Province of Ontario's Environmental Bill of Rights (EBR). The EBR requires that PTTW applications appear on the online environmental registry for a minimum of 30 days, during which time citizens and organizations have the opportunity to submit comments and concerns. Comments must be submitted in writing and be received by the specified contact person within the comment period. PTTW Coordinators in regional offices of the Ministry of the Environment manage applications and comments, so they hold the primary responsibility for applying public comments to decisions regarding assigning rights to use water. The degree to which comments received under the EBR actually influence permit approvals or conditions is difficult to assess; however, interviews with a PTTW coordinator and representatives of other organizations (MNR, GRCA) who review (but do not approve) applications indicate that public comments have only minimal impact on the approvals and terms of a permit compared to scientific studies or the discretion of PTTW coordinators. With the limited evidence available, the nature of involvement can best be described as 'consultation' and the degree of power sharing limited to 'tokenism' (Arnstein, 1969; Mostert, 2003).

The nature of involvement and degree of power sharing improve significantly when considering participation and collaboration via the WRT. The Terms of Reference for the Grand River WRT requires inclusion of representatives of all major interests, including various levels of government, industry, agriculture, environmental and recreational organisations, suggesting that the team represents the diversity of interests in the watershed. This claim is supported by interviews with key informants, most of who indicated that the WRT includes the appropriate organisations to represent the diversity of interests in the water resources and aquatic ecosystems of the Grand River and Whiteman's Creek.

Most informants also agree that the process for making decisions allows for a wide range of views to be heard and considered in decision making, albeit with some important caveats. As discussed in the equity discussion (section 5.2), informants with both the local angling group and the local First Nation expressed concern that their perspectives were to some degree marginalized in terms of influence on decisions and outcomes. A second caveat relates to the stage at which participation occurs in the OLWR. Comments provided by a particularly well-informed informant noted that under OLWR all interests are quite well represented when making decisions to move between low water response levels and implement related responses. However, outside of such situations, when proactive planning is or should be happening, decision making tends to fall to a few organisations with regulatory responsibilities and scientific expertise. As one member of the WRT (WC5) noted, "all interests are pretty well represented when the crisis hits, but not when proactive planning should be happening. There should be a process where agencies get together with users to ask them how they can help make the good decisions. Regulation won't solve problems the way getting brain power together to figure things out can."

Participation under the OLWR leads to increasing citizen and stakeholder power in decision making, the nature of which can be described as 'partnership' or co-decision making (Arnstein, 1969; Mostert, 2003). The convening role of the GRCA and the trust the organization has built across actors and interests factors significantly into the enhanced participation and collaboration in water governance that occurs under the OLWR in the Grand River basin. As one informant (WC4) notes, "the GRCA is a model CA with well-trained staff, and have done an exceptional job of fulfilling their original mandate, and going beyond to promote good stewardship of land and water."

Evidence suggests that the design and intent of the IAC mechanism hold significant potential to enhance participation and collaboration in water governance at the local level in

Whiteman's Creek; however, due to financial capacity constraints and a lack of local leadership and interest, the benefits of the IAC model in Whiteman's Creek are limited. As a representative of the GRCA (WC3) noted, "We are still working to get the IAC in Whiteman's to sit down and work together, but it is difficult; unless you can literally pay their time to be there. They are just not that interested in participating." The perspective is echoed by representative from the agricultural community (WC11): "The reason the Norfolk County IAC worked was that they were paid well to participate. So there would likely be more interest in the IAC in Brant County if we could better compensate people for participating." As noted above in section 5.2, interviewee WC11 speculated that farmers are valued at $2000 or $3000 per hour during the growing and harvest seasons. More research is needed to accurately determine this value, and to establish what level of compensation would be required to enhance and sustain participation in the IAC in Whiteman's Creek.

The IAC is viewed primarily as a means to avoid government bureaucracy rather than as an opportunity to engage in decisions with the goal of improving water management. Yet it appears as if the threat of government intervention has not been enough – at least to date – to create a viable IAC in Whiteman's Creek. As an informant (WC11) with the agricultural community notes, "We developed the IAC to help remove the impact of legal authority coming to farmers telling them what to do – they don't appreciate government folks from MOE or GRCA telling them 'you better do this'." Another informant (WC7) notes, "Any engagement in the IAC in Whiteman's Creek is driven by desire for MOE not to be there with the heavy hand...it is the better of the two options."

These views suggest that the challenges related to implementing the IAC model in Whiteman's Creek may not be limited solely to financial capacity; local culture within the agricultural community also undermines participation. As informant WC7 suggests, "Local culture has a huge influence on the IAC in Whiteman's Creek. Some members of the IAC don't agree and don't get along within the committee….some don't want to participate, and those that do don't want to lead." Similarly, informant WC11 notes, "The culture of the agricultural community in Brant County may also be an impediment; they don't tend to respond to forums like this." This view is consistent with previous research into IACs by Agnew (2004) who found that avoidance of government intervention was certainly an incentive to participate in IACs in the few places where they exist in Ontario. However, that research also indicated that in other locations participants also engaged in the IAC to advance a general interest in improving water management.

This notion of avoiding a heavy-handed, top-down approach is not limited only to the agricultural community. In fact, there was broad support among informants for a greater focus on decentralized decision-making mechanisms (the WRT and IAC). As an informant with MNR (WC10) noted, “Enforcement should be a last ditch effort. In a perfect world we would have more IACs that work well together, so it’s a matter of willingness and buy in and cooperation of individuals and agencies to lead and function effectively to come up with IACs that can allocate and distribute water to meet various needs in a non-combative way.” If well functioning, participation under the IACs could lead to increased stakeholder power in decision making, the nature of which can be described as moving toward ‘delegated power’ or ‘delegated decision making’ since the agricultural community would manage its water use with little if any day to day oversight by a regulatory body (Arnstein, 1969; Mostert, 2003).

When looking at the system of nested governance arrangements for water allocation in the context of participation and collaboration, it is important to consider their respective degree of influence on enhancing resilience in the SES. The OLWR, and potentially the IACs, provide opportunities for enhanced participation in decisions relating to changing levels of low water conditions (OLWR) and sharing limited supplies when droughts occur (IACs). However, these mechanisms provide little opportunity to engage in broader, proactive planning, such as defining the rules or conditions under which responses to low water responses are triggered. Such decisions tend to fall to scientific experts and regulators. Finally, given the bureaucratic nature of the PTTW, the governance system provides little opportunity to participate in more fundamental questions regarding the allocation of water rights, and conditions and criteria under which such rights are assigned.

5.6. Precaution and Adaptation

Despite the PTTW and the introduction of decentralized mechanisms such as the OLWR and IAC, the water governance regime in Ontario, at least as manifested in Whiteman’s Creek, remains largely reactive. Almost all respondents noted that the tendency is respond to crises rather than anticipate problems and plan proactively. This finding is consistent with reviews in the literature on both the PTTW and OLWR (Kreutzwiser, de Loë et al., 2004) and the IACs (Agnew, 2004).

The PTTW program is primarily reactive when it comes to enforcement. While some enforcement monitoring occurs, response from MOE enforcement officers typically comes when a complaint is received. As noted by an informant (WC7) representing a regulatory agency, "reports of non-compliance often start with another user who goes to the Conservation Authorities, who then come to the MOE, or other users coming directly to MOE." When discussing the impact of water takings on the creek ecosystem, and specifically about the potential for fish kills, this same informant indicated that "we'll hear about them when they happen, and we'll respond when we do."

The OLWR enhances proactive and anticipatory aspects of water governance – at least with respect to Levels 1 and 2; however, under extreme conditions (i.e., suiting a Level 3 response), it falls back to a much more reactive mode. Various informants suggested the need and potential for the OLWR to move from a primarily reactive mechanism towards a more proactive approach. This is quite clear given that, at the time the field work for this thesis was conducted, there was no agreed upon response to Level 3 conditions, and a lack of the required information to develop a response. As noted by an informant (WC10) with a regulatory agency, "nowhere in the province has there been a request to the OWDC to respond to Level 3 conditions, so it is not really understood what type of information, the availability of information, or the type of report that is needed to by the committee to invoke a Level 3 response."

The prolonged Level 3 conditions experienced in the midst of the field work for this thesis spurred an unplanned reaction, which required mobilizing significant organisational resources from multiple provincial and local government agencies, the GRCA and water users, to undertake rapid collection of new information on the economic, social and ecological risks associated with these conditions. As one informant (WC5) noted, "decisions are made responsively [under the OLWR] when crises are imminent. The problem is, that's not the best time to be making good decisions – this should happen when you have time to deliberate and develop contingencies and figure out better modes of practice. We should be sitting down when not in crisis to ask if this is the best way to manage, do we have the right practices and the right information."

The OLWR approach improves flexibility and enhances feedback for social learning in the water governance system. A number of informants who are members of the Grand River Watershed WRT discussed how members can phone into team meetings (i.e., conference calls) from the tractor in the field or streamside, providing significant flexibility in terms of making timely and inclusive decisions. This flexibility also allows team members to provide 'real time' information upon which to base decisions. For example, while stream gauge and precipitation data are the primary sources of information used to trigger a meeting to decide on a change between OLWR levels and responses, team members have reported in from the field that precipitation was occurring that, because of time lag, had not yet registered on stream gauges. The resulting decision was to delay a change in levels, which can be costly and cumbersome for all involved. Similarly, low water conditions posing threats to fish and fish habitat are often reported in from the field by local anglers and their associations. However, according to an informant representing the local angling organization, these calls do not trigger responses in the same way that calls from an extractive water user (e.g., agricultural irrigator, golf course operator) would, suggesting that some interests are more influential than others.

The IAC has the potential to significantly improve proactive and anticipatory aspects of water governance in Whiteman's Creek. This view was shared by most informants, and is reinforced by past research into the IAC model. For example, Agnew (2004: 12) found that "although deemed by farmers and ministry employees alike to be a reactive instead of proactive step toward managing local water resources, the IACs were seen to be taking a step in the right direction." If functioning well, the IAC model can also enhance the flexibility of the water governance system. An informant representing OMAFRA (WC13) familiar with IACs provides the following interpretation: "A problem with PTTW as an allocation mechanism is that it assumes a permit will be used to its maximum every day, and that the same amount of water is used every year. In agricultural irrigation, this is rarely the case. So a [hypothetical] stream may look over-allocated on paper, say, because five farmers each have permits to pump 1000 gallons per minute which together would impact negatively on streamflow. However, let's say three farmers only use their permits every second year because of rotation among crops that require no irrigation or each farmer only pumps their permitted amount two days per week. By applying the IAC model, these five irrigators have been empowered to 'make it work' and will take on the responsibility to ensure the stream keeps flowing."

Exercising precaution in water governance would mean that, in the face of uncertainty regarding significant environmental impacts of water use on, decisions related to water use should err on the side of caution, and seek to maintain or enhance system resilience. In Whiteman's Creek, the IFN study completed in 2005 provides the best available information with respect to the actual and potential future impacts of extractive water use on the ecological integrity of the creek ecosystem. Yet, in the summer of 2007, the report's recommendations to increase OLWR level 2 and 3 thresholds had not yet been acted upon by the WRT or the responsible government agencies (primarily MOE and MNR). According to one informant (WC12) familiar with the study and the WRT, the main hesitation in applying the information was a "lack of certainty" around it. This person also noted, "We don't have a clear cause and effect. We cannot say 'at this flow a fish kill will happen', and we may not be able to because it is so complex. We have no field data to show a cause and effect, and do we really want to get to that data...do we want to get to the stage where we kill fish before we respond or understand how to respond? No, but this is the type of information that regulators are looking for to make decisions. They don't seem to understand the complexity." Awaiting evidence of a clear cause-and-effect relationship before further constraining water use runs counter to a precautionary approach. The revised thresholds proposed in the IFN study were developed using an established desk-top method that employs on statistical analysis of hydrologic data (i.e., the Tessman method), not empirical data correlating changes in flow to biological indicators.

5.7. Integration

A wide and diverse group of actors has interests in governance of water allocation in Whiteman's Creek. One key integration challenge is the lack of an overarching water policy in the province of Ontario. Integrating across the provincial agencies, primarily the MNR and MOE, as well as the federal Department of Fisheries and Oceans, which together administer various legislation, regulations and policies that influence water allocation, is an ongoing challenge. For example, administration of the PTTW system requires assessment of the impacts of water takings on local aquatic habitat to ensure water takings do not result in contravention of section 35 of the Fisheries Act (i.e., the HADD provision). Responsibility for enforcement of the PTTW program lies with the MOE, while enforcement of the Fisheries Act, as well as fisheries management responsibilities of the OMNR, are delegated in large part to the GRCA. As one informant (WC5), with a long history in water management in Ontario including roles with both a provincial government agency and a non-government organisation, notes, "there is no overarching provincial water policy that clearly defines who the lead agency on water is, and how all the others play a role and participate. Without it, management remains a dog's breakfast. Conservation Authorities are becoming facilitators of provincial and federal legislation and programs, but they are stretched because the projects come with little money to build staff capacity."

The GRCA is the central integrating body for water governance in the Grand River watershed, including in Whiteman's Creek. The GRCA has a long history of partnering with and bringing together organizations, including governments and non-government actors, to facilitate planning and decision making, and to implement the outcomes of these processes. It plays a role in many aspects of water governance in Whiteman's Creek, including input on PTTW applications (but not approval), chairing and coordinating the WRT, and generating scientific information on water use and availability, fisheries and ecosystem water needs. However, the level of activity and degree of responsibility undertaken by the GRCA is not matched with the legal capacity it requires to act effectively. The IFN study is a case in point. As the 'owner' of that study, the GRCA lacks the human and financial resources, and regulatory authority, to act on study recommendations in ways that influence PTTW applications and or altering the thresholds under the OLWR plan.

While the OLWR adds complexity to the governance system, it includes mechanisms for improving integration across both governmental and non-governmental actors to ensure coordinated and coherent responses to low water conditions. At the local level, the watershed-based water response teams bring together a diverse group of actors with a broad range of interests in managing and mitigating the impacts of low water conditions on socio-ecological integrity. At the provincial scale, the Ontario Water Directors Committee (OWRC) provides for integration across the various provincial ministries active in water governance.

As has been noted previously, the OWLR functions relatively well at Level 1 and 2 conditions in terms of coordinated and coherent responses to drought; however, when SESs are stressed (Level 3 conditions), integrated responses become a challenge. This is also the case when new knowledge, such as that developed in the IFN study, suggests a need to alter existing decision-making criteria (i.e., OLWR thresholds). As an informant with MNR (WC10) noted in relation to taking action to implement the findings of the IFN study, "There will likely need to be a compromise to come to grips with the opposing concerns related to livelihoods and ecosystem health. This will mean the two key agencies, MNR and MOE working together to make tough decisions, along with DFO. The challenge is that we [MNR] don't always have the legislative responsibility and resources to take action."

The above discussion deals with the integration – or the lack of integration – among the various authorities and actors involved in water governance. As discussed in section 2.3.2.7, the integration criteria also direct attention to ensuring all criteria included in an conceptual framework are applied together as a set of interdependent parts in order to identify and capture mutually supportive benefits. That aspect of integration is addressed in Chapter 6 which reflects on the discussion of the seven assessment criteria and proposes recommendations for strengthening water governance.

5.8. Summary and Synthesis

The majority of interviewees perceived conditions with respect to water allocation, water use and the health of the aquatic ecosystem to be improving in Whiteman's Creek watershed. Interestingly, this perspective is inconsistent with the best available scientific information, which suggests that resilience of the SES is compromised or at least threatened. The combined impacts of frequent and severe low water conditions and heavy water takings continue to challenge water governance in Whiteman's Creek. While the existing governance regime has been able to 'get by' in managing these challenges, the future changes to water availability and regional hydrology anticipated under climate change pose greater risks to the long-term viability of the Whiteman's

Creek SES. Without changes to water governance, the risk of the SES shifting to a different and less desirable state is likely to increase.

As discussed in section 1.1, climate change projections for Whiteman's Creek suggest that the intensity and severity of low water conditions will increase as the climate warms. At the same time, as noted in section 5.1, there is evidence that water resources in the regional aquifer system are being depleted faster than they recharge, eroding the capacity of the groundwater system to buffer the impacts of water taking on the creek ecosystem during the irrigation season (May to October). Should the anticipated changes to climate trigger a multi-year drought, the SES would be at significant risk of shifting to a different state under which both the integrity of the creek ecosystem and economic opportunities of future generations would be compromised. Under such a scenario, availability of water for agricultural and other extractive uses would be reduced, and streamflow in the creek could decline to the extent that the local sport fishery is severely reduced or even wiped out. Together, these and other factors would lead to increased conflict among the many interests in the water resources and aquatic ecosystems in Whiteman's Creek watershed.

More efficient water use may provide some potential to manage and mitigate these risks, but as discussed in section 2.1.3, optimizing water productivity has its limitations. In Whiteman's Creek, many users are already employing water efficient technologies and limiting irrigation to essential periods, due in large part to contextual forces including the expense of operating pumps and the need to keep production costs low and produce high quality product to be competitive in the global marketplace. So the potential for gains in water efficiency to mitigate future risks to the SES are limited, and are likely insufficient to address the significant reductions in future water availability anticipated in Whiteman's Creek watershed. Indeed, one of the reports published as part of the OLWR Level 3 pilot study indicates that while "reducing surface water demands may stabilize low flow conditions allowing fish and wildlife to adapt in the short term" a "continued lack of precipitation will eventually result in the loss of baseflows with catastrophic implications for fish and wildlife" (Grand River Conservation Authority, 2007c: 20).

As discussed in section 2.2, the water challenge is largely one of governance, meaning that the issues and solutions relate much more to social and institutional factors than to than to lack of scientific understanding or adequate technology. Superimposing the OLWR and IAC onto the PTTW program has increased the density of institutional arrangements for water allocation operating in Whiteman's Creek and has led to a more decentralized governance regime. Addition of the OLWR has resulted in some improvement in terms of flexibility, positive redundancy, opportunities for social learning, and accountability and transparency. A well-functioning IAC could further enhance these improvements to the governance system. However, because of the participatory and collaborative nature of the OLWR and IAC, more societal resources, in the form of time, energy and effort of governments, water users and other interests, are required to make decisions and take action regarding water allocation and use. So the benefits associated with the introduction of these more participatory and collaborative governance arrangements may come with a trade-off to system efficiency.

According to the principle of subsidiarity, participation in governance is enhanced by establishing institutions and decision-making fora at scales more closely matched to the problem. Consistent with this thinking, the IAC holds significant potential for strengthening governance to enhance resilience in Whiteman's Creek. The participatory nature of the IAC was viewed by the majority of informants as a more desirable option for managing and mitigating the impacts of water withdrawals on the integrity of the creek ecosystem than a focus on enforcement via fines and other punitive measures. However, the fact that the IAC remains largely ineffective suggests that there are limits to the willingness or ability of non-government actors – in this case water users in the agricultural community – to take on the costs of engaging in more participatory and collaborative governance. So improving the effectiveness of the IAC will likely require additional public financial resources – literally paying farmers to participate – which would be a further trade-off of efficiency against gains to system resilience. These additional financial costs could be mitigated to some degree by focusing as much of the planning activity outside of the main irrigation period when participation is more feasible from the perspective of agricultural water users. It also bears noting that, given the cultural barriers to participation in the IAC discussed in section 5.5, provision of additional financial resources many not be enough to secure engagement of the agricultural community in Whiteman's Creek in this approach.

A fundamental problem with the water governance regime operating in Whiteman's Creek is that the management system remains largely reactive and is limited in terms of precautionary buffers against future, more extreme low water conditions. With surface water over-allocated under the PTTW program, regional groundwater resources in decline and the current OLWR Level 3 threshold set well below the best available, science-based cut-off flow required to protect the aquatic ecosystem, there is little buffer should a multi-year drought manifest in Whiteman's Creek. This is an example of the 'risky brinkmanship' discussed in section 2.3.2.6.

The inability to respond effectively to the OLWR Level 3 conditions experienced during the field work for this thesis reflects the gridlock in governance discussed in section 2.3.2.7 that can occur when multiple actors and agencies who share responsibility are not effectively integrated. The situation in Whiteman's Creek sheds light on unclear lines of accountability and a gap in leadership by the provincial government, which should have anticipated and ensured preparedness for Level 3 conditions and responses, given the ongoing challenges related to low water conditions in the watershed. Instead, leadership was left largely in the hands of the GRCA, which is the coordinating body for the WRT but does not have the legal mandate to implement the significant interventions, such as mandatory reductions in water use or issuing stop orders on water takings that the OLWR plan identifies as responses to Level 3 conditions. In the end, groundwater discharge from the regional aquifer maintained some streamflow in the creek and no fish kills were reported, the province clarified MNR's role as the lead agency responsible for low water and drought management, and MNR provided funding to the GRCA to undertake the OLWR pilot study aimed at developing recommendations for responding to Level 3 conditions in the future. So, while addition of the OLWR has improved adaptation to some degree, this crisis-driven response to Level 3 conditions further illustrates the largely reactive nature and lack of precaution that challenges water governance in Whiteman's Creek.

The situation in Whiteman's Creek could be viewed simplistically as a conflict between economy and environment, or between farmers and fish. For example, it could be argued that by not increasing the OLWR thresholds to levels more protective of the aquatic ecosystem, which would require agricultural water users to constrain water use more frequently and to a greater degree, water managers are exercising precaution about livelihoods rather than fish. But this perspective fails to reflect the economic value of the sport fishery in Whiteman's Creek and the other cultural, ecological and aesthetic values associated with maintaining the integrity of the creek ecosystem. Addressing the challenge of water governance in Whiteman's Creek will require that the problem be viewed more holistically as a challenge of maintaining and enhancing overall system resilience and envisioning a desirable future condition for the SES. Most informants interviewed agreed that while governments are ultimately accountable, water management is a 'shared responsibility'. This, combined with broad commitment to the OLWR among actors and interests, suggests that the foundations for transitioning water governance to a more proactive, precautionary and adaptive regime are reasonably well established in Whiteman's Creek. What is required is leadership, resources and a focus on integrated, long-term planning.

Chapter 6: CONCLUSIONS, RECOMMENDATIONS AND IMPLICATIONS

The objective of this research was to understand and assess whether governance arrangements for water allocation in Ontario are enhancing resilience and fostering sustainability "on the ground". Through a case study of Whiteman's Creek watershed, the thesis assessed the key governance arrangements and actors involved in water allocation, together with the dynamics of water use and availability and aquatic ecosystem integrity, as a complex SES. Taking the view that the existing governance regime in Whiteman's Creek is polycentric in nature – that responsibility for water allocation is dispersed among different centres of decision making at a number of scales – the work reflects an underlying interest in understanding the implications of polycentric governance regimes for resilience and sustainability.

This final chapter brings together the concepts and findings presented in the previous five chapters. Framed around the three research questions included in section 1.2, the chapter draws out key conclusions from the case study, makes recommendations for changes to water governance in Whiteman's Creek and in Ontario more broadly, discusses the conceptual and pragmatic implications of the research, and identifies directions for future study.

6.1. Thesis summary and conclusions

Arriving at a set of criteria to assess water governance required consideration of the depth and breadth of the framework – between narrowing in on a few criteria and undertaking an in-depth analysis or looking more broadly and comprehensively at the governance system but in less depth. The latter approach was chosen as it provided greater potential to develop a broad understanding and application of the concepts of water governance and systems thinking and to identify opportunities for future, more in-depth research within this broader understanding.

As discussed in section 2.4, two main challenges were experienced in developing the conceptual framework: (1) choosing a manageable and useful set of criteria from among a large number of potential options discussed in the literature on resilience and sustainability, systems thinking, governance and planning, and water policy and management; and, (2) maintaining coherence of the framework given the overlaps and interactions among the various criteria. The assessment criteria were originally developed with the intention of establishing a means-ends relationship – to determine what needed to be 'done' to arrive at a desired state or set of conditions. A key learning outcome, given the overlaps and interactions among the criteria, was that attention was better directed to understanding the tensions and synergies among the criteria in order to identify opportunities for improving the overall effectiveness of the governance system, rather than seeking to establish a clear ‘cause and effect’ relationship.

Whiteman’s Creek watershed proved to be a useful case for two key reasons. First, the persistent low water conditions combined with heavy water demand presented an opportunity to examine Ontario’s water governance system under ‘extreme conditions’, increasing the potential to expose its limitations and potentials. This opportunity was enhanced by the prolonged low water conditions experienced in the watershed during the period of May to October, 2007, which is when interviewing of key informants was conducted. Second, the governance regime in Whiteman’s Creek consists of a set of nested arrangements operating at different scales (i.e., PTTW, OLWR and IAC) that involve the participation of government and non-government actors. This arrangement provided an opportunity to understand how the various elements of a polycentric and collaborative governance regime function together as a system. In assessing the overall effectiveness of water governance, attention was directed to interactions among the multiple government agencies and jurisdictions at different scales whose mandates have implications for decisions related to water allocation, to the distribution of decision making from central agencies to watershed and local scales, and to the increased involvement of non-government actors (along with governments) in taking and acting on decisions.

As it touches ground in Whiteman’s Creek, Ontario’s existing system of governance for water allocation is continually challenged by episodes of low water conditions and in its current state is unlikely to be sufficient to deal with the more frequent and extreme water scarcity anticipated in the future as the climate changes. Introduction of decentralized and collaborative governance arrangements over the past decade, primarily the OLWR program and to a far lesser degree the IAC, has enhanced system capacity to cope with low water conditions through strengthened collaboration in decision making and improved coordination of drought responses. However, overall, the governance system remains largely reactive with only limited capacity for adaptive management and little in the way of anticipatory planning, leaving the SES exposed to and poorly prepared for future water scarcity risks.

Based on the findings of this research, focusing attention and resources on enhancing precaution and adaptation would be the most effective means for building resilience and fostering sustainability in Whiteman's Creek SES. Such a focus would entail a greater emphasis on anticipatory planning and on embedding adaptive management into the water governance regime. Directing attention and resources to such efforts would create synergies with most of the other criteria in the conceptual framework, forming a central element of a strategy to drive the SES toward sustainability by strengthening participation and collaboration, improving integration at the watershed and sub-watershed scales, and leading to greater transparency in water allocation and improved equity in terms of access to and influence on decision making.

Maintaining or enhancing socio-ecological system integrity in the face of less reliable and likely declining water availability demands a particular focus on integrating environmental flow thresholds into water governance and management. Doing so will mean confronting difficult questions regarding the priority that society places on the benefits of healthy, productive aquatic ecosystems relative to interests in maintaining or expanding the scale of water withdrawals in order to sustain the existing mode of economic development. Put differently, there is a need for planning processes and a water management regime that are able to maintain and enhance ecological integrity while also providing opportunities for livelihood and economic development within the constraints of a limited and less reliable water supply.

Shifting towards a more precautionary and adaptive governance regime may require greater social resources (i.e., money and time of state and non-state actors), which opens up questions about potential trade-off with decision-making efficiency. Under the current distribution of responsibilities for water governance in Whiteman's Creek and the Grand River watershed, the GRCA plays a central integrating and leadership role in governance of water allocation in the watershed: this despite the fact that these issues are beyond its legal mandate. Enhancing precaution and adaptation may place increased pressure on the limited capacity of the GRCA. Concerns related to increased resource requirements can be addressed to some degree by taking a longer-term view of efficiency that recognizes investments of time, money and energy in the near term to develop robust solutions are very likely to be more efficient than a short process that leaves problems unaddressed.

6.2. Recommendations

Three key recommendations are proposed for improving water governance to better foster sustainability and resilience in Whiteman's Creek SES. They reflect the conclusion that a focus on enhancing precaution and adaptation can drive the SES toward sustainability. The recommendations, which are elaborated below, are:

1. Integrate environmental flows into water governance;
2. Emphasize anticipatory planning and adaptive management; and,
3. Secure and sustain resources for implementation.

6.2.1. Integrating environmental flows into water governance

Maintaining sufficient water instream to sustain the integrity of aquatic ecosystems is a foundation of sustainable water management (Richter in Galloway and Pentland, 2003) and water security (de Loë and Bjornlund, 2010). Environmental flow thresholds provide a basis for establishing the sustainability boundary discussed in section 2.1.1, which, in theory, defines the amount of water made available for consumptive or extractive use within the constraints of that required to sustain aquatic ecosystem integrity (Postel and Richter, 2003).

There are a number of international and Canadian examples which can provide guidance for integration of environmental flows into water management in Whiteman's Creek and the Grand River watershed, and into water policy in Ontario. A comprehensive review of experiences from other jurisdictions was not undertaken for this thesis due to time constraints; the following examples provide some sense of efforts to address environmental flows internationally and elsewhere in Canada. Experineces from elsewhere may provide a means for identifying barriers that may be encountered in Ontario and guidance on avoiding or managing through such problems but should not be considered prescriptive solutions given the differences in water policy frameworks and local and regional biophysical, economic and social context.

In the caes of British Columbia's Campbell River, conflict over recreational uses of the river, salmon habitat and hydropower generation led to a participatory water use planning process that resulted in a flow management regime that better addresses competing interests in water use (Locke, Stalnaker, Zellmer et al., 2009). Such plans are now required for all of British

Columbia's large hydropower developments, and the provincial government is now considering integration of environmental flows into new water allocation legislation (Government of British Columbia, 2008). A similar water use planning process was undertaken for the lower Athabasca River in Alberta to establish limits on water withdrawals by the oil sands industry in order to secure sufficient water instream to protect fish habitat and other instream values (Ohlson, Long and Hatfield, 2010). The Instream Flow Council, an organization that represents the interests of state and provincial fish and wildlife management agencies in the United States and Canada, has published a volume of case studies on experiences integrating environmental flows into water management (Locke, Stalnaker et al., 2009). A number of international examples may also provide guidance. For example, South Africa's *National Water Act, passed* in 1998, refers to the need to ensure that requirements for basic human needs and the environment are met before potential users can be licensed to take water (Hughes and Hannart, 2002). In the United States legislation authorizing the reservation of water to protect instream flows has been enacted in Alaska, Oregon, Montana and Utah, and instream flows have been protected by case law or statute in Washington, Wyoming, North Dakota and Nevada (Swainson, 2008). In Australia, national water reforms have led to state governments adjusting policies and institutional structures for managing water to ensure implementation of legally-recognized environmental water allocations (Australian Government - National Water Commission, 2011). A global review of water policies undertaken by the World Wildlife Fund and The Nature Conservancy may provide additional direction on addressing the policy and management challenges of implementing environmental flows (LeQuesne, Kendy and Weston, 2010).

To integrate environmental flows into water governance in Whiteman's Creek, existing OLWR streamflow thresholds should be revised to reflect best available science (i.e., IFN study) and in a manner that incorporates a 'buffer' to reflect the anticipated impacts of climate change on future water availability and reliability. The IFN study recommends that the Level 3 threshold be increased to at least 0.80 m^3/s and Level 2 threshold to 1.0 m^3/s. Of the two, increasing the Level 3 threshold is of greater importance as it would guard against significant deterioration of fish populations and fish habitat. These values provide a starting point for revising OLWR thresholds; a workable set of revised thresholds and related responses should be established through participatory planning and refined as needed through adaptive management.

Immediate steps by regulatory authorities should also be taken to respond to better integrate environmental flow thresholds into water governance in Whiteman's Creek. Given the anticipated declines in water availability, a moratorium should be placed on new water taking permits for Whiteman's Creek (at least for the lower reaches) for the May to October period and consideration should be given to retiring or reducing the allowable takings of existing permits that come up for renewal.

While the IFN study did not establish a clear cause-and-effect relationship between low streamflow in the creek and fish kills, and uncertainty may exist regarding the precision of the recommended thresholds, the IFN study represents the best available science and acting on the recommendations would reflect a precautionary approach, particularly given the anticipated impacts of climate change on future streamflow in the creek.

6.2.2. Anticipatory planning and adaptive management

While it is well within the mandates of senior governments – specifically the Ontario MOE and federal DFO – to retire water permits or impose environmental flow thresholds to protect fish and fish habitat, such a top-down approach is unlikely to strengthen water governance or result in a more resilient SES. Such an approach would require significant and sustained investment of financial and human resources for enforcement, would increase the potential for conflict among regulatory agencies and water users, particularly in the agricultural sector, and could erode the collaborative and participatory spirit of water governance in Whiteman's Creek and the Grand River watershed. Further, such a top-down approach may be insensitive to the actual complexities of setting thresholds – to reflect the realities of water takings (i.e., timing and scale of actual water takings versus permitted allocations), the potential for additional improvements in water demand management, and the social implications of imposing such thresholds with limited or no consultation.

Enhancing resilience and socio-ecological system integrity in Whiteman's Creek will be best accomplished through a transitional strategy focused on anticipatory and participatory planning and adaptive management. Such a strategy should go beyond just designing a response to Level 3 low water conditions (although that should be done). To foster sustainability, a planning process is needed that considers the implications of changes to future water availability on livelihoods and economic development over the long term (i.e,. 30-50 year time horizons or longer) and that explores alternative, less water intensive livelihood options with the overarching goal of modifying the scale and patterns of extractive water use to ensure sufficient water is available to sustain the integrity of the creek ecosystem. Such a process is consistent with the soft path approach to water planning and management discussed in section 2.3.2.3. The soft path principles should be considered as a framework to guide water planning in Whiteman's Creek and possibly in the Grand River watershed more broadly.

The information from the IFN study, the analysis of social, economic and environmental impacts of low water conditions collected during the Level 3 study, and existing knowledge on the projected impacts of climate change on future water availability provide a strong basis on which to instigate an anticipatory planning process. The planning process should include an explicit objective of setting in motion an adaptive management cycle whereby data on ecological and socio-economic indicators are collected on an ongoing basis to resolve uncertainties related to OLWR thresholds and to assess the impacts of low water conditions on livelihoods. This information can be brought together with information on crop rotation, changes in land use and improvements to water efficiency to devise and implement strategies aimed at reducing extractive water uses to levels that ensure the low flow thresholds in the creek are not exceeded.

Consistent with the notion of post-normal science discussed in section 2.1.3, the adaptive management process should regularly bring together expert scientists to work with water users and other interests, thereby placing science in its social context to inform what are inevitably value-oriented questions and decisions regarding sustainable levels of water use and desired ecological integrity conditions. Rather than creating new forums or structures, transitioning to a more precautionary and adaptive governance regime can be accomplished by building on existing arrangements. The WRT provides a strong foundation for undertaking the type of planning proposed here and for sustaining an adaptive management cycle. The IAC, if its functions can be improved, could be an effective, local mechanism to complement the OLWR.

The *design* of planning processes and adaptive management activities will be critical to success. To engage the agricultural community effectively, this more involved planning process should, to the extent possible, be scheduled such that lengthy and numerous meetings are avoided during periods when farmers are busiest (i.e., May to October). More broadly, applying the design principles for participatory decision-making processes proposed by von Korff et al. (2010), discussed in section 2.3.2.5, would help to ensure that planning occurs in ways that works for and is viewed as legitimate by the greatest number of stakeholders.

6.2.3. Securing and sustaining resources for implementation

Moving to a more precautionary and adaptive governance regime is likely to require greater resources and demands strong leadership. The participatory nature of planning and adaptive management activities requires more time, information, energy and effort on the part of governments, water users and other interests, at least in the short term. Rather than pouring more resources into activities such as monitoring of compliance under the PTTW or of voluntary actions under the OLWR, resources are better directed to creating enabling conditions for planning and adaptive management. This includes human and financial resources for ecosystem monitoring and research and coordination of planning processes, and for payments to non-state actors, particularly those in the agricultural community, to participate in planning and management activities.

Given the trust and reputation the GRCA has built among state and non-state actors, it is the most appropriate organization to lead and coordinate a long-term planning process and adaptive management framework in Whiteman's Creek. However, because the GRCA's capacity to generate revenue is limited, and because the legal responsibility for water allocation and aquatic ecosystem protection rests with the senior governments, there is onus on provincial and federal agencies to provide financial and other resources.

This research did not explicitly address the scale of incremental financial and human resources required to sustain an effective adaptive management regime; this is a key area for future research. Given the ongoing trend of most government agencies towards cutting and curtailing funding for environmental initiatives, securing and sustaining sufficient financial resources will require consideration of alternatives or complements to direct transfers from governments. Partnerships with academic institutions and non-government organizations should be considered as options for enhancing resources for monitoring and research. Potential options for securing and sustaining financial resources include special levies on property taxes in high use watersheds and/or similar premiums on PTTW applications and renewals. Resulting revenues should be held in trust by the GRCA or MOE, with clear terms of reference establishing the activities that would and would not be supported but these resources.

6.3. Research limitations

As discussed in section 3.6, one of the key limitations of case study research, in particular when focusing on a single case, is the degree to which conclusions and recommendations can be generalized to other cases or to society more broadly. The findings of the case study of water governance in Whiteman's Creek are most appropriately generalized to situation types: that is, to drought prone, primarily agricultural watersheds, rather than to all watersheds in Ontario. That said, while Whiteman's Creek SES is distinctive in Ontario in terms of both biophysical conditions and socio-political aspects of water governance, the findings do have implications for water governance in the province more broadly, and findings have implications for theoretical and conceptual frameworks and propositions (Silverman, 2005; Yin, 2009).

The research and results are also limited in the sense that the conceptual framework, while it includes criteria drawn from relevant bodies of academic literature, has been applied and tested in this form in only this one case, which limits the potential for comparisons to other contexts and research findings. The research also leaves unanswered a number of important questions including those relating to the scale of financial and human resources required to implement the recommendations above and to the impacts of external forces such as global trade in agricultural commodities on local and regional water demand.

6.4. Implications of the research

This research has both pragmatic and conceptual implications. From a practical perspective, the situation in Whiteman's Creek suggests that the governance system for water allocation in Ontario is poorly prepared to respond to similar conditions in other watersheds. The recommended focus on enhancing precaution and adaptation in Whiteman's Creek is therefore applicable to water governance in the province more broadly, particularly in the southern part of the province where watersheds and are significantly developed.

The challenge of integrating environmental flows into the existing water governance regime warrants greater attention from provincial and federal agencies whose mandates cover water management and aquatic ecosystem protection (i.e., Ontario MNR and MOE; DFO). These agencies should collaborate on developing a guiding framework for assessment and decision making with respect environmental flows in Ontario. The results of these assessments should inform PTTW applications and be used to revise OLWR thresholds. The province should also ensure that mandatory OLWR Level 3 responses are defined for all watersheds before crisis conditions are reached. Similarly, the provincial government along with appropriate federal agencies (i.e., Natural Resources Canada, Environment Canada) should be working to integrate understanding of climate change impacts on future water availability into governance for water allocation.

While the existing and long-standing responsibilities of provincial and federal agencies establish the mandate for integration of environmental flows into water governance in Ontario, those mandates have not, for most part, been fulfilled in a comprehensive manner. This suggests more aggressive water governance reform is warranted to effectively address environmental flows and to foster sustainability and resilience in Ontario's watersheds. One approach to more aggressive reforms would be to amend the Conservation Authorities Act to incorporate management of environmental flows into the official mandate of Conservation Authorities, legally establishing them as lead implementation agencies responsible for watershed-based water planning and management. This reformed mandate of Conservation Authorities should be established in a manner that is consistent with the mandates of DFO, MNR and MOE, but ensures application of a more ecosystem-based approach than occurs under the existing governance regime.

Such reforms would need to be complemented by sustained financial resources from provincial and federal governments and/or by a mechanism through which the Conservation Authorities could generate additional revenues (see section 6.2.3). Also, given the substantial changes to power and authority that would occur under such water governance reforms, the reforms themselves should be developed through participatory processes that engage representatives of all relevant actors including federal and provincial government agencies, First Nations, water users, academia and NGOs.

Two important implications for the literature and theory of governance and planning emerged from the research. First, the understanding and analysis of shifts in governance towards more decentralized and collaborative regimes is best viewed as building on and complementing centralized, command-and-control approaches rather than supplanting them. A full suite of arrangements will factor into effective and robust governance systems. The more centralized arrangements that provide legal authority or policy guidance are critical for maintaining clear links to responsible elected officials and to ensure higher level accountabilities, including enforcing the rule of law. Decentralized, collaborative bodies or consultative forums complement these higher level legal and policy arrangements by facilitating deliberative decision making and local action. Thus, a key consideration in assessing governance regimes is to understand how the participating agencies, organizations and individuals work together as a system to define what functions are best performed by each and where resources are best directed to enhance resilience.

The second element relates to the role of planning in water governance. This research reinforces the perspective of Bjornlund (2005), discussed in section 2.2.4, who indicates that decisions regarding the allocation of water between instream environmental requirements and human demands (i.e., establishing sustainability boundaries) are best dealt with through collaborative, deliberative planning processes rather than market-based or administrative water allocation systems. Water governance in the 21st century requires a stronger focus on planning. Given the emerging challenges related to future water availability anticipated under climate change, there is a growing need in water governance for the 'future-oriented, public decision making' (Fainstein and Fainstein, 1996: 265) and 'foresight' (Hudson, 1979: 387) that are defining features of planning theory and practice. The soft path approach is a planning model that is particularly well suited to addressing potential conflict between withdrawal uses and environmental flows and to planning for future changes in water availability.

The conceptual framework developed for this thesis provided a sound basis for assessing and exploring water governance in the context of sustainability and resilience. A key strength of applying a comprehensive set of criteria is that it facilitated a broad understanding of the diverse and interconnected elements of a governance system. This approach was appropriate for my level of experience with academic research and it satisfied my personal academic objective of developing a broad understanding of water governance, applied to a particular aspect of water management (i.e. water allocation), to ground my career in water policy. On the other hand, applying a broad set of criteria – at least in this thesis – limited in-depth analysis based around a smaller subset of the criteria, which would have enhanced understanding of key elements of the governance system which would likely have led to more specific and elaborate academic and pragmatic conclusions and recommendations.

In future applications, this or similarly broad frameworks may be better utilized by applying the full framework to undertake a high level scan in order to identify a subset of criteria for more in-depth analysis and commentary. If one were to build a longer term research effort around this approach to studying water governance using these criteria it would make sense to apply all of the criteria to a number of case studies of water management to determine if a particular sub-set of criteria consistently emerge as areas of focus and leverage for advancing towards sustainability. If a consistent sub-set of criteria were to emerge, they could be applied to a growing number of case studies to deepen understanding of the specific elements of water governance that should be focused on to facilitate sustainability and resilience in SES.

6.5. Directions for future research

A number of opportunities for applied and theoretical research emerged from this thesis. With respect to water governance in Whiteman's Creek specifically, there is a need for research to explore in more depth the barriers to participation in the IAC and to identify incentives that would encourage and sustain participation. Opportunities include specific research into what levels of compensation would encourage farmers to participate in the IAC on an ongoing basis, as well as more exploratory research into innovative revenue generation models such as payments for ecosystem services as means for securing financial resources for water management.

Tension is growing around the world between withdrawal uses of water and securing sufficient water instream to sustain aquatic ecology and other instream values. As such, there is a need for research into mechanisms and processes for reconciling environmental flow prescriptions with water rights and water allocation systems, particularly in instances where water resources have been over-allocated and there is a need to return water instream. Specifically, a broad review of cases could be undertaken to identify key principles for effective planning, mechanisms for curtailing water demand and for reallocating water to the environment that maintain or enhance livelihood opportunities, and recommendations for capacity building.

Finally, with respect to governance more broadly, as suggested by Imperial (1999) there is a need for a more systematic approach to analyzing the performance of governance systems based on a consistent assessment framework. Also, there is a need for a more systematic analysis of the implications of shifting towards more decentralized or polycentric governance on system resilience. Given the growing focus on water governance, this may be an area of resource management and sustainability that can provide opportunities for such research. This is likely best accomplished by exploring a number of cases across a range of contexts in order to undertake comparative analysis and to generalize conclusions and recommendations.

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APPENDIX A: INTERVIEW GUIDE

1. What interests do you (or your organization) represent in decision-making around water allocation and water use planning in Whiteman's Creek?
2. In terms of managing water quantity, do you feel that water use in Whiteman's Creek is: (very sustainable / somewhat sustainable / somewhat unsustainable / very unsustainable)?
    a. Why or why not? (Potential responses/prompts: ecosystem health, sufficient water for livelihoods, water used efficiently, water put to 'most' valued uses).
3. Water quantity issues have been a challenge in the watershed for sometime; do you feel that conditions have: (significantly improved / somewhat improved / somewhat worsened / significantly worsened)?
    a. How so?
    b. To what would you attribute these changes?
4. Do you find processes for managing water use unnecessarily cumbersome? (Yes / Somewhat / No)
    a. How so?
    b. What aspects?
5. Whose responsibility is it to ensure water is used in a sustainable manner? (prompts / potential responses: Federal, Provincial governments, Conservation Authorities, users, shared responsibility)
6. Do you feel priorities for water use are…: (very clearly defined / somewhat clearly defined / somewhat ambiguous / very ambiguous)?
7. Do you think existing priorities are…: (very supportive / somewhat supportive / somewhat unsupportive / very unsupportive) …of sustainable water use?
    a. Why or why not?
    b. What should be given higher / lower priority?
8. Do you feel access to water in Whiteman's Creek is distributed (very fairly / somewhat fairly / somewhat unfairly / very unfairly)?

9. Do you feel that all interests are equally influential in decisions around water allocation and water use? (Yes / Somewhat / No)
    a. What interests generally prevail (dominate)? Why?
10. In your opinion, is the Ontario Low Water Response …(very effective, somewhat effective, somewhat ineffective, very ineffective) …in terms of protecting ecosystems from excessive water taking?
11. Do you think that existing management approaches will be…(very effective / somewhat effective / somewhat ineffective / very ineffective) … over the long-term?
    a. Why or why not?
12. Is sufficient information about water available to plan effectively for the future? (Yes / No)
    a. What information is lacking?
13. Are you aware of recent studies conducted to assess instream flow needs in Whiteman's Creek? (Yes / No)
    a. Results suggest that existing thresholds under the OLWR do not effectively protect the stream ecosystem. How do you feel this information should be acted on?
14. Do you have anything else to add? Who else would you recommend I speak with?

APPENDIX B: INTERVIEWEE IDENTIFIER CODES

ID	Key Interest / Mandate	Sector / Organization
WC1	Fishery / Aquatic ecosystem	NGO
WC2	Watershed management	Conservation Authority
WC3	Watershed management	Conservation Authority
WC4	Drinking water supply	Government (municipal)
WC5	Fishery / Aquatic ecosystem	NGO
WC6	Rural planning and development	Academia
WC7	Water management and environmental protection	Government (Provincial)
WC8	Indigenous rights, lands and livelihoods	First Nation
WC9	Rural environment / Aquatic ecosystem	Land owner (institutional)
WC10	Fishery / Aquatic ecosystem	Government (Provincial)
WC11	Agriculture	Land owner (Agriculture); IAC representative
WC12	Watershed management	Conservation Authority
WC13	Agriculture	Government (Provincial)